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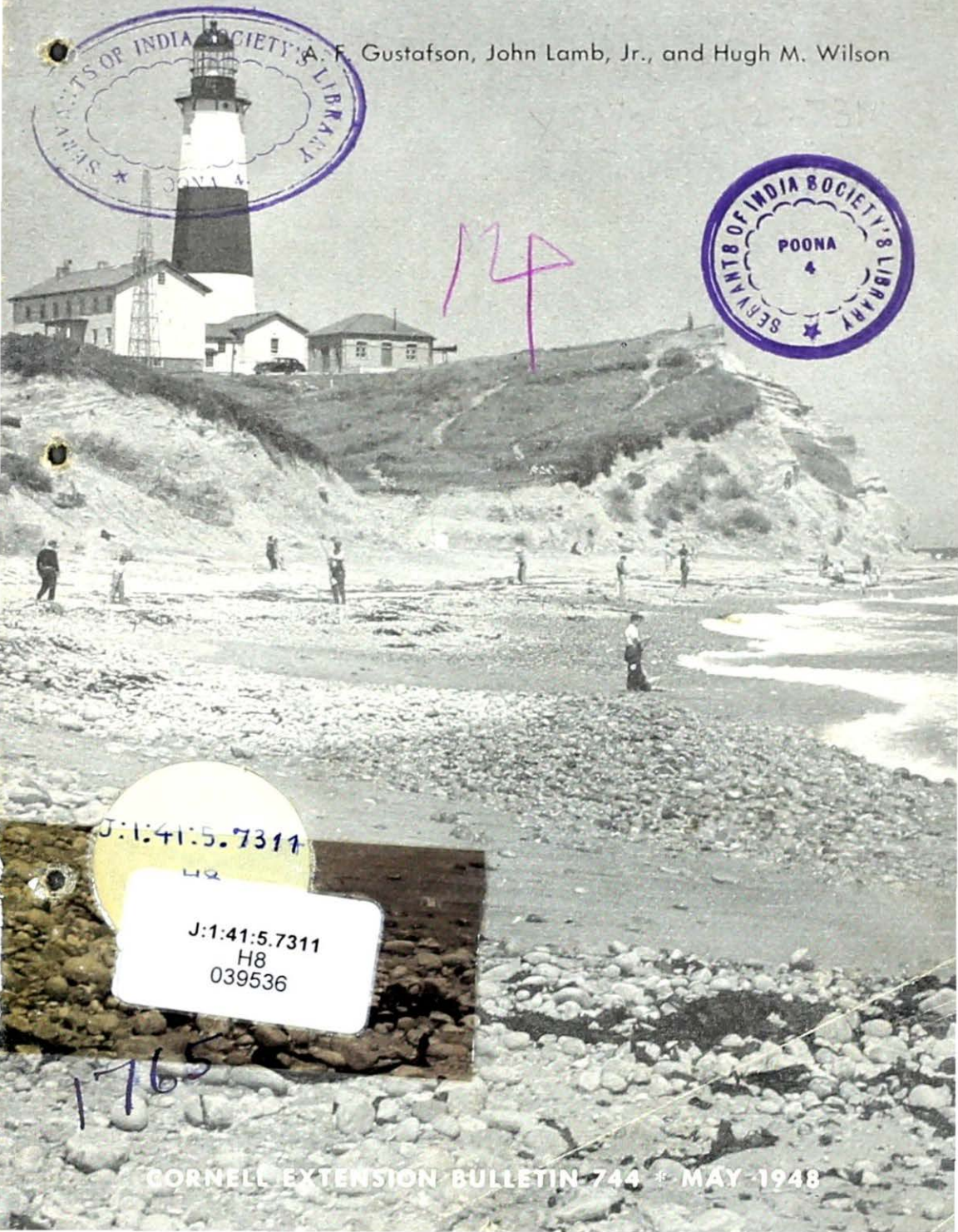
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# SOIL EROSION ON LONG ISLAND

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# Control of Soil Erosion on Long Island

A. F. GUSTAFSON, JOHN LAMB, JR., AND HUGH M. WILSON

**L**ONG Island is the largest island on the eastern coast of the United States. The main island is about 120 miles long and 20 miles wide. The island rests on a rock foundation that slopes about 64 feet to the mile in a general southeasterly direction. In Nassau County the rock foundation is about 400 feet<sup>1</sup> below the north shoreline and about 2000 feet below the south shoreline. The material between this rock floor and the surface of the island consists of successive layers of sand and gravel with lenses of clay. These layers of sand and gravel serve as aquifers, or underground storage reservoirs for fresh water. Here, rain-water is stored and may be drawn upon for farm and village water supplies and for irrigation.<sup>1</sup>

A few years ago a definite change took place in Long Island agriculture. At that time farms were mechanized. Heavy power machinery displaced horses. Brushy hedgerows were pulled out to make longer rows for more efficient use of larger implements. The hedgerows had served as windbreaks. Their removal exposed the surface soil to the action of high-velocity winds that are characteristic of Long Island. The acreage that had been used for hay and pasture to feed the horses was plowed and is now devoted to soil-exposing crops.

Manure produced by the horses not only afforded some actual protection against erosion but, like meadow and other forage crops, it added organic matter to the soil. Such organic matter had two beneficial effects: first, it increased the growth of crops which afforded protection from the beating action of raindrops; second, it tended to hold the soil together and to retain moisture for the benefit of crops.

Since the horse disappeared from the city as well as from the farm, little manure has been available recently for Long Island soils. Progressive deterioration of the tilth of the soil has been noted and, in fact, is continuing from year to year. Yields, however, have been maintained temporarily by heavy fertilization, liming, use of improved seed, and better control of diseases and insects.

<sup>1</sup>Information from W. Fred Welsch.

The breakdown of the granules of soils has been speeded up by these changes in conditions. The efficiency of cultivations in destroying the granules has increased with the advent of power machinery. Enlarged acreage of clean-tilled crops and increased use of mineral fertilizers have hastened the decay of soil organic matter. Organic matter protects the soil from the impact of power machinery, cushions the blows, and gives elasticity to the soil. It resists the packing action, promotes water movement into and through the soil, and increases the supply of water available to crops. The average annual precipitation (rain, snow, and sleet) on the Island is about 42 inches, but this amount varies somewhat from place to place. Precipitation is the only source of water supply for all purposes. Farmers reported that in many fields water stood in wheel tracks much longer in August 1946 than is usual and that the rotting of potatoes in the soil was common. Of course, August 1946 was a month of high rainfall.

In August 1946 samples were obtained of a Sassafras silt loam soil compacted by the rubber tires of a three-plow tractor and spray equipment. This soil had been farmed to cultivated crops for many years. In the laboratory this showed a volume weight of 1.75.<sup>2</sup> Little water moved through this soil when the volume weight<sup>3</sup> was greater than 1.5. Upon examination it was found that the soil had an organic-matter content of 2.2 per cent. At a moisture content of 19 per cent this soil appeared dry enough for tillage. Yet at that moisture content under a compacting force equal to that of the wheels of a two-plow tractor this soil packed to the maximum volume weight of 1.69. Thus we see that this soil will compact readily unless it is quite dry.

Soil from a fence-row nearby that had not been cultivated for many years had 3.4 per cent organic matter, and a moisture equivalent of 22 per cent. It was necessary to raise the moisture content to 27 per cent before a compacting force equal to that of the two-plow tractor mentioned packed this fence-row soil to the maximum volume weight of 1.48.

Low organic-matter content of such soils lowers their general productivity and resistance to almost any influence that is unfavorable for plant growth. It is well to cultivate at the proper moisture content and it may sometimes be necessary to break up the compacted subsoil. Heavy fertilization and irrigation and disease and insect control become unusually important. Erosion by wind and water is increased and is more difficult to control. Yet these undesirable effects of farming need

<sup>2</sup>Laboratory work through the cooperation of Professor M. B. Russell, M. D. Thorne, and G. R. Free.  
<sup>3</sup>By a volume weight of 1.5 is meant that a given volume of dry soil weighs 1.5 times as much as the same volume of water. Differences in volume weight result from differences in compaction or in differences in pore space or the space occupied by air.



*Figure 1.* Gullying may start in wheeltracks.

not occur. The proper use of the excellent machinery and fertilizers now available can be effective in maintaining soil productivity, as well as in exploiting that productivity (figures 1, 2, and 3).

Long Island soils consist mainly of loams and sandy loams underlain by gravel. The thickness of this surface layer of finer material determines the capacity of the soil to hold water and plant food and, therefore, largely determines its agricultural value. There are, however, two areas of silt loam — one the Sassafras silt loam on the north fluke east of Baiting Hollow, with an area of 26,000 acres, and the other the Bridgehampton silt loam, which occupies the south half of the south fluke between Southampton and East Hampton. There are 14,000 acres of this soil. These silt loams and a few small unmapped areas in addition hold water better and, therefore, produce larger



*Figure 2.* Gullying getting under way where surface soil had previously been lost by sheet erosion.





*Figure 3. Gullying on good land.*

yields than do more droughty loams and sandy loams. The loam and especially the sandy loam soils contain little silt and clay to hold them together. As a result, runoff water causes surface washing and sometimes gullying on surprisingly gentle slopes.

The Plymouth soils (134,600 acres), and the Haven soils (78,000 acres) also are gravelly underneath. Usually they absorb water readily because of the coarse consistency both of the surface and lower layers.



*Figure 4. Gullying on unusually valuable soil.*

Because of this condition, however, they have practically no binding material and, surface washing and gullying, therefore, take place easily if water is allowed to collect and flow over the surface (figure 4).

The Hempstead loam and the Sassafras loam and sandy loam have gentle slopes of from 13 to 25 feet to the mile from the north toward the Atlantic Ocean on the south. These slopes (from about 0.25 to 0.40 per cent) are so slight that little

erosion takes place on them. Within these general slopes, however, are steeper ones on which water collects during the heavier summer rains and runs off over the surface. Because most of the cropped land is growing such soil-exposing crops as potatoes, cauliflower, and other vegetables, erosion results from runoff. To be sure, very gentle rains are all absorbed without erosion.

Where the surface of the soil is not protected by vegetation, large raindrops churn the fine soil particles into suspension and they, along with the organic matter which is light in weight, are easily carried away. The coarse sand particles are left behind. After a summer rain near Riverhead a sample of soil that was deposited in a small pocket was found to be 19 per cent sand, 52 per cent silt, and 29 per cent clay. This was washed from a surface soil nearby that was 85 per cent sand, 11 per cent silt, and 4 per cent clay. Thus for every pound of fine material, silt and clay, carried away there was left almost 6 pounds of sand. Runoff from the heavier rains causes considerable loss by carrying away soluble fertilizer materials as well as organic matter and the finer soil particles themselves. If such runoff water finds a depression down slope, gullying follows because these soils contain so little clay to hold them together. Cover crops help greatly in controlling erosion under these conditions.

Long Island soils are most subject to erosion in the spring when the frost is leaving the ground. Frequently the surface of the soil is



*Figure 5.* Sand and gravel fans deposited at the mouth of gullies where the slope flattens out. The finer soil that holds water and supplies crops with nutrients, however, is carried off the land.

thawed and full of water. When rain falls on soil in this condition, the silt and finer particles are easily beaten into suspension. On slopes, the runoff water carries these soil particles away and they are definitely lost to the farm from which they came. The very finest material comes to rest on the bottom of one of the numerous kettle holes (figure 5) or goes on out to sea. That which goes out to sea is, of course, completely lost to mankind. The material that lodges in kettle holes forms a deep layer of productive soil. A depth much greater than 1 foot, however, is not of increasing value except that it does hold more water for use by crops in dry periods. Some day in the future, however, such soil may be moved to a place where it will be of definite value. In at least one place on Long Island, the writers have noticed that this fine material has been bulldozed back onto the slopes from which it came (figure 6). Such deep deposits of silt and fine sand may be useful for compost, for lawns and gardens on light soils, or for use in greenhouses and for floricultural and nursery production (figures 7 and 8).

### *What to Do*

There are two types of erosion: (1) by water in the spring and summer and (2) by wind in fall, winter, and spring.



*Figure 6.* Filled gullies. Here a bulldozer has been used to push eroded soil back up onto the slope and to fill gullies. This practice is seldom followed in this country.





*Figure 7.* Old erosion in central Long Island as seen from a plane. This picture and figure 8 were taken from elevations of 600 to 1000 feet. The erosion scars, which are usually irregular in outline, may be clearly seen. Scars caused by removal of topsoil by machinery are distinct because they are usually bounded by fairly straight lines. Earlier gullies have been plowed in, yet their pattern remains on the landscape.

## TO CONTROL EROSION CAUSED BY WATER

### *Till and Plant on the Contour*

Furrows and other depressions made by implements up-and-down or angling down slopes collect water from heavy rains. Water in a furrow on a slope flows faster than water that is spread out in a thin sheet. Thin sheets of water on gentle slopes may cause little or no loss of soil, but a deeper current in a furrow on the same degree of slope may cause considerable gullying (figures 1 and 9). Not only plow-



*Figure 8.* Old gullying and sheet erosion in eastern Long Island, from the air. The lighter patches at the left represent loss of the darker colored topsoil. Recent gullying and deposit of sand are seen at the left of center.

ing and seedbed preparation but planting and cultivation may often be done to advantage on the contour. All of these methods of tillage



*Figure 9.* Brush piled in gullies to check their growth—too little too late.



*Figure 10.* Bearberry grows well on gravel or other poor soil. Eventually it helps to control gullying.

leave more or less of furrows and ridges. On the contour, such ridges serve as a dike to pond water above them. On gentle slopes, these



*Figure 11.* Potato rows near the contour. Potato ridges on the contour on gently sloping lands, like most of those on Long Island, hold all the rain that usually falls until it soaks into the soil. Then there is no erosion.



*Figure 12.* Ridges left by potato digger. Even after they are harvested, the ridges in potato fields do much to hold rainwater against runoff.

ridges and furrows hold a great deal of water (figures 11 and 12). Water so held quickly soaks into most Long Island soils and is used by the crop or added to the ground-water supply. Nearly all Long Island soils have good drainage, and there is little danger of soils becoming too wet to work for any great length of time even if they absorbed all the rainfall. Any water retained by contour planting is usually needed by crops and, therefore, may be expected to increase crop yields.

A demonstration of contour and up-and-downhill potato cultivation was carried on at the Long Island Agricultural and Technical Institute. Plots were 100 feet long on a loam soil with a slope of 4 per cent. During 4 years when rainfall was too low at some period during the growing season, the contour potato rows outyielded the others by approximately 10 per cent. In the two wet seasons, the yield was 9 per cent less on the contour rows. Placing the rows on a grade of  $\frac{1}{2}$  per cent would permit the excess water to flow off slowly and still give the advantages of contour farming.<sup>4</sup>

It was observed that runoff occurred from moist soils when  $\frac{1}{4}$  inch of water fell in 15 minutes, and from dry ones with slightly more than  $\frac{1}{4}$  inch in 15 minutes. Erosion-producing summer rains are not uncommon on Long Island as may be seen in table 1.

<sup>4</sup>Information by H. B. Neville.

Table 1. Rainfall by months for 6 years, 1941 to 1946, at Mineola and Cutchogue, Long Island\*

Place	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
<i>Rains of one-half inch or more in one hour</i>													
Mineola.....	0	0	1	2	3	5	16	8	10	2	1	2	41
Cutchogue.....	1	0	3	2	2	4	8	12	7	3	5	2	39
<i>Rains of three-fourths inch or more in one hour</i>													
Mineola.....	0	0	0	0	1	3	7	3	4	0	0	0	18
Cutchogue.....	0	0	0	1	0	1	1	3	3	0	0	1	10

\*Information from the United States Weather Bureau.

In the five years of record, there were 25 high-intensity rains that caused runoff, and those of  $\frac{1}{2}$  inch or more in 15 minutes resulted in severe loss by erosion. Many farmers recall the rain of  $1\frac{1}{2}$  inches in August 1946 and the damage it caused to crops and soils.

On Long Island, as in many other localities, for one reason or another, farms were laid out in long narrow strips. Farming such lands on the contour is essential to the preservation of the soil. Yet this is not deemed feasible because of the short rows. Combining several farms or voluntarily adjusting farm boundaries to obtain suitable lengths of contour row is needed for economic crop production. By some such method of adjustment, it will be possible to farm economically on the contour with present-day, large farm implements and at the same time prevent further permanent decrease in productivity of the soil.

#### *Use Duck Manure*

Considerable tonnages of duck manure are produced every year in the growing of Long Island ducklings. Some of this valuable organic matter goes to waste, but good use can be made of all the manure that is recovered. Duck and hen manures are rich in plant food. The composition of these manures in comparison with cow manure is given in table 2.

Hen and duck manure are about twice as rich in nitrogen, seven and ten times, respectively, as rich in phosphoric acid, and a little higher in potash than cow manure. On the basis of its nitrogen content, one-half as much duck as cow manure may be used to advantage. From 5 to 8 tons of hen or duck manure may be used to the acre. It should be borne in mind, however, that frequent light applications of manure



Table 2. Water and plant-food contents of poultry and cow manures. \*

Manure	Water	Nitrogen	Phosphoric acid	Potash
	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
Hen (1 to 2 weeks old).....	67	1.41	1.03	0.57
Duck.....	61	1.12	1.44	0.49
Cow (liquid and solid).....	86	0.60	0.15	0.45

\*Poultry manures. By A. F. Gustafson and L. E. Weaver. Cornell Ext. Bul. 641. 1945.

often give better returns than heavy applications of manure at longer intervals. In other words, 5 tons put on every year give a larger total increase in crop yields than do 20 tons put on once every four years. This is particularly true on the lighter Long Island soils that are under continuous vegetable production. An application every year for the usual cultivated crops would be ideal.

Cultivated crops in an area with a long growing season use up the organic matter in the soil rather rapidly. By waiting until the soil is dry enough, one can make the best seedbed. This cuts down on the number of cultivations and thus conserves organic matter. Efficient modern machinery makes it possible to do this in the short time that conditions are most favorable. Usually it is best to cultivate only to kill weeds. Weeds that do not compete with the crop for soil moisture and fertilizer may be beneficial. Weeds and grass are nature's method of soil protection and soil building. Returning material to the soil as frequently as possible is desirable. Probably it is not feasible to try to build up the organic content of the soil to any great extent. The farmer's aim, therefore, should be to maintain the organic-matter content of the soil and not let it go down; it has been falling on many farms over a period of several years.

Although the use of green-manure crops may not rapidly increase the organic content of soils, it should decrease the rate of loss of organic matter. On the south fork, farmers are "resting" the land one year in four or five. Grain is grown, combined, and the straw left on the land. A legume, such as red or sweet clover, and a grass that fit into potato production may be seeded in the grain. Rye and wheat are needed locally; rye for cover-crop seedings and wheat for poultry feeding. When the straw and stubble from the grain are plowed down, approximately 200 pounds of sulfate of ammonia to the acre or a similar quantity of nitrogen in another carrier is needed to help decompose the straw.

According to H. D. Wells,<sup>5</sup> this practice not only increases the yield but also the quality of potatoes for several years. Moreover, plowing in the straw and stubble adds to the supply of soil organic matter and helps greatly to control soil erosion caused by both wind and water.

### *Terrace Long Slopes*

Terraces are needed on many slopes, especially the long ones, to take excess water off and to conduct it to places where it will percolate into the underlying gravel and do no harm. Because of the open nature of most of the soil of Long Island, terraces must be given a very slight slope which will encourage absorption of water by the soil. Moreover, because the soil washes so easily, the speed of the water in terrace channels must be kept low. Otherwise, washing will be caused by water collecting in the channels. By placing channels about every hundred feet, the concentration of much water in one place can be prevented and a larger proportion of it will be absorbed by the soil.

The absorption of water is advantageous from several standpoints. It is definitely added to the ground-water supply of the Island. Some of the water may stay, at least temporarily, in the zone within the reach of the roots of crops. This retention is more common and more beneficial to crops on the Bridgehampton and Sassafras silt loams than on the loams and sandy loams. Moreover, terraces might safely be given a slightly steeper slope on these silt loams than on the coarser soils (figures 13, 14, and 15).

Outlets for terrace channels are of the utmost importance. Wherever they are available, dry, old water channels that are now occupied by Mineola gravelly sandy loam in the Hempstead-loam area and by Babylon sand in the Sassafras soils, make good outlets. The soils in them are so porous that the water readily finds its way into the soil.

In parts of the Island there are rounded depressions often called *kettle holes* if dry, or *kettle-hole ponds* if they contain much water. Either of them can sometimes be used for outlets. Paving or planting shrubs and grasses may be needed in some places to let the water down from cultivated fields into these depressions without serious washing. Unless washing at the outlets of terraces can be prevented, it is better not to collect water in these channels. Areas occupied by woods, brush, or honeysuckle also furnish outlet protection.

All the outlets mentioned are for the growing season, when the soil is not frozen. Some of them, however, are suitable throughout the year.

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<sup>5</sup>Assistant County Agricultural Agent, Suffolk County.



*Figure 13.* Terracing with a blade terracer. Here is shown the beginning of the operation of moving soil to form a terrace channel and embankment. Two cuts have been made with the blade.

The problem of outlet is more difficult in late winter and early spring when the surface soil is frozen. Such soil takes up little water and gullying is a threat wherever water collects in any quantity.



*Figure 14.* Potatoes planted on terraced land in western Long Island. Here again the ridges left by the planter help to slow down runoff.



*Figure 15.* Terrace in eastern Long Island. Photographed in March, the channel has some ice and the entire area is well protected by a cover of rye.

Where no suitable area for the disposal of water is available, one can be made. To do this, locusts and honeysuckle, and shrubs if desired, may be planted at the end of a terrace channel or the area may be covered with a mulch of brush or other coarse material such as cornstalks. After a year or two there will be enough growth to prevent the soil from freezing so it will absorb water readily in late winter and early spring. Unprotected areas will be frozen at that time. Such an area will be equally serviceable for taking up water during the growing season.

A few terraces have been built on Long Island, and are satisfactory where they receive proper care. At Farmingdale on the farm of the Long Island Agricultural and Technical Institute, terraces were installed in 1941. In 1945, a diversion ditch was built to keep water from a wooded area off the crop land in the spring.

In many places throughout the farming area of Long Island, terraces can be used in cultivated fields to remove water from slopes that have suffered considerable erosion in the past and still are subject to further damage.

Diversion ditches, the channels of which are seeded to grasses and legumes, are needed to protect crop land and other erodible slopes. Diversion ditches are useful in the spring between rather steeply sloping wooded pasture land and crop lands. It is in the spring before the frost has left the land that these open wooded areas with little undergrowth contribute large quantities of runoff water. Warm rains and snow on frozen ground produce excess water. The frost largely pre-



vents the water from getting into the soil, consequently the water must run off. Where water flows, it soon cuts through the frozen soil and gullying is at once under way. Gullying was severe in many parts of the Island under these conditions in March, 1942 (figures 3, 4, 5, and 8). Outlet protection is needed for diversion ditches exactly as for terraces.

### *Plant Cover Crops*

The use of cover crops is a well-established practice on Long Island. A good cover crop effectively controls erosion. Some fields, however, go through the winter without this protection. Most of the cover crop is rye that is seeded after the potato, or some other early crop, has been harvested. Rye is sowed on the contour or across slopes, even gentle slopes, to help check runoff on frozen soil in winter or early spring (figures 16 and 17). If there are depressions, such as dead furrows up and down slopes, rye is broadcast thickly by hand in these waterways. The drill covers this seed and the growth produced gives complete protection to the waterway until the land is plowed again in the spring. Even then the network of roots of the rye helps materially to hold the soil against gullying.

Drill rows down slope fail to give the protection that is needed (figure 18). Broadcast seeders are available that sow the seed at random;



*Figure 16.* Rye cover crop. A successful growth of broadcast rye protects the soil against the beating action of raindrops and holds it against erosion by both wind and water.



*Figure 17.* Cover of broadcasted barley and rye in the spring. The spring barley died down the previous fall, but the rye is in active growth and is protecting the soil.





*Figure 18.* Drilled rye. Drilled cover crops must be on the contour to give good protection. In dry periods it pays to irrigate enough to obtain a growth of grain that will cover the soil and protect it against both wind and water erosion throughout the winter and early spring. A poor growth like that on the left exposes much soil to erosion.

there are no rows between which water may flow unobstructed. A light covering with a peg-tooth harrow or weeder on moist soil late in the season is satisfactory. If the soil is somewhat dry, contour rolling with the cultipacker, or corrugated roller, is enough to cover the seed and encourage early germination, particularly late in the growing season. Heavier seeding than for grain is desirable to obtain complete cover. Eight or even ten pecks of rye seed to the acre produce a cover that gives excellent protection against erosion. If, however, the rye is to be harvested for seed, 6 pecks are better.

Sometimes it is so dry in the fall that rye does not germinate promptly and inadequate cover-crop protection is obtained. Wherever provision has been made to irrigate crops, it will be wise to irrigate the cover crop at least enough to germinate it and to give it a good start. Then if rain fails to come and keep it growing, the land must be irrigated again. Soybeans on soils that are above pH 5.6 and thickly sown corn or these together after early-season crops may be grown to be plowed in for an early crop the next year. Leaving them on the land over winter protects the soil from blowing.



*Figure 19.* Right-of-way up to actual hard surface of highway being cropped. Destructive blowing and washing may result from this practice.

### *Discourage Cropping Right-of-Ways*

Plowing and planting almost to the very edge of the concrete or macadam pavement is a growing practice on Long Island (figure 19) that should be discontinued for a number of reasons. On slopes, water from the pavement and runoff from fields quickly fills silt basins with sand. Hand cleaning is costly. The farmer who causes this public expenditure has to help pay the bill. Moreover, these silt basins are installed in part to get the surface water into the soil without doing any damage. On many farms, gullying follows such concentration of water.

The sides of the right-of-way not needed for transportation should be in grass or shrubs. Such vegetation checks the movement of water and holds any moving sand. Any sand so held is kept out of the silt basins, and, if necessary, can be removed from the road at far less expense than from the silt basins. Moreover, vegetation, by slowing the flow of water, leads to the absorption of much of it by the soil. Any reduction in runoff reduces erosion on adjacent land and also reduces or eliminates the expense of cleaning out the silt basins. Where potato or other crop rows slope toward the highway, the roads are often covered with sand (figure 20). This has to be pushed aside with a road scraper to open the highways for traffic. In time, the pavement becomes a hard-surfaced bottom of a drainage way, an undesirable condition. From every public and private viewpoint the sides of right-of-ways of highways are of greater total value for these purposes than for the





*Figure 20.* Potato rows slope toward highway. After heavy rains the road must be cleared of sand with a scraper, as shown here. The finest soil particles have been lost entirely. Clearing is costly to the public, including farmer taxpayers.

production of crops. Moreover, the entire public suffers the damage but only the individual operator, owner, or tenant derives any financial gain by cropping the publicly-owned highway land (figures 21 and 22).



*Figure 21.* Sand and gravel washed down a side road. This too has been cleared off the concrete with a road grader.



Figure 22. Highway shoulder protected by trailing honey suckle (*Lonicera japonica Halliana*).

### *Maintain Productivity of the Land*

In many areas, there is need to maintain a high degree of productivity to protect the land from erosion. On Long Island, however, fertilization generally is enough to produce good yields. The phase that requires constant attention on Long Island is to maintain the supply of active organic matter.

Full use of duck and other manure available is one way to keep up the organic content of Long Island soils. Another is the use of cover and green-manure crops. The green rye that is turned down for early potatoes does not add very much to the supply of permanent organic matter in the soil. Nevertheless, rye is needed as winter cover to prevent erosion by wind and water and to prevent loss of organic matter that is so valuable and so difficult to replace. More mature materials, such as a mixture of grasses and legumes or grasses with nitrogen, that are added to the soil may slowly increase the permanent organic matter in the soil.

Wherever feasible, legumes, particularly deep rooted ones should be planted. These deep-rooted legumes, however, are slow to establish themselves and may be useful only for pasture or, in a very limited way, for hay production. The blue lupine makes good growth in summer; the Canada field pea, in early spring; and hairy or winter vetch as a winter annual. The vetch is seeded in rye in the fall and plowed

down in late spring for midsummer vegetables. More complete information on green-manure crops is given in Cornell University Agricultural Experiment Station Bulletin 755, pages 17 to 25, by A. F. Gustafson and D. B. Johnstone-Wallace.

### TO CONTROL WIND EROSION ON CROP LANDS

Considerable wind erosion takes place on bare loams, sandy loams, and sands in winter and early spring. Moreover, cool winds during spring hold down the temperature of the soil and of the air above the soil. This lowered temperature delays the growth of tomatoes and other warm-weather crops. In addition, by whipping plants about, the wind delays their early growth.

#### *Use Winter Cover Crops*

The winter cover crops, which have already been mentioned to control erosion caused by water, help to check wind erosion. For the control of wind erosion particularly, it is best to broadcast the cover crop of rye or other grain. Drilled grain protects while the wind direction is perpendicular to the rows of grain, but drilled rye affords little protection when the wind direction is the same as that of the rows. How wind directions shift is shown in table 3.

The charts on pages 44 and 45 of the Legislative Report for 1946 shows the direction of the wind for the different months of the year. Northwest winds prevail during the months of October through March.

*Table 3. Velocity and direction of winds, average for 7 years, 1933 to 1939. \**

Direction	Velocity in miles an hour		
	0 to 13	13 to 28	More than 28
	<i>Days</i>	<i>Days</i>	<i>Days</i>
Southwest.....	41	51	2
Northwest.....	24	38	4
Northeast.....	17	26	3
West.....	18	21	2
North.....	18	19	1
Southeast.....	14	16	1+
East.....	9	13	1
South.....	14	11	1-
Total.....	155	195	15

\*Records from 1933 to 1938 at the Forge River Coast Guard Station; 1939, at the Trana Coast Guard Station. Diagram, page 16. In *Report to the Legislature of the State of New York, 1946.*



In April and September, the direction is highly variable. In the months of May through August, southwesterly and southerly winds prevail. As may be seen from table 3, however, there is considerable variation in the direction of the wind.

In fact, when the wind shifts to a direction parallel to that of the drilled grain rows, the grain does not help much (figure 18). Broadcasting the grain protects the soil regardless of the direction of the wind (figure 17). Of course, if the cover crop makes enough growth to cover the space between the rows, drilled grain protects the soil the same as does broadcast grain. It is when the soil is dry in the fall and the cover crop makes little growth that there is the greatest danger of erosion by wind in winter and early spring. Enough irrigation to start the cover crop is, beyond question, a justifiable expense.

#### *Roughen Land with No Cover Crops*

Some crops such as cauliflower and brussels sprouts are not harvested until too late to obtain growth of a cover crop. Plowing single furrows from 20 to 30 feet apart in both directions across a field in the fall before the soil freezes roughens it. By plowing in both directions furrows are made in squares. The contour furrow is plowed last to catch water and prevent gullying. Blown sand is trapped and held in the furrows. Furrows that have been blown full of sand can be reopened in the spring. Although such furrows do not stop blowing entirely, they *prevent* the movement of most of the soil farther than from one furrow to the next. The finest material, however, may be picked up and carried away in spite of these furrows.

It is entirely feasible to broadcast rye just before the final cultivation of cauliflower and brussels sprouts. A fairly good cover is often obtained.

#### *Establish Windbreaks*

During the past few years, considerable timbered areas have been cleared to bring new land into cultivation. Formerly, these forests broke the force of the wind and protected the land to the leeward for varying distances. Moreover, the replacement of horses and mules with tractors has called for longer rows and the consequent removal of field divisions. Some of these divisions have grown up to vines, brush, and trees, called *hedgerows*. All of them serve as windbreaks. In many sections, however, little remains to check the destructive sweep of winds over large areas.

As previously mentioned, unobstructed winds in the spring keep the temperature down and whip certain plants about enough to reduce their early growth. Early planted tomatoes are particularly susceptible

and are representative of such wind injury to crops. Other truck crops and even potatoes may be delayed in their early growth by lowered temperatures.

Strong winds may injure crops by blowing sharp sand grains against them, which cuts the stems of the tender seedlings. This injury delays their growth and sometimes kills them. The crop must be replanted or a different one seeded that may produce a lower return. Sand is sometimes blown onto highways from which it must be removed at considerable public expense.

Windbreaks may be used to lower the velocity of the wind and thus to reduce the loss of soil and the damage to crops, homes, and highways. Among the native plants that could serve well as windbreaks are: bayberry (*Myrica Pensylvanica*), Silky cornel (*Cornus amomum*), and gray dogwood (*Cornus paniculata*). Introduced plants that are urged in windbreaks include: tartarian honeysuckle (*Lonicera tatarica*), amur privet (*Ligustrum amurense*), multiflora rose (*Rosa multiflora*), and rugosa rose (*Rosa rugosa*). The bayberry and roses should be planted on the windward side of the windbreak to check the velocity of the wind during winter and spring when these deciduous shrubs have no leaves.

Among trees, native pines and cedars may be used to thicken the windbreak somewhat in winter and early spring. There should be some space between the evergreens because the purpose of a windbreak is to check the velocity of winds, not to stop air movement completely. Ideally, it would be best to have enough windbreaks to prevent the wind from attaining the velocity needed to pick up soil particles or to move them along over the surface. The common black locust may be used because of its rapid growth and its value as post timber. In an ordinary hedgerow, black locust and any other tree that has grown too tall may be removed and used for posts, poles, or fuel that are usually needed on many farms.

Windbreaks should not be allowed to become so wide as to encroach unduly upon productive farm land. One or two rows of trees flanked by one or two rows of shrubs on each side should be enough. Low shrubs give the crop less competition from shade than do taller ones.

Woven picket or lath fences (snow fences) serve well as temporary windchecks in fields during winter and early spring. As soon as crops have reached a size that protects the soil from blowing and, therefore, themselves from injury, the fences may be removed. Four-foot fences placed from 40 to 60 feet apart both ways out in the open away from windbreaks of trees and shrubs, check winds and protect crops and soils.

Windbreaks of shrubs and trees planted along farm and field boundaries afford protection in proportion to their height and density (figures 23, 24, and 25). A windbreak 50 feet high may be expected to give some protection over a distance of about 500 feet. In winds of high velocity, however, the protected area is narrower than this. It is not advised to divide fields with permanent windbreaks, but to plant them along farm boundaries where they can be of real value. It is well to keep



*Figure 23.* A windbreak of privet. Such a windbreak is effective in lowering the velocity of winds in winter and spring as well as in summer.



*Figure 24.* A windbreak of sassafras along a field border.



*Figure 25.* A windbreak of mixed trees, shrubs, and vines. These windbreaks reduce the velocity so that air currents cannot pick up and move the soil. Thus they reduce loss by wind erosion.

in mind the benefits of these windbreaks: They check the loss of soil, reduce evaporation from crops and soils, help to raise the temperature and to reduce injury from whipping tender plants early in spring. It is the finest soil particles and organic matter that are blown away. Long Island soils are low in both fine particles and organic matter. Any loss of them, therefore, ultimately lowers the water-holding power and the productivity of the land. Windbreaks may be dispensed with, however, if a thick protecting ground cover is provided.

Wherever there is a choice of directions for establishing windbreaks, they are best placed along a northwesterly-southeasterly direction so they are at right angles to the prevailing summer winds. In winter the wind may be largely from the northwest. Picket fences placed at right angles to the northwest winds are needed at that time. Long Island winds change direction enough to warrant protection from all directions.

Vegetation, however, is the best protection against loss of soil by both wind and water. Cover crops, therefore, are of utmost importance for both purposes on Long Island. Following late-harvested crops where a cover crop cannot be produced, temporary windbreaks, such as picket fences, can be of great service to the farmer and the village dweller as well.

On lands that are being cleared, a strip of natural trees and shrubs

from 20 to 30 feet wide, may well be left around the new fields. Often plants of the size needed to thicken such a windbreak from the ground to the crowns must be planted to improve the effectiveness of such a windbreak.

### TO CONTROL BLOWING SANDS

Bare sands are subject to blowing, especially on the south shore of Long Island. The principles of control are those already stated: reduce the velocity of the wind or cover the soil with vegetation or any available mulching material. Often, it is difficult to accomplish this objective. Such sands are so nearly devoid of plant food that many plants grow too poorly to provide much protection to the soil. Because of such slow growth, reducing wind velocity, as with picket fences, must be a large part of the control measures.

It should be borne in mind that the wind is unusually strong and constant at the outer end of the Island. Much windbreak material, therefore, will be needed. Real control calls for lowering the velocity of the wind so that it cannot pick up or roll sand grains along on the surface. Many things serve as windbreaks. Woven picket fence, already mentioned, may be used (figures 26 and 27). Fences 4 feet high are best, placed about 40 to 50 feet apart and parallel to the shoreline or the barrier dune except where it is desired to build up the dune. There fences can be placed even closer together to trap all sand that is blown through the most southerly fence. Because the wind shifts to all points



Figure 26. Blowing sands on the south shore of Long Island.





Figure 27. The wind is covering these obstructions with sand. Anything that checks the velocity of winds reduces movement of sand.

of the compass, sometimes north, east, or west in addition to the more frequent southerly direction, it is advisable to place cross fences about 100 feet apart to afford some control from east or west winds. Brush, especially that of evergreens, including Christmas trees, is used to slow down air movement along the surface. Fine brush strewn over the surface controls the movement of sand, but there is not enough brush available. Nevertheless, brush can be used to reinforce picket fences.

American beach grass (*Ammophila breviligulata*) is available for

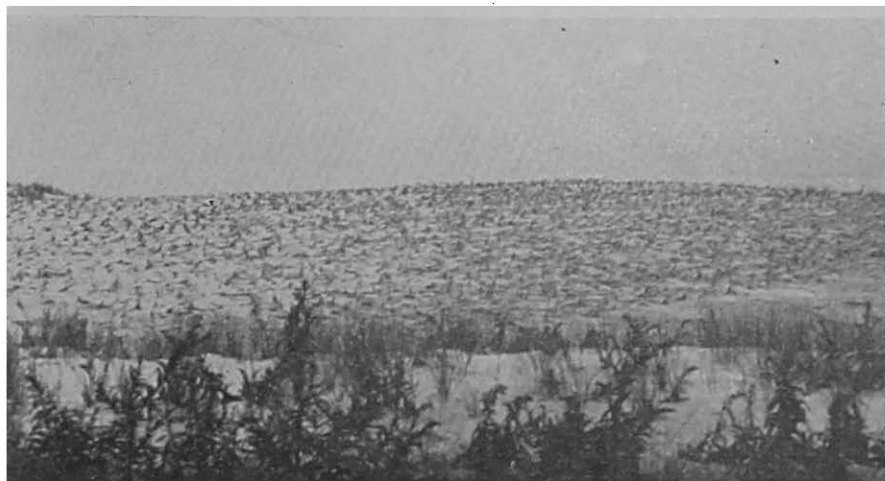


Figure 28. Recently planted Beach grass on dune sand on the south shore.

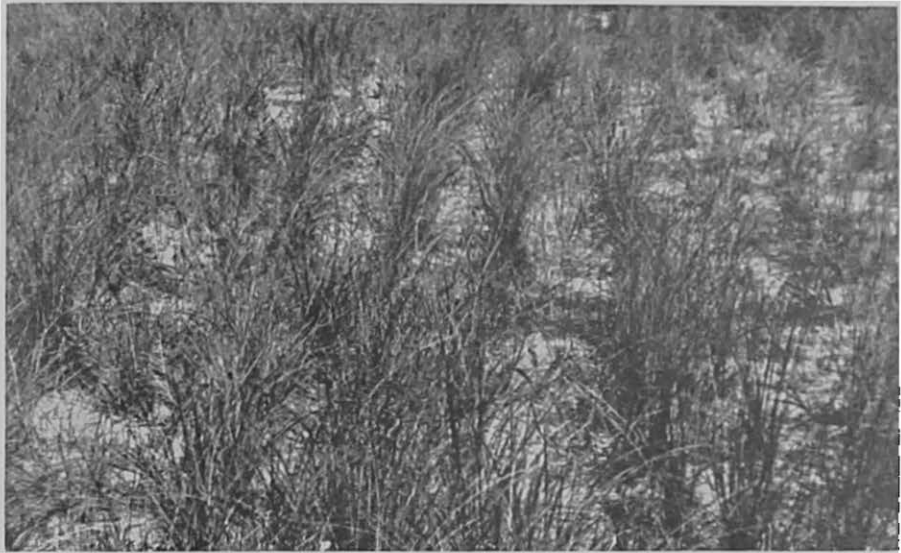


*Figure 29.* Beach grass about a "blowout." Note the piece of a mast of an old sailing vessel at upper left that is being uncovered by the wind in this blowout.

planting on beach sands. Much of it has been planted near Jones Beach with only moderate success. Some of the plants have died leaving bare spots where blowing can begin at any time. Beach grass should be planted at random, not in rows both ways. A good way is in concentric rings with plants staggered in the rings (figures 28 to 31). There are

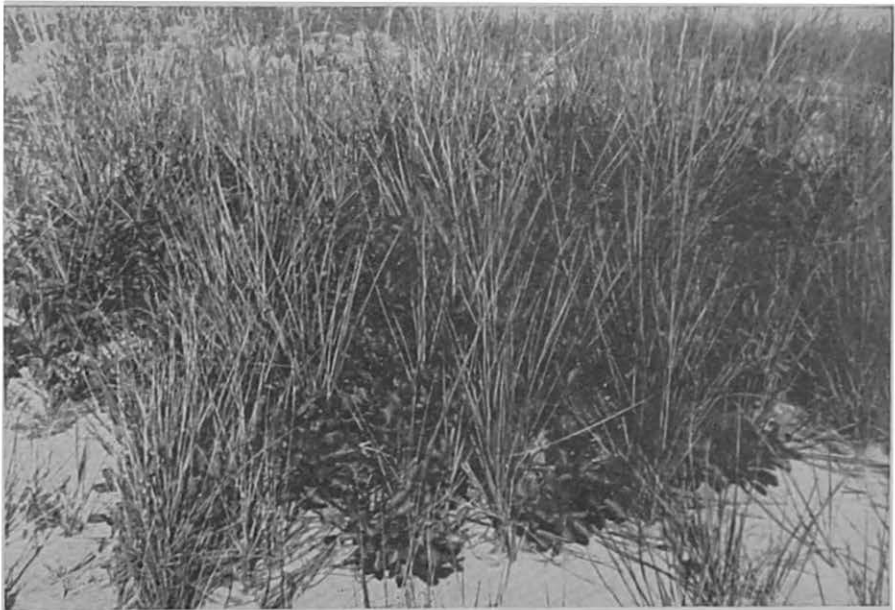


*Figure 30.* Picket fences and planted beach grass used to hold the sand in place. Note the drift held by the fence.



*Figure 31.* Beach grass effectively holding sand in place.

thus no rows in any direction for the wind to follow. Every plant checks the wind movement on the surface of the sand where reduced velocity is most important. Planted in cross rows the wind may blow



*Figure 32.* Beach pea with beach grass afford perfect protection. Beach grass must have nitrogen for thrifty growth. This element is supplied by the beach pea. Note the thick growth in the foreground with the pea; thin growth in the background without it.

parallel to the rows. Then the grass provides little protection.

Beach grass, like all grasses, must have nitrogen and other plant food for growth. Lack of enough nitrogen appears to be a cause of the partial failure of beach grass. Beach pea (*Lathyrus japonicus wild var glober* (Ser) Fern), a native perennial legume, grows well with beach grass (figure 32). The grass has a greener color and makes far better growth among the peas than alone. The fixation of nitrogen by the pea is the explanation for this difference. The beach pea has the above-ground appearance of large-growing, thrifty garden peas, but it grows from long, fleshy, spreading roots and obtains its own nitrogen from the air. Through its wide expansion of roots, it gets enough other plant food for good growth. A natural mixture of beach grass and beach pea makes a large, thrifty growth that soon becomes much thicker than does the grass alone, and the mixture gives ideal protection against wind movement. The mixture can be used to build up the barrier dune. As the sand is trapped in the grass, the grass and the pea grow up through the sand and hold it. In fact, it has been stated that beach grass thrives only in blowing sand. The trailing wild bean (*Strophostyles helvola*), wild lupine, (*Lespedeza capitata*), and partridge pea (*Cassia fasciculata*) are found on the sand areas of Long Island. None of them, however, makes the growth that the beach pea is capable of. Because of a worm within the pods, the trailing wild bean appears to mature seed sparingly. The partridge pea appears to thrive on heavier soils rather than on pure sands. Wild lupine has been found on sand in woods. Leguminous plants, however, should have a large place in plantings for the control of sand.

Deer-tongue grass (*Panicum clandestinum*) and broom beard grass (*Andropogon scoparius*), called little *bluestem* by some, make good growth in certain areas. Quack grass (*Andropogon repens*) has been found growing well in roadways on sand, and redtop is suggested for planting with beach grass. Beach plum (*Prunus maritima*), false heather (*Hudsonia tomentosa*), seaside goldenrod (*Solidago sempervirens*), wild rose (*Rosa virginiana*), and bayberry (*Myrica Pensylvanica*) grow on pure sand on the Island. Some use of them can be made in the control of blowing sand, but there may be some difficulty in establishing them. Early spring is suggested as the best time to transplant them. The bayberry, it should be added, has the ability to obtain its own nitrogen and, therefore, has a distinct advantage over most of the other woody plants listed. Goldenrod (figure 33) was found making excellent growth on the midwestern section of the south side of the Island.





Figure 33. Goldenrod and native grasses holding sand against blowing.

Black locust, especially the shipmast variety, may be started from root cuttings, and the ordinary black locust by planting seedlings or possibly seed. Early spring is suggested as the right time to establish them. Mixing the legumes and non-legumes gives non-legumes the benefit of nitrogen fixed by the legumes. Locally growing and other pines may be set among locusts for windbreaks. Pine and other brush scattered over the surface checks blowing while the transplanted seedlings are becoming established.

Quack grass (*Agropyron repens*) was found growing in roadways on sand where the sand had been compacted. Thus it held the water needed by this plant. Cocklebur (*Xanthium echinatum*), another weed, is making thrifty growth in sand in a few spots. Because they are usually regarded as *weeds*, neither of these plants is recommended.

Planting trees and shrubs among the beach-grass-beach-pea mixture is a good practice. Such a plantation may also be protected by a picket-fence windbreak because most plantings require protection at the start on the outer third of the Island because of the higher velocity of the wind in that area.

## TO CONTROL WAVE EROSION

Active wave erosion is common on all shores of Long Island. The sweep of the wind, its velocity, and the angle at which it strikes the shoreline affect the rate of wave erosion. There is no bedrock in the shorelines, or elsewhere, on Long Island; most of the shoreline consists



*Figure 34.* Shoreline of Long Island Sound at Shoreham about 10 miles east of Port Jefferson in 1943.

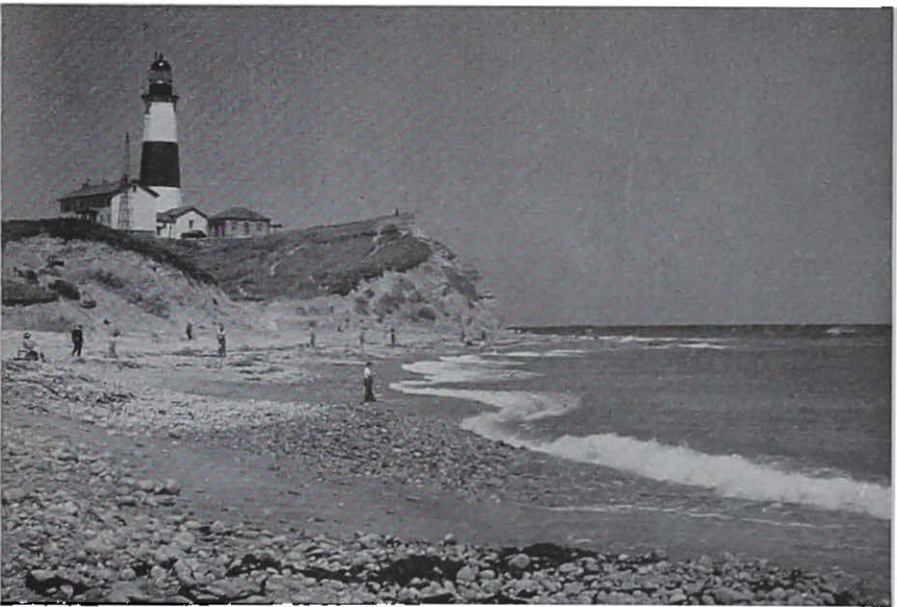


*Figure 35.* Same cottage as shown in figure 34. Photographed after the hurricane of September 14, 1944. About 40 feet of shoreline was cut away by the waves. Similar damage was done under like conditions in many places along the north shore of Long Island.





*Figure 36.* Wildwood State Park near Wading River. Representative of the bluff-type of shoreline. Vegetation protects it against erosion by wind and waves.



*Figure 37.* Lighthouse on Montauk Point at the extreme eastern tip of Long Island. Buildings erected in 1876. Surveys show that wave erosion has cut away an average of 18 inches of land a year, or 225 feet in the past century and a half. Montauk Point is doomed unless effective protection against wave action can be devised and installed.

of sand or gravel. At the outer end on the south, the shoreline consists of a mixture of sand, gravel, and boulders with some finer material and the waves are rapidly eating away the shoreline because it is peculiarly susceptible to erosion (figures 34 to 36).

At Montauk Point, government buildings were first erected in 1796 (figure 37). According to a report of the Joint Legislative Committee,<sup>6</sup> accurate surveys made in 1868 and periodically since show an average annual loss of 18 inches of shoreline. At Old Field Point on the Long Island Sound shore, the United States Light House was erected in 1824. This point is exposed to severe erosion by northeast storms. According to a report of the Joint Legislative Committee,<sup>7</sup> the shoreline is being worn away at the average annual rate of from 2 to 3 feet. Although these rates of loss do not seem great for a single year, the loss of land on Montauk Point is 150 feet in a century. In another century the light house there will be definitely threatened unless effective measures for the control of erosion are undertaken soon. At Old Field Point, the loss of land has been between 200 and 300 feet in a century. The protection of both of these points will be difficult and costly, yet the Montauk Point Light house certainly is an essential aid to navigation. Its location, therefore, must be protected from destruction by wave action.

The general movement of sand by the waves on Long Island is from east to west. The east side of inlets, therefore, moves westward. Measurement of diagrams in the 1945 Report to the Legislature indicates an average westward movement of 36 feet a year at Jones Inlet from 1834 to 1945. In Fire Island Inlet, the movement was about 18 feet a year from 1834 to 1934. Such movement of sand interferes with navigation, and the filling of the beds with sand injures the shellfish industry. In 1944, the market value of the oysters, clams, and scallops produced in the Long Island area was more than \$5,000,000. In addition, farm land is being washed away in a few places on the Island.

Controlling wave erosion is so costly that the individual farmer is almost helpless in protecting his land. Something can, of course, be accomplished by planting well back from the salt water. Because of the nature of the soil material, leguminous plants will make the best growth. Black locust, bayberry, rugosa rose, clovers, especially sweet clover, and nonleguminous trees, shrubs, vines, and grasses are helpful. The use of native or other adapted plants is advisable. Among trees, evergreens are useful for protection of the soil in winter. Grapes and

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<sup>6</sup>Report to the Legislature of the State of New York by the Joint Legislative Committee studying the problem of checking erosion along the Atlantic shoreline of the State, February, 1945, p. 52.

<sup>7</sup>Report to the Legislature of the State of New York by the joint Legislative committee studying the problem of checking erosion along the north shore of Long Island, February, 1946, p. 33.





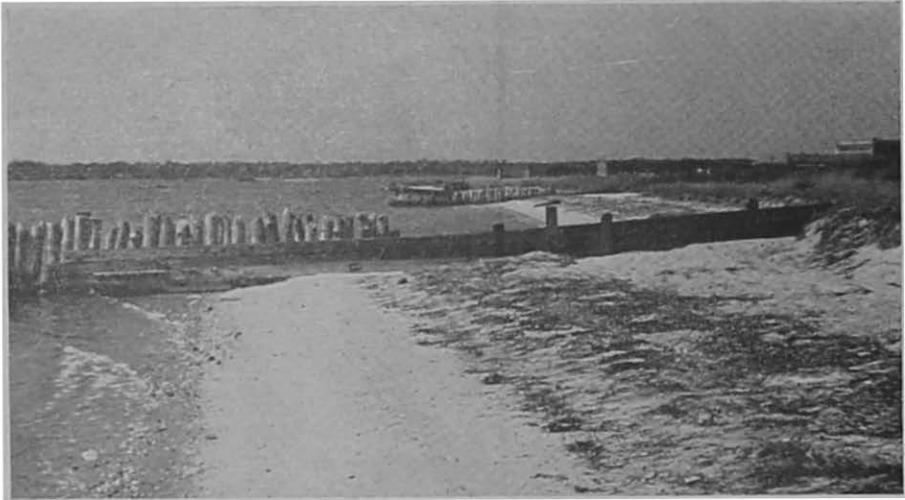
*Figure 38.* On the north shore of Long Island. Boulders being used as jetties to protect the road at right.

Virginia creeper planted in the surface soil at the edge of the eroded banks drape over and protect slopes. Sweet clover and Canada bluegrass and orchard grass may be expected to produce some protection in time. Any legume sown should first be thoroughly inoculated.

Most of the control of wave erosion, because of its cost, must be done by public agencies. State and federal governments are prepared to



*Figure 39.* On the south shore of Long Island. The waves have cut away the shoreline in spite of the protective works and the piling.



*Figure 40.* Here the jetty has been extended by heavy planks in an effort to arrest wave action. The success of this project appears doubtful. A well-planned systematic attack on so large a problem is essential for its success. It is rather too large an undertaking for the unaided individual owner.

assist the local units, counties, towns, cities, in building the engineering works for the control of wave erosion.

Jetties or walls extending from the shoreline out into the shallow water are generally used (figures 38, 39, 40, and 41). On the north shore of Long Island, there are three types of jetties. These consist of stone covered with heavy chunks of concrete that the waves cannot wash away. Since there is no rock on Long Island, the stone must be brought from a distance. Sheet-steel piling supported by 12-inch wooden piles is used. A third type is made of 4-inch creosoted wood sheeting supported on both sides by heavy wooden piles like those used with the steel piling. Protection of the shorelines of Long Island is essential even though the total cost will be millions of dollars.

## *Summary*

### CAUSES OF INCREASED EROSION

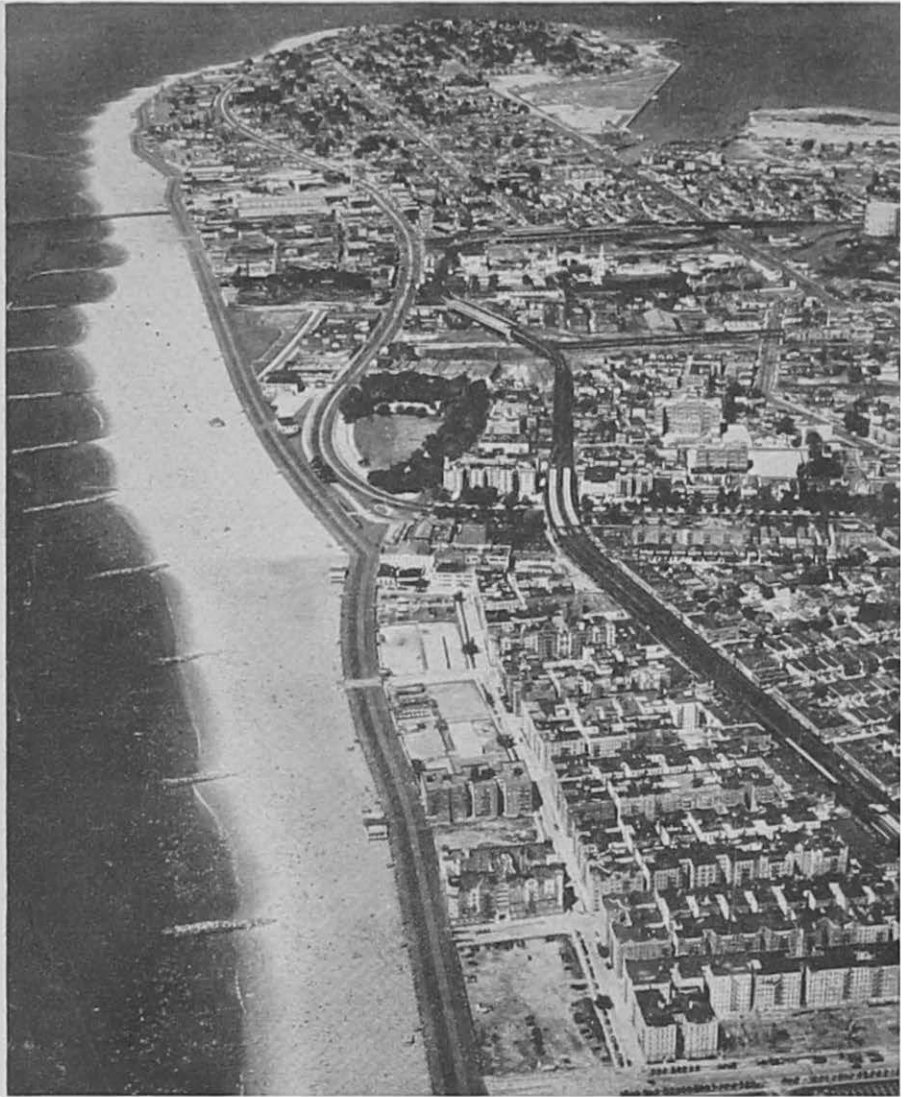
The transition from horses and mules to tractors on farms led to the plowing of land formerly in hay crops and planting it to soil-exposing crops. Manure practically disappeared at the same time. Both meadows and manure previously had helped to hold the soil against erosion.

Long Island soils were originally low in organic matter, high in coarse particles, and low in clay, and therefore susceptible to erosion. As the organic content decreased, the soil became easily compacted, lost water-holding capacity, and absorbed water less readily than before. Both runoff and erosion, therefore, increased.

Old fence rows were removed to make longer crop rows for greater efficiency, and timberland was cleared to bring it into cultivation. This cutting of trees and shrubs has removed their windbreak effects and increased blowing.

## HOW TO CONTROL EROSION

1. Conduct tillage, planting, and harvesting operations on, or close to, the contour.
2. Maintain productivity of the land by using fertilizers and all available duck manure. Use of fertilizer, however, is usually ample on Long Island.
3. Protect the soil during fall, winter, and early spring with thick-growing cover crops. Rye and spring barley are commonly used. Contour and broadcast seeding of cover crops afford more protection than do up- and downhill seeding.
4. Grow cover crops to protect the surface of soils against erosion by both wind and water.
5. Discourage cropping of roadsides.
6. Prevent concentration of water on crop lands unless you make some provision for absorbing the collected water.
7. Prepare absorptive, all-year outlets and terrace long slopes to "walk" the water across slopes to non-eroding outlets.
8. Establish windbreaks of picket fences, shrubs, or trees to reduce the velocity of the wind and to hold the soil on crop lands.
9. If land cannot be protected with cover crops or windbreaks, roughen it to catch and hold the wind-blown soil.
10. On the beaches and dunes, use picket, or snow, fences and any sort of trash, and plant adapted vines, shrubs, and trees and beach grasses with legumes to reduce blowing of the sand.
11. Install jetties at the water line and plant shrubs or vines on the higher part of wave-cut shorelines to help control wave erosion which is active on both shores of Long Island.
12. Wave-erosion control, however, is primarily a public problem rather than one for the farmer.



*Figure 41.* Coney Island. Here jetties protect this valuable beach for recreation.

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