Since the War the regulations for carrying into effect the provisions of the Federal-aid Highway Act of 1944 have placed administrative emphasis on the relationship of right-of-way and roadside improvement problems in the several States. Trees are often found to be a cost consideration in the acquisition of highway right-of-way. The paper by Mr. George G. Holley on the evaluation of trees as an element in highway land damage should be timely and useful.

Building Setback Lines - The right-of-way and roadside improvement problems, as already stated, are inter-related. The two must go together. The paper on Highway Zoning in Virginia shows how one State is trying to coordinate local county zoning of highways with State-wide planning for the mutual interest of all.

TREES AS AN ELEMENT IN HIGHWAY LAND DAMAGE

By
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Introduction - At the present time there seems to be no generally accepted method for evaluating shade trees on land acquired for highway construction. Appraisers for highway departments tend to place too low a value on such trees. Often the trees are considered as so much cord-wood or timber, but unless they are growing on woodland such evaluation is generally too low. On the other hand the property owner tends to value the trees too highly. It is only natural that he should try to get all he can. Thus, both parties are likely to arrive at their respective evaluations by more or less biased opinions. If it is conceded that the property owner should receive fair and just remuneration for his trees--but no more--some method must be found to arrive at a true value.

This paper is presented as an introductory review on the need for improved and more uniform procedures in determining the value of shade trees on land acquired for highway purposes. Nine different methods of tree evaluation are outlined and existing data are assembled in tabular form as a basis for development of a more complete and uniform procedure in estimating damage to trees on highway rights-of-way. The use of a complete formula for appraisal of shade trees is described. A list of native trees in the cool humid northeast portion of the United States is also included for guidance in the use of the tree appraisal formula.

Factors in Estimating Value of Trees - In estimating the value of trees, several factors should be considered: the tree species, size, location, condition, specimen value, land value, and other factors of lesser importance. The following is a brief discussion of these factors.

1. The species of the tree itself is important in fixing its value. A white oak or a sugar maple is more valuable than a common locust or a silver maple

of the same size, other factors being equal. However, the value of a species may vary in different localities and under various conditions. That is, a species is most valuable in localities where it thrives best, other factors being the same.

2. Location is also important. A tree located in a front yard is more valuable than one of the same species, size, etc., located out in a pasture or along a fence row well away from the house. Also a tree standing alone is generally more valuable than one in a group, unless its removal destroys the appearance of the group. Then the reverse may be true.

3. The physical condition of a tree has a tremendous influence on a tree's value. A tree may be in such poor condition as to be worthless and actually may be a liability. For example, a tree afflicted with a contagious disease, may spread infection to others. A tree seriously weakened by decay is a hazard to life and property. Such trees obviously have no value.

4. Specimen value is a factor which should not be overlooked. Two trees of the same size and species, located equally well and in the same physical condition may be valued quite differently. The tree which is the better specimen and has more character has the greater value. Nurserymen recognize this factor and always price specimen plants higher than plants of number 1 grade.

5. The value of the land on which a tree is growing has a direct affect on the value of the tree. A red oak on $5,000 per acre land is without question more valuable than the same tree on $100 per acre land.

6. A tree growing in regions where trees are scarce is worth more than one growing where they are plentiful, everything else being equal. For example, a tree in a heavily wooded region is not as valuable as it would be in a region where they are almost no trees. Likewise a tree in a wooded area is less valuable than the same tree standing alone in a field or pasture.

7. Sentimental and historical values are factors which occasionally must be recognized. A tree planted by a property owner's father or grandfather has a much greater value to him than one which just grew. We have all experienced seeing a community petition the highway department to spare a fine tree or row of trees which had been a familiar sight for many years, and which engineers had condemned to clear the way for highway construction. Quite often roads have been relocated at considerable expense to spare such trees.

There is an elm tree standing not far from the main entrance to Mount Vernon which is supposed to be a grandchild of the elm under which Washington took command of the Continental Armies at Cambridge, Massachusetts. If this tree were evaluated its historical value would far outweigh its value as a shade tree.

Sentimental and historical factors, however, are encountered so seldom that they present special cases which are generally recognized as such and handled accordingly.

Use of Various Methods - During the last 60 years or more, several methods for evaluating shade trees have been devised. As might be expected, the earlier methods were rather crude and inaccurate while the later ones came closer to the real value and depended less on guesswork. The following is a brief outline of these methods presented in a more or less chronological order:

1. The arbitrary method was one of the earliest used. A law was enacted in the State of Massachusetts whereby a fine of not less than $5.00 and not more than $150 could be levied for injury or destruction to a single tree. The assessment of damage was left to the court.

2. The Roth method consisted of adding 5 percent compound interest to the initial cost of a tree. For example, after twenty-five years a tree having an initial cost of $15.00 would be valued at $51.80.

3. The Circumference Measurement Method was simply multiplying the circumference of a tree in inches at breast height by $5.00.

4. The Diameter Measurement Method used the diameter of a tree in inches at breast height multiplied by $10.00.

5. The Square Foot Basal Method was developed collaboratively by Professor George E. Stone of the Massachusetts Agricultural College and Mr. George Parker, Park Superintendent, Hartford, Connecticut in the early 1900's. A value of $75.00 was used per square foot of cross section of the tree trunk at breast height. This $75.00 figure was modified by species and the physical condition of the tree. It seems to be the first time that species and condition were considered as affecting a tree's value.

6. The Square Inch Basal Method is supposed to have been devised in Massachusetts about 1920. A maximum value of seventy-five cents per square inch of basal area or cross section at breast height was used with deductions allowed for species and condition.

7. The Newark Method, a modification of the above method, was suggested by Mr. C. L. Pack, but the only difference seems to be an increase in the square inch value to $1.00.

8. The Replacement Value Method consists of the cost of removing a destroyed or badly damaged tree and replacing it with one of the same size and species in good soil surroundings.

9. The late Dr. E. P. Felt elaborated on the Newark Method by adding the factors of land value and location. Species and condition were included as well as a basal square inch value of $1. This method is by far the most complete and accurate of the nine methods just outlined. A tabulation (Table I) to assist in the use of Dr. Felt's improved Newark Method is as follows:

TABLE I. DATA TO BE USED WITH DR. FELT'S IMPROVED NEWARK METHOD

Diameter in inches	Basic Value	Species	Location	Condition of tree	Land value per acre	Ratio of tree value to land value
	Dollars	Percent	Percent	Percent	Dollars	Percent
6	28				500	25
8	50				1,000	45
10	79				1,500	70
12	113				2,000	100
14	154				4,000	150
16	201				6,000	200
18	254				8,000	240
20	314				10,000	280
22	379				12,000	300
24	453				14,000	320
			5 to 100			
26	531		(by units of 5)		16,000	335
28	616				18,000	350
30	707				20,000	365
32	800				22,000	375
34	907				24,000	385
36	1,018				26,000	395
					28,000	400
38	1,135					
40	1,257					
44	1,524					
48	1,810					

This table is set up to be used as follows: Each item or factor is to be taken in turn from left to right. In this example, assume that the tree has an 8-inch diameter. The basic value is then $50. The species is White Oak which has a rating of 100. The location is not too good, being too far from the house. The rating for this factor may be considered as 80. The tree's condition is excellent, rating 100. It is growing on land valued at $4,000 per acre so that the final figure is multiplied by 150 percent. Thus we have

$50 x 1.00 x .80 x 1.00 x 1.50 or $60 as the estimated value of the tree.

Footnote: Most of the information on the nine methods just outlined as well as Table I was obtained from Mr. O. W. Spicer's paper presented at the December 5, 1945, Twentieth Annual Meeting of the New Jersey Federation of Shade Tree Commissions: "Value of Trees to a Community."

Apparently the nine methods just described were devised for trees on residential property in urban and suburban areas. Land values ranging from $500 to $28,000 per acre as shown in the previous table are not as low as land values along highways in rural areas. For evaluating trees on land purchased for highway right-of-way, the following Table 2 is presented, with land values ranging from $50.00 to $10,000 per acre. On $10,000 per acre land maximum tree values approach the cost of replacing the tree with one of equal size. For example, a 12-inch diameter tree with a basic value of $110 as shown in Table 4 on $10,000 per acre land, would be worth 250 percent of the $110 basic value or a replacement value of $275. As a rule, the replacement value should be considered the maximum value that should be placed on shade trees growing on highway right-of-way. On $50.00 per acre land tree values tend to approach timber value. For example, on land of this value the same size 12-inch diameter tree with a $110 basic value would have a maximum value of 10 percent of the $110 basic value, or $11.00.

Table 2
Tree value for various highway right-of-way land values

Land value per acre	Ratio of tree value to land value
Dollars	Percent
50	10
100	20
200	30
500	50
1,000	70
2,000	100
4,000	150
6,000	200
8,000	230
10,000	250

Table 3
Simplified basis values adapted from Table I

Tree size: Diameter	Basic value of tree
	Dollars
6 inches	30
9 inches	60
12 inches	110
15 inches	180
18 inches	250
24 inches	450
30 inches	700
36 inches	1,000
42 inches	1,400
48 inches	1,800
54 inches	2,200
60 inches	2,800

Table 3 is suggested as a simplified table of basic values given in round numbers for trees with diameters from 6 to 60 inches. These values as shown in Table 3 have been used in subsequent tables.

It should be noted that in all the several methods, diameter and circumference measurements are taken at breast height or $4\frac{1}{2}$ feet above the ground in accordance with standard practice.

Proposed formula for shade tree evaluation along highways - In developing a formula for evaluating shade trees along highways five factors are used, namely: species, location, condition, specimen (Aesthetic) value, and ratio to land value. The specimen (A) value factor is used only when a specimen tree is involved. It always has a percentage value above 100, depending on the judgment of the appraiser. To be rated a specimen, a tree may be of any species and stand in any location, but it must have a rating of 100 for condition and must be well above the average in appearance. The species factor may have a percentage rating from 100 down but never reaches zero. The location and condition factors may be rated from zero to 100. The ratio to land value has a value ranging from 10 to 250, as shown in Table 2.

The proposed formula is

$$V = B \left(\frac{S+L}{2}\right) CAR \text{ where}$$

V = Value of shade tree

B = Basic value (This is the cross sectional area in square inches at breast height with a value of $1 per square inch on $2,000 per acre land) (See Tables 1, 2 and 3.)

S = Species in percent

L = Location in percent

C = Condition in percent

A = Specimen or Aesthetic value in percent (always above 100 percent but used only when a specimen tree is being appraised)

R = Ratio to land value in percent

Using values of 100 for the various factors, we have

$$V = B \left(\frac{1.00 + 1.00}{2}\right) (1.00) (1.00) R \text{ or}$$

$$V = BR$$

When the specimen factor is not used it may be left in and given a rating of 100, or omitted from the formula entirely.

Application of Suggested Formula - Thus a 12-inch White Oak rating 100 for all factors would be worth $110 on $2,000 per acre land. The following Table 4 shows the value of various size trees rating 100 for all factors, on land valued from $50 to $10,000 per acre.

Table 4 - Maximum Tree Values in Relation to Land Values
All Factors Rating 100

Land value per acre	Ratio of tree value to land value (R)	12-inch tree	24-inch tree	48-inch tree
Dollars	Percent	Dollars	Dollars	Dollars
50	10	11	45	180
100	20	22	90	360
200	30	33	135	540
500	50	55	225	900
1,000	70	77	315	1,260
2,000	100	110	450	1,800
4,000	150	165	675	2,700
6,000	200	220	900	3,600
8,000	230	253	1,035	4,140
10,000	250	275	1,125	4,500

These values may seem excessive, but very seldom does a tree rate 100 for all factors. Such a tree must be one of our best species, such as White Oak, must be ideally located such as in a front yard where it provides shade and improves the appearance of the house. It must be in perfect condition with no sign of disease or decay. A specimen tree would have a still higher value provided it rated 100 for all other factors.

When the several factors have ratings somewhat less than 100, the tree value falls surprisingly. For example, let us take a Cottonwood which is located away from the yard area. It is in only fair condition, having several dead branches. Under these conditions the values for the various factors may be S = 30, L = 50, C = 50 (A is not considered).

We then have

$$V = B \left(\frac{.30 + .50}{2}\right) (.50)\, R \text{ or}$$

$$V = .2BR$$

It is immediately evident that by using the factor ratings above, the value of V dropped much more than the average value of S, L and C. Whereas their average value is 43.3, the V value is only 20 percent of the value obtained when all factors rated 100. Thus a 12-inch Cottonwood on $50 per acre land is valued at 20 percent of $11 or $2.20, a 24-inch Cottonwood 20 percent of $45 or $9, and a 48-inch Cottonwood 20 percent of $180 or $36.

Table 5 indicates tree values obtained by using the factor ratings used above as a comparison with tree values in Table 4 where all factors were rated 100. Tree sizes in both tables are identical.

Table 5 - Tree Values in Relation to Land Values

Where S = 30, L = 50, and C = 50

Land value per acre	Ratio of tree value to land value	12-inch tree	24-inch tree	48-inch tree
Dollars	Percent	Dollars	Dollars	Dollars
50	10	2.20	9.00	36.00
100	20	4.40	18.00	72.00
200	30	6.60	27.00	108.00
500	50	11.00	45.00	180.00
1,000	70	15.40	63.00	252.00
2,000	100	22.00	90.00	360.00
4,000	150	33.00	135.00	540.00
6,000	200	44.00	180.00	720.00
8,000	230	50.60	207.00	828.00
10,000	250	55.00	225.00	900.00

These values of course are only one-fifth the values shown in Table 4.

It should be noted that the lower the average value of the factors, the greater is the proportional difference between that value and the V value. For instance, if all factor values rate 90, the V value is 81 or about eight-ninths the average factor value of 90. If all factors rate 10, the V value is 1, or only one-tenth the average factor value of 10.

In examining the formula, $V = B \left(\frac{S+L}{2}\right) CAR$, it is evident that when C has a rating of zero, the resulting tree value is always zero. Since S always has some value and L is the only other factor which may have a zero rating, V (the tree value) will always have some value unless the C value or condition of the tree is zero.

This is as it should be. The condition of the tree (C) is and should be the controlling factor in appraising value. For when the condition (C) is such that a tree has become a menace to human life or to the health and even life of other trees, or both, the tree has no value.

It is believed that this formula will aid in a more uniform appraisal, and will give results accurate enough to have a practical use in evaluating trees on highway rights-of-way. But it should be emphasized that no formula or method by itself will automatically produce satisfactory results. A person possessing good judgment and a knowledge of trees is more important than a good formula, but the combination of a qualified person and a workable formula should obtain reasonably true values.

Table 6 is a summary of data to be used with the proposed formula.

Table 6 - Data to be Used In The Proposed Formula

$$V = B \left(\frac{S+L}{2}\right) \quad CAR$$

Trees	Table 3	Tree factors evaluated by appraiser:					Table 2
Diameter in inches	Basic value (B)	Species (S)	Location (L)	Condition (C)	Specimen value (A)	Land value per acre	Ratio of tree value to land value (R)
	Dollars	Percent	Percent	Percent	Percent	Dollars	Percent
6	30					50	10
9	60					100	20
12	110					200	30
15	180	Values for the 4 factors				500	50
18	250	Species, Location, Condition				1,000	70
24	450	and Specimen Value to be				2,000	100
30	700	furnished by the appraiser				4,000	150
36	1,000					6,000	200
42	1,400					8,000	230
48	1,800					10,000	250
54	2,200						
60	2,800						

List of Native Trees With Suggested Species or S Value - The following list of native trees is limited for this paper to the cool humid region of the country, or northeastern United States. Several of them are found in the wild in only a limited part of the region, but grow well over a much greater area. A tentative S value in percent has been placed on each species. This value represents each species in the area where it grows best with the exception of American Elms. The future use of elm trees on highways is so uncertain that they have been rated lower than they would have been otherwise. The willows which have been listed are mostly of European origin but they have adapted themselves so well to this country that they now seem as much native to us as our own trees.

Generic name	Common name	Species or S value
Acer negundo	Box Elder	20
nigrum	Black Maple	100
pennsylvanicum	Striped Maple	40
rubra	Red Maple	80
saccharinum or dasycarpum	Silver Maple	20
saccharum	Sugar Maple	100
Aesculus glabra	Ohio Buckeye	60
octandra	Yellow Buckeye	60
Amelanchier canadensis	Downy Shadblow	60
laevis	Allegheny Shadblow	70
Betula lenta	Sweet Birch	80
lutea	Yellow Birch	60
nigra	River Birch	60
papyrifera	Canoe Birch	100
populifolia	Gray Birch	60
Carpinus caroliniana	American Hornbeam	80
Catalpa speciosa	Western Catalpa	40
Celtis mississippiensis	Sugarberry	70
occidentalis	**Hackberry**	70
occidentalis var. crossifolia	Bigleaf Hackberry	70
Cladrastis lutea	Yellow-Wood	80
Diospyros virginiana	Persimmon	80
Fagus americana	American Beech	100
Fraxinus americana	White Ash	70
nigra	Black Ash	70
pennsylvanica	Red Ash	70
profunda	Pumpkin Ash	60
Gleditsia triacanthos	Honeylocust	70
Gymnocladus dioica	Kentucky Coffeetree	80
Hicoria alba	Mockernut	90
cordiformis	Bitternut	80
glabra	Pignut	80
laciniosa	Shellbark Hickory	90
ovata	Shagbark Hickory	90
pecan	Pecan	90
Juglans cinerea	Butternut	50
nigra /1	Black Walnut /1	90
Liquidambar styraciflua	Sweetgum	90
Liriodendron tulipifera	Tuliptree	80
Magnolia accuminata	Cucumbertree	80
Nyssa sylvatica	Sourgum	90
Ostrya virginica	Hophornbeam	80
Oxydendron arborium	Sourwood	90
Platanus occidentalis	American Planetree	90

/1 - **Black walnut may be more valuable for its wood than any value derived from the formula.**

Generic name	Common name	Species or S value
Populus balsamifera	Balsam Poplar	30
deltoides	Southern Cottonwood	30
grandidentata	Largetooth Aspen	30
heteriophylla		30
monilifera	Northern Cottonwood	30
tremuloides	Quaking Aspen	30
Prunus serotina	Black Cherry	70
Quercus alba	White Oak	100
bicolor	Swamp White Oak	80
coccinea	Scarlet Oak	90
falcata	Southern Red Oak	100
imbricaria	Shingle Oak	90
lyrata	Overcup Oak	90
macrocarpa	Mossycup Oak	100
marilandica	Blackjack Oak	90
michauxi	Swamp Chestnut Oak	100
muhlandbergi	Chinquapin Oak	80
Quercus		
nigra	Water Oak	80
palustris	Pin Oak	90
phellos	Willow Oak	100
prinus	Chestnut Oak	100
rubra	Red Oak	100
stellata	Post Oak	100
velutina	Black Oak	100
Robinia pseudoacacia	Common Locust	40
Salix alba	White Willow	40
babylonica	Babylon Weeping Willow	50
fragilis	Brittle Willow	40
nigra	Black Willow	40
nigra var. falcata		40
vitallina	Golden Willow	50
Sassafras variifolium	Sassafras	40
Sorbus americana	American Mountain-Ash	80
Symplocos tinctoria	Common Symplocos	70
Tilia americana	American Linden	70
Ulmus americana	American Elm	70
fulva	Slippery Elm	60
racemosa	Rock Elm	60
serotina	September Elm	60

To this list should be added shade trees of foreign origin and evergreen trees both foreign and native which grow in the cool humid regions. A complete list of trees covering all of the climatic regions of the United States is also needed.

Conclusion - This review of methods for determining the value of trees along highways, and suggested "S" values for shade trees of the cool humid region are presented for introductory purposes. The Committee on Roadside Development will welcome any suggestions or constructive criticisms for consideration at its next annual meeting. Specific examples of the use of tree evaluation methods are invited by the Committee.

References:

Proceedings of the Twentieth Annual Meeting - New Jersey Federation of Shade Tree Commissions, December 5, 1945.

"Real Estate Appraising" - James D. Henderson - Bankers and Tradesman's Press, Cambridge, Massachusetts.

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HIGHWAY ZONING IN VIRGINIA

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The exorbitant cost involved in moving buildings and other structures for modern highway reconstruction has been of great concern to the State Highway Commission of Virginia. The General Assembly in 1944 instructed the Highway Commission to prepare a "Twenty Year Plan" for the development of the Virginia Primary Highway System. An intensive survey and study of the needs for this modernization indicated an estimated cost of nearly five hundred million dollars. The plans for this modernization provide for four classes of roads. Class I and Class II are interstate and intercity; Class I being a four lane divided highway, requiring a 160 ft. right of way - Class II, two lane, requiring 110 ft. right of way - Class III involves heavy travelled local roads requiring an 80 ft. right of way, while Class IV is a lightly travelled road with a 50 ft. right of way. When it is considered that before the adoption of this plan, normal rights of way in Virginia for the Class I and II roads were from 60 to 80 ft. in width and other roads from 30 to 60 ft., many built a decade or more ago, and all have, naturally, become built up with a ribbon development of houses, stores, garages, filling stations, and other structures. With no established setback lines, most of these buildings have been built close to the edge of the present right of way and will be within the future right of way line. While provision has been made in the estimated cost of the modernization program for the moving of existing buildings, it is impossible to forecast the cost of handling future encroachments in this area.

Surveys of Encroachment of Structures on Right-of-Way - A careful study of 178 miles of reconstruction projects, built during the past seven years, in different sections of the State and under varying conditions portrayed an overall cost of $528,666 for the moving, purchasing, or rebuilding of structures. This is an average of $2,970 per mile. Another rough survey was made within an area of ten miles of one of the leading cities, based on existing conditions and potential developments during the next decade, indicated that it would cost the State at