

# Flag Box Multi-Chamber Bat House

These plans describe the construction and installation of the “flag box” multi-chamber bat house. The flag box has similar internal roost dimensions as the BCI four-chamber nursery bat house. The materials, skills, and tools needed to build the flag box are comparable to those required for the BCI design.

The flag box should be oriented to face south. The primary direction of heat flow into a south to north oriented box remains mostly in the same throughout the day. This establishes a non-reversing temperature gradient through the box that allows the two primary faces to be individually specialized for warm vs cool exposure.

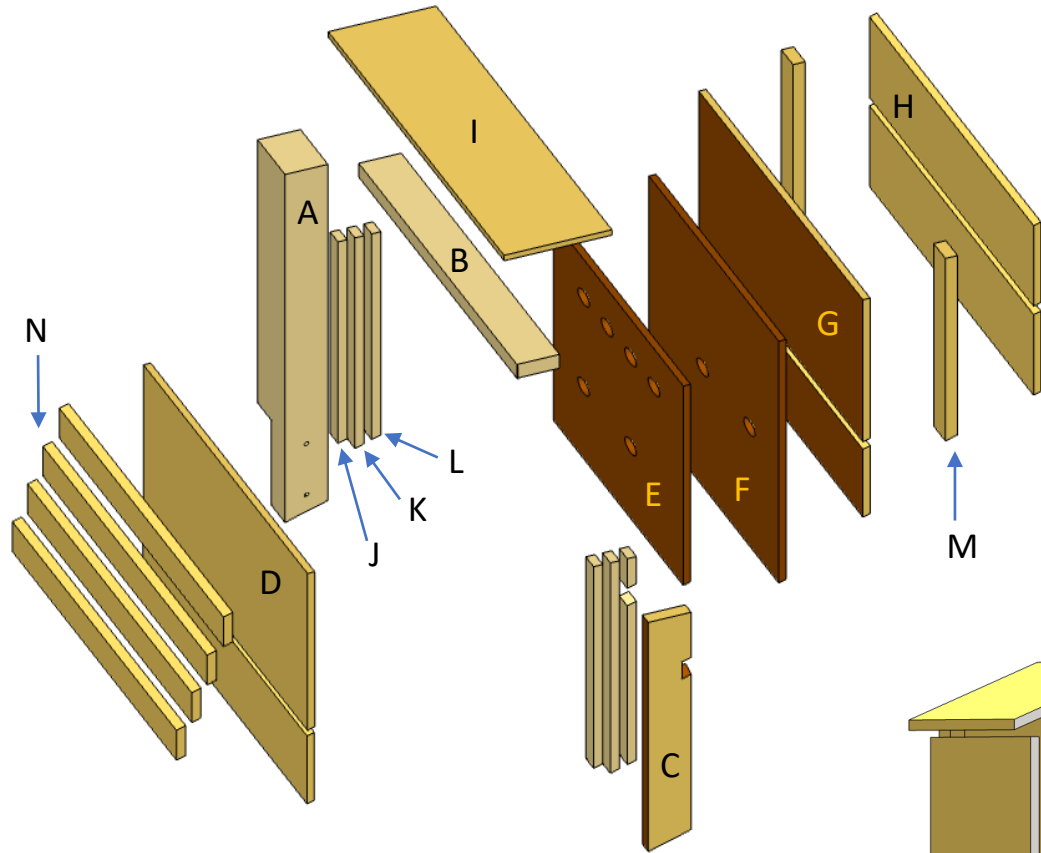
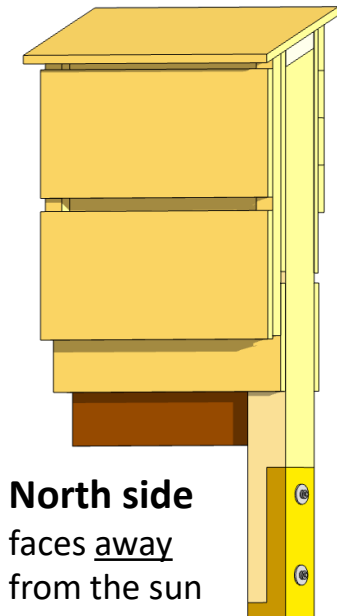
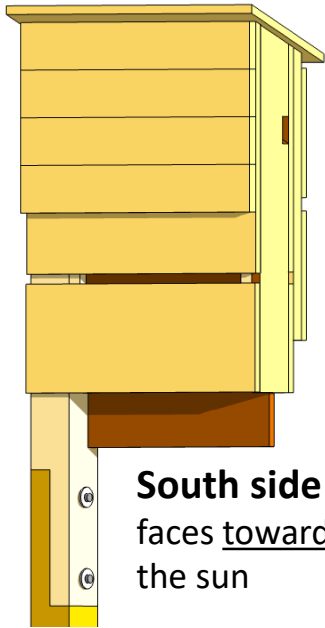
Heavier structural mounting components that are typically external to the roost were incorporated into the body of the flag box to moderate heat flow and for added heat storage. The upper passage-holes allow air that was heated in the south, sun-facing chamber to convectively flow into the middle chamber. The second partition extends to the ceiling to isolate the north chamber from convective flow from the two forward chambers. A side vent near the top of the north chamber provides ventilation. An outer “back porch” chamber is attached to the north face of the box under the roof overhang. It is deeper and open across the top for higher ventilation on hot days. The roof is inclined away from the sun to reduce solar irradiance.

The second partition also extends below the box to form a landing pad. This enables bats to enter and exit the box from two directions. Bats can also access the outer chamber directly from the landing space below it.

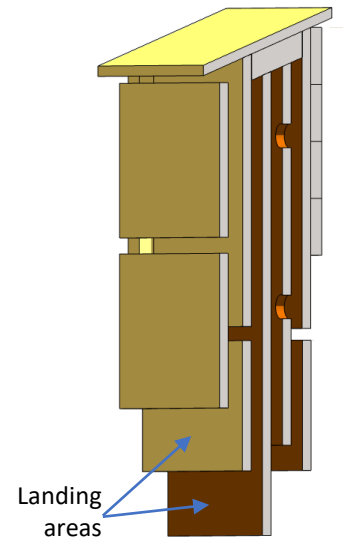
As a starting point, the exterior paint should have a Light Reflectance Value between 40% to 60%. This range may be updated in the future based on continuing research or from your local experience. A list of example colors is included.

The flag box is designed to be mounted on a 4” x 4” wooden post. These plans include a pivoting mechanism that will rotate in one direction but cannot pivot back up past vertical.

The cut-out on the upper end of the middle post (see drawings) can be located on any side of the 4” x 4” post. This allows the builder to choose the orientation of the box relative to the post. Please be aware of where you choose to make this cut. Plan ahead to ensure the post will pivot in the desired direction AND the designated face of the flag box will face south.



- |   |                      |   |                       |
|---|----------------------|---|-----------------------|
| A | Upper post           | H | Outer chamber panel   |
| B | Cross-piece          | I | Roof                  |
| C | East side exterior   | J | South chamber spacer  |
| D | South exterior panel | K | Middle chamber spacer |
| E | South partition      | L | North chamber spacer  |
| F | North partition      | M | Outer chamber spacer  |
| G | North exterior panel | N | Exterior boards       |



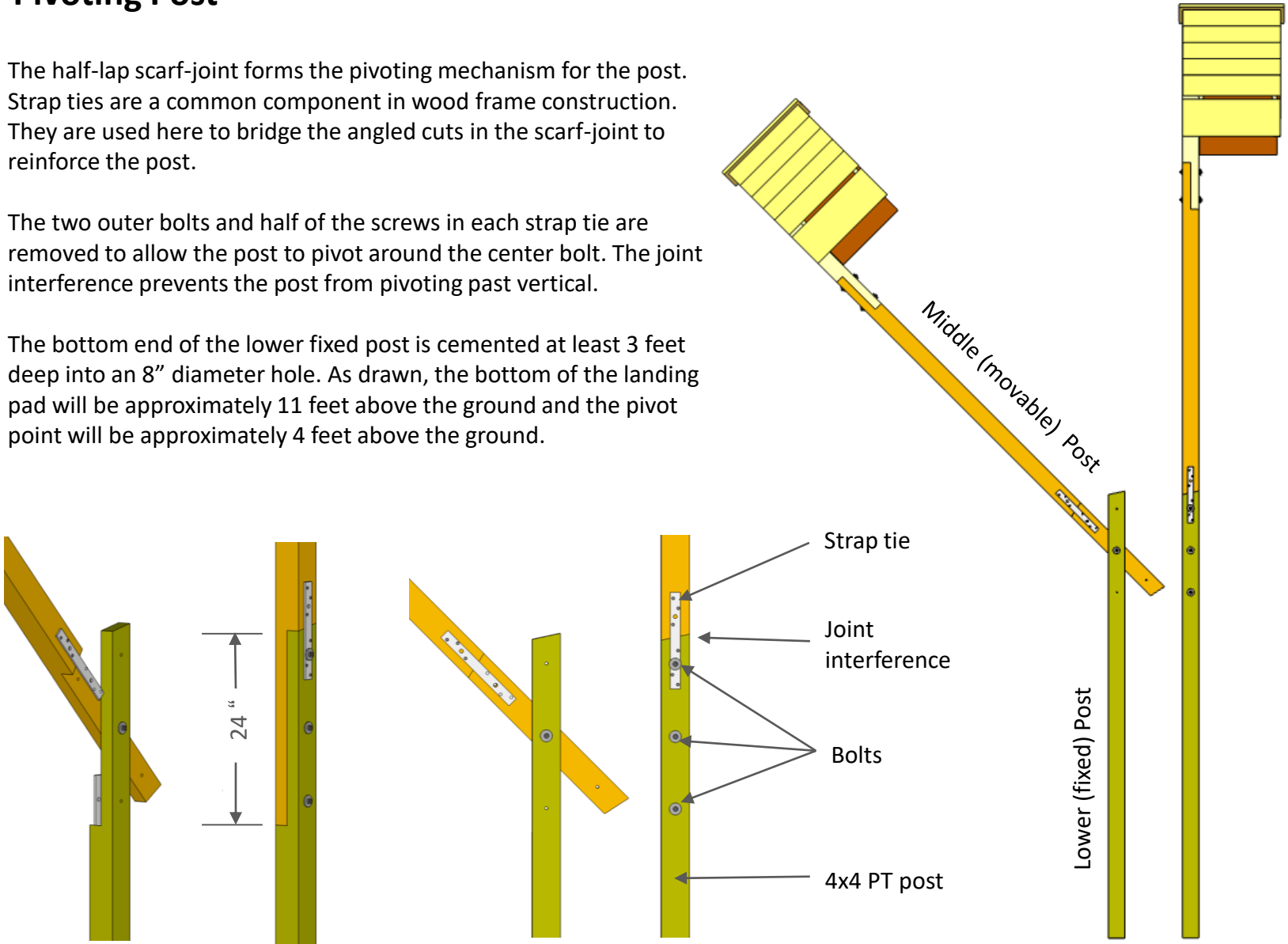
cross section

# Pivoting Post

The half-lap scarf-joint forms the pivoting mechanism for the post. Strap ties are a common component in wood frame construction. They are used here to bridge the angled cuts in the scarf-joint to reinforce the post.

The two outer bolts and half of the screws in each strap tie are removed to allow the post to pivot around the center bolt. The joint interference prevents the post from pivoting past vertical.

The bottom end of the lower fixed post is cemented at least 3 feet deep into an 8" diameter hole. As drawn, the bottom of the landing pad will be approximately 11 feet above the ground and the pivot point will be approximately 4 feet above the ground.

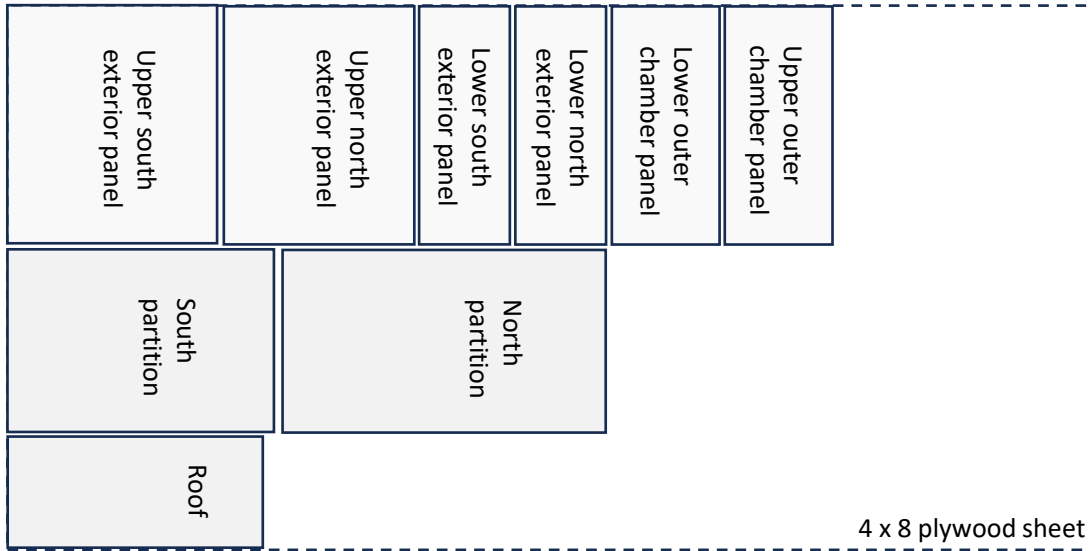


# Materials List

#	Description
1	19/32" thick, 4' x 8' untreated exterior plywood
2	1" x 4" x 8' untreated pine board
1	2" x 6" x 8' untreated pine board
1	4" x 4" x 8' untreated post
2	4" x 4" x 8' pressure treated post
1	1-5/8" exterior deck screws (~100/pack)
24	1-1/4" exterior flat head wood or deck screws
4	3" exterior flat head wood or deck screws
5	3/8" x 4.5" galvanized bolts
10	3/8" x 1-1/2" galvanized washers
10	3/8" galvanized nuts
2	1-1/4" x 12" galvanized strap ties
1	1/4" x 1-1/2" connector screws for strap ties (25/pack)
1	exterior wood glue
1	water-based exterior paintable caulk
1	water-based stain, (1 qt) dark brown
1	exterior water-based paint (1 qt) 40%<LRV*<60%
2	concrete mix, 60 lbs bags
-	shingles or roof flashing as needed

\* The LRV values are available from the paint manufacturer and can typically be found on their website.

# Component Layout

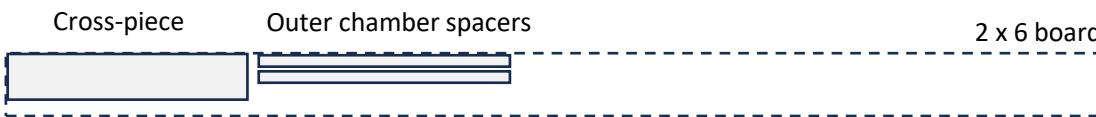
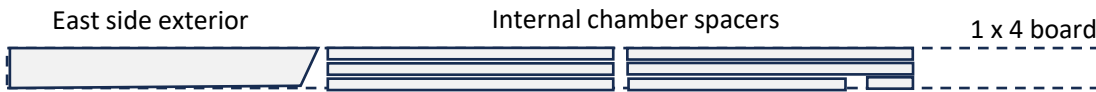


This layout allows for a 1/4" kerf width between parts.

The top edges of the partitions and the top edges of the upper exterior panels are beveled at 22 degrees.

The pass-through holes in the partitions are 1-1/2" in diameter. The edges of these holes should be rounded and smoothed.

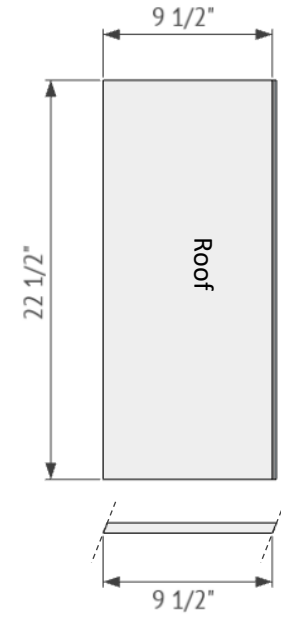
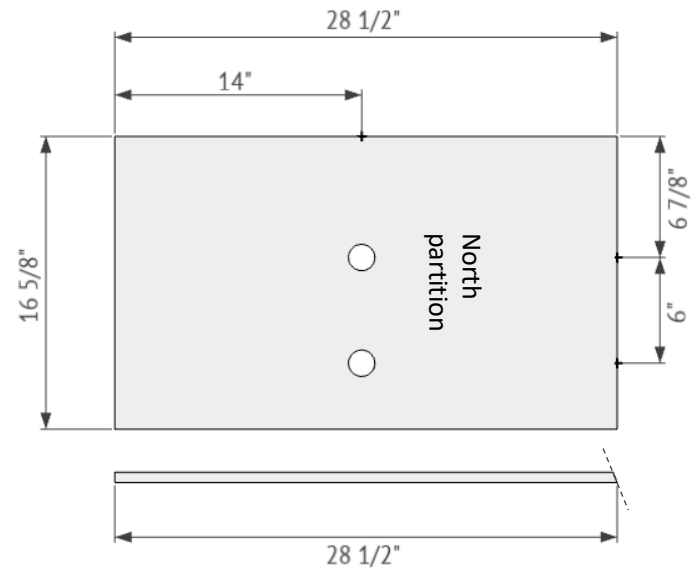
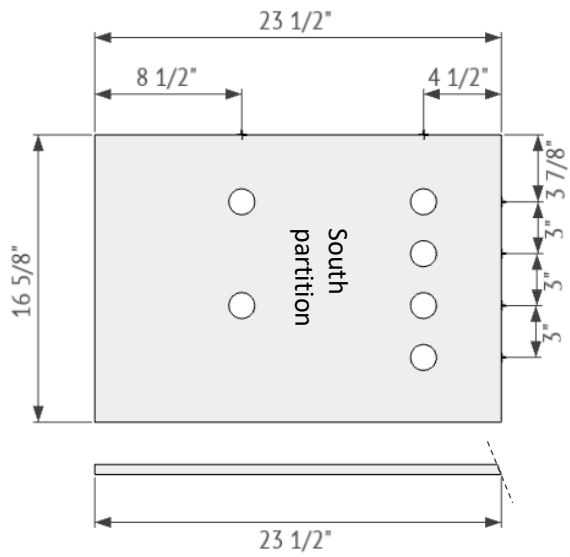
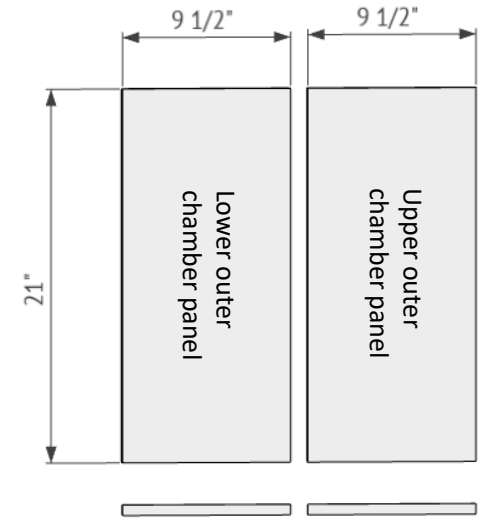
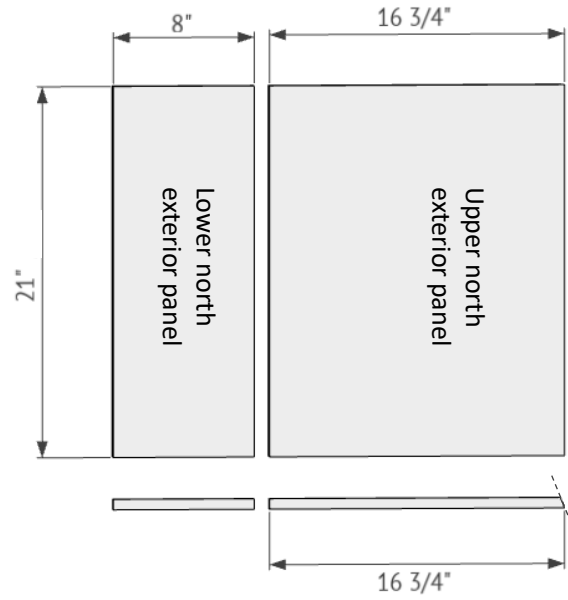
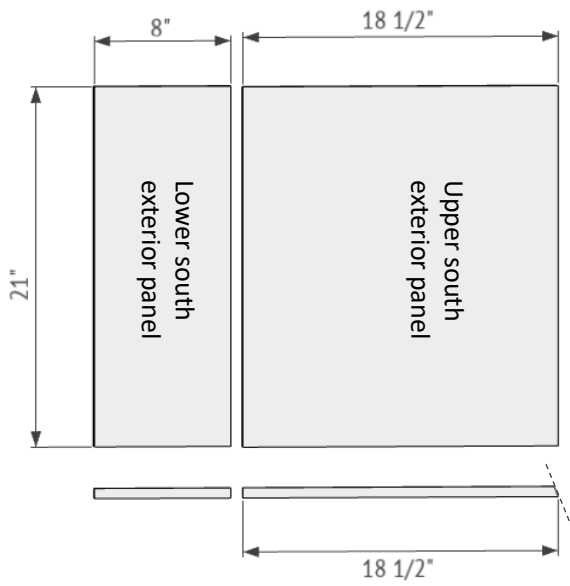
When the partitions are installed, the holes in one partition should not overlap the holes in the other partition.



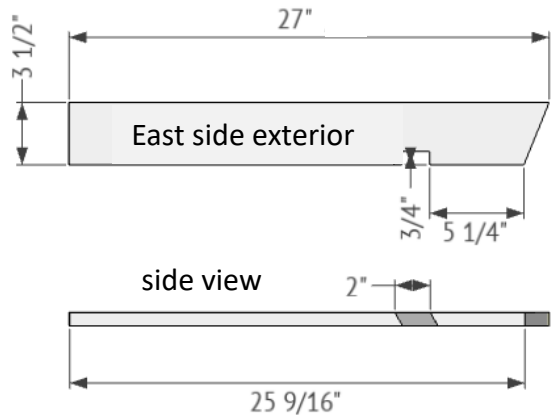
Both surfaces of the partitions and both surfaces the north exterior panels should be roughened by cutting shallow horizontal grooves 1/2" apart or by scoring.

The inside surfaces of the south exterior panels and inside surfaces of the outer chamber panels should be similarly grooved or roughened.

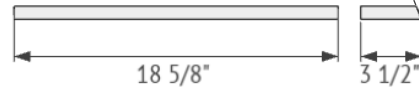
# Component Dimensions



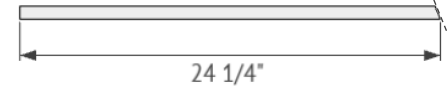
# Component Dimensions



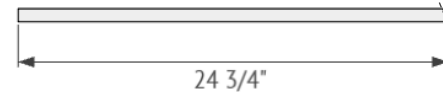
North chamber spacers - east



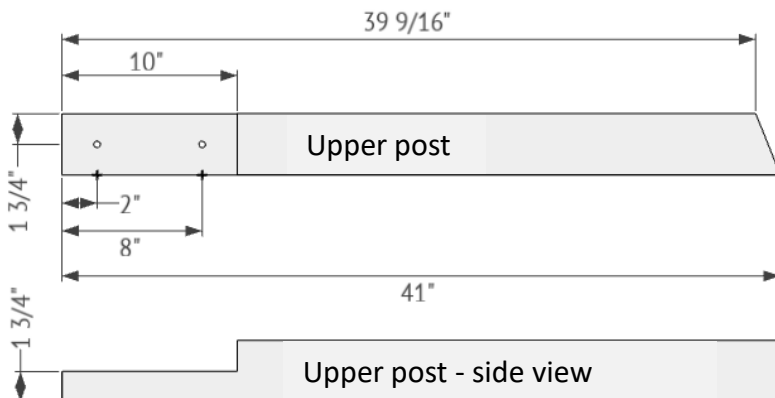
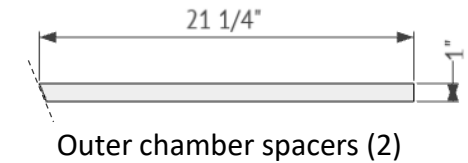
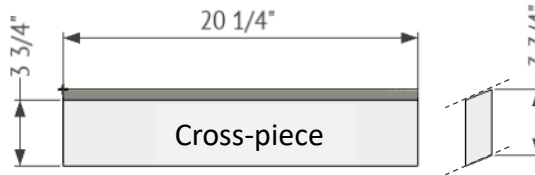
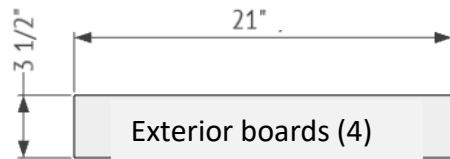
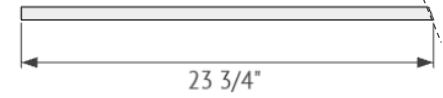
North chamber spacer- west



Middle chamber spacers (2)



South chamber spacers (2)



The south, middle, and north interior chamber spacers are cut from 3/4" x 1" strips cut from the 1" x 4" board.

The cross-piece (ceiling) is cut from the 2" x 6" board.

The outer chamber spacers are cut from 1" x 1-1/2" strips cut from the 2" x 6" board.

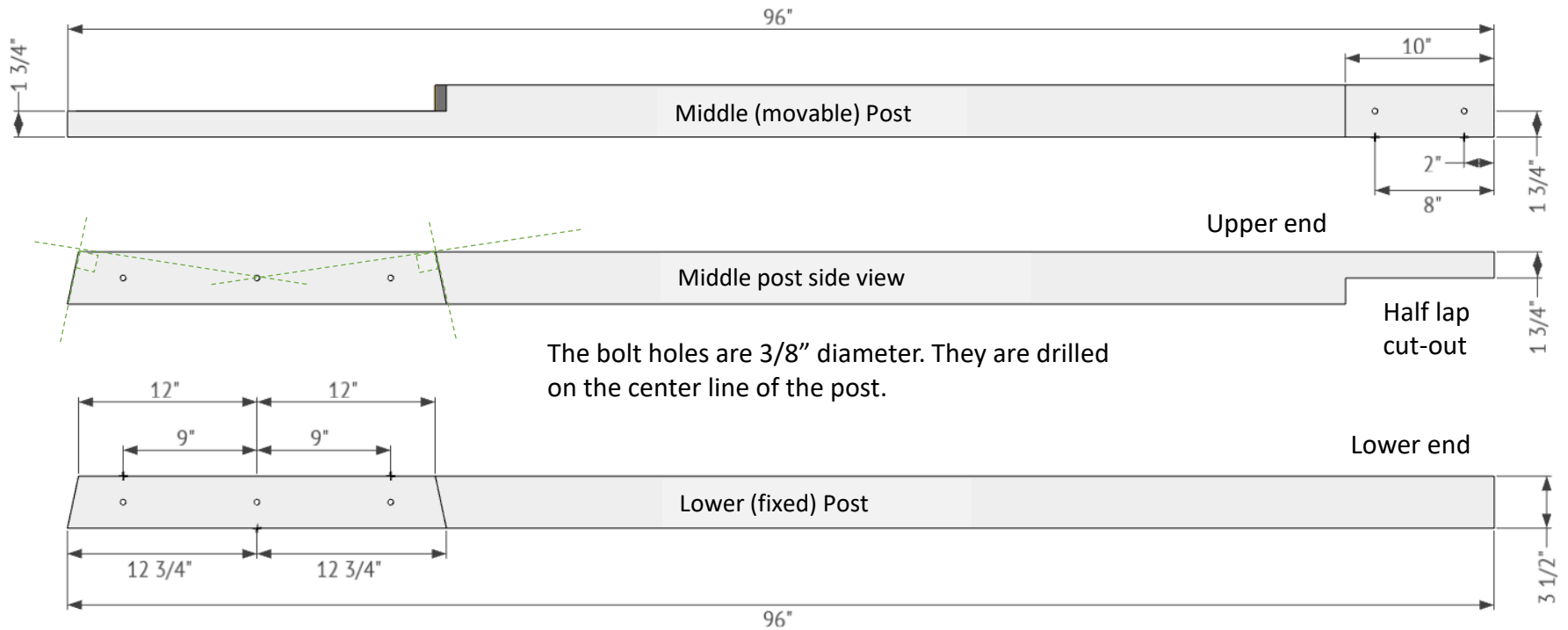
The upper post is cut from the untreated 4" x 4" post.

Bevels are 22 degrees.

# Component Dimensions

The middle and lower 4" x 4" posts are pressure treated and ground contact rated. The cuts are identical on both except for the additional half lap cut-out on the top of the middle post.

The half lap cut-out on the middle post connects to the upper post in the box. The cut-out can be placed on any side of the middle post. Ensure that the chosen position for the cut-out allows the roost to face south and the post to rotate in the desired direction.



# Instructions

- 1 Identify the location to install the bat house. Determine which direction you want the post to pivot. Determine which side of the middle (movable) 4" x 4" post will need to be cut out so the bat house can face south.
  - 2 Cut the plywood parts. Take note of where the beveled edges are located when cutting the various components.
  - 3 Cut shallow, parallel, horizontal grooves approximately 1/2" apart or otherwise roughen all the plywood surfaces that bats will use to roost or use as a landing pad.
  - 4 Cut the east exterior side from a 1" x 4" board.
  - 5 Cut three 1" wide strips from the remainder of the 1" x 4" board for the internal chamber spacers. Cut the spacer strips to length.
  - 6 Cut the four exterior boards from a 1" x 4" board.
  - 7 Cut the cross-piece "ceiling" component from the 2" x 6" board. Note the south and north edges are beveled at 22 degrees.
  - 8 Cut two 1" wide strips from the remainder of the 2" x 6" board for the outer chamber spacers. Cut the spacer strips to length.
  - 9 Cut the upper post from the untreated 4" x 4" post.
  - 10 Dry assemble the box to verify the component positions (see drawings) and check their fit. The internal chamber spacers should be oriented to give a 3/4" gap between partitions. The outer chamber spacers should be oriented to give a 1" gap.
  - 11 Stain all internal plywood surfaces, the bottom of the ceiling, and the internal chamber spacers with a dark, water-based stain. Do not stain the outside of the exterior panels. These surfaces will be painted later.
- Note Pre-drill and counter-sink the holes for the screws before installing the screws. Use four 3" wood screws to attach the cross-piece to the upper post. Use 1-1/4" wood screws to attach the exterior boards to the outside of the box. Use 1-5/8" deck screws for all other attachments. Ensure that no screw tips are exposed anywhere inside the roosting spaces. Glue can be used in addition to the screws to increase the strength of the structure.
- 12 Attach the cross-piece component to the top of the upper post.
  - 13 Attach the east side exterior board to the cross-piece.
  - 14 Attach the upper and lower north exterior panels to the upper post, cross-piece, and east exterior board. Leave a 3/4" gap between the two panels.
  - 15 Attach the north chamber spacers on the inside surface of the north exterior panels. Do not block the vent cut-out on the east side exterior board.
  - 16 Attach the north partition.
  - 17 Attach the middle chamber spacers.
  - 18 Attach the south partition. The pass-through holes should be staggered relative to the holes in the other partition.
  - 19 Attach the south chamber spacers.
  - 20 Attach the upper and lower south exterior panels. Leave a 3/4" gap between the two panels.
  - 21 Attach the exterior boards to the upper south panel as shown.
  - 22 Attach the roof. There should be a 3/4" overhang over the south, east, and west sides. There will be a larger overhang on the north side.
  - 23 Caulk all exterior joints on the box. Note: the outer chamber components are not attached at this point.
  - 24 Paint the exterior of the box with 2 coats of water-based paint.
  - 25 Paint the unassembled outer chamber panels and spacers with 2 coats of water-based paint.
  - 26 Attach the outer chamber spacers. Counter-sink the holes for the screws an extra 1/4" deeper to account for the larger thickness of these spacers.
  - 27 Attach the upper and lower outer chamber panels. Leave a 1" gap between the two panels. There will be a gap for ventilation between the top panel and the roof.
  - 28 Covering the roof with shingles or aluminum flashing is recommended.
  - 29 Cut the middle and lower posts from the pressure treated 4"x4" posts. The two post can be clamped together in their fully mated positions prior to drilling the bolt holes to ensure the holes will align when the bat house is raised.
  - 30 Dig a 3' deep by 8" wide post hole in the desired location. Call 811 before you dig if there is any chance buried utilities may be present.
  - 31 Center the lower (fixed) post in the hole and ensure that it is oriented so the post will pivot in the desired direction. Plumb the post. Mix the concrete and fill the hole around the post. Allow the concrete to fully dry.
  - 32 Attach the flag box to the top of the middle post using bolts with washers. Use two nuts on each bolt and fully tighten them.
  - 33 Connect the middle post to the lower post with one bolt through both center holes. Washers should be placed on the bolts on both sides of the post. The nuts should initially be slightly loose so the post can pivot.
  - 34 Carefully raise the bat house.

# Instructions

- 35 Position a strap tie over the bolt hole on the end of the scarf joint such that the strap tie will bridge across the cut to the other post (see example photos). Install a bolt with a washer through the strap-tie and then through the bolt hole. Repeat this for the other bolt hole. Install two nuts on all bolts and fully tighten them.
- 36 Install the 1-1/2" connector screws in the strap ties.
- 37 A predator guard can be installed on the post if desired.
- 38 To lower the bat house, remove the 1-1/2" screws from the sides of the strap ties with the bolts. The other screws can be left in place. Slightly loosen the nuts on the center bolt. Remove the two outer bolts. Carefully rotate the post to lower the bat house. The bolts and screws are all replaced after the bat house is raised again.
  
- 39 Monitor the bat house occupancy and report your observations to a roost monitoring project in your area such as the Georgia DNR Bat Roost Monitoring project <https://georgiawildlife.com/bat-roost-monitoring>.

Note Examples of brown colors that have a Light Reflection Value (LRV) near 50% from commonly available brands are listed in the table below.

Note For a given situation, heat flow into a bat house increases as the LRV decreases. Choose a paint color with a lower LRV to increase the warmth in the bat house or a color with a higher LRV for a cooler bat house.

Note The flag box can be built without the outer chamber if desired. In this case, the outer surfaces of the north panels would not be roughened or grooved and the roof would only need to be 7-3/8" wide instead of 9-1/2".

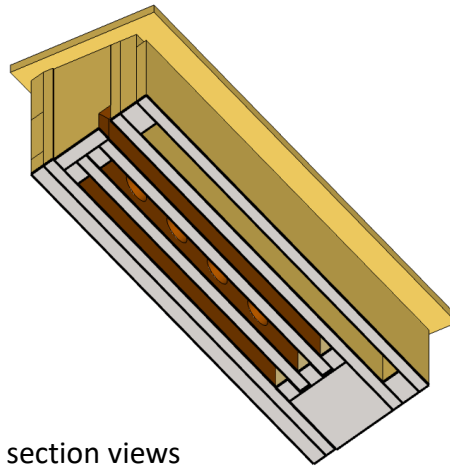
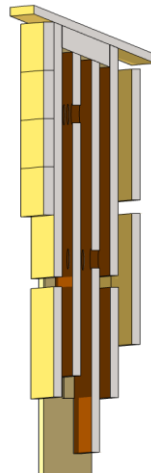
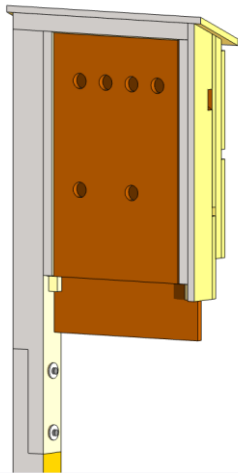
# Pivoting Post and additional construction views



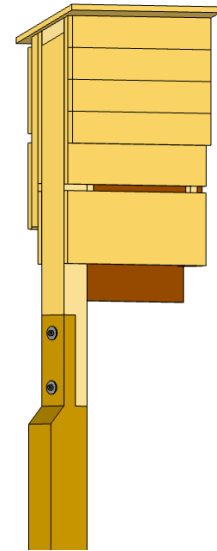
strap tie

This 4" x 6" pivoting post illustrates the use of a similar modified half-lap scarf joint as the pivoting mechanism. The strap ties bridge the cut to reinforce the post.

Illustration of a flag box mounted on a 4" x 6" post



Cross section views



# Exterior Paint

This table lists examples of brown colors that would be appropriate for the bat house from commonly available brands. These colors have a Light Reflection Value (LRV) near 50%. Use a flat or low luster, water-based, exterior paint.

COLOR	CODE	LRV	R	G	B	Link
<b>Behr</b>						
Hayloft	MQ2-22	50	205	186	150	<a href="https://www.behr.com/consumer/ColorDetailView/MQ2-22">https://www.behr.com/consumer/ColorDetailView/MQ2-22</a>
Sonoran Desert	N240-3	50	207	184	161	<a href="https://www.behr.com/consumer/ColorDetailView/N240-3">https://www.behr.com/consumer/ColorDetailView/N240-3</a>
Beech Nut	S230-3	50	215	181	154	<a href="https://www.behr.com/consumer/ColorDetailView/S230-3">https://www.behr.com/consumer/ColorDetailView/S230-3</a>
Cellini Gold	HDC-CL-18	50	221	181	130	<a href="https://www.behr.com/consumer/ColorDetailView/HDC-CL-18">https://www.behr.com/consumer/ColorDetailView/HDC-CL-18</a>
Squash Bisque	M240-5	50	231	177	124	<a href="https://www.behr.com/consumer/ColorDetailView/M240-5">https://www.behr.com/consumer/ColorDetailView/M240-5</a>
<b>Benjamin Moore</b>						
Cinnamon 'n Spice	1215	51	--	--	--	<a href="https://www.benjaminmoore.com/en-us/paint-colors/color/1215/cinnamon-n-spice">https://www.benjaminmoore.com/en-us/paint-colors/color/1215/cinnamon-n-spice</a>
Groundhog Day	1166	51	--	--	--	<a href="https://www.benjaminmoore.com/en-us/paint-colors/color/1166/groundhog-day">https://www.benjaminmoore.com/en-us/paint-colors/color/1166/groundhog-day</a>
Outer Banks	1206	51	--	--	--	<a href="https://www.benjaminmoore.com/en-us/paint-colors/color/1206/outer-banks">https://www.benjaminmoore.com/en-us/paint-colors/color/1206/outer-banks</a>
Sepia Tan	1116	51	--	--	--	<a href="https://www.benjaminmoore.com/en-us/paint-colors/color/1116/sepia-tan">https://www.benjaminmoore.com/en-us/paint-colors/color/1116/sepia-tan</a>
August Morning	2156-40	50	--	--	--	<a href="https://www.benjaminmoore.com/en-us/paint-colors/color/2156-40/august-morning">https://www.benjaminmoore.com/en-us/paint-colors/color/2156-40/august-morning</a>
<b>Gliddon / PPG</b>						
Crepe	PPG1094-4	52	212	188	148	<a href="https://www.ppgpaints.com/ppg-colors/crepe">https://www.ppgpaints.com/ppg-colors/crepe</a>
Pony Tail	PPG1086-4	50	210	188	153	<a href="https://www.ppgpaints.com/ppg-colors/pony-tail">https://www.ppgpaints.com/ppg-colors/pony-tail</a>
Splash of Honey	PPG1088-4	50	216	185	140	<a href="https://www.ppgpaints.com/ppg-colors/splash-of-honey">https://www.ppgpaints.com/ppg-colors/splash-of-honey</a>
Honey Bunny	PPG1090-3	50	219	184	129	<a href="https://www.ppgpaints.com/ppg-colors/honey-bunny">https://www.ppgpaints.com/ppg-colors/honey-bunny</a>
Baguette	PPG12-30	49	206	186	151	<a href="https://www.ppgpaints.com/ppg-colors/baguette">https://www.ppgpaints.com/ppg-colors/baguette</a>
<b>Sherwin Williams</b>						
Ecru	SW 6135	51	208	186	148	<a href="https://www.sherwin-williams.com/en-us/color/color-family/yellow-paint-colors/SW6135-ecru">https://www.sherwin-williams.com/en-us/color/color-family/yellow-paint-colors/SW6135-ecru</a>
Dhurrie Beige	SW 7524	50	202	186	168	<a href="https://www.sherwin-williams.com/en-us/color/color-family/neutral-paint-colors/SW7524-dhurrie-beige">https://www.sherwin-williams.com/en-us/color/color-family/neutral-paint-colors/SW7524-dhurrie-beige</a>
Goldenrod	SW 6677	50	208	186	148	<a href="https://www.sherwin-williams.com/en-us/color/color-family/orange-paint-colors/SW6677-goldenrod">https://www.sherwin-williams.com/en-us/color/color-family/orange-paint-colors/SW6677-goldenrod</a>
Ginger Root	SW 9095	50	210	183	155	<a href="https://www.sherwin-williams.com/en-us/color/color-family/orange-paint-colors/SW9095-ginger-root">https://www.sherwin-williams.com/en-us/color/color-family/orange-paint-colors/SW9095-ginger-root</a>
Quinoa	SW 9102	49	207	181	151	<a href="https://www.sherwin-williams.com/en-us/color/color-family/orange-paint-colors/SW9102-quinoa">https://www.sherwin-williams.com/en-us/color/color-family/orange-paint-colors/SW9102-quinoa</a>
<b>Valspar</b>						
Sandstone Cliff	8003-19C	52	215	187	152	<a href="https://www.valspar.com/en/colors/browse-colors/lowes/yellow/sandstone-cliff-8003-19c">https://www.valspar.com/en/colors/browse-colors/lowes/yellow/sandstone-cliff-8003-19c</a>
Fragrant Coriander	3002-6A	52	234	181	131	<a href="https://www.valspar.com/en/colors/browse-colors/lowes/orange/fragrant-coriander-3002-6a">https://www.valspar.com/en/colors/browse-colors/lowes/orange/fragrant-coriander-3002-6a</a>
Spun Gold	3001-5C	52	238	179	119	<a href="https://www.valspar.com/en/colors/browse-colors/lowes/orange/spun-gold-3001-5c">https://www.valspar.com/en/colors/browse-colors/lowes/orange/spun-gold-3001-5c</a>
Jacob's Ladder	8003-20D	51	218	184	141	<a href="https://www.valspar.com/en/colors/browse-colors/lowes/yellow/jacobs-ladder-8003-20d">https://www.valspar.com/en/colors/browse-colors/lowes/yellow/jacobs-ladder-8003-20d</a>
Sunswept Sand	8003-16C	51	222	181	142	<a href="https://www.valspar.com/en/colors/browse-colors/lowes/orange/sunswept-sand-8003-16c">https://www.valspar.com/en/colors/browse-colors/lowes/orange/sunswept-sand-8003-16c</a>