VEGETATING VERMONT SAND AND GRAVEL PITS

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FOREWORD

Plant materials are the basic tools used in effective erosion control, regardless of whether the context is based upon environmental or economic conditions. Plants, in addition to defining our environment, protect our soil and water resources from mutual degradation. The role of plants cannot be over emphasized with regards to protecting our ecosystem.

Man is continually inventing new ways to impact upon the resources that nurture and protect all life. Industrial activity, inappropriate farming techniques, disposal of wastes and increased runoff from hard surfaces all combine with a growing population to threaten long-term resource stability. Intelligent use of plant–related systems will bear heavily on our future well being.

The USDA Natural Resource Conservation Service (NRCS) administers the Plant Materials Program for the purposes of: (1) identifying and making available superior plants for protecting soil and water resources; (2) determining improved techniques for using plants and plant systems; (3) providing for commercial increase of superior plants; and (4) promoting the use of plant materials to meet the objective and priorities of the National Conservation Program.

To carry out the plant materials program, a system of Plant Materials Centers and Plant Materials Specialists operates within each region of the country. Plant Materials Specialists provide direct assistance to NRCS personnel in each state seeking vegetative solutions to site specific problems.

This report is a product of the NRCS Plant Materials Program in Vermont and New Hampshire. It provides vegetative recommendations to help solve the persistent and difficult problem of vegetating sand and gravel pits.

Francis M. Keeler
State Conservationist

INTRODUCTION

Soil erosion and aesthetics are two of the concerns associated with the operation, maintenance and closure of sand and gravel pits. A good vegetative cover of grasses and legumes can alleviate both of these concerns. Vegetative cover will retard surface runoff and prevent erosion, reducing the sedimentation of nearby streams, waterways and water bodies. Vegetative cover can also do much to enhance aesthetics of sand and gravel pits while providing nesting and escape cover for wildlife.

This paper discusses vegetative treatment of sand and gravel pits in Vermont for the purposes of minimizing soil erosion, enhancing site aesthetics and cover ground nesting. The primary purpose is to address erosion. By its nature, establishing vegetation will enhance site aesthetics. Long term stabilization will allow for the transition to forested cover.

The vegetative recommendations are based on the evaluation of test plantings made at sand and gravel pits throughout New England and New York. The Natural Resources Conservation Service (NRCS) coordinated the plantings and conducted follow-up evaluation during the period 1975-1990. Although to a lesser degree, plantings and evaluations have continued in later years to gain more insight and knowledge. NRCS will provide updated recommendations when and if further study warrants them.

Establishing Vegetation: Recognizing the Problem

It is often difficult to establish permanent vegetative cover on sand and gravel pits. Of all sites to be successfully and permanently vegetated in Vermont, sand and gravel pits are one of the most difficult sites, exceeded only by the difficulty of vegetating stream banks. The difficulty can almost always be attributed to one factor: the topsoil is usually sold and is not stockpiled for reclamation. The topsoil removal compounds some inherent characteristics of sand and gravel areas; namely droughty conditions, low soil organic matter, and low soil fertility. These characteristics make it difficult to establish and maintain a grass or legume cover on what remains after mining ceases.

The argument often presented is that it is not customary to stockpile topsoil. Stockpiling some topsoil can virtually eliminate the usual difficulty associated with the vegetative efforts. It is important to note that it is necessary to save all the available topsoil to establish vegetation. Enough topsoil to provide a 4-inch cap will usually be sufficient. Once all topsoil has been removed however, it becomes very difficult to establish permanent vegetation. This report addresses this difficulty.

SITE PREPARATION: ENGINEERING

Erosion prevention may require two basic considerations: engineering and vegetative. Sometimes engineering practices are not required. Each site, however, needs to be evaluated to determine if engineering practices are needed to maintain soil stability and to prevent erosion. Not addressing and applying needed engineering practices will

hinder and, in some cases, prevent the establishment of effective vegetative cover. While some sites require specific and detailed engineering plans, there are some general guidelines that can be considered on all sites. If considered and adhered to, these applied guidelines can do much to ease the task of establishing vegetation.

1. To provide stability, cut and fill slopes should not exceed 2:1 (2 horizontal feet for 1 vertical foot). Flatter slopes (3:1) are preferred to facilitate seeding efforts.

2. Avoid long slopes to help prevent erosion and to allow access for seeding and mulching. Control slope length by installing one terrace (10 feet wide and sloped into the cut slope) for every 40 vertical feet.

3. Construct diversions at tops of slopes to divert off site runoff away from the slope banks to a stable outlet.

4. Construct sediment basins where concentrated runoff is unavoidable and sediment can be expected.

SITE PREPARTATION FOR SEEDING

1. Remove large stones, boulders and other debris that will hinder the seeding process and establishment of vegetation.

2. If available, on site, spread enough topsoil over the site to put down a 4-inch cap.

3. Obtain samples by collecting 6 to 8 small samples (1 or 2 handfuls) of soil material from the area to be seeded. Mix the small samples to obtain one composite sample.

4. Use part of the sample for a soil test to determine lime and fertilizer needs. Run the balance of the sample(s) through a sieve analysis to determine the percent by weight passing a 200 mesh sieve.

SEEDING PROCEDURES

A. Seed Mixtures vs. Percent Fines

Select one of the three grass/legume mixes shown below, based on the percent weight passing a 200 mesh sieve as outlined above. Mix 2 is recommended if suppression of woody growth is desired. The standard Soil Conservation Mix available from local seed suppliers is **not** recommended. This mix usually provides a green cover very quickly but the plant species begin to die out in 2-4 years on sterile and droughty sites.

Mix 1

Costal Panicgrass Species	**Atlantic Varieties (Select One)[a]**	**Lbs/Acre (PLS)[b]**
Switchgrass	Pathfinder, Shelter, Trailblazer	2.0
Big Bluestem	Niagara, Kaw	4.0
Little Bluestem	Camper, Aldous, Blaze	2.0
Sand Lovegrass	NE-27, Bend, Common	1.5
Birdsfoot Trefoil	Viking	2.0
Sand Bluestem	Gold Strike	2.0

Mix 2

Species	**Varieties (Select One)[a]**	**Lbs/Acre (PLS)[c]**
Flatpea[d]	Lathco	10.0
Perennial Pea[d]	Lancer	2.0
Crownvetch[d]	Penngift, Chemug	10.0
Tall Fescue	KY-31, Rebel, Ken-Hi	10.0

Mix 3

Species	**Varieties (Select One)[a]**	**Lbs/Acre (PLS)[c]**
Sheep Fescue	Covar, Common	4.0
Tall Fescue	KY-31	2.0
Redtop	Streaker, Common	2.0
Canada Wildrye	Common	3.0
Virginia Wildrye	Common	3.0
Birdsfoot Trefoil[d]	Viking, Empire	3.0

a. Varieties are listed in preferential order.

b. Warm season grass seed is sold and planted on the basis of pure live seeds (PLS). An adjustment is made to the bulk pounds of seed to compensate for inert material and dead seed.

c. Legume and cool season grass seed is sold and planted on a bulk basis, the weight is not compensated for dead seed and inert material.

d. These legumes must be inoculated at the time of seeding. If seeding by hand, used sticking agent; such as cola or milk to stick inoculate to seed. If seeding with hydro seeder, use 4 times the recommended rate of inoculates. Note that seed must be tracked in with a bulldozer. If Crownvetch (mix2) is an invasive concern, substitute hairy vetch (Madison) at same rate. Even though not native, hairy vetch may be less invasive.

Where percent by weight passing a 200 sieve is less than 15, use mix 1. If less than 10 percent add sand bluestem.

Where percent by weight passing a 200 sieve is 15 to 20, use Mix 1 or 2. If suppression of volunteer woody plants is needed, use mix 2.

The species in Mix 1 may not be available from local seed suppliers in Vermont. If not, and if the local supplier will not order such seeds, consider the following sources.

Stanford Seed Co.
RR 1 Box 405
Denver, PA 17517
(215) 267-3805
(Switchgrass only)

Stock Seed Farms
RR 1, Box 112
Murdock, NE 68407
(402) 867-3771

Ernst Conservation Seeds
RD 5 Box 806
Meadville, PA 16335
(814) 425-7276

Sharp Seed Company
Route 4
Clinton, MO 64735
(816)885-8521

Seed can be ordered direct from these sources. Local seed suppliers will in most instances have to order the seed for the buyer. Thus, sufficient lead time will be needed to obtain what is needed.

The species in mixes 2 and 3 are generally available through local seed suppliers but some will not carry all the species and will have to order that seed. NRCS can provide some additional guidance on species substitutes and available seed sources.

B. Seeding Dates

The primary seeding window begins as soon as the snow is gone in the spring and ends May 15. The importance of early seeding cannot be overemphasized. This is especially true for mix 1. Substantial failure can be expected if seeding is done later, depending on weather conditions.

Late summer and early fall seedings are not recommended for mixes 1 and 2. If late season seedings of mixes 1 and 2 are necessary, they should be done after October 20 to prevent fall germination and subsequent winterkill.

Mix 3 can also be seeded from August 15 to September 15 if the spring window is missed.

C. Fertilizer and Lime Recommendations

Mix 1 - In lieu of soil test, lime at the rate of 1 ton/acre (50 lbs/1000 sq. ft.). Fertilize with 500lbs/acre (11 lbs/1000 sq. ft.) of 10-20-20. The nitrogen fraction should be ammonium nitrate.

Mix 2 and 3 - In lieu of soil test, lime at the rate of 2 tons/acre (90lbs/1000sq. ft.). Fertilize with 500 lbs (11lbs/1000sq. ft.) of 10-20-20.

The seed needs to be incorporated to ensure success and to shorten establishment time. This is especially true for mixes 1 and 2 and most critical for the legumes in mix 2. On the flatter slopes, use a bulldozer to 'track in' the seed. To help anchor mulch, spread the mulch before "tracking" with the bulldozer or other equipment.

D. 'Tracking' the Site

No matter how the seed and fertilizer is spread, the site should be immediately 'tracked' with a bulldozer. This is performed by running the bulldozer up and down slope, off setting by the track width on each pass. The entire area should be covered with tracks when done. Omitting this step will compromise success.

E. Mulching

Mix 1-Weed free mulch is a 'must.' Clean straw is recommended. Mulch at the maximum rate of 1,500 lbs/acre. (34 lbs/1000 sq. ft.) Higher mulching rates and mulch with seed content will inhibit seeding success significantly. If the erosion hazard is low, mulching is not necessary for seeding success. Mulch mix 1 AFTER the site has been 'tracked.'

Mixes 2 and 3 - Mulch with weed free hay or straw, and mulch at the rate of 2-3 tons/acre (92-138lbs/1,600 sq. ft.) for mix 2 and 1-2 tons/acre (50-90 lbs/1000 sq. ft.) for mix 3. The higher mulching rate is recommended where seed incorporation is more difficult. This is especially critical for mix 2.

Follow-up seeding may be needed to establish vegetation on the more difficult parts of some sites. The need to do follow-up seeding can be determined the year after seeding.

F. Seeding Response

The plant species in mixes 1 and 2 germinate and grow slowly. Complete cover may not occur for 2-3 years. However, a well established stand will endure for years. Initially, most of the seedlings will appear in the cleat tracks.

MAINTENANCE

Substantial stand vigor can be achieved if the site is top dressed with fertilizer one year after planting. If topdressing mix 1, fertilize between June 15 and July 15. The timing of this topdressing is important. Mixes 2 and 3 should be top dressed in the early spring. Top-dress mixes 1 and 3 with 60 lbs of nitrogen/acre. For example, apply 200 lbs of 33-0-0/acre. Top-dress mix 2 with 500 lbs of 0-20-20/acre. Where mix 2 is used without topsoil, boron deficiency is the cause of yellowing and capping of legume leaves. Where this is detected, the addition of 1.0 (one) 1b/acre of boron will improve plant vigor. Boron can be added to bulk fertilizer by special order.

If mowing is desired to suppress woody growth, mow mix 1 about mid-July leaving a stubble height of 8 inches. It is not necessary to mow mix 2. A good cover of flatpea will prevent invasion of woody species. Mix 3 can be mowed at any time.

ASSISTANCE FROM THE NATURAL RESOURCE CONSERVATION SERVICE

NRCS personnel are available to help evaluate specific sites and to assist in fitting the above recommendations to the site(s). Plantings of some of the species identified in mixes 1 and 2 are located in Addison, Bennington, Franklin, Orange, Orleans, and Washington counties. If interested in seeing these plantings, contact the appropriate USDA/NRCS field office.

310 Main Street
PO Box 505
Bennington, VT 05201
Tele: (802) 442-2275

109 Professional Drive,
Suite 2
Morrisville, VT 05661
Tele: (802) 888-4935

1153 Main Street, Suite 2
St. Johnsbury, VT 05819
Tele: (802) 748-2641

617 Comstock Road, Suite 1
Berlin, VT 05602-8927
Tele: (802) 828-4493

59 Waterfront Plaza, Suite12
Newport, VT 05855-4877
Tele: (802) 334-6090

28 Farmvu Drive
White River Jct., VT
05001
Tele: (802) 295-7942

28 Vernon St. #2
Brattleboro, VT 05302
Tele (802) 254-9766

170 South Main Street,
Suite 6
Rutland, VT 05701-4558
Tele: (802) 775-8034

600 Blair Park Road,
Suite 230
Williston, VT 05495-7529
Tele: (802) 879-4785

68 Catamount Park, Suite B
Middlebury, VT 05753
Tele: (802) 388-6748

27 Fisher Pond Road,
Suite 1
St. Albans, VT 05478
Tele: (802) 527-1296

ADDENDUM A Gravel pit and other sandy and droughty site renovation trials and experiences in New Hampshire and Vermont.

A Search for an Effective Herbaceous Cover

In 1976, 1977, and 1978, ten plantings were made in six northeast states comparing six cool-season grasses, six warm-season grasses, and four legumes. Study methods, results, and discussion is presented in a paper by F.B. Gaffney and J.A. Dickerson titled Species Selection for Revegetating Sand and Gravel Mines in the Northeast States.

Conclusions of the initial study and subsequent plantings study had relevance to roadsides and sandy/gravelly borrow pits in New Hampshire and Vermont. Subsequent plantings were done in several New Hampshire and Vermont counties during the 1980s and 1990s. Key conclusions are as follows:

(1) Cool-season grasses, when planted alone, are not effective long-term species.

(2) Where fines (particles passing the 200-mesh sieve) are greater than 15 percent, legumes such as flatpea, crownvetch, and the trefoils are much more effective than the cool-season grasses.

(3) Where fines are less than 10 percent, switchgrass, big and little bluestem, and other warm season grasses are the only effective herbaceous species for long term, low maintenance cover.

(4) The long term need for fertilizer is less for warm-season grasses than for cool-season grasses.

Warm-Season Grass Background

(1) Warm-season grass seed germinates at a minimum soil temperature of about 60 degrees Fahrenheit. These temperatures are achieved earlier in the season on sands and gravels than on agricultural soils.
(2) These plants make most of their growth during the heat of summer while most cool-season grass growth occurs in spring and fall months. Above ground growth of mature plants typically occurs after May 15th in New Hampshire and Vermont.
(3) During the seeding year, warm-season grasses grow down, not up. The top growth typically amounts to a narrow straight leaf until late in the summer. These seedlings can be difficult to see, even for experienced growers. Inexperienced growers are almost always convinced they have a failure the first year. Most of the time they actually have the start of a good seed stand. Patience must be a part of the vegetative establishment process for consultants, seeding (vegetative establishment) contractors, purchasers of services, and community representatives administering ordinances and regulations. The rewards on

droughty sandy and or gravelly sites are long term vegetation versus the short term vegetation of cool-season plants.

Growing Warm-Season Grasses in Droughty Sand and Gravel in New Hampshire and Vermont

Droughty sand and gravel substratum material provides a far different environment for growing warm season grasses than the silty and clayey topsoils of the Midwest. Keys to the success of these plants are deep root systems that develop rapidly after germination, large root systems, apparent low fertility requirements, the ability to thrive during hot summer months, and low pH requirements.

The plot trials established between 1984 and 1990 revealed species, varieties, seeding techniques, fertilizer requirements, and cost information useful in providing plant cover on droughty, sandy, and gravely surfaces in both states.

Species

Switchgrass, Coastal Panicgrass, Indiangrass, Big Bluestem, Sand Bluestem, Little Bluestem, Deertongue, and Sand Lovegrass will grow well, when established in droughty sands and gravels of borrow pits and other cut and fill slopes. Seed of these plants is commercially available.

Varieties

Selecting suitable varieties for a climatic situation is as critical as selecting a species. For example, 'Trailblazer' Switchgrass established well in most of New Hampshire, but 'Alamo' Switchgrass winter-killed.

Establishment, Seed Germination, and Seedling Development

Seed germination appears to be dependent on about a 2-week period of moistened seed at a time when soil temperatures have reached 60 degrees Fahrenheit. In droughty sand and gravel, the surface two to three inches of the seedbed is too dry most of the time to keep the seed moist long enough to germinate. While most warm-season grass seed will remain viable in or on the soil for several years, it will not germinate until prolonged moisture is available at warm temperatures. Consequently, it may be the spring after seeding before seedlings are observed. In fact, it is usually the second year when the success of a seeding becomes evident.

Seeding Methods and Other Considerations

Several observations were made during the course of several years of seeding sand and gravelly was in New Hampshire and Vermont. They are as follows:

Mulch

Mulch is not an answer to a moist seedbed. Seedling development was best without the use of grass or straw mulch in some of the plantings.

(1) In New Hampshire trials, there was little soil moisture difference with or without mulch.

(2) The soil seedbed beneath the mulch was much cooler than the soil seedbed without mulch.

(3) Where mulch was disked as an anchoring technique, it seemed to act as a wicking agent causing the soil in slits to remain dry for extended periods. Germination was poor in the slits.

(4) Except for hydroseeding efforts, mulch is not currently recommended in New Hampshire for warm-season grasses seeded on droughty sands and gravels.

Compaction

Concerns about soil compaction around the seed were addressed in the various seeding methods tried. These methods included:

(1) Loose raking of seed, lime, and fertilizer;

(2) Walking in the seed, lime, and fertilizer on steep, loose, sandy, slopes;

(3) Tracking a site with a farm tractor with deep knob type tires after the seed, lime, and fertilizer were applied;

(4) Tracking many sites with bulldozers having deep grousers or cleats after the seed, lime, and fertilizer were applied;

(5) No till drilling,

(6) Hydroseeding numerous sites.

Loose raking

The raking of seed, lime, and fertilizer by hand has worked well on several hundred small plots (10’ x 10’). It works well where topsoil or composted sludge is used.

Walking in

Walking back and forth across the slope has worked well where slopes are steep, sandy, and loose. The method works on stockpiled sand, and other slopes too steep and loose for effective tracking with bulldozer.

Tracking With a Farm Tractor

Complete failure. No better than throwing the seed on the ground surface and walking away. Insignificant compaction around the seed was observed.

Tracking with Bulldozers

This is, by far, the most dependable method for assuring the success of a warm-season grass seeding on droughty, sand, and/or gravely sites based on New Hampshire trials. Large or small dozers work well on nearly level sites. Large dozers are necessary on steep slopes. Small dozers slip, loosening the seedbed rather than pressing the seed into the ground surface on steep slopes. Dozers movement should be up and down the slope.

Seedlings develop in the grouser tracks apparently benefiting from compaction, seed covering from sand washed and blown into the tracks, and perhaps lime and fertilizer that may have moved with the sand particles. The grouser tracks provide an important function of reducing erosion during the seedling establishment period. Do not track a site after applying hay or straw mulch. The pressed in material keeps the track dry and inhibits germination.

Drilling

Results were mixed with two sites rated excellent and two sites rated poor for seedling establishment. Reasons for the failure were not evident. Drilling requires special seeding equipment for seeds with awns such as Big Bluestem, and Indiangrass. Switchgrass, Panicgrass, and Sand Lovegrass work well in the Tye and Moore no till seeders providing the drive works in the sand. Although Switchgrass seed in a Tye drill was placed two and three inches deep in sand dunes, seedlings developed in the drill rows. Sand blowing against or accumulating on the seedlings subsequently killed many plants in this trial; however, the seeding method worked.

Hydroseeding

All seed readily passes through the hydroseeder nozzle, thus facilitating the use of awned seed species. This appears at this time to be the easiest method for distributing lime and fertilizer on long steep slopes.

The search is still on to select techniques that will consistently result in acceptable seedling distribution. Hydroseeding seed, lime, and fertilizer followed by the application

of hay or straw mulch and tackifier is more weather dependent for success than other methods involving seed incorporation. A reason for this may be the germination process. Seed laying on top of the ground sends out a thin rootlet that, in many instances, grows over a quarter of an inch on the surface before moving downward into the soil. This exposed rootlet often dried out in trials in the dry microclimate of sand and gravel pits. Many potential seedlings were lost in this phase of development. A seeding technique under investigation to improve hydroseeding results involves tracking the site prior to application of the various materials.

Plant Populations

Warm Season Grasses

In evaluating warm-season grass plantings, a minimum of one vigorously growing plant per three square feet should be looked for four years after seeding. This plant population will provide adequate erosion control, visual enhancement, and wildlife habitat to satisfy knowledgeable evaluators. Most warm-season plantings will have higher plant densities.

Cool Season Species

A look at numerous gravel pits seeded in prior years to cool-season grass and legume mixtures revealed red fescue to be the only consistent surviving species where there are less than 15-percent fines. This plant provided poor ground cover in all cases due to poor vigor and inadequate population for the species. Seeded birdsfoot trefoil, tall fescue, perennial ryegrass, redtop, and annual ryegrass were mostly missing from these sites.

Several contractor experiences with annual ryegrass demonstrate why this plant should not be included in seeding mixtures used on New Hampshire and Vermont droughty sands and gravels. This plant can be so aggressive under droughty conditions as to prevent other species from getting a start. Since it will die over winter, a long term cover will not be established.

Perennial ryegrass is a very short-lived perennial plant under droughty conditions in New Hampshire. When used with warm-season grass plant populations compared to control plots.

The planting of American Beachgrass Culms and subsequent development on these soils is a success story. This plant spreads by rhizomes and is useful in stabilizing the toe of slopes having accumulating sand, and in reducing wind damage to other seeded species. It is useful in small area plantings such as sand blowouts due to funneled wind on interstate road systems.