

# REPORT OF SUBCOMMITTEE ON PLANT ECOLOGY

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## THE SELECTION AND USE OF GROUND COVERS ON HIGHWAY AREAS

### SYNOPSIS

This is an initial report based on the experience of the State highway departments in the *Northeast and Middle Atlantic States* in the use of low growing native shrubs, vines, and grasses as a protective cover for slopes, intersection islands, central strips of divided highways, and other areas of bare soil. *The methods listed will apply in principle wherever sod or mat-forming vegetation can be established without intensive maintenance.* The species of plants listed should of course be used only *within their natural ranges* or in localities where they have been naturalized over a period of many years.

In general the ground cover species listed and the methods of their use described are intended to apply in regions 22 to 28 inclusive as outlined on Figure 1. In all cases, however, field examination of each section of roadside, with a careful technical landscape analysis of topography, soil and existing vegetation, should be the basis for selection of ground cover plants and the methods to be used in their establishment.

One of the most essential operations in highway landscape improvement is the protection of areas of bare soil against erosion. No method is so economical or effective under average roadside conditions as the establishment of native or naturalized grasses and low shrubs or vines. The term ground cover as here used will be understood to cover annual and perennial grasses, perennial woody vines, low native colony-forming woody shrubs which do not as a rule exceed 2½ to 3 ft. in height at maturity, and certain mat- or sod-forming herbaceous plants such as the most common types of ferns.

### PRELIMINARY OPERATIONS

Experience indicates that the following stages of landscape work are essential before the actual seeding, sodding or planting of ground cover begins:

*Landscape Reconnaissance:* It is essential that highway areas in need of protection against erosion be carefully examined and analyzed by competent technical landscape personnel. The expenditure of highway funds for seeding,

sodding and planting cannot in the long run be effective except as based upon skilled analysis of soil, drainage, aspect, and other site conditions.

*Preserve Trees, Topsoil, Sod, Stone:* Before grading begins, provision should be made for preservation of outstanding existing trees and groups of existing shrubs or other desirable vegetation as far as this conservation can be combined with the development of a well-rounded cross section. Topsoil, sod, stone, and other native materials which can be advantageously used in landscape development should be removed from areas of excavation and stock piled if necessary. It is a serious lack of foresight not to conserve topsoil in original construction especially on new center line location in areas of cut across cultivated fields or pasture land. Topsoil is usually an inferior subgrade or fill material. Topsoil restored to the exposed surfaces of finished cuts and fills is a major factor in preventing erosion. Even without seeding or planting, native vegetation soon becomes established in topsoil covered surfaces which have been flattened to

1 on 2 or more. Slopes which already have a satisfactory cover of vegetation will as far as possible be left undisturbed during grading work. Outstanding trees, rock ledges, and similar landscape features may control or limit the extent of slope flattening and rounding.

**Grading:** To facilitate the rapid establishment and growth of ground

depending upon the total slope height. Grading operations can usually be most economically performed as a part of original construction contracts.

**Soil Preparation—Topsoiling:** Following landscape grading the soil on slopes or intersection areas may be prepared for seeding, sodding or planting. Topsoil should be restored and manures

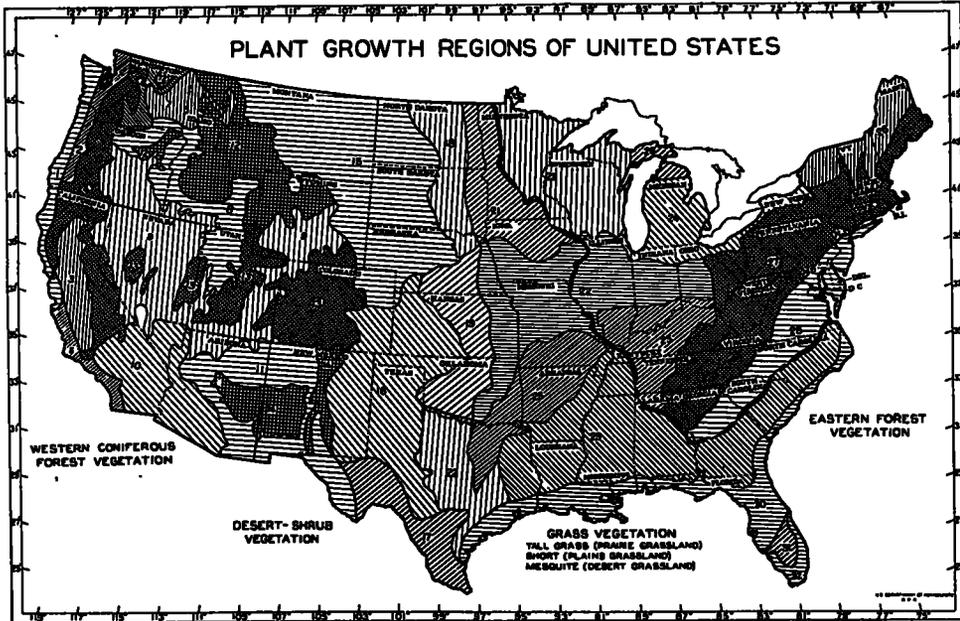


Figure 1. This Map is adapted from the Map of the United States found in figure 2 on page 4, U. S. Department of Agriculture Farmers Bulletin 1482, titled "Trees for Roadside Planting," by F. L. Mulford. Numbers within the border lines on both Maps indicate those Regions having approximately similar growing conditions for the same elevations. Darker areas are mountain or hill regions where altitude and topography have an important influence on plant growth.

covers, highway slopes should be flattened and rounded within the limits set by existing topography and available right-of-way and easements from property owners. Slopes, after being flattened, should be liberally rounded, beginning at a point between one-third and about one-half the distance between the slope stake and ditch line, and extending to a point about 5 to 15 ft. behind the slope stake toward the right-of-way line,

or fertilizers added as required by existing site conditions. For example, on low flat slopes, shoulders or intersection areas with sterile gravel or clay soils of bad texture,<sup>1</sup> loam or sandy loam topsoil may be broadcast to a depth of 2 to 4 in. to insure satisfactory growth of grass. Where existing soils are of fairly good

<sup>1</sup> For definition of soils by texture, see Atlas of American Agriculture, Part III, pages 11-12.

texture (sands, sandy loams or loams), addition of harrowed or raked-in commercial fertilizers or farm manures may be effective without the added topsoil. The amount of topsoil or fertilizer required and the method of application will be best determined by a careful examination of the site and soil by competent landscape personnel.



Figure 2. Well Rounded slopes plus a soil covering which will support plants are necessary for the rapid establishment of ground cover plants in all climatic regions.

#### TREATMENT OF CUT AND FILL SLOPES

No seeding, sodding or planting should be done on highway slopes until proper flattening and slope rounding as governed by existing topography, have been done.

*Selection of Plants:* 1. Running vines or drought resistant native colony-forming woody ground covers of types similar to such vegetation already found existing along the road should be selected for planting on high steep highway slopes. Where moderate slope (1 on 3 or flatter), good soil, and other site conditions indicate the use of seeded or sodded grass, grasses may well be used for slope protection.

2. In general native types of vines and shrub ground covers will be found available from nursery sources. Nursery grown vines, particularly, will be found most satisfactory for roadside planting.

3. Where native ground cover shrubs are available in necessary quantity near

the highway, these can usually be successfully collected providing:

- A. Analysis of collecting field soil indicates favorable transplanting conditions. For example, loam and clay soils favor collection; loose sands and gravels render collection difficult.

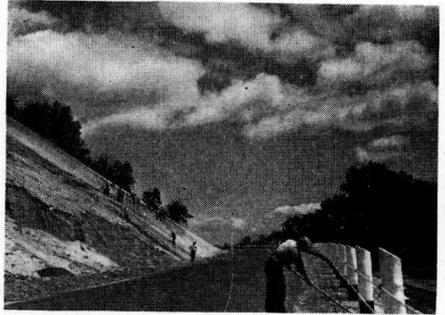


Figure 3. A Bare Sand Slope before Landscape Treatment



Figure 4. The Same Slope after mulching with hay, planting with sweetfern and sumac, and seeding.

- B. Collection can be done during proper season. For example, most plants are best collected in spring.
- C. Collected plants can be dug and handled under supervision of well-trained landscape personnel. Collection should not be attempted unless at least a "skeleton force" of experienced

labor is available. This is often the difference between success and failure.

D. Collected plants can be transplanted from the growing site directly to the planting site without delay. Heeling in of collected plants will usually mean a low percentage of survival at the planting site, and may increase costs to the point where it may be advisable to use nursery grown plants.

4. Shrub or ground cover species which do not form a compact fibrous root system after a year or two in the nursery may well be collected rather than nursery grown. This class of collectible materials includes, for example, the common sumacs (*Rhus copallina* and *glabra*), the elderberries (*Sambucus* species) and plants with similar coarse pulpy root systems.

*Planting Operations:* In general, planting operations (to be successful) will require:

1. Trained landscape personnel plus a skeleton force of experienced laborers in each untrained labor crew.

2. Particular care in inspection of nursery grown or collected plants during digging and at the point of delivery. Only healthy plants with adequate root systems should be delivered to the planting crews.

3. Care during transportation and planting to avoid drying out of root systems. Thorough watering where necessary after planting.

4. Proper mulching of planted trees, shrubs or vines after planting. In planted groups or colonies of ground cover, bare soil between plants should as a rule, be covered with two or three inches of loose straw, hay cuttings, pine needles or other available mulch. This mulch tends to conserve moisture and to keep out weeds. Rain cups must be left around individual

plants or a trench planting method should be used designed to evenly distribute surface water to the plants.

5. Where mulching is not required because of good soil and abundant moisture a light seeding of rough pasture type of grasses may be done in spaces between plants on the planted slopes. For example, use 25 or 30 lb. per acre of red clover and timothy or a similar pasture seeding adapted to local soils and climate. Individual planted vines or low shrubs should always be mulched to control weed growth.

After planting, pruning of shrubs or vines will be necessary. In general, prun-



Figure 5. Planted and Natural existing sweetfern on a New England Highway. Well-rounded slopes mulched with hay or local woods litter will often cover themselves without the need for planting.

ing will accomplish reduction of top growth in proportion to the root growth of each plant pruned away during transplanting operations. Vines and fast-growing, soft-wooded shrubs will usually be cut back almost to the ground, leaving only the first two or three buds on stems.

Maintenance for about the first two seasons following planting of shrub or vine ground covers will usually be necessary. For example: watering will be done regularly when needed; rain cups or trenches shall be kept in their original condition; mulch will be kept in place to adequate depth around plants; tall weeds

will be pulled up and destroyed in spaces between planted shrubs or vines; mowing of grass or weeds on areas adjacent to beds or groups of planting will be done with care, special attention being given to preventing injury to young shrub or vine growth which may come in among the grasses from seed or root suckering.

Every precaution will be taken against fire which may destroy the planting. Clean, well-mowed shoulders and shoulder slopes are the best possible fire insurance. The placing of about a half inch of loam upon dry mulch materials may also be advisable both as a precaution against fire and to prevent displacement of the mulch by wind or surface water.

#### TREATMENT OF INTERSECTION TRIANGLES, CIRCLES, ISLANDS, AND MEDIAN STRIPS

Intersection areas should be seeded or planted in such a manner that they merge with the adjacent backslopes and with the landscape beyond road borders. Thus in a landscape dominated by grasses where grass ground covers are properly used to cover nearby slopes, the same seeded grasses are used on intersection areas. Where, for example, planted honeysuckle or other vines are used to cover nearby slopes the same types of vines may be used on intersections as a solid continuous ground cover.

*Clear Sight Distance:* Planting of intersection islands should be done with low-growing plants and in such a manner that clear sight distance is maintained. Usually plants which exceed about 3 ft. in height at maturity must not be used where sight distance must be reduced by the planting of taller growing shrubs and trees. Traffic safety must be the controlling factor in all design.

Evergreen trees and high-growing evergreen shrubs should especially be used with caution at intersections. High-headed deciduous shade trees which will allow clear vision underneath their

branches are the only tall plants advisable as a rule for intersection planting, in central strips of divided highways, or elsewhere where sight distance must be kept open for traffic safety.

Tall-growing flowering shrubs of ordinary "garden types" are not recommended for intersection or for slope planting on open country roadsides. Such shrubs are difficult to maintain in healthy condition on roadsides, tend to cause snow-drift formation in winter, and do not form the low, continuous, smooth mat of vegetation usually desired at intersections.

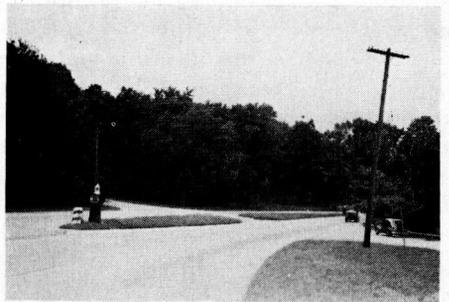


Figure 6. Honeysuckle planting on intersection islands. Planted evergreen vines like this require one mowing about every two years. By comparison grass sod is much more costly to maintain.

Planting of native low shrubs which will not exceed three feet in height at maturity, should be done in natural combinations found in adjacent fields and pastures. One type of ground cover should, however, dominate the planting in each intersection island or triangle. Solid groups of plants should cover the entire area of small triangles or should be confined to terminals and edges of large intersection areas.

*Central Strips:* On level intersection areas of large size native meadow types of grasses with occasional groups of high-headed shade trees located to facilitate machine mowing are usually indicated.

On level intersections of small size, or on median strips of a divided highway, solid vine or other low woody ground covers will usually be preferable to grass, and high-growing shrubs or trees should not be planted. Some exceptions to this rule as regards shade trees or flowering trees are permissible on central strips of divided highways 25 ft. wide or wider, or on slightly narrower median strips where bridges are a factor in the design. As a rule planting of trees or ground cover is not desirable on islands or central strips less than 10 ft. in width. Islands between about 6 and 8 ft. in



Figure 7. Median strips should be designed for easy maintenance. Here the sod can be readily mowed by modern machine methods.

width will usually best be seeded with grass. When less than 6 ft. wide, islands or central strips will best be filled with gravel or bituminous surfacing materials contrasting in color and texture with the traffic lanes, because the growth of healthy grass will under these conditions be found almost impossible over a period of years.

On rough intersections of such an irregular or rocky surface that machine mowing is impracticable, running vines

can best be used as a solid ground cover using one kind of vine on the whole area. Grass ground covers will rarely be satisfactory on highway intersection or slope areas where machine mowing cannot be done readily.

#### LANDSCAPE TREATMENT

The experience of the States to date has led to the preparation of Tables 1-5. It will be understood that the data here given apply only to average conditions



Figure 8. Median strips should be planted with low masses of solid ground cover. The groups of laurel shown here are most costly to maintain.

as listed. The methods given are intended to be flexible and must be varied as landscape analysis of each particular site indicates to be desirable. Species of plants listed are intended for use only within their natural ranges or where naturalization is no longer questionable.

These tables are subject to future revision based on the experience of the States and the Public Roads Administration.

TABLE 1  
SOME RECOMMENDED SLOPE PROTECTION METHODS  
For use under humid climatic conditions of the United States

Soil type	Height of slope	Slope* ratio before rounding	Recommended treatment
1. Pervious: Sands Sandy loams Sandy gravels, etc.	To 10 or 12 feet.	1 on 1½ to 1 on 2	A. Mulch with hay, straw, pine needles, etc.; plant groups or colonies of common native ground cover types. B. Broadcast manures or organic types of commercial fertilizer, mix with existing soil on slopes to average depth of 3 to 4 in.; seed with pasture grass or wild grass mixture; follow seeding with light hay, straw or peat mulch.
2.	More than 10 or 12 feet.	1 on 1½ to 1 on 2	A. Prepare large pockets, plant vines or native shrubs in irregular groups; mulch unplanted space or seed pasture grasses between plants; apply light mulch on seeding. B. On pure sands plant bayberry Indian grass, beach grass or other plants growing nearby on sandy soil. Mulch with hay or straw. (See footnote, Table 2.)
3. Impervious: Clays Clay loams Silty clay loams, etc.	To 10 or 12 feet.	1 on 1½ to 1 on 2	A. Prepare large pockets or contour trenches; fill with good loam topsoil. Plant with running vines, seed pasture grasses between plants or mulch with peat moss, straw, etc. B. Broadcast topsoil or topsoil plus equal part sand. Use harrow or rake to incorporate topsoil with existing soil to depth of 2 or 3 in.; seed with pasture grasses, follow with light ½ to 1-in. mulch.
4.	More than 10 or 12 feet.	1 on 1½ to 1 on 2	A. Treat as per method 3A above. (NOTE: Sub-surface drainage may be necessary where heavy seepage occurs.) Planting in pockets or contour trenches as above.
5. Pervious or Impervious: Sands to Silty clay loams as above.	To 10 or 12 feet.	1 on 2 to 1 on 3	A. Broadcast topsoil where required because of sterile nature of existing soil; seed pasture grasses, follow with ½ to 1-in. mulch or— B. Add topsoil; seed or seed plus strip sod. Add light mulch on South or West exposures and on erodible types of soil.
6.	More than 10 or 12 feet.	1 on 2 to 1 on 3	A. Treat as per 1A, 1B or 2B above. (NOTE: Subgrade drainage as necessary.)
7. Loams Sands Clays Silts	To 10 or 12 feet.	1 on 3 or flatter	A. Broadcast topsoil; where possible, incorporate this loam with existing slope soil to depth of 3 to 4 in.; seed with lawn or pasture grasses. Mulch usually needed on erodible soils or on dry South or West exposures.
8.	More than 10 or 12 feet.	1 on 3 or flatter	A. Broadcast topsoil, strip sod, or seed and strip sod on erodible soils; mulch on erodible soils after seeding. B. Broadcast topsoil; seed; follow with light mulch on slopes facing South or West. C. Plant in contour furrows, or pocket available collected low shrubs or native vines. Seed with pasture grasses between planting, or mulch whole area of bare soil on dry slopes with light cover of well-rotted manure or hay cuttings.

TABLE 1—Continued

Soil type	Height of slope	Slope* ratio before rounding	Recommended treatment
9.	Level inter-section shoulders.	Level or nearly level	A. Broadcast topsoil; pocket running vines or mass plant with a single kind of low native ground cover; mulch between planting on dry sites; seed between planting on moist soils. B. Broadcast topsoil and incorporate added soil with existing soil to depth of 3 or 4 in.; seed with lawn or pasture grasses; light mulch where required by dry soil conditions. On shoulder areas treat as per B—vines or shrubs not recommended.
10. Rock or gravel	Various slope degree and height		A. Prepare large pockets of good topsoil where digging conditions permit. Plant rapid-growing, coarse-textured vines such as wild grapes, etc. Mulch to preserve moisture in plant holes (mulch about plants 2-3 in. deep).

\*NOTE: Establishment of ground covers on earth slopes steeper than 1 on  $1\frac{1}{2}$  is very difficult, and sometimes impossible. Where topography will not permit flattening of 1 on 1 cut slopes to 1 on  $1\frac{1}{2}$  before rounding, use methods 1A or 2A.

## GENERAL NOTES

1. Above methods should be varied to meet existing conditions as analyzed by landscape engineer prior to landscaping work. Where a choice exists select the method of treatment which involves lowest maintenance cost in future years.
2. Study common native vegetation near highway area to be landscaped.
  - a. In "grass localities"—grasses ordinarily will be favored on most bare highway areas.
  - b. In "shrub localities"—shrubs and vines will be favored, particularly on steep slopes which cannot be readily mowed by motorized equipment.
3. Adopt method to site conditions—for example:
  - a. On steep slopes and particularly sterile dry soil conditions, favor vine and low native shrub planting.
  - b. On flatter slopes with fairly good moist soils, conditions may tend to favor grass ground cover.
  - c. North and East slopes are relatively favorable to plant growth; thus less drought-resistant grasses and vines or shrubs may be used.
  - d. South and West slopes, relatively unfavorable to plant growth; use drought-resistant vines and ground covers in preference to grasses. Light mulch one-half to one inch deep to follow seeding—heavier mulch two to three inches deep around and among planted vines or shrubs.
4. Where there is choice of ground cover materials, use:
  - a. Plants or grasses which require least soil preparation and least cultivation or "feeding" after planting or seeding, and which are similar in type to existing vegetation along each section of highway.
5. Where grasses or planted native shrubs are used, observe general rule that natural mixtures of several kinds of grass or plants are preferable to any one kind of grass or other ground cover. Where running vines are planted, use one kind only on each planting site unit.
6. Do not plant on same planting site on open country roadsides:
  - a. Native and "horticultural" types of shrubs.
  - b. Fast-growing vines and erect-growing shrubs or shrub ground covers.
7. As a rule use planted native wild types of grasses, woody vines or native, low shrubs on all slopes which cannot be readily mowed by machine methods.
8. Mulch. Two types of mulch as are referred to in the table above:
  - a. Heavy 2-in. to 4-in. depth of loosely compacted pine needles, straw, hay cuttings, peat moss and the like designed to prevent all weed or grass growth and to conserve moisture on the areas covered between planted vines, shrubs, or trees, and about the roots of such plants.
  - b. A light  $\frac{1}{2}$ -in. to 1-in. loose mulch of same materials as above designed to hold grass seed in place, to prevent erosion while seed is germinating, and to permit grass to grow through it.

TABLE 2

## PARTIAL LIST OF GRASSES OF NORTHEAST AND MIDDLE ATLANTIC STATES

NOTE: For purposes of this report, grasses have been divided into "lawn grasses" and "pasture grasses." "Cover crops" are included in the table though they are not usually permanent ground covers and must usually be followed by, or used in conjunction with, types of true grasses for permanent ground cover protection.

"LAWN" GRASSES	REMARKS—BEST ADAPTED FOR
Bent grass—Rhode Island, etc. . . . .	Northeast coast areas—moist slightly acid soils; sand to clay
Kentucky bluegrass . . . . .	Moist loams or clay loams; neutral to slight alkaline.
Canada bluegrass . . . . .	Moist to dry clay loams and clays—not acid in reaction.
Red top . . . . .	Various soils—not too acid or alkaline—very moist to dry.
Red or Chewing's Fescue . . . . .	Sandy soils—slightly acid to slight alkaline; shade tolerant.
Rough stalked meadow grass . . . . .	Fairly moist soil, as for Kentucky blue—shade tolerant.
Perennial rye grasses—Italian, English . . . . .	Require fairly moist soils, rapid growth, form temporary sod; some strains are annual, not perennial. Rye grasses tend to produce a "bunchy" sod.

NATIVE OR PASTURE GRASSES<sup>1</sup>

Timothy . . . . .	Various good soils—not too dry or sterile.
Orchard grass . . . . .	Various soils—less fertile than for timothy.
Tall meadow oat grass . . . . .	Light sandy or gravelly soils—well-drained.
Meadow fescue . . . . .	Forms better sod than grasses above. Moist or wet soils.
Sheeps fescue . . . . .	Poor sands, clays and gravels—forms a bunchy sod.
Red top . . . . .	Various soils, best if slightly acid.
Broom sedge (Andropogon) <sup>2</sup> . . . . .	Various poor clays and clay loams—well-drained.
Indian grass (Sorghastrum) <sup>2</sup> . . . . .	Various poor soils—well-drained gravelly or sandy clays and gravelly loams.
Beach grass (Ammophila) <sup>2</sup> . . . . .	On pure sand, particularly on seacoast.

## LEGUMES AND COVER CROPS

White clover (native) . . . . .	Good loams and clay loams—well-drained.
Red clover . . . . .	Good soils—not acid in reaction.
Crimson clover . . . . .	Good soils—not acid in reaction.
Alsike clover . . . . .	Prefers moist lands—not acid in reaction.
Sweet clover (Melilotus) . . . . .	Dry sands and clays—slightly alkaline.
Wheat	Use grain crops in combination with lawn and pasture grasses—particularly as nurse crops for late fall seeding; buckwheat and oats should as a rule be sown in spring.
Rye	
Buckwheat	
Oats	
Hairy or winter vetch . . . . .	Various well-drained sandy and gravelly soils. Sow in spring.

<sup>1</sup> Except for red top and meadow fescue, these are grasses which do not always form a continuous sod. Red top or meadow fescue should usually be mixed with seed formulas of bunch grasses, such as timothy or sheeps fescue.

<sup>2</sup> It is believed that these wild "pasture grasses" can be readily established on slopes by mowing old fields in summer and mulching bare slopes with the hay cuttings. Mowing should be done if possible just before the grasses are "ripe."

NOTE: (1) Seed of legumes if introduced on soils where they have not previously been grown, should be inoculated before sowing.  
 (2) Consult State Agricultural Experiment Stations for information regarding cover crops and grasses.  
 (3) Percentage of clovers to be sown mixed with lawn grass seeds, should not ordinarily exceed 3 to 5 percent by weight of total grass seed formula or mixture. Clovers, alfalfa, etc., should be mixed with pasture grasses as per formulas recommended by nearest agricultural experiment station.

TABLE 2—Continued

## GENERAL RULES FOR SEEDING

1. Purchase and handle all species of seeds separately: mix seed formulas on the job to fit existing site condition variations.
2. Analyze variations in seeding sites. Prepare soils as required by analysis of ground conditions; usually plowing and harrowing or equivalent will be required.
3. Add topsoil where necessary; topsoil may not be required for "pasture or wild grass" types.
4. Seed only during proper spring or early fall season for each locality.
5. Under average highway conditions, seed at rate not exceeding 100 lb. of lawn grass mixture per acre (between 30 and 75 lb. usually best).
6. Rake or cover grass seeds lightly, not more than  $\frac{1}{4}$ -in. deep.
7. Roll after seeding—light roller not more than about 25 lb. per ft. of roller length. Do not roll heavy clay soils after seeding.
8. Mow seeded areas with scythe about time grass reaches 6 in. in height. Mow at least three times during first season to eliminate weeds.
9. Do not attempt to rely on seeding on high slopes (more than 10 or 12 ft.) with a degree of 1 on  $1\frac{1}{2}$  or 1 on 2. Strip sodding with seeding may succeed under favorable slope conditions, but usually irregular spot planting with native low shrubs or running vines recommended, with a light mulch or seeding between planted areas or individual plants.
10. As a rule, solid sodding is recommended only as a last resort because—
  - a. Sodding has the highest cost per square yard of slope surface treatment of the above methods, and involves a high maintenance cost per unit of area in future years.
  - b. Because sod may be established temporarily on almost any degree of slope, there is a tendency to overuse this method. Satisfactory grass sod can seldom be maintained in good condition on steep dry slopes over more than a few years, without extra care and expense.
  - c. Solid sodding on highway sections where grass is not the predominant type of existing ground cover, tends to retard the establishment of native low shrub ground covers which are more permanent and require less maintenance (in the long run) than grass sod.
11. Observation of existing grasses in a locality is the recommended basis for selection of grass species to be sodded or seeded.

TABLE 3  
PARTIAL LIST OF NATIVE AND NATURALIZED VINES  
Recommended for Trial on Highway Slopes in North and Atlantic States

Common name	Latin name	Symbol	Average Spacing	Adaptation to Soil and Shade
			1. 3 to 5 feet 2. 5 to 8 feet	D—dry—well-drained M—moist—well-drained W—wet—poor drainage S—will stand some shade
Boston ivy	<i>Ampelopsis tricuspidata</i> (suburban areas only)	1-D to M		
Porcelain Amp.	<i>Ampelopsis heterophylla</i>	1-M		
Monkshood Vine	<i>Ampelopsis aconitifolia</i>	1-M		
Virginia Creeper	<i>Ampelopsis quinquefolia</i>	1-M-S		
Actinidia	<i>Actinidia arguta</i>	2-M-S		
Trumpet Creeper	<i>Bignonia radicans</i> and <i>B. capreolata</i>	2-D to M		
Bittersweet	<i>Celastrus scandens</i>	1-D to M		
Oriental Bittersweet	<i>Celastrus orbiculatus</i>	1-D to M		
Virgin's Bower	<i>Clematis virginiana</i>	1-W to M		
Sweet Autumn Clematis	<i>Clematis paniculata</i>	1-W to M		
Dutchman's Pipe	<i>Aristolochia siphocampylus</i>	2-M-S		
	<i>Aristolochia macrophylla</i>	2-M-S		
Matrimony Vine	<i>Lyceum chinense</i>	1-D		
	<i>Lyceum halimifolium</i>	1-D		
Hall's honeysuckle	<i>Lonicera japonica halliana</i>	1-D-S		
Dutch woodbine	<i>L. periclymenum belgica</i>	1-D to M		
Trumpet honeysuckle	<i>L. sempervirens</i>	2-D to M		
Grape honeysuckle	<i>L. prolifera</i>	1-D to M		
Other climbing honeysuckles	<i>Lonicera</i> species			
Wichuraiana rose	<i>Rosa wichuraiana</i> (many hybrid climbers)	1-M		
Kudzu vine	<i>Pueraria thunbergiana</i> (Virginia and south only)	1-M		
Wild grape	<i>Vitis cordifolia</i> and other local species	2-D-S		
	<i>V. rotundifolia</i> — <i>V. labrusca</i> , <i>V. vulpina</i>	2-D-S		
	<i>V. aestivalis</i> and other species	2-D-S		
Wisterias	<i>Wisteria chinensis</i> (suburban areas only)	2-M		
English ivy	<i>Hedera</i> (suburban areas only)	1-D to M		

NOTE: Vines normally should be nursery-grown though they can be successfully collected where commonly occurring along roadsides on heavy sod, as does Hall's honeysuckle.

All plants should be planted in large pockets or trenches of good topsoil where existing soils on slopes are poor.

Prior to planting, all highway slopes should be examined to determine:

1. Location of areas of good soils above dry cut slopes. Trailing vines planted here will cover the slopes below.
2. Location of seepage areas on the face of dry slopes where vines can be readily established.
3. Location of points at the foot of slopes where the "water table" is near the surface.

NOTE: Do not plant rapid-growing vines on same slope area with erect growing or flowering shrub or herbaceous ground covers which may be overgrown by vines. Mulch spaces between planted vines with hay, straw, pine needles or other available materials to control weeds, or seed open spaces on slopes with fast germinating grasses adapted to soil conditions where soil conditions are favorable to plant growth.

Warning: Certain vines such as Hall's honeysuckle and oriental bittersweet are not frost-resistant in northern Maine west to Minnesota.

TABLE 4

PARTIAL LIST OF NATIVE AND NATURALIZED SHRUB GROUND COVERS  
For Highway Slopes in North and Atlantic States

## Plants Marked:

C—have been collected  
N—commonly available  
nursery grown

W—require moist or wet sites  
D—will grow on dry sites  
S—will tolerate shade

## Average Spacing Recommended indicated by:

1. 1 to 2 feet
2. 2 to 4 feet
3. 3 to 5 feet

Common name	Latin name	Symbol	Specially adapted to soil
Jersey tea	<i>Ceanothus americana</i>	C-2D	Dry, sandy slopes
Hazelnut	<i>Corylus americana</i>	N-3DS	Moist woods edges
Beaked hazelnut	<i>Corylus rostrata</i>	N-3DS	Moist woods edges
Sweet Fern	<i>Comptonia asplenifolia</i>	C-1D	Sands and gravels
Scotch Broom	<i>Cytisus scoparius</i>	N-3D	Moist cool soils
Dwarf Bush Honeysuckle	<i>Diervilla trifida</i>	C-N-2W	Moist acid soils
Bayberry	<i>Myrica carolinensis</i>	N-2D	Sands and sandy loams
Wax Myrtle	<i>Myrica cerifera</i>	N-3D	Sands and sandy loams
Male Berry	<i>Lyonia ligustrina</i>	C-3W	Moist acid soils
Stagger bush	<i>Lyonia mariana</i>	C-3W	Moist acid soils
Fragrant Sumac	<i>Rhus canadensis</i>	N-2D	Well-drained soils
Smooth Sumac	<i>R. glabra</i>	C-1D	Well-drained soils
Dwarf Sumac	<i>R. copallina</i>	C-1D	Well-drained soils
Meadow Rose	<i>Rosa blanda</i>	N-C-3D	Moist sandy soils
Swamp Rose	<i>R. palustris</i>	N-C-3W	Wet soils
Sweetbrier Rose	<i>R. rubiginosa</i>	N-C-3D	Moist sandy soils, clays
Rugosa Roses	<i>R. rugosa</i> (many hybrids)	N-3D	Moist sandy soils
Prairie Rose	<i>R. setigera</i>	N-C-3D	Moist clay soils
Wild Roses	Various local species	C-3D	Well-drained soils
Northern Dewberry	<i>Rubus procumbens</i>	C-1D	Slightly acid soils
Southern Dewberry	<i>Rubus trivialis</i>	C-1D	Acid to neutral soils
Meadow Sweet	<i>Spiraea alba</i>	C-2W	Wet soils—sand and loam
Hard-hack	<i>Spiraea tomentosa</i>	C-2W	Wet soils—sand and loam
Snowberry	<i>Symphoricarpos racemosus</i>	N-C-3D	Various soils
Coralberry	<i>Symphoricarpos vulgaris</i>	N-C-3D	Various soils
True Ferns (collected sods)	Many species as adapted to local conditions	C-1D to W-S	Moist shaded areas
Bracken Fern (collected sods)	<i>Pteridium</i> , in oak-pine regions	C-1D	Acid sands and loams
Low Blueberry and Huckleberry	<i>Vaccinium</i> and <i>Gaylussacia</i> —many species	C-2D	Acid—well drained
Bearberry	<i>Arctostaphylos-uva-ursi</i>	N-C-1D	Acid—sands
Mountain Laurel	<i>Kalmia latifolia</i>	N-C-2W-S	Cold north and east slopes and under pine and oak woods
Lambkill (collect in sods)	<i>Kalmia angustifolia</i>	C-2D-S-W	Cold acid soils
Bunchberry (collect in sods)	<i>Cornus canadensis</i>	C-1W-S	On acid soils
Periwinkle	<i>Vinca minor</i>	N-1W-S	Suburban roadsides

NOTE: The plants listed above should be used *when they are common* on nearby borders of highway slopes to be protected from erosion. They can be collected in sods if not available from nursery sources.

These plants should be used in extended colonies or drifts in lots of 100 to several thousand in one group or colony. Plant in same type of soil and on same exposure as where found in nearby areas,

TABLE 5

PRELIMINARY LIST OF TREES, SHRUBS AND VINES FOR NORTH AND MIDDLE ATLANTIC STATES

Includes a number of native and naturalized trees, shrubs and vines well adapted to Roadside Landscape Use in Northeast and Middle Atlantic States. (With special reference to spacing, methods of arrangement and relationships between various types of plants.)

NOTE: The following list includes certain typical combinations of species of native plant materials which commonly exist on open country roadsides and are available from nursery sources or may be "nursery collected" from the wild. The list is prepared mainly for the purpose of illustration of certain principles of recommended landscape practice and will be subject to future addition and modification. The general suggestions which follow will apply particularly to open country roadside projects. On city or suburban roadsides, they may have little or no bearing in some cases.

Legend:

- N—Best nursery grown
- C—Collectible
- C S—Transplant in spring
- C F—Transplant in fall
- B & B—Should be balled and burlapped

LARGE EVERGREENS

Large evergreen trees are not considered as a substitute under usual roadside conditions for the large deciduous trees which are more valuable for shade. Evergreens are normally of value for screen purposes—and will normally be used only where mixed stands of hardwoods and evergreen or pure evergreen woodlands occur along certain roadsides. Spacing becomes larger with larger planting stock within the limits stated.

Tree Pines	Recommended average spacing ft.	Remarks Special character Pines
Pinus strobus . . . . . N—B & B	12 to 20	Plant pines in irregular groups, not in squares or straight lines.
Pinus resinosa . . . . . N—B & B	12 to 20	Use against background of sky or hillside, whenever possible in mixed sizes.
Pinus rigida . . . . . N—B & B	12 to 20	Do not use where smoke and gas from freight yards and factories is a problem.
Pinus virginiana . . . . . C—B & B	12 to 20	Plant pines with front and filler planting of common native shrubs and small trees adapted to sunny dry sites: Combinations: With birches, common sumac species, flowering dogwood, cercis, amelanchier, hawthorns etc.
Hemlocks . . . . . N—B & B	10 to 30	Plant in massed groups of rounded outline in good moist soils.
White Spruce . . . . . N or C S, B & B (Use white spruce, P. canadensis, in northern States where common in native landscape.)	10 to 30	Adapted to under planting under high deciduous trees. Use in combination with and background for—white birches, Kalmia and Rhododendron, azalea, etc., flowering dogwood, cercis, amelanchier, etc.

TABLE 5—Continued

Tree	Recommended average spacing ft.	Remarks Special character
Junipers . . . . . N—B & B Juniperus virginiana Juniperus communis	6 to 15	Plant in irregular scattered groups in dry sunny sites—never use for under planting. Use in combination with—White birches—high bush and low blue berries. Ground juniper and blueberries. Common sumacs, hawthorns, etc. Bayberry, sweet fern, etc.
Arbor vitae . . . . . N—B & B	6 to 15	Plant in rounded dense groups—on moist sites—can be used for under planting.

Arbor vitae is not recommended for planting on roadside except in Northern New York, Vermont, Massachusetts and North in regions where arbor vitae is normal part of landscape—use with larch along streams, swamp edges, etc., to emphasize topographic changes.

GENERAL NOTE: All evergreens best transplanted in early spring or early fall. Plant evergreens on open country roadside only where each type of tree used is prominent among existing growth along the road or where a winter screen is needed.

## LARGE DECIDUOUS TREES

The large shade trees are the backbone of all good roadside planting. Each region and each type of topography within each region has certain existing shade trees which form a basis for selection. Always merge types of tree planting into each other without abruptly stopping one type of planting to begin another. Do not plant large shade trees under public utility wires.

*Ridge Types*

Oaks (except willow and pin oak) . . . . . N	25 to 60 or 75	Plant on hillsides, exposed sunny sites where soil is adapted to particular species used. Use as individuals or in loose irregular widespaced groups; where possible use one kind of tree as most important feature in each topographic unit.
Sugar maple . . . . . N		
Red maple . . . . . N		
Honeylocust . . . . . N		

*Intermediate or Bottom Land Types*

Oaks (as above) . . . . . N	25 to 60 or 75	Plant as above.
Maples (as above) . . . . . N		
Honeylocust . . . . . N		
Elms . . . . . N	35 to 60 or 75	Do not use elms in masses—Plant in wide spaced groups to allow full top development. Warning: extensive elm planting will require annual spray program to keep trees in healthy condition. Use elm mainly in association with other species.
Tulip poplar . . . . . N		
Beech . . . . . N	35 to 60 or 75	
White ash . . . . . N	35 to 60 or 75	

*Lowland and Shore Types*

London plane . . . . . N	30 to 40	In groups or drained sites.
Pin and Willow Oaks . . . . . N	25 to 50 or 60	Plant in connected groups on moist drained sites.
Sweet Gum . . . . . N	20 to 40	On drained moist sites.
Larger willows . . . . . N	20 to 40	Plant on wet sites where other species will not grow—to frame water views, avoid weeping willow types in open country.
Tupelo . . . . . N	20 to 50	
Red Maple . . . . . N	as 20 to 50	

NOTE: Avoid use of willows in Northeast where the willow blight is prevalent.

TABLE 5—Continued

Tree	Recommended average spacing ft.	Remarks Special character
Poplars—		
<i>P. balsamifera</i> } <i>P. tremuloides</i> } <i>P. eugenei</i> }	15 to 40	Plant in relation to existing poplars of some species—Use for quick screen only. Not recommended for general roadside planting. Never good street trees.
Silver maple		
Canoe and river birch . . . . . N—C S	12 to 30	Plant along shores to frame views.
Birches can be collected to $\frac{3}{8}$ in. caliper during 2 or 3 weeks in spring when buds are opening—Birches should not be transplanted in fall.		
SMALL AND FLOWERING TREES		
The small and flowering deciduous trees usually are of secondary value to tall shade trees in roadside planting. They are mainly to be used to front down existing tall-growing trees, to accent views—and structures—and in other special cases. The smaller deciduous trees may be planted, however, under wires or on narrow right-of-way or otherwise where there are limitations to height and spread of planted trees.		
Flowering trees should be used in connection with low ground covered or grass-covered areas, should not be mixed with high-growing shrubs unless spaced to prevent crowding by surrounding growth. Japanese and Chinese flowering cherries not well adapted to roadside planting. All flowering trees best transplanted in spring.		
The flowering or small trees have the proper main purposes of tying in the roadside to the adjacent landscape. They are used, as may be the flowering trees, in an intermediate position between tall trees in the background and lower shrubs, ground cover or grass along the edge of the roadbed.		
The Hawthorns		
<i>C. cordata</i> . . . . . N—B & B	7 to 12	Naturally appearing groups.
<i>C. mollis</i>		
<i>C. crugalli</i>		
<i>C. punctata</i> , etc.		Plant in connected dense irregular groups—to merge with existing materials of the same or related species. Dry, sunny locations with preferred clay soils. Good thorny hedge plant or screen adapted to meadow country.
The Wild Crab Apples		
<i>Malus coronaria</i> . . . . . N—B & B	12 to 20	Plant in specimens or in loose irregular groups to allow sunlight on all sides of tree (dwarf crab like <i>M. Sargentia</i> spacing 6-10 feet). Use in open meadow or orchard country roadside.
<i>Malus ioensis</i>		
<i>Malus sieboldi</i>		
Wild Plums		
<i>Prunus maritima</i> . . . . . N—B & B	6 to 12	Plums and crabapples best handled B & B.
<i>Prunus americana</i>		
Flowering Dogwood		
<i>Cornus florida</i> . . . . . N—B & B	8 to 20	Plant as specimen or in masses or groups to front down existing woodland, or in studied relationship to existing high trees. Half shaded areas with preferably rich soil.
Flowering dogwood is an excellent small shade tree under wires where tall-growing trees cannot be grown.		
Red Bud		
<i>Cercis canadensis</i> . . . . . N—B & B	8 to 12	Use with and like above in groups of 5 to 7 or more. To be effective, groups should be larger than associated dogwoods.

TABLE 5—Continued

Tree	Recommended average spacing ft.	Remarks Special character
June Berry or Shad Bush... N—B & B	7 to 12	Use along streams or swamp edges, planting in scattered irregular groups with background of hills or other trees.
Blue Beech..... N—B & B	7 to 12	Plant on sites as found in nature.
Grey Birch..... N—C S	10 to 15	Birch in open meadow lands in full sunlight on variety of soils. Hornbeam, silverbell, and hop tree along edge of woodland in moist good soil and for underplanting under tall shade trees.
Hornbeam..... N		
Hop Tree..... N		
Silverbell..... N (2 species)	12 to 20	

## DECIDUOUS AND EVERGREEN SHRUBS

The taller shrubs may be used to prevent erosion on slopes as are the vines and ground-cover plants. They are as a rule in most open-country roadsides the least important class of plant material, and may often be omitted from the planting in open cultivated types of country because the vines and low ground covers are usually more effective in preventing erosion than the higher growing shrubs. The shrubs have their most important function in the tying in of the planted roadside with the adjoining open country landscape. There are two important types of native shrubs from the standpoint of arrangement—(1) Shrubs which naturally occur as specimen plants or in wide spaced thickets, (2) Shrubs which naturally grow in colonies or dense rounded masses closely spaced.

(1) The following group of shrubs will normally be planted with a wide spacing based upon the width of plants at maturity. They may be planted for various purposes to be stated on plan sheets, but their use will usually be based upon the occurrence of the same species on or near the roadside to be planted. These types of shrubs will be planted as specimens or as small groups for accent purposes. Not suitable for ground cover uses as are group 2 following:

## The Viburnums

V. dentatum . . . . .	N—C S	4 to 7	Plant in connected loose groups to front down existing or planted trees.
V. cassinoides . . . . .	N—C S	depending on species used	Can be used under shade for screen or as a "filler."
V. lantana . . . . .	N—C S		
V. lentago . . . . .	N—C S		
V. prunifolium . . . . .	N—C S		

The Viburnums are valuable for flowering effect and fall color on moist sites.

High Bush Blueberry . . . . .	N	5 to 7	Plant as specimens or in loose scattered connected groups.
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Exceptional fall color—use in combination with junipers and low blueberry types, with deciduous holly, alder, or other natural associates.

Sambucus in 2 varieties (Elder)	N—C S	3 to 7	Plant on moist sites, open sun, stream borders, etc. and at culverts and bridges.
Ilex verticillata (Holly) . . . . .	N—C S	5 to 7	Use both staminate and pistillate forms of holly.
Rhus typhina . . . . .	C S	4 to 7	Plant in loose irregular rounded groups for screen purposes or to front down woodlands with naturally associated plants in preferred types of soils.
Rhododendron species . . . . .	N		
Nine Bark . . . . .	N		
Hazel . . . . .	N		
Witch Hazel . . . . .	N		
Bush Dogwoods . . . . .	N		
(except <i>C. paniculata</i> )			

TABLE 5—Continued

Tree	Recommended average spacing ft.	Remarks Special character
Alder.....	C S	On moist sites.
Wild Roses ( <i>Rosa setigera</i> , <i>R. multiflora</i> and other taller growing types).	C S or C F 3 to 5	On well drained drier sites.
<p>This group might be expanded almost indefinitely to include (on suburban roadsides only) the common types of garden shrubs, forsythias, deutzias, bush honeysuckle, mock orange, lilacs, etc., many of which may be used (in landscapes where their types already occur) in the same way as flowering trees. These high-growing shrubs may be used behind and among groups of ground covers (see class 2) for variety and ornamental effect. Ordinarily native and garden types of shrubs should not be combined in the same planting.</p>		
<p>SPECIAL NOTE: Do not plant tall-growing shrubs in central strips of divided highways or at intersections where clear vision may be interfered with.</p>		
<p>(2) The following shrubs of both flowering and non-flowering (inconspicuously flowering) types are used as ground covers and should be planted in dense colonies of rounded irregular outline. Because of their natural close spacing they will be normally used in hundreds or even thousands. These ground covers can be most effective when one or two kinds tend to dominate the planting on one-half mile or more of roadside.</p>		
Sumacs		
<i>Rhus glabra</i> .....	C S 18" to 3'	Plant in dense masses or colonies, in drifts, extending over slopes. Usually 100 to several thousand in each continuous drift or colony.
<i>Rhus copallina</i> .....		
<i>Rhus canadensis</i> .....		
Low Bush Blueberry, Huckleberry.....	C S (soda) 18" to 3'	
<i>Cornus paniculata</i> .....	N C S 2 to 4	
Azaleas.....	N 2 to 4	Plant to extend same types of existing growth on various soils and in full sunlight. Azaleas and <i>Kalmias</i> usually best on fairly moist acid soils in part shade. Sweet fern and bayberry do well on sandy soils.
<i>A. nudiflora</i> .....	N	
<i>A. calandulacea</i> , etc.....	N	
Sweet Fern.....	C S	
Bayberry.....	N—C S	
<i>Rhodora</i> .....	C S (soda)	
Wild Roses (low growing)		
<i>Rosa blanda</i> .....	N—C S or C F 2 to 4	On dry, well-drained sites, in extended drifts or colonies.
<i>Rosa palustris</i> .....	N—C S or C F	
<i>Rosa humilis</i> .....	N—C S or C F	
Laurel		
<i>Kalmia latifolia</i> .....	N or C S B & B 3 to 4	Do not plant on dry sterile slopes. Best on acid soils at edge of pine, oak woods.
<i>Kalmia angustifolia</i> .....	C S 18" to 3'	
<i>Juniperus communis</i> ....	N—C S B & B 3 to 7	On well-drained sites.

Many other native ground covers of this type will be found in each locality. In practice the commoner, easily collected shrubs, such as sumacs and wild roses will usually be used for many hundreds of feet along roadsides to cover slopes and to tie in the roadside with existing growth of the same type as that planted. Laurel in certain regions may be the commonest existing ground cover and in such regions will tend to be used in roadside planting to the exclusion of other types of ground cover. Except for wild roses native ground covers should be collected in spring—not fall season. *Rhododendrons*, *kalmias* and *azaleas* require slightly acid soils.

VINES

The vines are the best of all ground covers since they tend to form a dense mat of root and top growth in a minimum of time. Vines may be divided into two rough classes, (1) Strong-growing rampant types, (2) Slow-growing types. All vines should be nursery grown unless otherwise stated.

TABLE 5—Continued

Tree	Recommended average spacing ft.	Remarks Special character
(1) The following partial list of vines covers certain types valuable for roadside planting. Most of these vines (if heavy rooted 2- to 3-year old plants can be secured) can be spaced 4' to 7' apart. In general, vines should be planted in good topsoil, larger trenches or pockets being desirable on hot sunny slopes with poor soils than on partly shaded slopes with good soils. It will be understood that slope flattening and rounding must always precede all planting, particularly of ground covers.		
The Wild Grapes..... Vitis cordifolia Vitis labrusca Vitis vulpina Vitis rupestris, etc.	5 to 8	Adapted for use on high, rough, rocky slopes where large pockets can be dug for topsoil. Do not use rapid-growing vines on same planting site with shrubs or flowering trees.
Actinidia arguta.....	5 to 8	
Honeysuckle..... Lonicera japonica and other species	4 to 6	Best adapted to clay and loam soils, and on north and east slopes. In clays, sands and gravels become established on sunny south or west slopes very slowly. Covers bare soil rapidly after first season. This vine ideal ground cover on islands. A very strong grower. Do not plant honeysuckle in association with shrubs or low trees. Not hardy north of Massachusetts along coast.
Bittersweet..... 2 species Celastrus scandens Celastrus orbiculatus	4 to 5	Bittersweets tend to grow erect for first few seasons before spreading over ground. Usually slow growing first two years after planting. Best planted on partly shaded slopes, but will stand heat and drought after becoming established.
Clematis..... C. virginiana C. paniculata Akebia quinata	4 to 7	Best planted on north and east slopes and on fairly moist locations. Difficult to establish on hot, dry slopes. Requires large pockets of good topsoil for good flowering effect.
Virginia Creeper, etc..... Ampelopsis quinquefolia Ampelopsis aconitifolia Ampelopsis heterophylla Bignonia radicans Lyceum chinense	3 to 7	Good rapid-growing vines. Vigorous climbers, some with good fall color. Tend to grow rapidly in length but some species do not always form dense wide mats as rapidly as honeysuckle or wild grape.
(2) Slow-growing vines. This group of vines is not so well adapted to roadside use as the above. This slow growth may have definite advantages in ground cover planting in small traffic islands, or in planting vines on stonework, bridge, or culvert parapets and headwalls, etc., where it is not desirable to completely hide stonework.		
Wichuraiana Rose.....	4 to 6	A low, flat-growing vine which trails rather than climbs. Adapted to fairly rich soils on slopes which are not too hot or dry. Excellent ground cover on traffic islands.

Common hybrid climbing roses are not usually recommended on open country roadsides except near homes and gardens.

TABLE 5—Continued

Tree	Recommended average spacing ft.	Remarks Special character
English Ivy ( <i>hedera helix</i> ).....	2 to 4	Slow-growing evergreen vines which climb stonework wall. <i>Ampelopsis</i> species slow to grow compared to other of genus. Adapted for use on bridges and retaining walls.
Euonymus— <i>radicans</i> ..... and other species.....		
Boston Ivy		
<i>Ampelopsis tricuspidata</i>		
Geranium creeper		
<i>A. tricuspidata lowii</i>		
Periwinkle		
<i>Vinca</i> ..... N or C S	18" to 2'	Slow-growing though fine flowering evergreen ground covers. Trailers rather than climbers.
Bearberry		
<i>Arctostaphylos</i> ..... C S or N	1' to 18"	Bunch berry is a small shrub rather than a vine. This group all are slow-growing evergreen ground covers. If available in good field collected sods, first two may be used for roadside erosion control on limited areas.
Bunchberry		
<i>Cornus canadensis</i>		
Partridgeberry		
<i>Mitchella repens</i>		

The bearberry, bunchberry and partridgeberry are of very refined character. Not adapted for use on ordinary roadside conditions. Can only be recommended on limited sites, i.e., as a ground cover on traffic islands, near monuments or in other special situations of relatively small area.

1. GENERAL NOTE: As a rule ground cover planting cannot readily be established except on well-rounded slopes 1 on 1½ or flatter. On dry sterile slopes mulch between plantings serves to conserve moisture and to control weeds.

2. As a rule grass seeding or sodding should be done mainly on roadside areas which can be readily mowed. Since machine mowing cannot be done on slopes steeper than 1 on 3, or 1 on 4, ground covers are indicated wherever slopes are higher than 5 to 10 feet and steeper than 1 on 3.

3. IMPORTANT NOTE: Use low colony-forming shrubs or vines on islands of divided highways and intersection triangles to replace grass. On steep slopes use hay, straw or other mulch between planted vine or shrub individual plants or groups, or seed pasture grasses or cover crops in space between planting.