Calculating costs for a maple tubing system
Stephen Childs, NYS Maple Specialist with Cornell University

An important part of beginning or improving the tubing system in a maple enterprise is to have a good estimate of just how much the project will cost. Though there are many variables in installing a new or replacing an old system the cost of materials is predictable. Two factors allow you to make a reasonable estimate of what a sap collection system will cost in materials. The first is the number of taps per acre. The second is the density of trees.

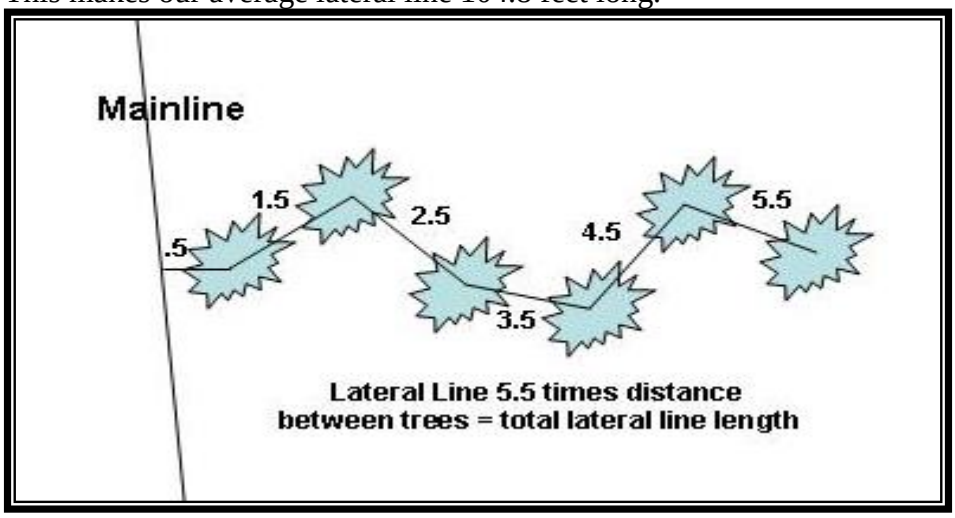
Tree density and number of taps per acre can be calculated by measuring out 26' 4" from a center point in a circle, this distance is the radius of a $1/20^{th}$ of an acre circle, count the number of tappable trees inside the circle and multiply by 20. Take several samples and then average the results to estimate the usable trees per acre. Number of taps can depend on tree size. Start with one per tree and add a tap for trees greater than 18 inches DBH. If areas of the woods differ significantly from others you would want to do separate density estimates for each area. Then estimate how big of an area the differing density samples represent. If you don't have any idea how large your sugarbush is, your county Farm Service Agency or Soil and Water Conservation Office may be able to assist you from aerial photos.

The cost calculations here are based on one tap per tree, using 5/16th spouts, and all main lines connecting the 5/16 lateral lines are 1" in diameter. This cost estimate only includes mainlines used to collect sap from the lateral lines within the sugarbush. It does not include the mainline conductor lines to the sugar house or collection tank. Those would need to be added based on total system size and distances. I decided not to include them in this sheet as putting in a automatic estimate of it would make the overall result much less accurate.

The average number of taps on a lateral line is an important decision. Research at the University of Vermont indicates that the fewer taps on a lateral line the more sap is yielded per tree. The recommendation for the number of taps on a lateral line tries to balance the overall system cost vs. getting good vacuum at the tree. In the early days of tubing much larger numbers were suggested. Six taps per lateral, on average seems to be a reasonable compromise.

Once you have estimates of average trees per acre and average taps per lateral line you can calculate how long lateral and main lines will be. In this example I use an average density of 120 trees per acre. From this density I calculate the average distance between trees. This is done by dividing the square footage in an acre of sugar bush by tree density, in this case 43,560 square feet per acre divided by is 363 square feet. The square root of the 363 feet gives us the average distance between two trees, in this case is 19.1 feet. Use a calculator with a square root function for this. Now to determine the average length of a lateral line I multiply the average distance between trees by 5.5. 5.5 because we chose 6 taps per lateral line. The lateral line includes the whole width for the first five

trees on a lateral line but only half of the distance for the final tree on the lateral line. This makes our average lateral line 104.8 feet long.



For the number of lateral lines in one acre divide the density of 120 trees per acre by the number of trees or taps per lateral line, in this case 6 giving us 20. Now determine the total length of lateral line by multiplying 20 lateral lines by 104.8 feet each for a total of 2095.8 feet.

To calculate the total length of mainline needed to connect all of the lateral lines, multiply the total number of lateral lines in the acre by the average distance between trees as the average distance between trees will also be the average distance between lateral lines were we let the distance between lateral lines fall at its most efficient distance. This calculation sets the distance between mainlines as the average distance between 6 trees or 6 times 19.1 feet or 114.6 feet. If were decided we wanted the distance between main lines to be less and decided 80 feet would some how be better. The lateral lines would stay the same 104.8 feet to capture the sap from 6 trees but the distance between lateral lines would become greater so we would be adding more main line to accomplish the same task. This would not in any way make this system more efficient. Lateral lines are the same length and we now would have more mainline to add to vacuum loss due to more air friction from passing through more main line. At this given density, if we wanted mainlines to be closer than 114.6 feet we should consider reducing the number of taps per lateral line. This change would reduce total lateral line length in the acre by 38 feet and increase main line length by 76 feet.

To determine the length of 5/16 tubing that will go into uses other than lateral lines we multiply the number of taps by 2 feet to total the tubing used in drop lines. In this example I am using end Y fittings to end the upper end of lateral lines which also need about 3 feet of tubing to go around each end tree. This could be one place where a maple producer could use old lateral lines rather than new since sap never enters this part of the line. However at a cost of about $4 to $5 per acre to use new tubing for this loop, the labor to handle a separate batch of tubing may not be worth the effort to get old tubing to each of the end trees. To determine the number of wire ties it will take to secure the mainline to the mainline wire, I assume a wire tie every 18 inches or dividing the

mainline length by 1.5. Side tie wires to tighten and secure the main line is estimated at placing a wire tie every 30 feet and using an average of 5 feet of wire for each side tie. Protection for the side tied trees is needed but here I assumed old materials would be used. In this example side tie wire amounted to a little over 60 feet per acre.

Number of trees per acre (one tap per tree)	120
Number of trees per lateral line	6
Average distance between trees	19.1
Average length of a lateral line	104.8
Number of lateral lines per acre	20.0
Main line length per acre	381.1
Total length of lateral lines	2095.8
Length of 5/16 lines end tree loop (3' each)	60.0
Length of 5/16 in drop lines (24" each)	240.0
Number of wire ties (one every 18")	254.0
Length of side tie wire	63.5

Next I put a price on each of the materials needed.

Costs:		
Spouts - use spouts or stubs not both	0.39	$46.80
Stubs -use spouts or stubs not both, must include one kind of adapter	0.29	
Stub adapter - use adapter or check valve not both, must also include stub	0.21	
Check Valve adapter - use adapter or check valve not both	0.5	
Saddles, all single connect	2.95	$59.00
T's	0.24	$24.00
Y's	0.77	$15.40
Hooked connector	0.33	$6.60
Lateral end tree loop (leave this blank if you use old tubing here)	0.09	$5.40
Drop lines	0.09	$21.60
Lateral Lines	0.09	$188.62
Main Lines (1") Black use black or blue not both	0.383	$145.94
Main Lines Blue (1") use black or blue not both	0.42	
Main Line Wire same length as mainline	0.055	$20.96
Wire ties	0.014	$3.56
Wire grips estimated at 3 per acre	1.75	$5.25
Tree hooks estimated at 2 per acre	3.5	$7.00
Tensioners estimated at 1 per acre	5.95	$5.95
Side tie wire	0.07	$4.45
Mainline valves one on each end(1 for each 3 acres) brass plus fitting and clamp	52	$17.33
Total material cost per acre		$577.86
Cost per tap		$4.82

All of the prices are based on a 2009 catalog and are subject to change and subject to variation depending on source. The first item is the spout. Listed first is the health or tree saver 5/16th inch spout. It would be used alone on the drop line. If you plan to use the new check valve adapter or the regular stub adapter, the stub spout would need to be purchased along with one of these adapters. A T is used to connect the drop line to the lateral line on all taps that are not end trees. To get the number subtract the number of lateral lines listed above from the total number of taps and then multiply times the cost each. There is an end Y and a hooked connector for each lateral. Next the total length of 5/16th tubing from lateral lines, drop lines and end tree lines is multiplied by the cost of 5/16th line at 9 cents per foot. The price for mainline per foot was based on purchasing the largest rolls listed and calculated out to a per foot cost. The chart includes a place to calculate costs for either black or colored mainlines, choose one or the other or use the chart to compare costs. The mainline wire is based on purchasing a 2000' roll of 12.5 gauge wire price out on a per foot basis. I calculated the number of wire ties above. Now I multiply that times the calculated cost for each. Finally, I advise having a shut off valve where a mainline connecting to the lateral lines meets the main conductor line that connects a number of mainlines to the holding tank or sugar house. I also recommend a valve at the upper end of this mainline. These valves can be very helpful when washing mainlines and when finding and solving vacuum leaks in the line. Here I estimated that the system would need one valve for each 3 acres of installation. This is based on the tree density in this example.

Now I can sum up all of the material costs for a total per acre and divide this by the number of taps. This will give the material cost per tap for the tubing system only on that given acre. Remember this number does not include the mainline needed to transfer the sap to the holding tank or the sugarhouse. It does not include the costs of a releaser, vacuum pump or other components related directly to the vacuum system. All of those costs will vary significantly depending on the size of the whole system and the distances between the woods and there rest of the collection and vacuum system. These other costs can be estimated in a fashion similar to what I have done here once the additional information is provided.

Now that you see how the calculations are done, provided below is second example of how the costs work out on a woods with fewer tapable trees per acre.

Number of trees per acre (one tap per tree)	50
Number of trees per lateral line	6
Average distance between trees	29.5
Average length of a lateral line	162.3
Number of lateral lines per acre	8.3
Main line length per acre	246.0
Total length of lateral lines	1352.8
Length of 5/16 lines end tree loop (3' each)	25.0
Length of 5/16 in drop lines (24" each)	100.0
Number of wire ties (one every 18")	164.0
Length of side tie wire	41.0

Costs:		
Spouts - use spouts or stubs not both	0.39	$19.50
Stubs -use spouts or stubs not both, must include one kind of adapter	0.29	
Stub adapter - use adapter or check valve not both, must also include stub	0.21	
Check Valve adapter - use adapter or check valve not both	0.5	
Saddles, all single connect	2.95	$24.58
T's	0.24	$10.00
Y's	0.77	$6.42
Hooked connector	0.33	$2.75
Lateral end tree loop (leave this blank if you use old tubing here)	0.09	$2.25
Drop lines	0.09	$9.00
Lateral Lines	0.09	$121.75
Main Lines (1") Black use black or blue not both	0.383	$94.21
Main Lines Blue (1") use black or blue not both	0.42	
Main Line Wire same length as mainline	0.055	$13.53
Wire ties	0.014	$2.30
Wire grips estimated at 3 per acre	1.75	$5.25
Tree hooks estimated at 2 per acre	3.5	$7.00
Tensioners estimated at 1 per acre	5.95	$5.95
Side tie wire	0.07	$2.87
Mainline valves one on each end(1 for each 3 acres) brass plus fitting and clamp	52	$17.33
Total material cost per acre		$344.69
Cost per tap		$6.89

A spread sheet is available in Excel format to actually do all of these calculations for you. You need to provide a good estimate of your forest density as described earlier in this article and the desired number of taps per lateral line. It is a great tool to compare how costs and distances change with changes in these details. It comes loaded with the 2009 material prices but you can also adjust these depending on your supplier or other ways you may choose to change your set up. It is available at no cost from the Cornell Maple Program at cornellmaple.com