Erosion Control Compost Use Demonstration Project Vermont Route 15

Photograph by Ezra Neale, NEBHE Intern

Developed By: The Agency of Natural Resources,
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INTRODUCTION

There are many challenges to the management and proper disposal of solid waste. Recycling and source reduction efforts are the most widely used methods but composting, a waste transformation process, is another effective way of removing waste from the waste stream. Composting is the process of controlled biological decomposition that reduces organic materials to a substance that exhibits qualities of high organic matter, high water holding capacity, and is a slow release fertilizer. The beauty of the composting process is that it both diverts organic waste from entering landfills and produces a valuable product that can be used in a variety of applications, including highway construction. This report has been put together with the intention of summarizing the results of a demonstration project for erosion control on construction projects in Vermont.

Background Material

1.1 Project Development

The state of Vermont has been fairly productive on their development of recycling programs and other waste management initiatives but has very few composting processing facilities. Although there are facilities in various locations in the state the amount of organic waste that they recycle through composting is minimal compared to the amount of organic waste that is produced. In order to increase the amount of organic waste that is composted the Environmental Assistance Division (EAD) has begun a series of programs. These include setting up regional on-farm composting sites to spur the production of compost, investigating alternative uses of compost, and promoting compost use through demonstration projects.

Compost=s soil conditioning and nitrifying properties have been known for many years and are currently being used avidly in the horticultural, agricultural, and landscaping industries. Recently many state department of transportation=s (DOT=s) have been investigating and

obtaining positive results for the uses of compost for erosion control and turf establishment. States such as California, Massachusetts, Maine, Minnesota and Florida have found that composted materials can be functionally, environmentally and economically beneficial to their construction projects. Some of these DOT=s have developed specifications for the material and have used it as a substitute for traditional methods for many years.

1.2 Compost Use Specifications

Many groups have developed specifications for compost use for highway construction, the most recent additions were provided by the Coalition for Northeastern Governors (CONEG) in their report AModel Procurement Guidelines for Source Separated Compost.@ This report addressed the various applications of source separated compost for construction and maintenance projects. It is aimed at introducing the material as a valuable commodity to state DOTs. The report was put together by representatives of various northeastern state DOT=s, members of state environmental departments, and by other composting authorities in the northeast.

One of the compost uses that CONEG identified was for erosion control using a material called Compost Erosion Control Mulch (C.E.C.M.). The mulch is a material that consists of composted leaf and yard trimmings, clean wood or bark or any other material would meet the specifications present in the report. The material is applied to the exposed slope in a way similar to wood bark mulch but can be used as a seeding substrate.

Most construction projects require a final application of topsoil for the revegetation of the site for aesthetic and erosion control purposes. The Agency of Transportation is one of the biggest users of topsoil in Vermont because of the sheer number of highway construction projects that require its use. Erosion control also requires the use of sediment barriers such as sediment fences and/or hay bales that require large amounts of labor and money. Recently

developed compost technologies such as the C.E.C.M are making it evident that recycled organics can be used to replace or supplement materials in the traditional methods of erosion control and turf establishment. In order to determine the effectiveness and feasibility of compost use for erosion control the EAD chose to demonstrate its properties in the real world on an AOT construction project.

1.3 Soil Erosion and Nonpoint Source Pollution

Soil erosion, a form of nonpoint source pollution, can have dramatic effects on surrounding waterways and can be harmful to both the wildlife and the human users of the ecosystem. In undisturbed conditions nature has developed a fantastic way of reducing the amount of sediments that enter the waterways. Rain, the primary player in the movement of sediments, first hits layers of vegetation including trees and herbaceous plants which break its impact. Soils in these areas, typically high in organic matter, act to absorb the water, slowing its flow and filtering it. In this system when the water finally reaches the waterway it is clean and free of sediments.

Unfortunately very often construction projects as well as other activities such as logging, and farming requires the mechanical disruption of this natural erosion control system. By removing the vegetative cover and the primary layer of organic soil, embankments are left exposed and extremely vulnerable to soil erosion.

The cumulative effect of these types of operations can greatly affect waterways by clogging them with sediments and upsetting the natural balance of the ecosystem. High levels of suspended sediments caused by soil erosion can disrupt food chains, smother spawning and feeding habitat, irritate the gills of fish making them prone to disease, kill bottom dwelling animals and add excess nutrients that can encourage algae blooms(). In addition uncontrolled water flow can aid in the movement of pollutants such as heavy metals, herbicides, pesticides,

petroleum-based chemicals and other toxic materials.

1.3 Compost Use For Erosion Control - Theory Behind its Use

In natural buffer zones trees and other forms of vegetative cover drop leaf litter which gradually builds up and decomposes creating a thick organic layer. This layer protects the underlying mineral soil from the force of falling water by creating a porous substrate that has a high water holding capacity and infiltration rate. In addition organic soil layers such as in natural buffer zones comprise materials that have a high humus content, a substance that is able to bind immobilize many chemicals and nutrients that can be harmful to aquatic systems. The nutrients can then be take up by plants for use.

As stated above construction projects often disrupt and/or remove this valuable organic layer leaving soils without their natural protection. One of the best ways to protect our waterways from sedimen tation is by recreating this natural organic layer. Compost is a material with a high hummus content which exhibits many of the valuable properties discussed above. The composition of leaf and yard waste compost is usually comprised of sticks and twigs of various sizes surround by a soil like organic material that aids in holding the material in place. This matrix acts as a filtration device capturing and removing suspended sediments and other particles such as road sands and salts. These attribute of compost were studied thoroughly in a study conducted by W&H Pacific, an environmental firm stationed in Portland Oregon that evaluated a leaf compost as a material for storm water treatment. The study found that compost was one of the most effective materials for removing pollutants commonly found in storm water runoff. With these qualities compost appears to be one of the best materials for the control of erosion and would be particularly useful as an erosion control device surrounding environmentally sensitive areas for the improvement of water quality. Its compostition combined with its high water and infiltrating properties creates a material that will protect a slope initially

without the establishment of vegetation but that can be used as a grass growing medium.

2.0 The Demonstration project

2.1 Typical Erosion Control Techniques

Typical erosion control techniques used by the AOT usually include protecting the disturbed slope with a four to five inch application of topsoil, seeding it and then mulching with hay. In addition most projects use methods to filter sediments from water running off the slope, common practices include using silt fences and hay bails applied at the toe of the unprotected slope. These methods usually provide adequate erosion control but there are some problem areas that need to be addressed.

Topsoil is a nonreplenishable resource that Vermont relies upon on for growing crops for both human and animal consumption. The use of topsoil on construction projects has the potential to reduce the amount of topsoil that is available for agricultural use. These erosion control methods also rely on the establishment of vegetation for the control of sediments. This makes the slope susceptible to excessive soil movement that requires maintenance and could be damaging to the water quality of the surrounding waterways. Although sediment fences are commonly placed at the bottom of the slope, these devices require a significant amount of time and labor to put up and are difficult to maintain in their most functional position. Sediment fences can fall down from environmental influences of because of poor set up procedures.

2.2 Erosion Control Project Site Description

Often during construction projects newly graded embankments are created with material that has been excavated from other sites. In Underhill, Vermont along Route 15, the AOT was working on a federal culvert project that required building a newly constructed 1:2 slope that was adjacent to a wetland. The proximity of the site to the wetland required immediate erosion control. It was decided by the EAD and the AOT, that the site would be an excellent demonstration for compost erosion control mulch.

The entire embankment was created using a subsoil material from other sites that consisted of an aggregate of different sized particles, overall the material was very stony and inadequate for holding moisture or growing vegetation of any kind. To effectively vegetate the site would require the addition of a growing medium that could support the growth of grass for an extended period of time. Due to the proximity to the wetland it was mandatory that a sediment barrier be put along the toe of the slope before, during, and after the slope had been completed.

2.2 Project Design

The design of the project was primarily conducted by the EAD but all propositions were thoroughly discussed and agreed upon by the AOT. The EAD was in charge of locating, purchasing, and transporting the compost material while the AOT was responsible for applying the material, seeding and providing the necessary maintenance. The compost demonstration project was designed so that its use would mimic traditional AOT topsoil application procedures. This was done in order to minimize the changes required to introduce the usage of the material.

Approximately 112 cubic yards of screened leaf and yard waste compost were transported by tractor trailer to the construction site in Underhill. The compost came in two different 56 cubic yard loads, the first consisted of pure leaf and yard waste compost. Due to a limited supply the second load was topped off with eight cubic yards of sandy topsoil. The two loads of compost were unloaded along the road side at different times using a walking floor trailer. The unloading process mixed the sandy tosoil and the compost and no other mixing was needed. The loads were applied separately and a delineation was made between them.

The substrate that made up the fill slope was inadequate for good root establishment. Do to this aspect both the topsoil and compost were applied at a depth greater than the traditional 3 inch application rate. A bulldozer was used to apply the compost at a fairly uniform depth of 5-inches. After the remaining portion of the fill slope was covered with topsoil, both materials were seeded using a hand seeder. The seed was then tracked over with the bulldozer in order to ensure that the seed came in direct contact with the soil. The topsoil was mulched with hay but the compost was not mulched because its composition would help hold the seed in place. The original silt fence was left in place to ensure that the wetland was given adequate protection.

The 112 cubic yards of compost and eight cubic yards of sandy topsoil covered approximately 1/4 of the exposed slope. In order to

compare the composted materials effectiveness to the topsoil application the project was placed in the center of the fill embankment. To determine the changes to the compost and the topsoil the site will be monitored by the EAD.

2.3 Description of Compost Tested

A previous study conducted by W&H Pacific and the Portland Metro Division of Oregon tested various types of compost as an erosion control mulch and determined that the best composted material for the control of erosion was a medium particle size mixed leaf and yard waste compost. Mixed leaf and yard waste compost is a material that is produced from sticks, leaves, grass and any other vegetative waste that may be produced by landscapers, arborists, home owners, etc. Leaf and yard waste is collected and composted at many district transfer stations and municiple recycling facilities. Although a large amount of compost was available much was not managed properly or had not reached a point of maturity. The best quality compost was located at the Rutland County Solid Waste District located in Rutland, VT. The waste was collected at the regional transfer station and ground in a tub grinder to reduce the size of the material. After grinding the material was placed in elongated piles called windrows and composted.

Correctly managed compost requires the periodic turning of the piles with a front end loader to ensure that they are receiving enough oxygen and that they are reaching thermophilic temperatures, or temperatures high enough to eliminate pathogens and make weed seeds unviable. Usually correctly managed leaf and yard waste compost takes between four and six months to become mature.

This produced a compost that consisted of a jumbled mixture of woody particles mixed

with a dark humus like material that is very soil like. Unscreened leaf and yard waste compost can be used as straight mulch but the many woody particles would make the material difficult to vegetate. To remove the large woody particles the compost was screened to a size of 3/4 inch minus with a vibrating Reed screen all. The finished product was a very dark rich looking soil like material that contained only thin 1 - 2" woody particles. The composition of the compost looked as though it would aid in stabilizing the gravel embankment but also looked like it would provide an excellent vegetation substrate.

2.4 Compost Heavy Metal Analysis

The state of Vermont regulations for compost use requires that the material be completely free of any heavy metals or other pollutants that could be harmful to the environment. In order to ensure that the material would be adequate for erosion control the compost was thoroughly tested by the University of Vermont=s soil testing Laboratory. The results determined that the compost was almost completely free of heavy metals or other contaminants and exhibited levels far below state or federal regulations for compost use.

2.5 Soil sampling and Analysis

Although the project was not a research project, it was being established to compare the composted material with traditional topsoil applications. A comprehensive comparison would require conducting a variety of soil analyses on the topsoil, the compost topsoil mixture, and the straight leaf and yard waste compost.

After the materials were applied, the EAD with the help of Craig Dusablum of the AOT collected representative samples of each material. A sample of each was sent to both the University of Vermont soil testing lab and the University of New Hampshire testing laboratory

and a complete analysis was conducted. While taking the samples, compost and soil depths were taken to determine the average application rate of each. Both materials were applied at almost equal rates of 5 inches plus or minus an inch in some spots.

Also conducted on the materials were a compaction test, and a sieve analysis. The compaction test was used to determine the amount of compaction that would occur with all three types of materials. A material that compacts very tightly and has little rebound will create a substrate that is difficult for roots and water to penetrate but one that rebounds quickly will remain aerated and will quickly absorb moisture and allow roots to penetrate. A sieve analysis provides information relating to the particle size distribution of each material. The relative size distribution is directly related to the ability of the material to grow vegetation and stabilize the bare soil. These tests give us a range of parameters that combined with observation will allow one to evaluate the effectiveness of the two materials as an erosion control substrate.

2.6 Monitoring the Demonstration Project

A literature search revealed research projects have produced produced fairly quantitative data regarding composts ability to control erosion and other pollutants. In this demonstration project observation will be the primary way of evaluating the material. The EAD will be monitor the project no less than bimonthly and more as time permits. Observations will be taken and recorded at each visit to the site. Initially visits will be planned after large rainstorms that could pose problems to the slope.

The observer will evaluate specifically, any problems with the stability of the slope, which could include previous movement of compost or topsoil by the action of water. This would be indicated by riling and/or gullying that has occurred on the slope. The rate of vegetation establishment of both the topsoil and the compost will be observed and recorded. The quality of grass coverage that initially covers the topsoil and the compost, characteristics such as thin,

splotchy, thick, dark green, light green will also be carefully noted.

3.0 Results

3.1 The Economics of Compost Use

Amount of Material Required: The demonstration slope required approximately 480 cubic yards of material to cover it at the proper depth.

Costs of materials

Leaf and Yard waste Compost Unscreened: $5 per cubic yard

Approximate value of Screened Leaf and Yard Waste Compost: $10 per cubic yard

Cost of Topsoil: $13 per cubic yard

Total cost of Applied Material

1. Total Cost Compost

Material cost = 480 cubic yards * $10/cubic yard = $4,800

Trucking Cost = $490 for 120 cubic yards of material from Rutland, VT * 4 = $1960

Total Cost of 480 cubic yards applied to slope = $6760

2. Total Cost of Topsoil

Material Cost = 480 cubic yards * $13/cubic yard = $6240

Trucking Cost = estimated cost of $1000

Total Cost of 480 cubic yards applied to slope = $7240

4.0 Discussion:

4.1 Evaluation using Compost Erosion Control Mulch

The compost demonstration project has only been in place for three weeks and although it has been through several fairly heavy rains at this point, with no signs of erosion on the compost of topsoil sections, due to limited time, there is no real room for making judgments on

the effectiveness of the material based on our individual observations. From speaking with others who have used the material on an avid basis and those who have conducted thorough studies, the evidence seems to point to the conclusion that it is one of the most effective and environmentally sound materials for the control of erosion. Still there are some issues that need to be addressed when considering the use of leaf and yard wast compost.

4.2 Availability, Quality issues and Processing Improvements

Leaf and yard waste is a waste is produced throughout the state and is collected at many transfer stations and municipal recycling facilities. When properly composted, this material can be produced at high quantities and has a fairly rapid turnover rate. The product of well-processed leaf and yard waste is very consistent in its structure and texture and could be readily available for construction projects.

Unfortunately during our search for high quality leaf and yard waste compost we came across many facilities that had several hundred yards of compost available but because of lack of proper management the compost was inadequate for our demonstration. Often the piles were not turned properly which kept much of the waste from receiving the proper amounts of oxygen. The results were a product that had been composting for far more time than was needed to become stable and mature and ready for use but were very immature in the centers of the piles.

Although proper composting methods require very limited maintenance, they do require the use of large equipment for turning the compost and a fair amount of knowledge. Many district waste management facilities have access to large front end loaders that can be rented by the smaller facilities when they are in need of turning the piles. The main problem that needs to be addressed is the lack of education that recycling managers has on the process of composting. When recycling managers see the value of the compost produced they will be

more interested in proper management of their piles. With proper pile building and turning, they will be able to produce a quality product.

The screening of the compost is essential to creating a medium that could be used for seeding. Currently the Chittenden County Waste District has a screen that can be rented for compost screening. The Rutland District is also in the process of getting a screen that will be used in the southern section of Vermont. The addition of a second screen will greatly improve the ability of each recycling facility to produce a product that will be useful compost erosion control projects.

If processing improvements were made in each of the waste management facilities the production of quality compost would increase significantly. These improvements would make compost readily available in any part of the state providing consistency and quality in a leaf and yard waste compost.

4.3 Cost

The leaf and yard waste compost that we used for the demonstration project was bought for a very small fee. This was due mostly to the lack of processing of the raw material. The actual price that I included in the cost relationship between topsoil and compost was generated by evaluating the cost associated with screening as well as including the added value for compost after it had been screened. After including these variables the compost cost was still below that of the topsoil.

Another problem that was noted with topsoil is that it is often of poor quality and is not always available on a consistent basis. If management improvements were made in the compost production sector a consistent and reliable erosion control material would be available. The use of C.E.C.M also eliminates the cost of using hay as mulching material which would reduce the project=s cost to an even greater degree. Overall the compost appears to be economicaly comparable to topsoil with the potential for significant savings. It=s use where

available should be encoutaged by AOT as an option.

4.4 Specific and Important Applications of Compost Erosion Control Mulch

4.4.1 Late Season Erosion Control

The construction season stretches from early spring too late fall which is a very minimal amount of time to complete all the projects the AOT is working on. Often projects are pushed so late in the season that establishing a vegetative cover on the final topsoil application is impossible. This leaves the soil uncovered and unprotected from the early spring rains and the late winter run off that can cause massive amount of sediment removal and can be devastating to the unprotected embankments and the surrounding waterways. C.E.C.M is a material that is able to protect mineral soils without the establishment of a vegetative cover but is still able to be seeded and grow grass. These attributes would allow compost to be put down as a mulch to protect mineral soils during the late fall and early spring when erosion can be at its worst but still would grow grass in the spring for more permanent erosion control.

4.4.2 Compost Use Around Environmentally Sensitive Areas

Composts filtering and binding quality=s make it a perfect material for use around aquatic environments and environmentally sensitive areas. Often our waterways are in close proximity to areas such as parking lots and roads that can trap many deposites of petroleum-based pollutants, heavy metals, nutrients, road salts and sands as well as other sediments. W&H Pacific=s studies on compost=s binding properties have made it evident that compost has the ability to bind with many of these materials that can be harmful to our waterways. The use of compost would not only aid in protecting the exposed slopes of mineral soil but would provide an artificial buffer zone to combat and control these unwanted entities. Compost use around these areas would I believe be a highly valued addition to traditional erosion control methods.

5.0 Additional Consideration for Compost Use on Highway Construction Projects

Although our demonstration project only evaluated C.E.C.M there are several other composts uses that CONEG introduced into their specification that we feel are important to consider for use on construction projects in Vermont. The two technologies include Erosion Control Filter Berms(E.C.F.B=s) and Compost Manufactured Loams(C.M.L=s)

E.C.F.B=s are a compost technology that is being used as a replacement for silt fences and hay bails. They are generally composed of materials similar to C.E.C.M but are made up of many differently sized particles. An adequate material for the berms could be unscreened leaf and yard waste compost. The berms are constructed in long piles with a height of 1ft. and a base of 4ft. and applied at the toe of the slope that is in need of protection. The berms filter the water running off the slope and capture the sediments preventing them from entering the water ways. The benefits of the berms are that unlike silt fences they require a minimal amount of labor to apply. The berms are also virtually maintenance free and there is no need for their removal because they are made of organic matter that can decompose and eventually will return to the soil. The cost of the material used for making erosion control berms is very minimal and once applied they have been shown to control erosion equal to or better than silt fences.

C.M.L=s take advantage of compost=s high organic matter, and its nutrient content which many soils lack. A C.M.L is created by mixing compost derived from materials such as food waste, manure, and other wastes that are high in nitrogen and other nutrients essential for plant growth with soils that lack proper organic matter and nutrient content. At the right ratio a soil can be created that will have the needed nutrient, organic matter, and mineral content to provide and ideal substrate for vegetative growth. These types of soils can be created either by mixing the compost into the slope or by mixing material that has been stockpiled with compost.

The advantages of this process is that you can create a value added product from a recycled waste and a poor soil material.

6.0 Recommendations

Based on our research C.E.C.M is a material that can effectively control erosion and is economically comparable to traditional erosion control applications. The one barrier to compost use for erosion control on construction projects is the lack of development in the production part of the sector. This area is continuing to develope with a great deal of attention by both the Agency of Natural Resources the large district waste management facilities, and many others and will begin to improve rapidly. This development will increase especially if interest in the product is developed. These are our recommendations based on the present situation with compost production.

X Leaf and yard waste compost should be considered for inclusion as a specified material in the AOT construction material handbook as an additional option for erosion control.

X Do to the problems encountered with seeding late in the season compost should be introduced as a material that can protect mineral soils without vegetation establishment and can be used to protect slopes late in the season after grass growth is unlikely.

X C.E.C.M should be considered as a material that would be exceptionally useful near aquatic ecosystems and environmentally sensitive areas as a means of controlling nonpoint source pollution.

7.0 For Further Investigation

The following elements of compost use on construction sites in Vermont should be considered for further investigation if the significance of compost use is to be fully recognized.

X A comprehensive survey of all facilities currently producing leaf and yard waste compost

should be conducted. This survey should include an assessment of the annual volume of compost production, the relative quality of the compost produced, the price of the material, and the needed manufacturing and processing improvements at each facility.

X Further trials should be conducted using the Compost Manufactured Loam, the Erosion Control Mulch, and the Erosion Control Filter Berms. To truly understand the benefits of the compost the trials should include a variety of site locations and environmental variables.

X Although the CONEG specifications for compost use in the Northeast have outlined a basic specification, compost tends to vary widely according to the location of the processing facility and the original ingredients that went into the compost. After more comprehensive testing it might be useful to evaluate the significance of the CONEG specification to the actual compost that is produced in Vermont and if needed develop the most adequate specification.

CONCLUSION

My time spent researching the many uses of compost use for erosion control has lead me to the conclusion that compost is a fantastic material that has a wide array of applications and areas of use. It is recognized that construction projects are not always easy on the environment and people are continually looking for ways in which to minimize this impact. By using compost for erosion control a triple environmental benefit is produced. First compost use will provide a use for a recycled waste material and will promote its production redirecting waste from the landfill to a useful application. Second its use will limit the amount of agricultural soils that are used. Third the use will aid in keeping our beautiful lakes, rivers and wetlands free of sediments and other pollutants and our natural environment clean and healthy.