

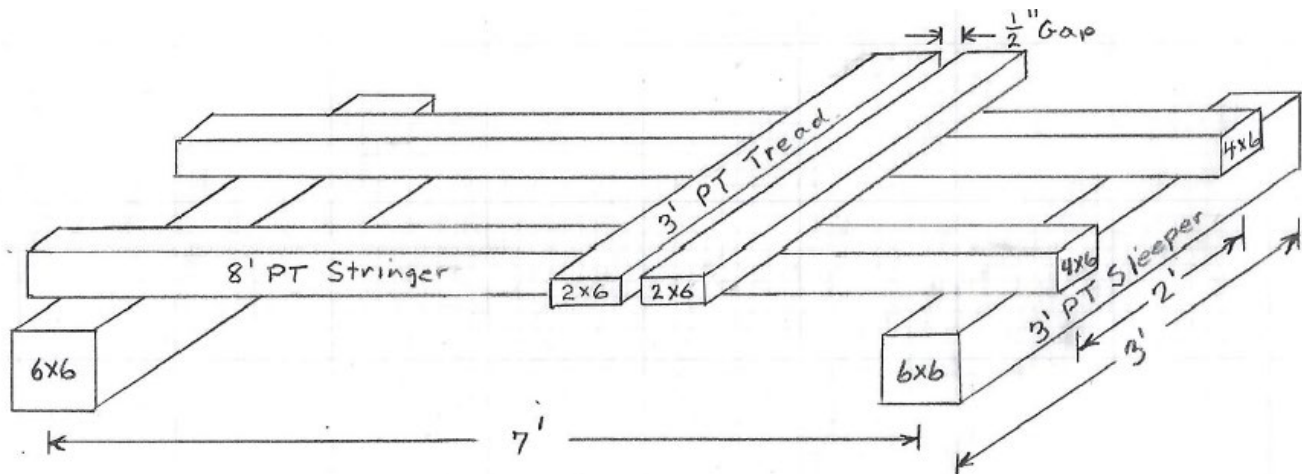
Trail Bridges and Steps Designs

Wellesley Trails Committee

1. Bog Bridges

1.1 Design

Bog bridges are used to cross muddy areas of trail. There are many different types of bog bridges designs, and this design using pressure treated wood has proven to be a good sustainable bridge for suburban woodland trails. It is simple to construct, very rigid, and has a long life span. It is movable for repair, leveling, or replacement. It can be used on curved trails by cocking sections together, and on sloping terrain by stepping level sections down a grade. Note that bog bridges should not be used in locations where there is flooding. Since they are not attached to the ground, they can become misaligned or float away.



1.2 Parts List

Qty	Item
2	6x6 3-ft sleepers, pressure treated wood
2	4x6 8-ft stringers, pressure treated wood
16	2x6 3-ft treads, pressure treated wood
8	18-gauge galvanized steel angle brackets
	20D 4\" exterior galvanized common nails
	10D 1-1/2\" exterior galvanized common nails

1.3 Preparations

1. Review safety warnings about handling and using pressure treated wood.
2. All hardware must be exterior galvanized and rated for pressure treated wood.
3. Cut all pressure treated wood to size off-site, sweep up saw dust, and dispose into trash.
4. Drill four 5/32\" pilot holes in each tread, two on each side ,about 6\" from the edge, and staggered about 1\" to prevent splitting stringer. This will make it easier to nail on the treads. Do off-site, sweep up saw dust, and dispose into trash.

1.4 Construction

1. On flat ground, space the two 6x6 sleepers parallel and 7-ft apart on centers.
2. Place the two 4x6 stringers, wide side down, parallel and 2-ft apart on centers.
3. Make sure everything is square and evenly spaced.
4. Attach stringers to the sleepers with angle brackets using four 10D 1-1/2" nails on both sides of the stringers.
5. If assembled away from site, move assembled base frame to location on the trail (about 175 lbs).
6. Level base frame by removing earth from under sleepers.
7. Nail treads to stringers using four 20D 4" nails per tread, with 1/2" spacing between treads. Use 1/2" dowel as a temporary spacer to keep a uniform gap between treads.

1.5 Locations

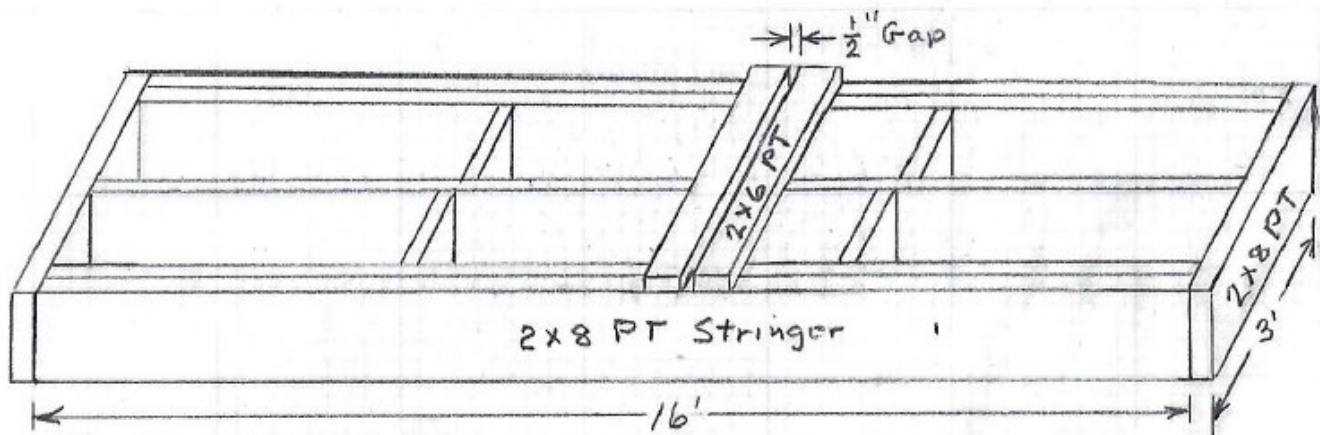
Examples of bog bridges built by Eagle Scouts can be found at:

1. Boulder Brook Reservation. There are two sets of three bog bridge sections over wet areas in the middle of the meadow.
2. Carisbrooke Reservation. On the trail from White Oaks Rd, there is six section bog bridge along the bank of a stream.

2. Footbridges

2.1 Design

Footbridges are mainly used to cross flowing water. For shorter spans, footbridges can be designed similar to bog bridges, with either two or three 4x6 pressure treated wood stringers on end depending on length. For spans greater than 12-ft, a box frame will provide better rigidity. When siting footbridges, look for high banks and short spans. If banks are low and give inadequate clearance, use sleepers under the end plates to elevate the bridge. Also, if there is more than a 30" drop-off at the crossing, install a railing as a safety measure.



2.2 Parts List

Qty	Item
5	2x8 16-ft stringers, pressure treated wood
2	2x8 3-ft end plates, pressure treated wood
4	2x8 14-1/4" braces, pressure treated wood
32	2x6 3-ft treads, pressure treated wood
16	18-gauge galvanized steel angle brackets
4	1" steel pipe, 2-ft long
4	Galvanized pipe clamp
	16D 3-1/2" exterior galvanized common nails
	10D 1-1/2" exterior galvanized common nails

2.3 Preparation

1. Review safety warnings about handling and using pressure treated wood.
2. All hardware must be exterior galvanized and rated for pressure treated wood.
3. Cut all pressure treated wood to size off-site, sweep up saw dust, and dispose into trash.
4. Drill six 1/8" pilot holes in each tread, two on each side, and 2 in the middle. Along the edge, stagger the holes so that one nail attaches to the outer stringer, and the other to the inner stringer. This will make it easier to nail on the treads. Drill off-site, sweep up saw dust, and dispose into trash.

2.4 Construction

1. Nail both the two outside 2x8 stringers together with 16D 3-1/2" nails. Nail at an angle so that nails do not protrude to other side, and nail from both sides.
2. On flat ground, assemble the bridge frame together with the two double stringers, the single stringer, and two end plates.
3. Place the four 2x8 braces between the stringer, and secure them in place with 16D 3-1/2" nails to the center stringer and with angle brackets using 10D 1-1/2" nails to the side stringers.
4. Move assembled base frame to the stream crossing (about 250 lbs).
5. Nail treads to stringers using six 16D 3-1/2" nails per tread, with 1/2" spacing between treads. Use 1/2" dowel as a temporary spacer to keep a uniform gap between treads.
6. Drive 1" steel pipes into the ground at the corners of the bridge and secure with galvanized pipe clamp with 10D 1-1/2" nails.

2.5 Locations

Examples of footbridges built by Eagle Scouts can be found at:

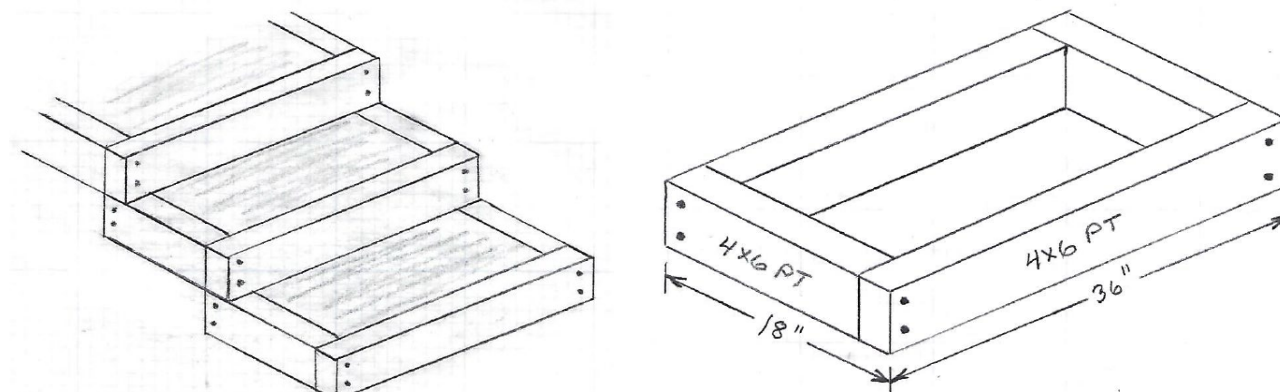
1. Boulder Brook Reservation. On the trail from Chesterton Rd, there is a 16-ft footbridge over a stream.
2. Sudbury Aqueduct. East of Cartwright Rd on the Sudbury Path is a 16-ft footbridge over drainage from the aqueduct course.

3. Steps

3.1 Design

Box steps are used for trail grades that are too steep to comfortably climb, usually over about 30%. Box steps are adjustable for different grades by sliding the front edge of the step above back and forth over the step below and by changing the depth of the step. Thus they can be used to accommodate terrain with changing grade. Typical

dimensions are shown in the diagrams below with the front edge of the step overlapping the back of the step below, giving a step grade of 38%.



3.2 Parts Lists

Qty	Item – per box step
1	4x6 36" front, pressure treated wood
2	4x6 14.5" side, pressure treated wood
1	4x6 25" back, pressure treated wood
10	HeadLok 6" heavy duty flathead deck screws

Qty	Item – for staircase
4	1/2" rebar, 2-ft long
	Pea gravel

3.3 Preparation

1. Review safety warnings about handling and using pressure treated wood.
2. Screws must be exterior grade and rated for pressure treated wood.
3. Do a site survey to determine the grade and total height of the staircase.
4. Calculate the best side length that accommodates the average trail grade. If there are any major changes in grade for the staircase, you will have to change the side length for that section.
5. Calculate the number of steps needed.
6. Cut all pressure treated wood to size off-site, sweep up saw dust, and dispose into trash.
7. Assemble the box steps using 6" heavy duty deck screws with a battery powered drill using 2 screws at each joint.
8. Drill two 1/2" holes in the top of the back of the top step and two holes in the top of the front of the bottom step for the rebar.

Calculation Example:

1. On-site measurements are: Vertical height is 66". Horizontal distance is 174".
2. $\text{Grade} = 66''/174'' = 0.38$ (38%)
3. 4x6 lumber actual dimensions are: 3.5" x 5.5"
4. $4x6 \text{ side length} = 5.5''/0.38 = 14.5''$
5. $\text{Number of steps} = 66''/5.5'' = 12$

3.4 Construction

1. Install string line to align edge of steps.
2. Start at the bottom, dig out a flat area, set the first step in place, and make it level front to back and side to side.
3. Fill the box step with soil, leaving about 1" of space for the gravel layer. Pack soil down.
4. Dig out the area for the next step, set in the step, and again make it level. With two 6" heavy duty deck screws, screw the top front to the bottom back at an angle. This is done from the inside of the top step.
5. Fill the box step with soil, leaving about 1" of space for the gravel layer. Pack soil down.
6. Dig out the next step, set and level it, screw it down, fill with soil, and continue until the staircase is complete.
7. Drive the four rebar into the top and bottom steps.
8. Level off each step with pea gravel.

3.5 Locations

Examples of steps built by Eagle Scouts can be found at:

1. Sudbury Aqueduct. West of Brookside Rd on the Sudbury Path are steps down from the siphon house.
2. Sudbury Aqueduct. East of the Waban Arches on the Sudbury Path are steps down to trail under the arches.