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Mitigation of Acid-Producing Soils

FINAL REPORT
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Submitted by

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16. Abstract

This project produced a method for stabilizing the pH of acid-producing soils in order that the soils could support the growth of vegetation needed to minimize erosion. Recipes for the modification of acid-producing soils have been successfully used by the National Minelands Reclaimation Center and the Arkansas Power and Light Co.. Those recipes rely on the ability of a fly ash/kiln dust to bind with the sulphur in the soils to thus minimize the production of Sulfuric acid. This project used a mixture of lime-stabilized sewage sludge as an amendment.

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SUMMARY

Acid-producing soils are soils that contain high amounts of sulfide-bearing materials. This project researched and demonstrated a method for neutralizing and stabilizing those acid-producing soils typically found on roadways in New Jersey. These soils are in need of neutralization and stabilization in order to support the growth of vegetation which in turn is needed to minimize erosion.

A recipe using lime-stabilized sewage sludge was tested at two application strengths at a road site having acid-producing soils. A control section was also created. After application of the sludge the site was monitored for several years.

The application of lime stabilized sewage sludge proved to be an effective treatment in the mitigation of acid producing soils. A final recommendation was devised for treating future acid-producing soils.

Background

Acid-producing soils occur naturally in New Jersey. When exposed to air, these soils produce excessive acidity that prevents vegetation from growing and thus creates an erosion problem, especially where these soils occur on slopes. This project attempted to find a cost-effective method for stabilizing the pH of acid-producing soils to a level that would support vegetation without further amendments to the soils. Ideally, any mitigation measure should not involve the use of specialized equipment, or utilize environmentally-damaging chemicals. Also, a stabilized pH close to 6.5, the ideal pH for growing grass, should be achieved.

Acid-producing soils are soils that contain high amounts of sulfide-bearing materials. When these materials are exposed to air (oxidation), sulfuric acid is produced (sulphuricization). Acid production has also been called sulfidation or puritization by some authors. Early studies of acid-producing soils dealt with "cat clay" soils that occurred in recent sediments and tidal marshes. When these soils were artificially drained, environmental conditions produced soils with low pH's. Later studies looked at the acid-producing properties of older sediments and rocks exposed to air during ground disruption consistent with mining operations.

Within New Jersey, acid-producing soils occur in the southern half of the state south of an imaginary line drawn from Shrewesbury, Monmouth County to Trenton, Mercer County. The soils occur in irregular bands. Their presence is not predictable unless numerous borings are made. During highway construction, grading operations often expose these soils. Their initial appearance does not usually indicate their potential acidities. PH tests performed when the soils are first uncovered give agronomically acceptable results (above 4.1 pH) for the use of the material as topsoil. Consequently, these soils were often spread as topsoil, usually with the addition of some ground-limestone and produced acceptable stands of vegetation for two years. However, as the soils oxidized their pH values dropped dramatically to as low as 2.5 pH causing the vegetation to die and erosion to start. This erosion was especially troublesome on cut-slopes where veins of acid-producing soils were also exposed to air besides the surface layer of "topsoil".

Recommendations for the various New Jersey Soil Conservation Districts stated that the optimal treatment of acid-producing soils is to avoid disturbing them and if they are disturbed to quickly rebury them to minimize air contact. On road projects, these recommendations have not been possible to follow for several reasons. Firstly, the acid-producing soils are not usually recognizable. Secondly, the grading operations that expose the soils also redistribute them over large areas. Thirdly, the extent of the potential acidity problem is not generally understood by the people involved with the construction activities.

New information on the problem of stabilizing acid-producing soils is being gathered by Rutgers University from studies of landfills. Acid-producing Woodbury Clays are currently used as cap materials on several landfills in New Jersey. These clays are used to provide an impervious cap to the waste materials buried underneath. Unfortunately, when these clays oxidize they produce sufficient acidity to prevent the growth of vegetation covers planted on top of the clays thereby allowing erosion to occur to the point that the buried waste materials can be eventually exposed. Currently, several techniques are being tried to stop the clay from oxidizing. They techniques use layers of plastic films, lime, flyash and topsoil to prevent air from reaching the clay. Preliminary results indicate that the approach may work but the costs would be prohibitive for any sizeable acreage.

Another area of concern where acid-producing soils occur is in mine spoils. Reclamation efforts to date have concentrated on trying to stabilize the pH's of these soils by applications of neutralizing agents such as limestone and flyash/kiln dust mixtures. No permanent solutions have been found but rather the research has indicated that the soils need to be continuously monitored and new application of neutralizing agents made as needed.

Literature Search

A literature search for information on acid-producing soils produced few results when the traditional engineering indices such as Science and Technology and the Engineering Index were consulted. Use of the agricultural indices at Rutgers University produced better results. One article, in particular, related a possible approach to stabilizing the acidifies of problem soils. The article detailed the results of the Arkansas Power and Light Company to stabilize a bank of acid-producing soils exposed during the construction of a railway spur. The company used a mixture of kiln dust enriched flyash and composted leaves. The mixture was incorporated into the existing soil to provide a suitable growing medium for vegetation. The results were positive enough to warrant further consideration as a possible solution for New Jersey's acid-producing soil problems.

Site Selection and Experiment Parameters

Consultation with individuals at the U. S. Geological Survey office in New Jersey and with individuals at Rutgers University gave optimism to the proposal to develop a recipe of kiln dust/fly ash and composted sewage sludge to be used for stabilizing acid-producing soils. After several field trips with NJDOT landscape personnel, a test site was located at Halls Mill Road and Route 33 in Monmouth County. [See Figure 1] Tests of the existing soils indicated a pH range of 4.4 to 3.8. Grasses grow best in soils having a pH from 6.0 to 7.5. The landscape was sparsely vegetated with noticeable amounts of erosion gullies. Touching the soil produced a stinging feeling on any hand cut or abrasion similar to the sensation one could receive by putting lemon juice on one's hand.

Concurrent with locating a test site, enquiries were made to locate a suitable source of sludge. Because it was important to both neutralize and stabilize the soil, a lime-stabilized sludge product was needed. The Middlesex Sewage Authority produces a product called MeadowLife, which is a lime, stabilized sludge. The product is marketed as an artificial soil for non-crop use and is monitored for heavy metal contamination. MeadowLife has a pH of about 10 making it very basic and therefore a good neutralizer.

Using technical support from the Middlesex Sewage Authority, two application rates for the test site were decided on:

1. One hundred and twenty tons of MeadowLife per acre (plot A) and
2. Sixty tons of MeadowLife per acre (plot B).
3. The control section did not receive any MeadowLife.

Test site preparation began in October to take advantage of optimal growing conditions for establishing new grass. Approximately six acres of uniform, flat land with generally uniform distribution of acid-producing soils was staked into three equal plots. Using a farm tractor, the entire six acres was tilled to a depth of ten inches. Next, MeadowLife was applied at rates of one hundred and twenty tons per acre to one of the plots and at a rate of sixty tons per acre to the other plot.

The correct amount of MeadowLife needed for each plot was uniformly spread within each of the two plots. When this work was completed both areas were again rototilled to a depth of ten inches to ensure uniform incorporation. The control section did not receive any MeadowLife.

The final steps in the process were to seed all areas with a standard NJDOT turf grass seed mixture with the addition of some wildflower seeds. All areas were then mulched with straw and tacked as per NJDOT specifications.

Within four weeks the grass/wildflower seed mix had germinated on all the plots, including the control plot. With the onset of cold weather the seedlings went dormant for the winter.

In the following spring the plots were observed regularly. Plot A (120 tons per acre) showed the most vigorous growth, almost double that of Plot B (60 tons per acre). [See Figures 2] The control plot was beginning to show signs of stress in that the grass was dying out leaving many bare spots.

During the subsequent summer, Plot A showed markedly better vegetation cover than Plot B. The grass showed enhanced vigor and there were few bare spots evident. However, plot B showed acceptable vegetative cover. The control plot had numerous bare spots and was showing signs of erosion. [See Figures 3 & 4]

After two summers the differences between plots A and B were becoming less noticeable. The control plot showed total failure with worsening erosion in the forms of gullies.

By the third summer there was little difference between plots A and B. Both plots exhibited healthy vegetation. The decline in vegetation in the control plot continued.

Monitoring of the plots for the next several years showed little degradation of the vegetation. [See Figures 5] Soil tests indicated a pH range of around 7.7, which is very favorable for most turf grasses.

In 2002, the land where the plots were located was needed by contractors undertaking the remaining construction of Route 33.

CONCLUSIONS

Soil test results and visual inspections showed that MeadowLife markedly enhanced and neutralized typical acid-producing soils. The higher rate of application proved to be harmless to soil chemistry and indeed promoted faster establishment of turfgrass. This conclusion was substaniated by soil tests performed by Rutgers University to test heavy metals and calcium contents of the soil.

RECOMMENDATIONS

NJDOT continues to encounter acid-producing soils along its right-of-ways. In some areas, significant drops in pH levels have resulted in the loss of vegetation and subsequent erosion. It is recommended that a specification for remediating these soils be put in place. That specification should consider the following:

- Acid-producing soils should be identified by soil analysis and visual inspection particularly when they are newly exposed to air.
- The use of a lime-stabilized sewage sludge with a pH of at least 10 should be the material of choice for applying to acid-producing soils.
- The rate of application of lime-stabilized sewage sludge should be one hundred and twenty pounds per acre of area to be treated.
- The sludge should be incorporated into the existing soil to a depth of ten inches using rototilling equipment.
- Standard NJDOT specifications for seeding and mulching should be used.

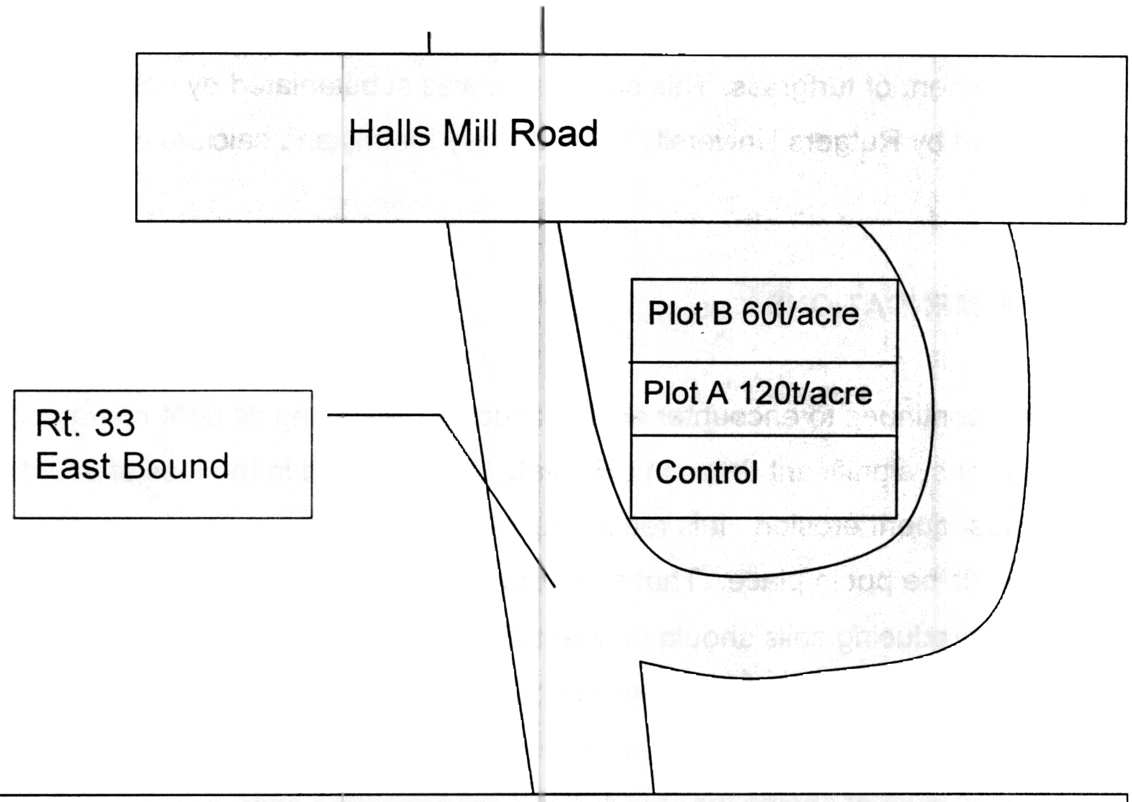

Figure 1. Test location at Halls Mill Road and Route 33 in Monmouth County.

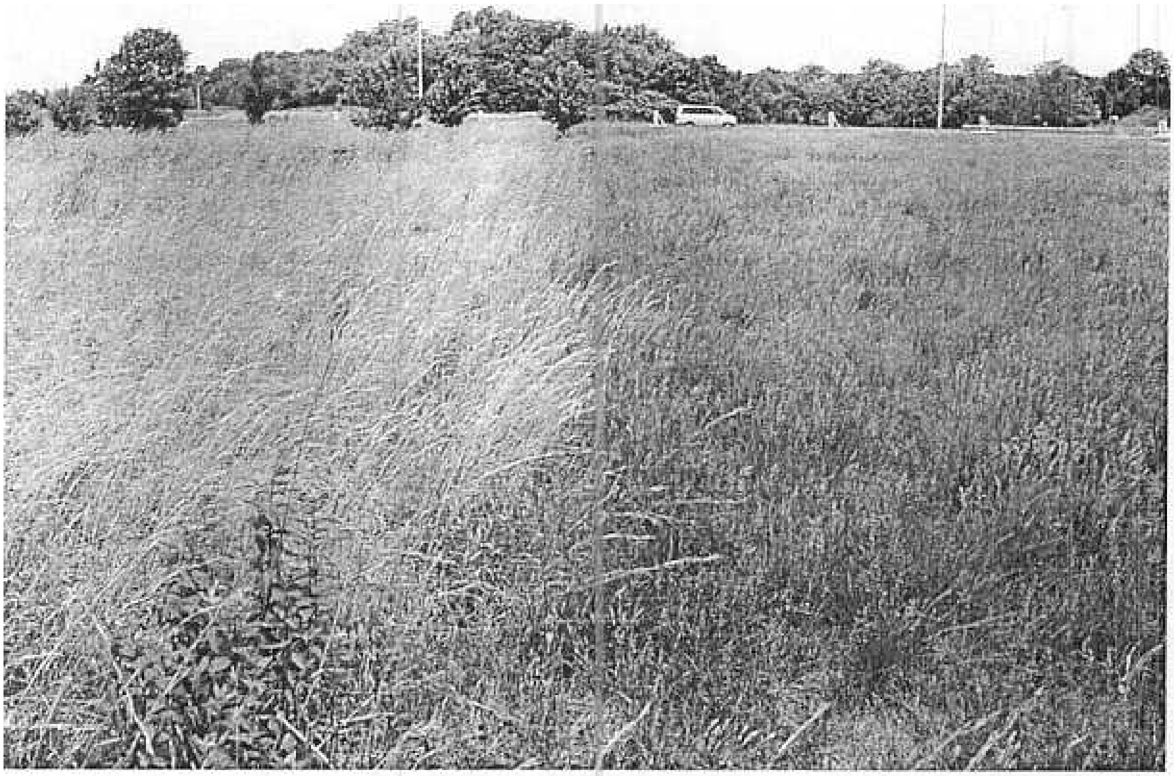

Figure 2. Route 33 Test Plot the spring after installation showing the control section on the left and the Plot A on the right. Vegetation on the control section was mainly annual brome, which succumbed by the summer. The vigorous turf grass growth in Plot A continued to remain vigorous.

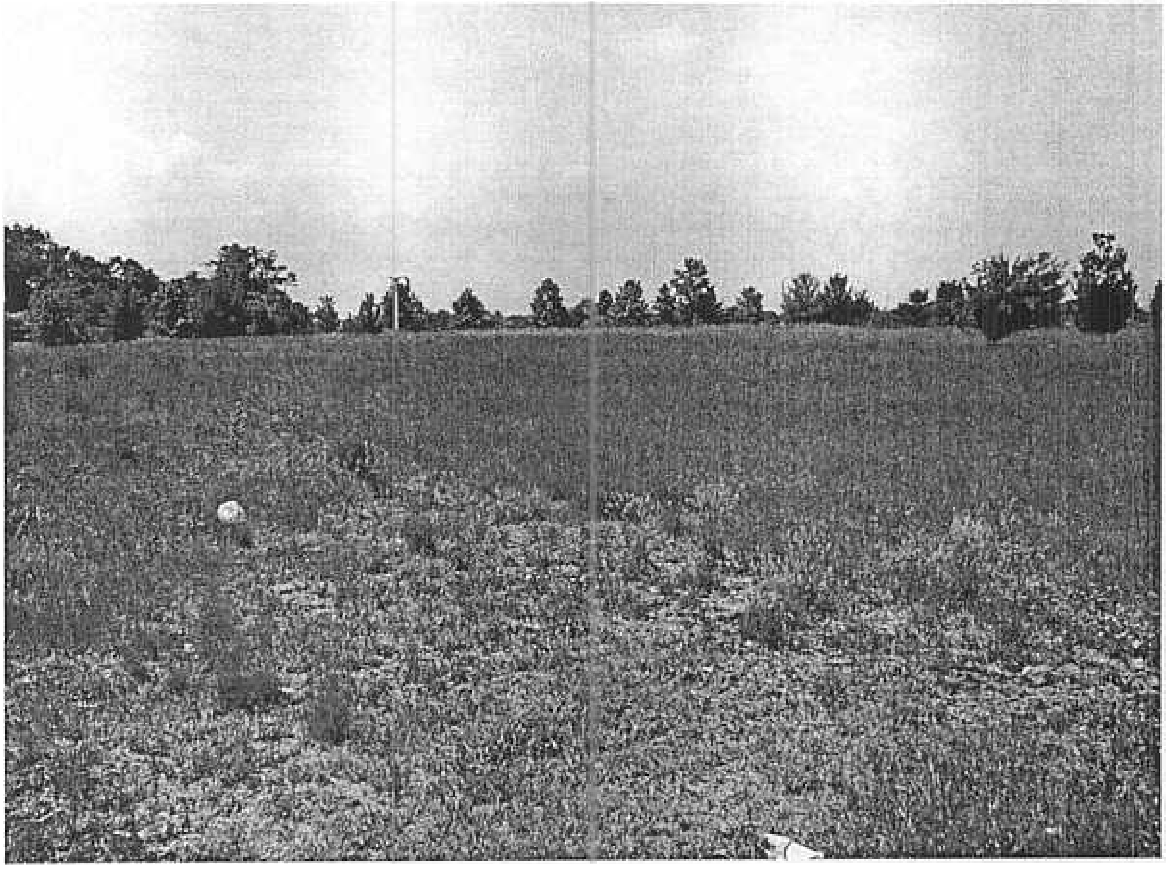

Figure 3. Route 33 Test Plot the second fall after installation showing the control section is on the left and foreground and Plot A is on the right and background. Vegetation was mostly absent from the control section and erosion was beginning. The grass in Plot A continued to thrive.

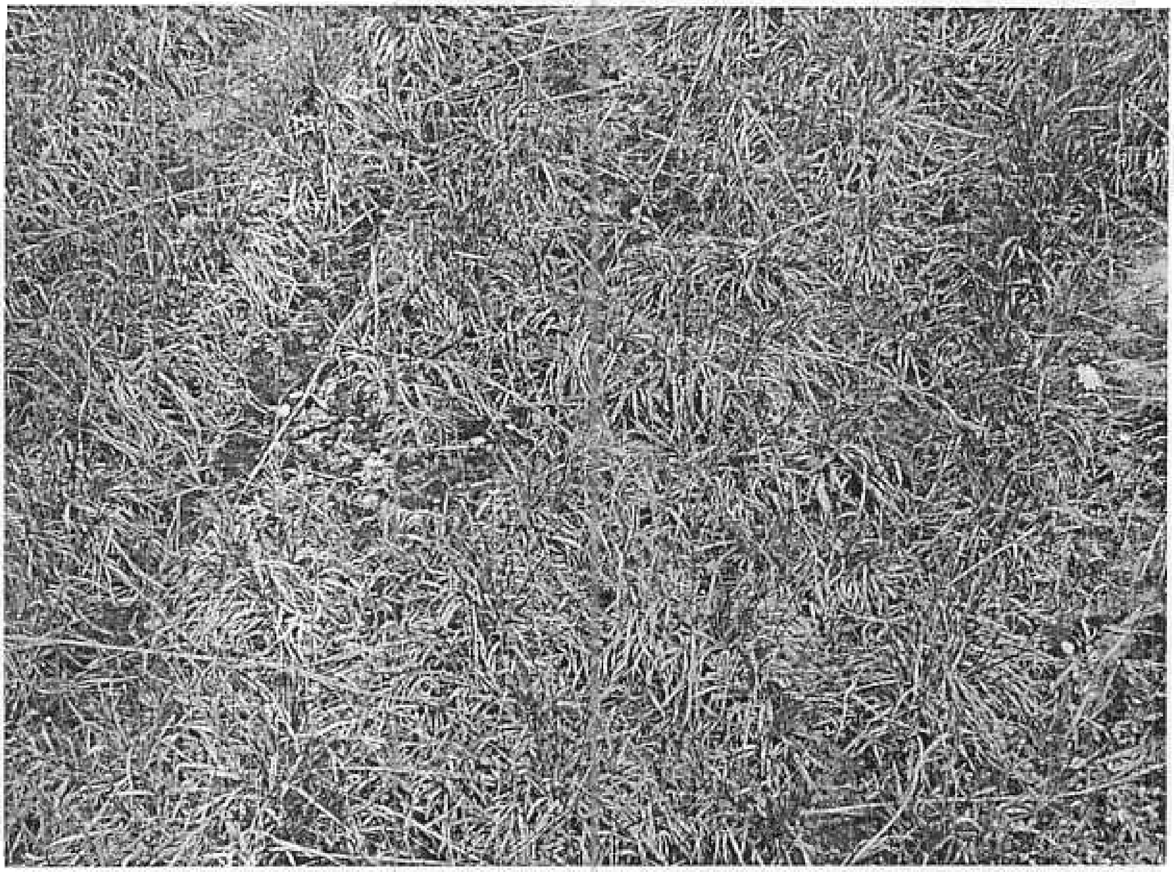

Figure 4. Route 33 Test Plot detail showing the annual brome grass dying in the control section. Dead grass provided only temporary erosion control. After the vegetation decomposed in several months, erosion gullies began to appear.

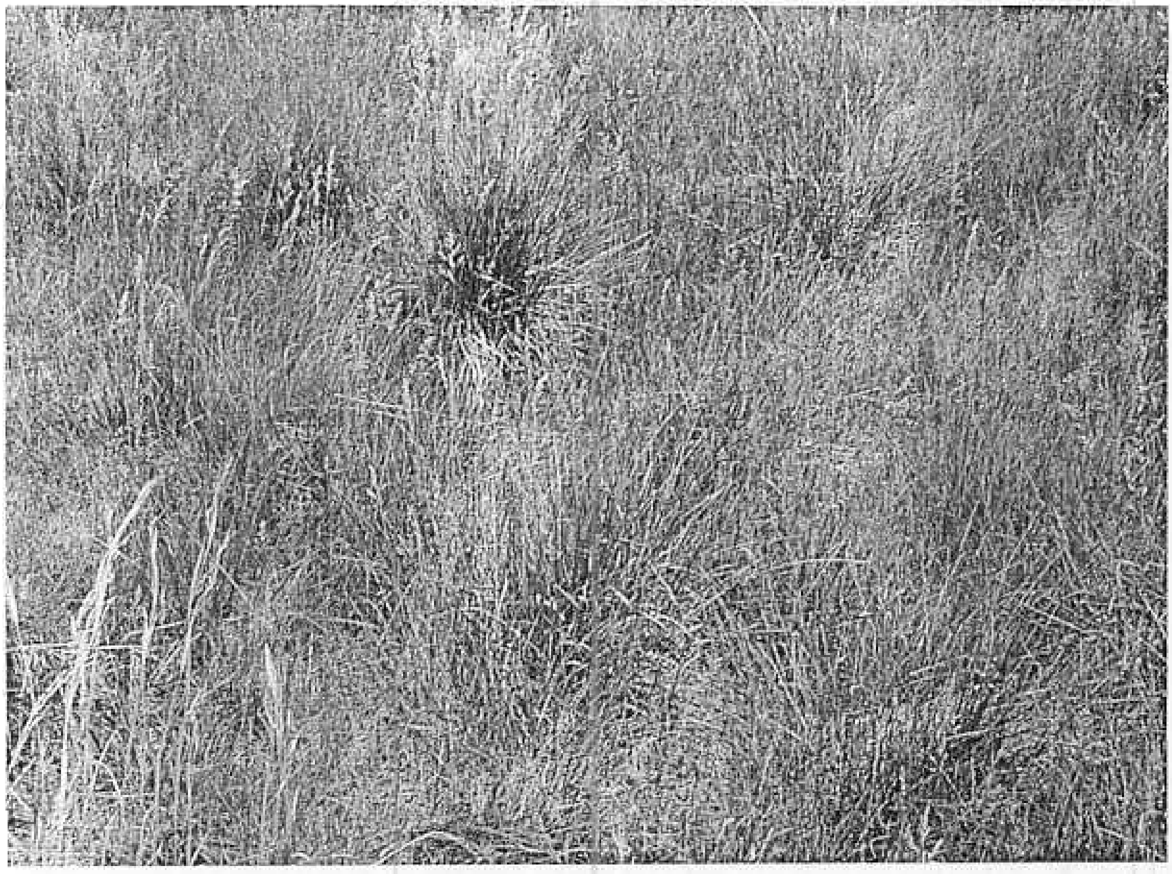

Figure 5. Route 33 Test Plot detail of Plot A after several years of growing. The vegetation, mostly clump type grasses, is very vigorous. No surface erosion was apparent.