holding these in place will be the subject of a project outline for the current year.

DIVISION III—EDUCATION, SPECIFICATIONS, AND PUBLIC RELATIONS, P. H. ELWOOD, HEAD, IOWA STATE COLLEGE

The need for a course of study for in-service-training of employees of the several highway departments, especially as it relates to roadside divisions, was stressed. The value of regional courses at state universities was forcibly portrayed and a furtherance of this procedure was heartily recommended. Such a short course on highway development is now an annual feature at Ohio State University with the cooperation of the State highway department. Sixteen neighboring states were represented at the Sixth Annual Short Course. The University is planning to combine the Seventh Annual Short Course with the Road School to form a cooperative Highway Engineering and Development Conference.

In order to expedite the handling of various projects contemplated for the current year, the Committee hopes to be able to reorganize the regional coordinating organization similar to the operation before the War. This offers an ideal clearing house for both this Committee and the Committee on Roadside Development of the American Association of State Highway Officials.

Organization of Personnel

The typical state, municipal, and federal qualifications for professional grades of landscape engineers, landscape architects, supervisors, foremen, et cetera, as outlined in the 1943 Report of the Committee, is offered as a basis for continuing study, as well as for organization procedure in the various states, especially those engaged in forming new organizations.

In conclusion, the Committee re-emphasizes the belief that no one group of engineering specialists or technicians can solve the many inter-related problems involved in "Complete Highway" design. This calls for complete cooperation between all members of the staffs of the several state and federal highway organizations. This is the only path to the common goal of safer highway service to the public.

STABILIZED SHOULDERS WHICH WILL SUPPORT VEGETATION

Progress Report

By Harry H. Iurka

Landscape Architect, New York Department of Public Works

SYNOPSIS

Stabilized shoulders were built on four projects on Long Island in 1945 and 1946, and seeded with about 50 different kinds of grasses, grains, legumes and other plants to investigate the feasibility of growing vegetation on such shoulders.

Details of the construction are given and the results to date are discussed. It is indicated that vegetation can be grown on mechanically stabilized shoulders, which will support occasional use by traffic.

The plants rated best after two seasons are Red Fescue, Smooth Brome, Orchard Grass, Redtop, Perennial Rye, Wild White Clover, Birdsfoot Trefoil, Grim Alfalfa and Yarrow.

An interesting observation is that many practices such as rolling and raking, usually considered essential, may be eliminated in this shoulder work.

The soil was sandy with approximately less than 5 percent passing the No. 100 sieve. The stabilizing process consisted generally in adding about 1 in. of binder soil containing approximately 10 percent passing the No. 200 sieve and mixing with 6 in. of the soil in place. Average dry densities in the top 6 in. ranged approximately from 116 to 132 lb per cu ft.

A study on the construction of mechanically stabilized road shoulders which will support vegetation is being conducted along state highways on Long Island. The locations of the projects are shown on Figure 1.

Field test areas have been established which are designed for study and correlation of the requirements for a good turf growth with the requirements for a mechanically stabilized shoulder.

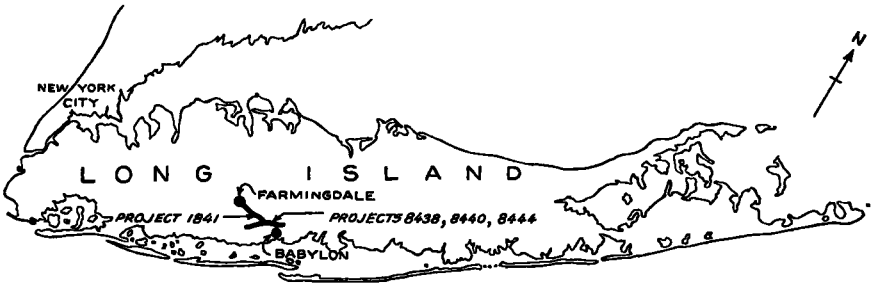

Figure 1. Location Map

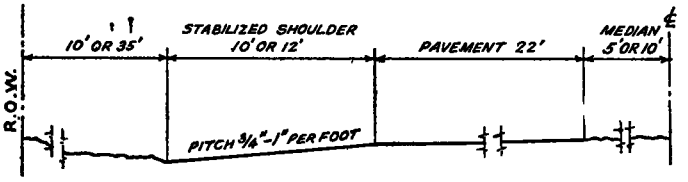

Figure 2. Typical Section

Total Traffic Count
August 10, 1946. 7 A.M. 7 P.M. both roadways

On project no.	*Count*
1841	5230
On projects nos. 8438, 8440, 8444	7194±

Periodic inspections have been made and records kept of the comparative results of various treatments for the establishment of turf on the stabilized shoulders. Analyses of the shoulder soils have been made to determine grading, density, compaction, and pore space and tests will be made in the spring of 1947 to determine the bearing capacities.

DESCRIPTION OF FIELD TESTS

The first project was built in the spring of 1945. This was purely a test project as the shoulder had been stable and grew a fair turf.

Three projects were built in the spring of 1946. These were sections of shoulder which had been unstable, at least during a part of the year and which were improved by the construction while serving as tests. The soil material on one of these was very high in fines and on the other two, was very sandy.

The plan of these tests was approximately the same as that used for the project built in 1945. The shoulder was divided into sections and each of these subdivided into beds in order to study the various factors of the test. A standard treatment was used throughout each project except for the variation of one factor, for the study of that factor. Figure 2 shows a typical cross section.

Figure 3 gives pertinent meteorological data covering the period of the tests and soil size distribution curves of typical samples of the top 3 in. of the stabilized material are given for three projects in Figure 4. ("Top three inches" refers to the portion from the surface of the soil, top growth of turf having been removed, to 3 in. below the soil surface.)

PLANTS USED

All Projects:

Nearly fifty different kinds of grasses, grains legumes, and other plants were seeded

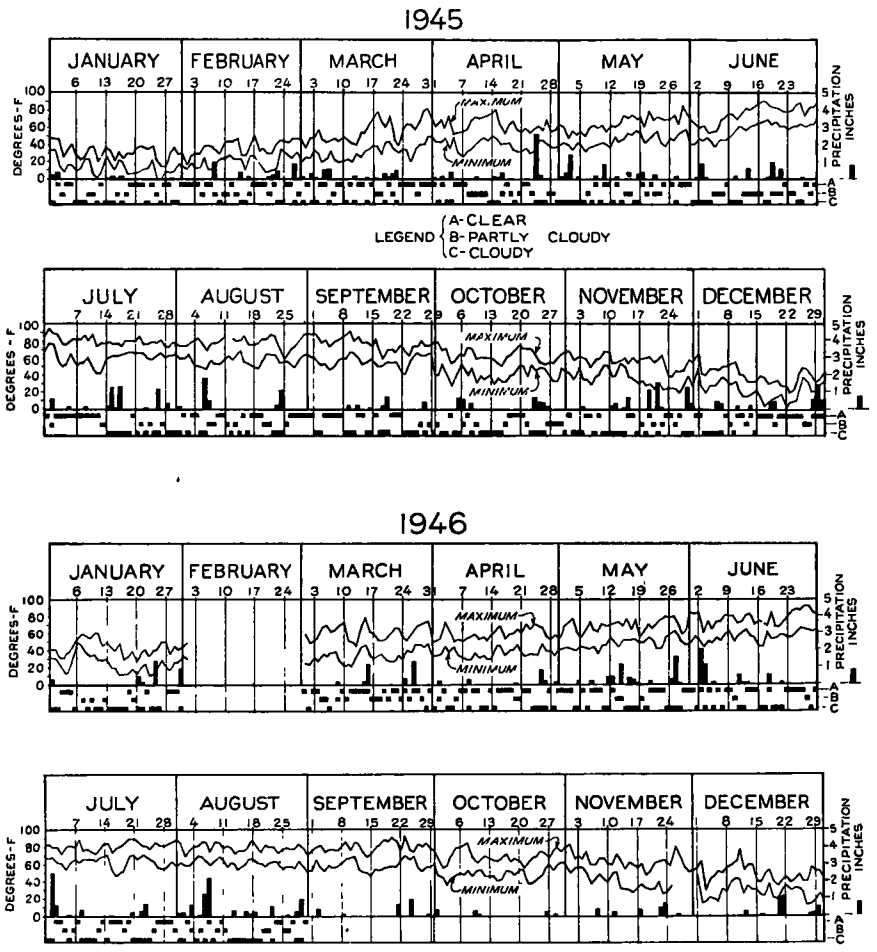

Figure 3. Meteorological Record Made from the Records of Dr. Louis Pyenson Taken at Farmingdale, Long Island, New York

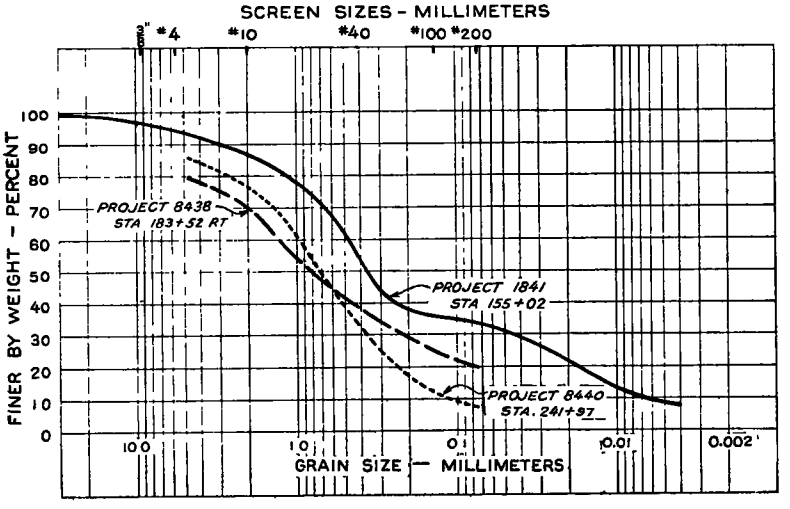

Figure 4. Sieve Analysis of Samples at 0- to 3-in. Depth

in tests of variety of plant and most of these were seeded on all projects.

Project 8444:

The seed mixture used for most of this project was:

	%
Red Fescue	74
Colonial Bent	2
Redtop	20
Legumes	4

Projects 1841, 8438, 8440:

The seed mixture for general use on these projects was:

	%
Red Fescue	48
Smooth Brome	33
Redtop	8
Colonial Bent	4
Canada Blue	4
Legumes	3

PROJECT 8444

This project (3,000 lineal ft of 12 ft wide mechanically stabilized shoulder built in the spring of 1945) was reported to the last annual meeting of the Highway Research Board (1945). Since then, additional work has been done on the "season of seeding" test, inspections have been made and comparative results noted at regular intervals, and density determinations have been made (in November 1946) at the same locations as those made in December 1945.

RESULTS

Density

The density determinations are summarized as follows for the top 6 in.[1] in Table 1.

The density determinations made in 1946 by the New York State Department of Public Works Bureau of Soils Mechanics were taken in increments of 3 in. in depth to a depth of 9 in. at several locations. The top 3-in. in all of these is less dense than the next 3-in. increment. A decrease in density in the top 3 in. during the past year may be indicated. (See Table 2.)

[1] All densities referred to are those determined in November 1946, unless otherwise specified.

There has been no failure of the shoulder under traffic.

Vegetation as Affected by Factors of Study

Compaction: Satisfactory turf is growing on the stabilized soil shoulder where a dry density of 128.3 lb per cu ft was determined for the top 3-in. layer in November 1946.

Poor turf is growing where dry densities as high as 134.7 for the top 6 in. were determined in December 1945.

Type of shoulder: Vegetation has failed on the shoulder built of 4-in. stone course with 1-in. top soil on top and is poor on the 4-in. cinder course with 1-in. top soil on top; the stone is unraveling. The turf on the mechanically stabilized shoulder is satisfactory.

TABLE 1

DENSITIES, PROJECT 8444

Location of Test Hole	Dry Density, lb per cu. ft.	
	Dec. 1945	Nov. 1946 (Approximate)
Average of 4 tests 2 ft off pavement	130.8	126.4
" " " " 6 ft " "	120.2	119.7
" " " " 10 ft. " "	116.1	117.8
Maximum density	134.7	130.3

It is better than it was the first year after construction and better than the original turf cover before stabilization of the shoulder.

Amendments: There is no conspicuous difference in the growth of turf due to various treatments with organic materials, fertilizer or lime.

Mulches: There is no conspicuous difference in the growth of turf due to various types of mulches used.

Variety of Plant: Of the 33 varieties of plants sown, Perennial Rye, Smooth Brome, Orchard Grass, Red Fescue, Redtop, Meadow Fescue are the best of the grasses and Wild White Clover, Birdsfoot Trefoil and Grim Alfalfa are the best of the legumes in the order given.

Chewings Fescue was crowded out by Perennial Rye where the proportion was ⅔ Fescue to ⅓ Rye by weight in the mixture.

Rate of Seeding: No difference is apparent due to variation in rate of seeding from a minimum of 25 lb per acre in increments of 25 lb to a maximum of 125 lb per acre.

Season of Seeding: Turf from seeding done in October 1945 and February 1946 is slightly better than turf from seeding of April and June 1945.

Method of Seeding: Broadcasting seed without any other operation resulted in just as good turf as that resulting from removing weeds, raking, seeding, raking and rolling. This seeding was done October 19, 1945. Broadcasting seed on February 18, 1946 resulted in a good turf.

and water added to give approximately optimum moisture content. Fertilizer was included in the water. The material was then harrowed to mix completely, shaped and then compacted with a Gallion power roller giving 285 lb pressure per inch of tread width. Part of the shoulder was raked before seeding. Seeding was done with a spreader and part of the shoulder was rolled after seeding, using the Gallion with the roller empty of water (weight = 3½ ton, 42 in. width).

TABLE 2
SHOULDER STABILIZATION DENSITY REPORT
Project No. 8444

Station	Offset	Depth	Dec. 1945	Nov. 1946					
			Dry Density Top 6 in.	Wet Density	Dry Density	Moisture Content	Average Top 6 in. Approx. Dry Density	Average Top 6 in. Approx. Moisture Content	Condition of Turf
	ft	*in.*	*lb/cu ft*	*lb/cu ft*	*lb/cu ft*	%	*lb/cu ft*	%	
457+00	2 0	0–3	126 8	125 1	116 4	7 6	119 7	8 9	Poor
		3–6		135 7	122 9	10 2			
		6–9½		129 0	114 9	12 2			
459+52	2 0	0–3	130 3	129 0	117 8	9 4	124 9	7 4	Good
		3–6+		139 0	132 0	5 3			
		6+–9		141 0	134 0	5 1			
459+52	6 5	0–3½	124 5	121 5	111 5	9 0	120.8	7 8	Good
		3½–6		138 5	130 0	6 5			
		6–9		142 1	135 5	5 0			
459+50	11 0	0–3	115 1	120 7	112 0	7 9	123 9	6 4	Good
		3–6½		142 3	135 7	5 0			
		6½–9½		139 5	133 5	4 5			
458+60	2 0	0–3½	134 7	130 0	121 4	7 1	130 3	6 1	Poor
		3½–6½		146 1	139 1	5 1			
		6½–9½		137 1	130 5	5 0			
458+60	7 0	0–3½	116 0	120 9	109 6	10 2	118 9	8.0	Good
		3½–6½		135 7	128 2	5 8			
		6½–9		135 1	129 5	4 3			
458+60	10 5	0–3	113 7	120 6	112 7	7 0	117 9	5.8	Excellent
		3–6½		128 9	123 1	4 7			
		6½–9		130 0	125 7	3 5			
470+19 5	2 0	0–6½	130 0	135 8	128 3	5 8			Fair
	6 0	0–6½	118 0	124 6	116 9	6 5			Good
	10 0	0–6½	118 0	122 7	116 1	5 7			Excellent
472+50	2 0	0–6½	128 3	132 6	121 9	8 9			Fair
	6 0	0–6	122 0	132 8	122 1	8 7			Fair
	10 0	0–6	117 4	122 1	113 1	8 0			Good
483+00	3 0	0–6½	119 1	133 1	125 1	6 3			

PROJECT 8440

Soil Material

Project 8440 is a section of shoulder approximately 600 ft long and 12 ft wide which had a sandy soil containing less than 3 percent of material passing the No. 200 sieve and 5 percent passing the No. 100 sieve. It was unstable under traffic. There was no vegetation.

Construction

The binder soil available contained 11 percent material passing the No. 200 sieve. About 1 in. of binder soil was spread over the shoulder area, disced in to a depth of 6 in.

A portion of this shoulder was used for a test of season of seeding and a portion for test of kind of mulches. Over the seeded areas not used for a test of the variety of mulches, salt hay was spread by hand at the rate of about two tons per acre and this was then covered with soil which was spread by a sanding machine fed from a truck to which it was attached.

RESULTS

Density

The maximum dry density obtained by analyses in November 1946 were 129.2 for the top 3 in. and 135.0 lb per cu ft for the next 3 in.

The density for the increment from 6 to 9-in. depth at this point was 125.8 lb per cu ft.

The densities for the top 3 in. are in all cases less than those for the second 3-in. depth. (See Table 3.)

The shoulder has been stable under traffic.

Vegetation as Affected by Factors of Study

Compaction: A satisfactory turf developed under the entire area but the densities are not very high except for one location where seeding has not yet been done as this is reserved for a part of the test of season of seeding. The average dry density for the top 6 in. is 124.7 lb per cu ft.

followed by an unusual period of rainfall which probably accounts for the success of that particular seeding.

Method of Seeding: Omission of the raking, rolling, or of raking and rolling had no affect on the resultant turf. The seeding of October 1st was done by broadcasting seed without preparation of the seed bed and then spreading sand over the seed, using a sand spreader fed from a truck to which it was attached. This was very successful.

PROJECT 8438

This project is a section of shoulder approximately 1,000 ft long and 12 ft wide on each side of a road running east and west. The soil was sandy, one sample of it containing only 4 percent of material passing the No. 100 sieve. This portion was not stable under traffic. There was very little vegetation.

TABLE 3
SHOULDER STABILIZATION DENSITY REPORT
Project 8440 Nov. 1946

Station	Offset	Depth	Wet Density	Dry Density	Moisture Content	Average Top 6 in. (Approx.)		
						Dry Density	Moisture Content	Condition of Turf
	ft	*in.*	*lb/cu ft*	*lb/cu ft*	%	*lb/cu ft*	%	
238+49	2 5	0 -3	131 0	123 0	6 8	125 5	5 4	Good
		3 -6½	133 0	128 0	4 0			
		6½-9½	129 5	123 8	4 4			
239+62	2 5	0 -3	137 7	129 2	6 5	132 1	6 1	Not seeded
		3 -6½	142 5	135 0	5 7			
		6½-9½	129 9	125 8	3 1			
241+97	8 5	0 -3½	121 9	116 9	4 2	118 5	4 4	Fair
		3½-6½	125 4	120 0	4 5			
		6½-9	115 0	108 7	5 9			
242+12	8 5	0 -3½	129 5	120 7	7 2	122 5	5 6	Fair
		3½-6½	129 7	124 3	4 1			
		6½-8½	139 9	132 5	5 5			
Averages						124 6+	5 3+	

Mulches: Salt hay in various depths, old grass, pine needles, beech leaves, cinders, chicken manure and peat moss, sand and stone chips were used as mulches in test beds along with two check beds. There is no difference apparent, due to this variation in treatment.

Variety of Plant: One section of shoulder was seeded with Red Fescue only. This section developed a much better turf than the remainder of the shoulder which was seeded with a mixture of grass and legumes having a large percentage of Red Fescue.

Season of Seeding: The general area was seeded April 25th. One bed was seeded July 21st, another August 27th and another October 1st. These have all resulted in a better stand than that from the original seeding of April 25th. The seeding of July 21st was

Binder soil containing 10 percent passing the No. 200 sieve was added and mixed to a depth of 6 in. Fertilizer and lime were spread by hand and incorporated to the full 6-in. depth during the mixing process. Water was then added to approximately the optimum moisture content, the material mixed, shaped and compacted. The shoulder was then raked and seeded in the usual manner, rolled by the power roller, empty of water, salt hay mulch spread and covered lightly by soil, except as noted below.

Portions of the shoulder were used for the tests of the various factors as listed under results.

RESULTS

Density

The maximum dry density obtained was 130.0 lb per cu ft for the top 4 in. and 132.0 lb per cu ft for the depth from 4 in. to 7 in. The average density for the 6-in. depth of four tests is 125.7 lb per cu ft. The top 3 in. is less dense than the next lift of 3 in. in three of the four test holes. (See Table 4.)

The shoulder has been stable under traffic.

Vegetation as Affected by Factors of Study

Compaction: There is a good growth of turf at the location where a maximum density of 130.0 was determined.

Amendments: The use of tankage plus muriate of potash and of chicken manure and peat moss incorporated in the 6-in. stabilized course gave better results than 5:10:5 fertilizer when used at rates giving approximately comparable applications of the various elements.

Mulches: There was no conspicuous difference of turf due to the type of mulch used.

Variety of Plant: Red Fescue and Redtop were the grasses conspicuously successful from the general seeding. Weeping Lovegrass, Field Brome, Perenniel Rye, Italian Rye, Washington Brome, Red Fescue, Orchard Grass, were the best of thirty varieties seeded in the order given within the area of test of varieties.

Rate of Seeding: There is no difference due to doubling or tripling the standard rate of seeding which was 100 lb per acre.

TABLE 4
SHOULDER STABILIZATION DENSITY REPORT
Project 8438 Nov. 1946

Station	Offset	Depth	Wet Density	Dry Density	Moisture Content	Average Top 6 in. (Approx.)		
						Dry Density	Moisture Content	Condition of Turf
	ft	*in.*	*lb/cu ft*	*lb/cu ft*	%	*lb/cu ft*	%	
181+88 L	2 5	0 –4½	136 3	130 0	5	131 0	4 2	Good
		4½–7½	136 5	132 0	3 4			
		7½–9	137 8	132 8	3 6			
181+88 L	5 5	0– 3½	135 0	128 2	5.3	131 9	4 2	Good
		3½–7½	140 0	135 5	3 2			
		7½–9½	132 7	129 5	2 4			
183+52 R	3 0	0 –3	131.0	119 5	9 7	123.2	8 4	Poor
		3 –6	136 0	126 8	7.1			
		6 –9½	141 0	135 0	4 2			
187+06 R	2 5	0 –3	132 5	119 1	11 1	116 6	13 0	Good
		3 –6	131 0	114 1	14 8			
		6 –9½	136 2	128 0	6 2			
Averages..						125 7	7 4+	

PROJECT 1841

Soil Material

This project is a highway running north from Babylon through an area of sassafras sandy loam soil. At the time of the construction of the road 6 in. of top soil brought from outside sources was spread on the shoulders. In the spring, at the time frost was leaving the ground, this shoulder was badly rutted by traffic and was frequently so unstable that vehicles were mired. Borings indicated that the top soil was underlain by sand along a portion of the road. A section of 3,000 ft of this portion was chosen for the test. Analysis of the top soil indicated a content of silt and clay of 60 percent and of the sand underlayer of 5 percent passing the No. 200 sieve. Some areas were not positively drained and had an impervious layer of soil under the sand layer. The shoulder had "built up." There was an excellent turf.

Plan

On all the other projects the soil material used for stabilizing approached the lower limiting grading curve specified by A A S H O for stabilized base and surface courses. It was proposed to construct the shoulder on this project so that the material for the stabilized course would approach the upper limiting

curve with the expectation that greater densities would be obtained as well as a larger

TABLE 5

Item	Vehicle	Amount per acre
Lime	Hydroxide	¾ ton
Fertilizer	9:9:5	1 ton
Seed	Mix A	120 lbs.
Mulch	Salt Hay	2 tons

of from 4 to 6 in. of top soil and 6 in. ± of sand underlaying this top soil were plowed and disced. Some sand was brought in from outside sources and added where necessary. This material was then thoroughly mixed by discing. The top 6 in. of a portion of the shoulder was bladed aside to permit rolling of the subgrade and was then replaced. Fertilizer and lime were added in the process of adding water to obtain optimum moisture content, except in those areas where tests of organic

TABLE 6
SHOULDER STABILIZATION DENSITY REPORT
Project 1841 Nov. 1946

Station	Offset	Depth	Wet Density	Dry Density	Moisture Content	Average Top 6 in. (Approx.)		
						Dry Density	Moisture Content	Condition of Turf
	ft	*in.*	*lb/cu ft*	*lb.cu ft*	%	*lb.cu ft*	%	
155+02	3.5	0 - 3	134 2	122 5	9 9	123.0	10 6	Excellent
		3 - 6	137 7	123.5	11 3			
		6 -10	132 0	119 0	10 9			
156+95	3	0 - 3.7	133.5	124 2	7 5	125 8	8.1	Excellent
		3 7- 6	138.3	127.3	8 8			
		6 - 8 5	134 0	129.6	3 4			
161+03	3.3	0 - 3	128 3	117.4	9 2	118 3	10 1	Good
		3 - 6	132 8	119 2	11 1			
		6 - 8 5	130 5	120 2	8 5			
170+23	7	0 - 3 3	133 6	122 7	8 8	120 3	10 4	Good
		3 3- 5 6	132 0	117 8	12 0			
		5 6- 9 0	136 5	119 0	14 8			
170+31	2	0 - 3½	137 2	125 3	9 5	122 3	10 4	Good
		3½ - 6	133 0	119 2	11 4			
		6 - 9	139 0	122 0	14 0			
173+82	2 5	0 - 2¾	134 8	120 6	11 7	123 2	11 0	Good
		2¾ - 6	138 7	125 7	10 4			
		6 - 9	136 5	119 2	14 6			
180+00	5 0	0 - 3	154 0	120 8	11 1	122 6	11 5	Good
		3 - 6½	139 0	124 3	11 9			
		6½ - 9	135 3	121 2	11 6			
Averages		0 - 3+		121.93	9 7-	122.2	10 3	
		3+- 6+		122 43	11 0-			
		6+- 9+		121 45	11 1+			

proportion of finer material in the mixture, so that additional information could be obtained on the minimum pore space or maximum density permitting plant growth. Improvement of the stability of the shoulder is expected except in those areas where impervious sub-soil, together with the lack of positive drainage creates water pockets.

It was planned to vary compaction in certain areas along the shoulder. The standard treatment, except where varied for study of the factors of the test is given in Table 5.

Construction

Sod and the "built up" portion of the shoulder were bladed off. The resulting depth fertilizers and of top application of fertilizer were made. The soil material was then thoroughly mixed,, shaped and compacted. Most of the shoulder was raked before seeding. Seeding was done with a seeder and a part of the seeded area rolled. A mulch of salt hay was spread by hand and covered by a light layer of soil, spread by the sander. Portions of the shoulder were overseeded before mulching, after mulching and after mulching and spreading soil.

RESULTS

Density

We failed to obtain the expected greater density, the average of seven tests for the top

6 in. being only 122.2 lb per cu ft, the maximum 125.8. The top 3 in. was less dense than the next 3 in. in five of the seven test holes. (See Table 6.)

Vegetation as Affected by Factors of Study

Amendments: There is no conspicuous difference due to the use of organic fertilizer as compared with inorganic fertilizer. The area which received surface application of fertilizer showed a quicker germination and a more vigorous early growth but this effect was obscured by early summer and thereafter.

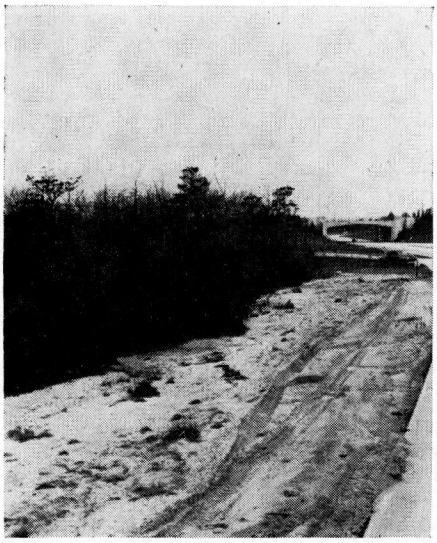

Figure 5

Mulches: There is no conspicuous difference due to the variety of mulch used although beech leaves resulted in a slower development of turf.

Variety of Plant: Creeping Red Fescue, Weeping Lovegrass, Redtop, Meadow Fescue, Perennial Rye were the best of the plants seeded in the order given. Competition with weeds was more of a problem than growth in a dense soil in this test. In the general seeding Red Fescue was the most successful.

Season of Seeding: On October 1st portions of the shoulder were seeded by broadcasting without preparation of seed bed and then covered with sand spread by the sander. The resulting turf is better than that from the seeding of last spring.

Method of Seeding: Raking before and (or) after seeding, and rolling had no affect on the turf resulting. Overseeding before and after mulching had no affect on resulting turf, although the germination was much faster where the overseeding was done on top of the light soil cover placed on the mulch.

DISCUSSION

All the test shoulders were built flush with the surface of the pavement and sloped from $\frac{3}{4}$ in. to 1 in. per foot away from the pavement.

Where vegetation did not develop adjoining the pavement the level of the soil was very soon lower than the pavement by $\frac{1}{2}$ in. to 1 in. or more. It might not be good practice to construct the shoulder lower than the pavement, unless a transition of bituminous material was used.

Figure 6

Failure of the turf resulted from more than occasional use. Mail delivery once daily caused failure of the turf on the wheel tracks.

Soil which did not contain weed seed supported a more pure stand of the plants sown than did a topsoil containing weed seed. It remains to be determined which will be the better turf in time.

The lesser densities of the top 0 to 3-in. layer of stabilized shoulder soil as compared with the 3-in. to 6-in. layer after a season's growth seems to indicate a decrease of density in the former, possibly due to the effect of plant growth since the compaction was done in lifts of 6 in. or more. Further study of this subject is needed and if the assumption is correct our method would be changed to build a stabilized course with 2 in. or 3 in. of soil over it which would be material satisfying the specifications for stabilizing but would not be compacted to maximum density.

Density change of the stabilized course might be a factor in build up of the shoulder.

Mr. Earl Bennett, Principal Engineer of the N. Y. Bureau of Soils Mechanics advises us that we may include up to 6 percent organic in our particular soils for stabilized shoulders without harm to stability.

The three photographs of Project 8440 (Figures 5, 6, 7) illustrate the improvement of the shoulders by stabilizing and seeding.

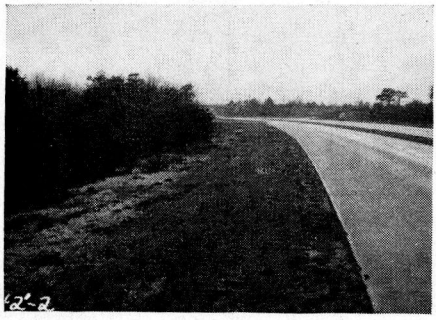

Figure 7

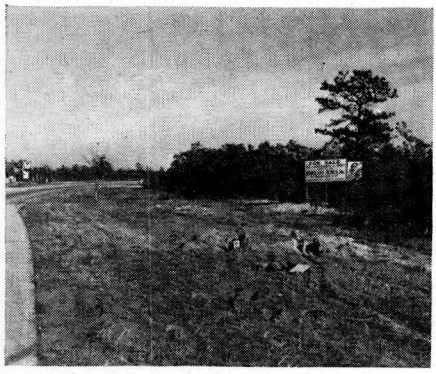

Figure 8

Figure 5 shows the hazardous condition existing before treatment. Figure 6 shows the same shoulder stabilized by incorporation of binder soil and compaction just before seeding. Figure 7 shows the turf existing on the same shoulder the following November.

Figure 8 is a photograph of the same project facing in the opposite direction, which is evidence of the stability of the shoulder. A car ran off the shoulder and was stuck in the sand of the backslope. A wrecker stood on the shoulder to hitch onto the car. Note the marks on shoulder and pavement made by spinning of the wrecker's wheels.

The "before" and "after" photographs of Project 1841 (Figs. 9 and 10) showing the

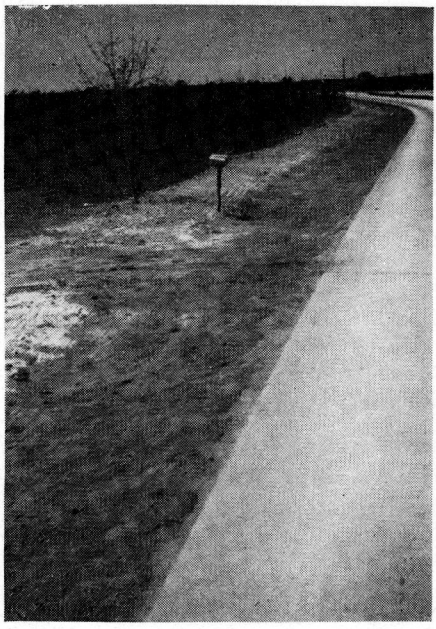

Figure 9

Figure 10

intersection of an unimportant side road indicate the imp ortance of understanding the

value of a turf cover. There is no turf in the foreground where the shoulder is crossed by several cars each day. There is no turf in the track used in delivering to the mailbox once a day. But there is an excellent turf beyond this where the shoulder is subjected to occasional traffic.

Mechanical analyses of five samples of the stabilized soil of Project 1841, not completed in time for inclusion in this report, indicate that we have obtained a soil material which varies from 26 to 42 percent material passing the No. 200 sieve. All the fractions over 0.35 mm. of all the samples are within the limiting size distribution curves for Type A material (AASHO Specif. M56-42).

Mechanical analyses of three samples from Project 8438 show these to be within the limiting curves and of three samples from Project 8440 show these to be within the limiting curves except that the percentages of the fractions retained on No. 4 sieve and coarser are too great.

CONCLUSIONS

The study to date seems to indicate the following conclusions for the conditions encountered on Long Island.

1. Mechanically stabilized soil shoulders can be built which are quite stable under traffic and which will support a fair turf growth subjected to occasional use by traffic.

2. Many of the cultural practices, such as raking and rolling, considered essential in establishing turf may be eliminated with resultant economies and no decrease in the quality of turf required for highway shoulders.

3. The use of granular material such as stone or cinders for shoulders on Long Island is not economically sound where soils such as those reported are readily available.

4. Adequate drainage is essential.

5. Any type of mulch material is effective.

6. The most economical yet effective method of seeding used to date has been the broadcasting of seed on an unprepared seed bed and covering with a light layer of sand which is an effective mulch.

7. "Topsoil" is not needed to secure a fair turf.

8. The varieties of plants rated best after two seasons growth are Red Fescue, Smooth Brome, Orchard Grass, Redtop, Perennial Rye, Wild White Clover, Birdsfoot Trefoil, Grim Alfalfa, Yarrow. The Fescue has improved during the past season.

9. Rosen Rye, seeded lightly, has been very satisfactory as a temporary grass for spring seeding which will germinate quickly, thereby preventing surface erosion of the shoulder, and will not compete with the permanent plants.

10. Rate of seeding, season of seeding and kind and amount of fertilizer are of relatively lesser importance within reasonable limits.

FUTURE STUDY

In further study it is planned to test the actual bearing value of the test shoulders in the spring of 1947 when the frost is coming out of the ground and the soil is saturated. A truck loaded as necessary to cause failure will be used.

The indication, that the top of the stabilized course decreases in density with time, possibly due to plant growth, will be investigated.

A study of the reasons for "build up" of shoulders has been started. Cross sections have been taken at various locations reading to hundredths at 2-ft intervals across the shoulder and density determinations have been made near these locations. These readings will be repeated to determine the effect of season, weather, frost, plant growth, silting and other factors which may be suggested.

Acknowledgements

Our appreciation of the help given by various experts is hereby expressed particularly to the following:

Dr. John Lamb, Cornell University and Soil Conservation Service
A. F. Gustafson, Cornell University
E. B. Coffman, Soil Conservation Service
Dr. M. M. McCool, Boyce Thompson Institute.