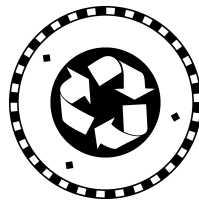


The Composting Council and CWC
present

Development of Landscape Architect Specifications for Compost Utilization

December 1997



Development of Landscape Architect Specifications for Compost Utilization

FINAL REPORT

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Report No. CM-97-2

ACKNOWLEDGEMENTS

Landscape Architecture/Design Specifications for Compost Use was developed through funds provided by the CWC as part of its commitment to the composting industry and the development of sustainable compost markets. Many other individuals and organizations also made this publication possible. Additionally, thanks go out to The Composting Council, its staff, and Market Development Committee members for providing input, direction, and review of this publication. Appreciation is also extended to the Landscape Architecture/Design industry who provided valuable input and review through leadership provided by the American Society of Landscape Architects (ASLA), the Washington (State) Chapter of the ASLA, and the Association of Professional Landscape Designers.

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December 1997

Dear Landscape Architect/Designer:

Thank you for your interest in the specification and use of compost. Throughout the Country, compost has proven to be an excellent tool for landscapers to improve the environment in which plant materials are to be grown. Compost is a unique product which can improve soil and other growing media physically, chemically/nutritionally, and biologically. Today, it is estimated that approximately 5,000 composting facilities exist throughout the United States that manufacture product from various agricultural, municipal, and industrial source materials (feedstocks). The use of compost has not only proven to dramatically improve soil quality, and therefore, turf and ornamental plant growth, but also reduce replacement costs in the field by improving plant survival rates. Also, by providing and allowing for the proliferation of various microorganisms, compost has been shown to improve plant nutrient uptake as well as suppress many soil-borne diseases.

The enclosed package contains a series of short and long compost use specifications that were developed for various landscape applications. Both product specifications and end use instructions are provided. They may be used *as is* or modified to meet the specific needs of your client or project. For instance, you or your customer may prefer a compost produced from a specific feedstock, or you may wish to adjust application rates based on manufacturer's recommendations or *tighten up* the product specifications based on personal preference.

Our goal is to provide landscape architects, landscape designers, municipal agencies, and other specifiers with compost use specifications which are written in a commonly used format, thereby allowing specifiers to "cut and paste" the appropriate information. We hope that this will not only allow easy incorporation into your current project specifications, but also provide information that can be easily modified for different geographical areas, climatic conditions, and soil conditions. We appreciate your support of compost, *an annually renewable resource*. Please review the article that follows this letter. It provides insight on how best to use compost under various soil conditions.

Sincerely,

The Composting Council

P.S. For additional information regarding compost use, composting, as well as test methodologies used in its compost evaluation, please find The Composting Council's publications list in the Appendix 2 of this document

SELECTING ORGANIC SOIL AMENDMENTS FOR LANDSCAPES

**Francis R. Gouin, Professor Emeritus
University of Maryland College Park**

Success in establishing landscapes is dependent upon knowing the soil that exists on site, knowing the species of plants to be planted, and knowing which organic amendment to use. It is also important to understand that all three of these elements are of equal importance.

In new construction, the soil used in landscaping often contains little of what we classically consider to be topsoil. Furthermore, areas surrounding the site are often heavily compacted due to construction equipment and practices. In improving existing landscapes, especially if plants are not performing as expected, the problem can often be attributed to poor soil conditions. Therefore, soil testing is necessary in order to determine how the soil can be improved and to provide guidance on selecting plants that can thrive under existing soil and/or improved soil conditions.

The auger that is used for taking soil samples can also be used to determine the degree of soil compaction. If the auger is incapable of penetrating to a depth of 8 to 10 inches, it means that the soil is heavily compacted. In addition to amending the soil with organic matter, it will be necessary to subsoil to a depth of 14 to 18 inches at 2 to 3 foot intervals when the soil is dry. Subsoiling allows for fracturing of the hard pan layers without mixing the topsoil and the subsoil. Subsoiling should be done after the organic amendments have been added so that some organic matter drops down into the cavities created by the subsoiler.

Soil testing for laboratory analysis should be a composite of samples taken from an area spanning no larger than 10,000 square feet. If the soil appears to be highly variable, more samples from the area to be landscaped should be submitted. A minimum of 10 core samples should be taken, to a depth of 6 to 8 inches, from each area. They should be mixed thoroughly together before extracting a pint sample for laboratory analysis. The air-dried sample(s) should be sent to a reputable laboratory for analysis and recommendations. In addition to a general nutrient analysis and pH, one should also request testing for percent organic matter (O.M.).

Understanding the requirements of the various plants to be installed is also important in selecting which organic amendment(s) will be used. There are species of plants that perform at their best

when planted in acid soils (pH below 5.0), while others perform best when growing in only mildly acid soils (pH 6.5). Aside from turf and ornamental grasses, most ornamental plants perform best at a pH of 7.0 or below. Although the addition of large amounts of organic amendments to soils allows one to grow plants over a wider range of pH's, it is important to remember that, in time, the roots of plants will extend far beyond their intended planted area, and the amount of organic matter in the soil will decrease with time.

It is important to remember that not all compost and other organic amendments are alike. There is wide variation in the percent organic matter, pH, nutrient content, soluble salts, etc. When selecting organic amendments, it is important to understand the characteristics of the organic amendments available. This allows selection of the amendment that best improves the soil and meets plant requirements. Plant nutrient requirements can often be satisfied when compost is used at the recommended rate.

Existing Soil Conditions and Plants to be Established

Soil pH is less than 5.0 & establishing non-acid loving plants

If existing soil pH is below 5.0 and the soil has less than 6% organic matter and only plants that grow best in mildly acid soils are to be planted, it will be necessary to add limestone in addition to compost unless compost made from lime dewatered biosolids is available. If limed compost is available, there is generally sufficient lime in the compost to adjust the pH to the desired level.

Soil pH is less than 5.0 & establishing acid loving plants

If existing soil pH is below 5.0 and the soil has less than 6% organic matter, one should select a compost that has a pH at or below neutral (pH 7.0) and does not contain any liming agents (e.g., limestone, hydrated lime, ash, etc.). Although the compost will raise the pH of the soil to above the desired range, the increased organic matter content will compensate for the difference.

Soil pH is greater than 5.0 & establishing non-acid loving plants

If existing soil pH is above 5.0 and non-acid loving plants are being grown, compost containing liming agents should not be used except in areas where turf and ornamental grasses are to be established. Only compost not containing liming agents should be used for amending soils in

ornamental plantings of ericaceous crops and plants that prefer mildly acid soils. Ornamental grasses and turf species are more tolerant to high pH's than are most broadleaf species.

Soil pH is greater than 5.0 & establishing acid loving plants.

Most acid loving plants perform best when planted in soils having an abundant supply of organic matter. However, despite the pH buffering capacity of organic matter, it is important to maintain a pH as close to ideal as possible. Under such soil pH conditions, it is often better to use peat moss or pine fines and not compost as a soil amendment and supply nutrients using chemical fertilizers. Using a 1:1 blend (v/v) of peat moss or pine fines and compost (unlimed) can also be beneficial. Since most peat moss (Canadian, Sphagnum) have a pH near 3.5, there is often sufficient acidity in the peat moss to neutralize the higher pH of the compost.

Using Compost to Meet Nutrient Needs.

Compost made from biosolids often has a higher nitrogen (N) and phosphorus (P) concentration than compost made from animal manures and yard trimmings. Composts made from animal manures and yard trimmings generally contain elevated levels of potassium (K) and lower levels of P. Knowing this information can provide guidance in selecting a compost that would be most beneficial and reduce chances of creating nutrition related concerns in the future. Although not a typical occurrence, compost that contains extremely high levels of calcium (Ca) has the potential of binding P and essential trace elements in both the compost and soil, thus preventing their uptake by plants.

The overall best compost to use can also be further determined through soil test results. If soils are low in P, using a compost made from biosolids can eliminate the need for having to add commercial phosphate fertilizers. If the soils are deficient in K but rich in P, then using a compost from yard trimmings and/or animal manures in place of biosolids is preferred. For amending soils possessing high levels of Ca, one should avoid using a compost that contains additional liming agents.

Soluble Salts in Compost

Most commercial composts contain a significant amount of nutrients in the form of fertilizer salts. These fertilizer salts are also referred to as soluble salts. Since excessive amounts of soluble salts can stunt or kill plants, caution should be taken when using compost around salt

sensitive plant species. For composts that contain high levels of soluble salts (over 5 mmhos/cm), one should not exceed a 20% inclusion rate in a soil mix where salt sensitive species are to be established. Greater amounts of compost can be used if they contain low to moderate levels of soluble salts. Although salt-related injury is not common, thorough watering at the time of planting will significantly reduce potential risk.

Sand vs. Clay

Although it is difficult to use an excessive amount of compost on sandy soils, some have found the excessive use of compost on clay soils to be problematic. When incorporating compost at a 20% inclusion rate or higher, some clay soils have been found to hold excess moisture. This can make the soil slow to dry and difficult to work even when the soil is lightly wet. In turf and other permanent planting areas, this would not be a concern. However, it should be considered in areas where on-going mechanical cultivation is practiced (e.g., annual flower beds).

GENERAL COMPOST INFORMATION

INTRODUCTION

This landscape architecture/design specifications package has been developed to provide you with compost use instructions which have been verified through research and field experience. Data used in the development of this package was made available through a series of nationally funded projects that culminated in the development of 13 technically based *compost use guidelines*. These *guidelines* provided step-by-step instructions for compost use in specific applications. Data from the landscape related *compost use guidelines* was then used as a basis for this specifications package. Along with a series of long and short specifications, this package also provides associated information about the characteristics and benefits of using compost as well as several other related topics. This associated information, which may also be found in the *Field Guide to Compost Use*, was provided with permission from The Composting Council.

What is Compost?

Compost is the product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth. Compost bears little physical resemblance to the raw material from which it originated. Compost is an organic matter resource that has the unique ability to improve the chemical, physical, and biological characteristics of soils or growing media. It contains plant nutrients but is typically not characterized as a fertilizer.

How is Compost Produced?

Compost is produced through the activity of aerobic (oxygen-requiring) microorganisms. These microbes require oxygen, moisture, and food in order to grow and multiply. When these resources are maintained at optimal levels, the natural decomposition process is greatly accelerated. The microbes generate heat, water vapor, and carbon dioxide as they transform raw materials into a stable soil conditioner. Active composting is typically characterized by a high-temperature phase that sanitizes the product and allows a high rate of decomposition, followed by a lower-temperature phase that allows the product to stabilize while still decomposing at a

lower rate. Compost can be produced from many feedstocks. State and federal regulations exist to ensure that only safe and environmentally beneficial composts are marketed.

1.0 BENEFITS OF COMPOST AND ITS EFFECT ON GROWING SYSTEMS

As more and more compost is produced and utilized and as the body of end-use related research grows, the benefits of using compost have become more evident and measurable. Because of its many attributes, compost is extremely versatile and beneficial in many applications. Compost has the unique ability to improve the properties of soils and growing media physically (structurally), chemically (nutritionally), and biologically. Although many equate the benefit of compost use to lush green growth, caused by the plant-available nitrogen, the real benefits of using compost are long-term and related to its content of living-organic matter.

Physical Benefits

Improved Structure: Compost can greatly enhance the physical structure of soil. In fine-textured (clay, clay loam) soils, the addition of compost will reduce bulk density, improve friability (workability) and porosity, and increase its gas and water permeability, thus reducing erosion. When used in sufficient quantities, the addition of compost has both an immediate and long-term positive impact on soil structure. It resists compaction in fine-textured soils and increases water-holding capacity and improves soil aggregation in coarse-textured (sandy) soils. The soil-binding properties of compost are due to its humus content. Humus is a stable residue resulting from a high degree of organic matter decomposition. The constituents of the humus act as a soil 'glue,' holding soil particles together, making them more resistant to erosion and improving the soil's ability to hold moisture.

Moisture Management: The addition of compost may provide greater drought resistance and more efficient water utilization. Therefore, the frequency and intensity of irrigation may be reduced. Recent research also suggests that the addition of compost in sandy soils can facilitate moisture dispersion by allowing water to more readily move laterally from its point of application.

Chemical Benefits

Modifies and Stabilizes pH: The addition of compost to soil may modify the pH of the final mix. Depending on the pH of the compost and of the native soil, compost addition may raise or lower the soil/compost blend's pH. Therefore, the addition of a neutral or slightly alkaline

compost to an acidic soil will increase soil pH if added in appropriate quantities. In specific conditions, compost has been found to affect soil pH even when applied at quantities as low as 10-20 tons per acre. The incorporation of compost also has the ability to buffer or stabilize soil pH, whereby it will more effectively resist pH change.

Increases Cation Exchange Capacity: Compost will also improve the cation exchange capacity of soils, enabling them to retain nutrients longer. It will also allow crops to more effectively utilize nutrients, while reducing nutrient loss by leaching. For this reason, the fertility of soils is often tied to their organic matter content. Improving the cation exchange capacity of sandy soils by adding compost can greatly improve the retention of plant nutrients in the root zone.

Provides Nutrients: Compost products contain a considerable variety of macro and micronutrients. Although often seen as a good source of nitrogen, phosphorous, and potassium, compost also contains micronutrients essential for plant growth. Since compost contains relatively stable sources of organic matter, these nutrients are supplied in a slow-release form. On a pound-by-pound basis, large quantities of nutrients are not typically found in compost in comparison to most commercial fertilizers. However, compost is usually applied at much greater rates; therefore, it can have a significant cumulative effect on nutrient availability. The addition of compost can affect both fertilizer and pH adjustment (lime/sulfur addition). Compost not only provides some nutrition, but often makes current fertilizer programs more effective.

Biological Benefits

Provides Soil Biota: The activity of soil organisms is essential in productive soils and for healthy plants. Their activity is largely based on the presence of organic matter. Soil microorganisms include bacteria, protozoa, actinomycetes, and fungi. They are not only found within compost, but proliferate within soil media. Microorganisms play an important role in organic matter decomposition which, in turn, leads to humus formation and nutrient availability. Microorganisms can also promote root activity as specific fungi work symbiotically with plant roots, assisting them in the extraction of nutrients from soils. Sufficient levels of organic matter also encourage the growth of earthworms, which through tunneling, increase water infiltration and aeration.

Suppresses Plant Diseases: Disease incidence on many plants may be influenced by the level and type of organic matter and microorganisms present in soils. Research has shown that increased population of certain microorganisms may suppress specific plant diseases such as pythium and fusarium as well as nematodes. Efforts are being made to optimize the composting process in order to increase the population of these beneficial microbes.

Additional Benefits of Compost

Some additional benefits of compost have been identified, and have led to new uses for it. These benefits and uses are described below.

Binds Contaminants: Compost has the ability to bind heavy metals and other contaminants, reducing both their leachability and absorption by plants. Therefore, sites contaminated with various pollutants may often be improved by amending the native soil with compost. The same binding affect allows compost to be used as a filter media for storm water treatment and has been shown to minimize leaching of pesticides in soil systems.

Degrades Compounds: The microbes found in compost are also able to degrade some toxic organic compounds, including petroleum (hydrocarbons). This is one of the reasons why compost is being used in the bioremediation of petroleum contaminated soils.

Wetland Restoration: Compost has been used for the restoration of native wetlands. Rich in organic matter and microbial population, compost and soil/compost blends can closely simulate the characteristics of wetland soils, thereby encouraging the re-establishment of native plant species.

Erosion Control: Coarser composts have been used with great success as a mulch for erosion control and have been successfully used on sites where conventional erosion control methods have not performed well. In Europe, fine compost has been mixed with water and sprayed onto slopes to control erosion.

Weed Control: Immature composts or ones which possess substances detrimental to plant growth (phytotoxins), are also being tested as an alternative to plastic mulches for vegetable and fruit production. While aiding in moisture conservation and moderating soil temperatures, immature composts also act as mild herbicides.

Benefits of Using Compost

1. Improves the soil structure, porosity, and density, thus creating a better plant root environment.
2. Increases infiltration and permeability of heavy soils, thus reducing erosion and runoff.
3. Improves water holding capacity, thus reducing water loss and leaching in sandy soils.
4. Supplies a variety of macro and micronutrients.
5. May control or suppress certain soil-borne plant pathogens.
6. Supplies significant quantities of organic matter.
7. Improves cation exchange capacity (CEC) of soils and growing media, thus improving their ability to hold nutrients for plant use.
8. Supplies beneficial microorganisms to soils and growing media.
9. Improves and stabilizes soil pH.
10. Can bind and degrade specific pollutants.

2.0 COMPOST SOURCE MATERIALS (FEEDSTOCKS)

Quality composts are being produced from many different materials or *feedstocks*. Typical feedstocks include agricultural by-products, yard trimmings, biosolids (sludge), food by-products, industrial by-products, and municipal solid waste. Some of these feedstocks, such as biosolids must be blended with wood chips, sawdust, paper, biodegradable packing, etc. to enhance the composting process. The majority of composters in the United States primarily compost agricultural by-products, yard trimmings, or biosolids. If prepared properly, composts produced from various feedstocks will be somewhat similar in nature and function. However, composts produced from certain feedstocks do possess some unique characteristics.

Agricultural By-Products: Agricultural by-products can include manure and bedding from various animals, animal mortalities, crop residues, cull fruits and vegetables, and processing/packaging by-products. Composts produced from agricultural by-products, especially manures, are known for generally possessing higher nutrient concentrations as well as elevated salinity levels. They are typically low in contaminants and are commonly available in both bulk and bagged form.

Yard Trimmings: Yard trimmings compost consists of grass clippings, leaves, weeds, twigs, brush, tree and shrub pruning, Christmas trees, and other vegetative matter from land clearing activities and from residential, commercial, and institutional properties. The compost generated may contain one or all of these source materials. Yard trimmings composts are also referred to as "yard waste", "yard debris", or "green waste" composts. Yard trimmings composts are typically lower in nutrients and contaminants. The soluble salt concentration is typically low, but may be elevated where the feedstock is collected unbagged or uncontainerized in areas where road salts are commonly used. Yard trimmings composts are popular with both professional users and homeowners and are often marketed in both bulk and bagged form.

Biosolids (sewage sludge): Biosolids are the organic solid residue derived from residential, commercial, or pre-treated industrial wastewater processing. Biosolids are treated to reduce pathogens and contain only minimal levels of heavy metals and organic contaminants. Only biosolids that meet a "Class A grade" (exceptional quality) as outlined in the US EPA's 40 CFR Part 503 regulations can obtain permits for general distribution (see Appendix 1 for Part 503 contaminant parameters). Compost produced from biosolids that contain greater levels of

contaminants may be usable, depending upon state regulations, on a restricted use basis. Biosolids composts are fairly rich in plant nutrients and typically possess a pH between 6.0 and 7.5. Some biosolids used to produce compost have been treated with liming agents that can affect pH, buffering capacity, and soluble salts level, thus limiting their horticultural use to a degree.

Food By-Products: Food by-products can be obtained from various sources, including food processors and restaurants or institutions which separate the food by-products from the general waste stream. Although food by-product composting is increasing in popularity, it is currently only a small percentage of the composting industry. Food by-products that are commonly composted included culled or damaged fruits and vegetables, coffee grounds, egg shells, fish residues, bakery items, among others. Composts produced from food by-products are typically rich in plant nutrients, but may also possess elevated salinity levels.

Industrial By-Products: Many corporations that produce organic residues have begun recycling these materials through composting. Industrial by-products may include wood processing by-products, paper goods, biodegradable packaging materials, pharmaceutical by-products, paper mill sludges, forestry by-products, brewery residuals, and so forth. These materials are typically unique in nature and may possess some excellent properties for plant growth or environmental improvement. Their overall characteristics will vary widely based on their feedstock.

Municipal Solid Waste (MSW): MSW is typically considered to be mixed residential or commercial refuse that has not been source-separated for the removal of specific recyclable items such as paper, glass, plastics, and so forth. However, in most cases, mixed municipal solid waste that is intended for composting will be processed after collection to have recyclables and household hazardous wastes removed by mechanical or hand separation. MSW composts, especially those containing significant quantities of paper, possess a lower quantity of nutrients and higher pH (7.5-8.0). Because MSW tends to be rich in paper, its compost often has a higher water holding capacity. Communities that source-separate residential waste usually have lower contaminants and the compost has a higher plant nutrient content.

As composting grows and becomes a better understood science, more and more organic by-products will be used as feedstocks. Although end users will have their own personal

preferences regarding the type of product they utilize, it is important to stress that high-quality compost products have been produced from all of the feedstocks described. We urge you to try different types of composts to better determine which product you prefer, based on performance, and which products may be best suited for a specific application. It should be understood that the qualities of a particular compost are not indicative of the quality and characteristics of all products produced from that same feedstock. For instance, if you purchase a yard trimmings compost that is not fully stabilized and robs available nitrogen from the soil, you should not assume that all yard trimmings-based composts would have the same affect. As far as quality and usefulness of compost are concerned, it is typically more an issue of the completeness of processing than it is an issue of feedstock.

3.0 COMPOST CHARACTERISTICS/PARAMETERS

Described in this section are the compost characteristics or parameters that are important in compost quality evaluation. These parameters represent the basic chemical, physical, and biological data needed to assure successful compost use and overall satisfaction. The parameters are also necessary to assist you in determining which compost products possess the characteristics needed for your specific application or are of particular importance to you. We should urge our compost suppliers to provide us with this data.

Since growing conditions and plant needs differ, we can benefit greatly from accurate characterization data pertaining to the compost products we use. This data will allow us to use compost in a way that best meets our particular need or specific situation. Specific characteristics of a compost dictate how and in which applications it can be used. By obtaining accurate characterization data, we can obtain a compost that is appropriate for a specific application and use in a way that best meets our particular need.

The following table lists important compost parameters and their rationale for inclusion. In the table, the term "necessary for system management" means the specific value associated with each parameter will allow end users to more effectively manage the "plant growing system." For instance, specific crops grow best within a certain pH range. Composts possess a specific pH and when used in specific quantities, can influence soil or media pH. Therefore, by knowing the compost pH, users can better estimate its influence and more easily manage the system. Soil or media testing can assist in this endeavor.

The compost parameters are characterized as quantified, qualified, and unspecified. Quantified parameters are described using numerical values and qualified parameters are described using a qualifying statement, whereas unspecified parameters may be described either quantitatively or qualitatively once industry standard test methods are established.

Compost Parameters*	Rationale for Inclusion:
pH	Necessary for system management, effect on pH adjustment.
Soluble Salt Concentration	Necessary for system management, potentially toxicity, effect on watering regime, effect on fertilizer application rates.
Nutrient Content (N-PET-K, Ca, Mg)	Necessary for system management, effect on fertilizer requirements.
Water Holding Capacity	Necessary for system management, effect on watering regime.
Bulk Density (lbs/yd ³)	Product handling and transportation issues, estimation/conversion of application rates.
Moisture Content	Product handling and transportation issue.
Organic Matter Content	Necessary for system management, relevant in determining application rates. Some use as a basis to measure cost effectiveness.
Particle Size	Necessary for system management, effect on porosity. May determine usability in specific applications.
Trace Elements/Heavy Metals	Necessary for system management, effect on fertilizer requirements, potential toxicity. Necessary to address and reduce public concern.
Stability	Necessary for system management, effect on nutrient availability (nitrogen), odor generation.
Growth Screening	Necessary for system management, effect on seed germination/plant growth.

* Recommended test methods for all proposed parameters may be found in the Composting Council's *Recommended Test Methods for the Examination of Compost and Composting*.

Quantified Parameters

It is suggested that quantitative data (e.g. compost possesses a pH of 6.0-6.7), with respect to the eight qualified parameters, be routinely provided to compost users to help assure successful compost use and overall satisfaction.

pH: pH is the numerical measure of the acidity (or alkalinity), or hydrogen ion concentration of a material. The pH scale ranges from 0-14, with a pH of 7.0 indicating neutrality. Compost typically possesses a pH between 5.0 and 8.5. Specific plant species can flourish when grown within a specific pH range, and based on typical compost application rates, it is understood that the addition of compost can affect the pH of soil and growing media. Therefore, to estimate the effect, which in turn will affect maintenance practices or system management, pH is a necessary parameter. pH is adjusted through the use of such materials as lime, to increase alkalinity, and sulfur, to increase acidity.

Liming agents are sometimes used in the production of compost. Although the addition of lime in the composting process may not dramatically effect the compost's pH, it will have a pronounced effect on calcium levels. Therefore, pH adjustment of these composts is much more difficult due to the compost's higher buffering capacity, and for that reason may not be appropriate for specific applications.

Soluble Salts (salinity): Soluble salts concentration is the concentration of soluble ions in a solution, which is measured by the ability of a medium to conduct an electric current. Excess soluble salts can be phytotoxic (damaging) to plants, yet many nutrients are supplied to plants in salt form. Some soluble salts, such as sodium and chloride, are more detrimental to plants than others. Most plant species have a salinity tolerance rating and maximum tolerable quantities are known. Soluble salts are measured in dS or mmhos/cm. Compost may contribute to, or dilute, the cumulative soluble salts concentration of a growing medium or soil. Manure compost tends to be higher in soluble salts, while soluble salt concentrations in biosolids and yard trimmings composts are more variable. Reduction in soluble salts concentration can sometimes be achieved through heavy watering (leaching). However, management practices for leaching will be dependent on the salinity of the irrigation water. Most composts produced from municipal feedstocks possess a soluble salt concentration of 10 dS (mmhos/cm) or below.

Nutrient Content: Nitrogen (N), phosphorous (P), and potassium (K) are the three nutrients used by plants in the greatest quantities (macronutrients), and are the nutrients most often applied through commercial fertilizers. These nutrients are measured and expressed on a dry weight basis as a percent (%). The percent of plant available phosphorous and potassium are expressed as P_2O_5 and K_2O , respectively. Nitrogen in compost is predominantly in the organic form and must be mineralized to available forms (NO_3 and NH_4) for use by plants. Nitrate and ammonium levels in stable compost are generally low. The total nitrogen content should be expressed and the amount of water soluble (NO_3 and NH_4) and insoluble nitrogen forms should be known. The content of these nutrients, as well as magnesium and calcium, should be known to allow users to make correct decisions regarding supplemental nutrition and pH adjustment. Calcium (Ca) and Magnesium (Mg) may be applied through fertilization application or pH adjustment (e.g. lime, gypsum). Providing data relative to the content of other nutrients can also be helpful, and may be necessary for specific applications or crops.

Water Holding Capacity: Water holding capacity is the ability of a compost to hold water. Water holding capacity is measured as a percent of dry weight. Water holding capacity measures the potential benefit of reducing the required frequency of irrigation, as well as gross water requirements for the crop. The water holding capacity should be known to allow users to monitor, or estimate, the compost's effect on their watering regime. Most composts produced from municipal feedstocks possess a water holding capacity of 75%-200% of their dry weight.

Bulk Density: Bulk Density is the weight per unit volume of compost. Bulk density is used to convert compost application rates from tonnage to cubic yards. In a field application, cubic yards per acre would subsequently be extrapolated to express an application rate represented as a depth in inches (e.g., 1 inch application rate). Bulk density is also used to determine the volume of compost that may be transported on a given vehicle. Bulk density is typically measured in grams per cubic centimeter, then converted to pounds per cubic yard. Most composts possess a bulk density of 700-1,200 pounds per cubic yard; most would consider 800-1,000 pounds per cubic yard as preferred.

Moisture Content: Moisture content is the measure of the amount of water in a compost product, expressed as a percent of total solids. The moisture content of compost affects its bulk density and, therefore, will affect transportation costs. Moisture content is also relevant because it affects product handling. Compost that is dry (35% moisture or below) can be dusty and irritating to work with, while compost that is wet can become heavy and clumpy, making its application more difficult and delivery more expensive. Most composts possess a moisture content of 30%-60%, while 40%-50% is preferred for product handling.

Organic Matter Content: Organic matter content is the measure of carbon-based materials in a compost. Organic matter content is typically expressed as a percent of dry weight. Being aware of a product's organic matter content may be necessary for determining compost application rates on specific applications, such as turf establishment. In this application, standard agricultural soil tests may be used to determine the recommended application rate of compost. However, these application rates are specified as the quantity of organic matter needed per acre. Therefore, the organic matter content of compost must be known to convert the application rate to a usable form. Most composts possess an organic matter content of 30%-70%, with 50%-60% being preferred.

Particle Size: The specificity in which compost particle size is measured should be based on the product's intended use or other customer requirements. For most applications, merely specifying the product's maximum particle size or the screen size through which the compost passes is sufficient. However, for specific applications, such as a component of potting media, a full particle size distribution may be required. A compost's particle size distribution will effect the porosity of the media to which it is added. Porosity is related to the ability of a potting mix to resist water logging, and low media oxygen levels. Particle size distribution measures the amount of compost meeting a specific size. Particle size distribution figures are expressed as the percent of material retained per sieve size. A compost product's particle size may also determine its usability in specific applications. For example, a yard trimmings compost screened through a 1/4-inch screen would probably not be appropriate to use as a mulch, whereas the same product screened through a 1-inch screen could be acceptable.

Typical Characteristics of Municipal Feedstock-Based* Composts

Parameter	Typical Range	Preferred Range for Various Applications under Average Field Conditions
PH	5.0 - 8.5	6.0 - 7.5
Soluble Salts	1 - 10 dS (mmhos/cm)	5 dS (mmhos/cm) or below
Nutrient Content (dry weight basis)	N 0.5 - 2.5% P 0.2 - 2.0% K 0.3 - 1.5%	N 1% or above P 1% or above
Water Holding Capacity (dry weight basis)	75 - 200%	100% or above
Bulk Density	700 - 1,200 lbs/yd ³	800 - 1,000 lbs/yd ³
Moisture Content	30 - 60%	40 - 50 %
Organic Matter Content	30 - 70%	50 - 60%
Particle Size	--	Pass through 1" screen or smaller
Trace Elements/Heavy Metals	--	Meet US EPA Part 503 Regulations
Growth Screening	--	Must pass seed germination, plant growth assays
Stability	--	Stable to highly stable

* Municipal feedstock-based composts are primarily derived from yard trimmings, biosolids, municipal solid waste, or food by-products, or a combination of one or more of these feedstocks.

Qualified Parameters

It is suggested that qualitative data, with respect to trace elements/heavy metals, be routinely provided to compost users, where appropriate, based on feedstock.

Initially, it is suggested that only qualitative data be provided to customers pertaining to trace element/heavy metals, as well as other regulated contaminants. This approach is suggested because providing an all-inclusive chemical analysis to most end users is confusing, impractical, and would not be necessary in most situations. Instead, a quality assurance statement could be offered in its place, for example, "our product meets the Federal EPA's definition for an exceptional quality product" or "our product is approved for unlimited distribution and, therefore, can be used on...". It is further suggested that qualitative data describing trace element concentrations be made available upon users request. This data may be necessary to assist specific users adjust their fertilizer programs to avoid phytotoxicity.

Trace Elements/Heavy Metals: Heavy metals, are so named for their location on the Periodic Table of the Elements. Heavy metals are trace elements whose concentration is regulated due to the potential for toxicity to humans, animals, or plants. The quantity of these elements are measured on a dry weight basis and expressed in parts per million (ppm) or milligrams per kilogram (mg/kg). Regulations governing the heavy metal content of composts derived from specific feedstocks have been promulgated on both the state and federal levels. Trace elements, also referred to as heavy metals, are arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc. **The mere presence of these elements does not mean that the product is unsafe. Rather, some of these elements are essential in the diets of plants, animals, and humans and many are included in common vitamin supplements.** Therefore, measuring the concentration of these elements, as well as other plant nutrients, will provide valuable management data relevant to the nutrient requirements of plants, and subsequent fertilizer application rates. Certain heavy metals and trace elements are known to cause phytotoxic effects in plants, and some plant species are more sensitive than others. These elements are boron, manganese, molybdenum, nickel, and selenium. Although detrimental quantities of these elements are not typically found in compost, some can accumulate in the root zone over time. To avoid potential plant damage, these elements should be monitored. Potential damage is unlikely, however, since minimal amounts of trace elements are actually available to plants because they are tightly bound within the compost's organic matter.

In many ways, the concern surrounding the use of *waste derived* composts has been unwarranted, especially in recent years, since great effort has been placed in the reduction of contaminants in the waste streams. The United States Environmental Protection Agency, with assistance from the United States Department of Agriculture, has studied this issue extensively using a full scale risk assessment and has developed a series of regulatory limits. This risk assessment data is the basis for federal and many state regulations, and has helped assure the safety of the products being produced.

Unspecified Parameters

Unspecified parameters are compost parameters not classified as quantitative or qualitative because of a current lack of industry consensus regarding definitions, test methodologies, or correlation of data. Yet these parameters are important and will be included as quantitative or

qualitative parameters in the future. Producers should measure these parameters using one or more test methodologies.

Growth Screening: The growth screening test is an indicator of the absence or presence of phytotoxic substances, including volatile fatty acids, alcohol, soluble salts, heavy metals, or ammonia. Many scientists use the term "maturity" specifically to relate to the absence or presence of volatile fatty acids. Any of these substances may cause delayed seed germination, seed or seedling damage, plant damage, or death. The growth screening test is not intended to identify the growth inhibiting compounds, but rather a general measure of acceptability. Growth screening tests include germination, root elongation, and pot tests. It is important to note that compost passing initial growth screening tests may fail a similar test later if stored improperly. This is because specific growth inhibitors, such as volatile fatty acids and alcohol, may form in compost stored under anaerobic conditions. Therefore, we should ask vendors how their compost is stored in order to avoid buying compost that has gone anaerobic.

Stability: Stability is the level of biological activity in a moist, warm, and aerated compost pile. Unstable compost consumes nitrogen and oxygen in significant quantities to support biological activity and generates heat, CO₂, and water vapor. Stable compost consumes little nitrogen and oxygen and generates little CO₂ or heat. Unstable, active compost demands nitrogen when applied to soil and growing media. This can cause nitrogen deficiency and be detrimental to plant growth, even causing death to plants in some cases. If stored improperly and left unaerated, unstable compost can become anaerobic and give rise to nuisance odors.

Until industry standards are developed, it is important that growth screening (including maturity) and stability tests be performed and used for process control and to qualify these parameters. There is a great need to standardize test methods for maturity and stability, and to develop industry standard definitions for the terms. Only then can we develop a full and measurable understanding of their effects on specific crops and in specific situations.

Other

It should be noted that this list of important *compost parameters* was developed to represent a wide variety of compost applications and composts produced from various feedstocks. It is difficult to include each parameter of specific importance to every user, or relevant to composts

produced from every feedstock. Other compost characterization data may need to be provided for certain composts or for specific uses. For example, porosity and weed seed viability may be important to nurserymen, while flowability, odor presence, ash content, or calcium carbonate equivalence may be important to landscapers and turf managers. Also, where quantifying the concentration of man-made materials, such as glass, plastic, and metal, may be appropriate for MSW or yard trimmings compost, it may not be appropriate for biosolids or food by-product compost. The presence of man-made materials may be an issue of worker safety and also a significant aesthetic issue that can affect the product's acceptability. Aside from these other issues, the compost must also be properly composted to assure it has been sanitized, thus destroying any potentially harmful organisms.

4.0 COMPOST SELECTION

Compost produced from different feedstocks and with different levels of refinement may have different uses. For example, compost produced from municipal solid waste will generally possess a greater water holding capacity than other composts because the feedstock from which it is produced typically contains paper and paper products. Therefore, this compost may be more suitable to use in areas where drought conditions exist (e.g., sandy soils) or low maintenance occurs (e.g., roadsides), or perhaps in erosion control. Understanding that no two composts or applications are exactly the same will help you select a compost that best meets your specific requirements. At the same time, one product may be versatile enough to use for a number of different applications. In selecting a compost, it is important that you purchase from firms who test regularly and supply data to their customers. The section entitled "Compost Characteristics/Parameters" provides a discussion of the compost characterization data we should be provided to help us use compost properly. Aside from working with a company that manufactures a compost which meets your requirements and provides characterization data, you must be assured that they are capable of producing a consistent product. Only the production and use of a consistent product can assure uniform results. Even a compost product that is mediocre in quality, but is consistent in nature, can be used successfully as long as all parties understand its attributes and limitations.

As more compost is produced and marketed, users will have the task of evaluating suppliers. Increased competition for your business should improve the quality and variety of available compost, stabilize prices, and improve customer satisfaction.

The Compost Supplier

It is critical to find a reputable supplier. A supplier should have a history of providing good customer service, reliability, and a consistent compost. A good supplier is always open to suggestions and will work to satisfy your particular needs. Bear in mind that there is a cost involved in responding to customer needs and addressing quality-related issues. Buying an inferior compost for a superior price is no deal. If a supplier can provide you with technical assistance and service your needs, don't be afraid to pay for it.

Whether your compost supplier is a facility or a broker, they must be able to provide compost when needed. This requirement is accentuated due to the seasonality of the green industry. To

assure product availability, it is helpful to know the production cycles and storage capacity of your supplier. Other issues to consider include how the compost will be delivered, site hours, and whether the vendor can arrange for trucking and payment terms.

Remember, every compost is different, every supplier is different, and so is every customer. Seek out the ones that best suits your company's needs.

Important Attributes of a Compost Supplier

- Produce compost possessing attributes/characteristics that meet end user or application requirements
- Supplies/Produces a consistent product
- Has implemented an on-going quality assurance or testing program
- Can supply current compost characterization data (quantifying and qualifying their product's attributes)
- Provides good overall customer service, employs a "service minded" staff
- Can assure prompt and reliable delivery (size of truck and mode of unloading are also important)
- Possesses adequate storage to ensure availability
- Can provide technical assistance regarding end use

5.0 COMPARING COMPOST TO OTHER HORTICULTURAL/AGRICULTURAL PRODUCTS

Comparing compost to other horticultural/agricultural products is not an easy task. The variability of the particular compost and the need to compare effectiveness in a specific application makes comparisons difficult. Within this section is a discussion of various horticultural and agricultural products that are used in conjunction with or instead of compost. This section is included for reference purposes only and as a means to compare the general characteristics of compost to these materials. Following are descriptions of these other horticultural/agricultural products.

Peat Moss is derived from Sphagnum that grows in bogs and becomes covered with water when it dies. Because of the cold wet climate in which it grows, peat moss accumulates to great depths undergoing partial anaerobic decomposition. Over the years, peat moss has changed both physically and chemically due to harvesting methods and location. Coarse chunky peat with a pH above 5.0 is seldom available. In its place is a finer material that possesses a pH between 3.3-3.5. This finer peat moss shrinks rapidly and requires twice, and sometimes three times more, limestone to neutralize its acid concentration than in previous years. Although peat moss initially starts with a high cation exchange capacity, it decreases with time, thus reducing its ability to hold nutrients as the aging process continues.

Sedge Peat or Native Peat generally consists mostly of sedges and grasses that grow in bogs. When these grasses and sedges die, their tops sink into the water and undergo partial anaerobic decomposition. Since these plants are high in cellulose and contain little lignin, they decompose more rapidly than peat moss and contain few fibers. Although sedge peat and native peat can be used as a substitute for peat moss, they are generally not as satisfactory in certain nursery applications. Also, they are highly variable from bog to bog and can be equally as acidic as peat moss. The cation exchange capacity of sedge peat and native peat is similar to peat moss.

Softwood Bark has become a major source of organic matter for the ornamental horticultural industry. Products such as pine, fir, hemlock, redwood, and cypress barks are used throughout specific regions of North America. Because they are low in cellulose and high in lignins, they can be used either fresh or composted and do not decompose rapidly. Cypress and redwood sawdust is also low in cellulose and can be used in much the same way. However, only

coniferous barks with less than 10% cellulose can be used fresh. Coniferous bark with 10% or more cellulose must be composted. For optimum growth, when used as a soil amendment or growing media component, the bark products should be milled to particle sizes no larger than 1/2-inch diameter. Unlike peat moss, sedge peat, or native peat, the cation exchange capacity of bark improves with age. However, not all barks are the same and their availability is diminishing in certain regions. The landscaping industry not only uses ground coniferous bark as a soil amendment but coarser materials are popular as decorative mulches.

Hardwood Bark, Sawdust, Shavings, or Wood Chips should never be used in blending potting media unless they have been thoroughly composted. These materials are high in cellulose and low in lignins; therefore, they shrink rapidly and will rob plants of nitrogen. The competition for nitrogen may not be effectively offset by supplying additional nitrogen in a fertilizer program. It is important to note that the use of these materials in field applications should be limited to areas where planting will not occur for several months. Using a fine-textured and well-aged or composted hardwood bark will minimize negative effects.

Topsoil is defined as "the surface or upper part of the soil profile." Individuals who use topsoil often define it as a naturally produced medium consisting of sand, silt, clay, organic matter, trace amounts of nutrients, and other inerts capable of supporting plant growth. However, in many parts of the Country, even in agricultural areas known for their productive soils, many of the soils purchased as topsoil and used for horticultural applications are not true topsoils. Many of the materials purchased and used as topsoil are mineral soils obtained from below the true topsoil layer. These subsoils are often devoid of organic matter and essential plant nutrients and do not possess the physical structure required for optimum plant growth. These materials are typically processed to remove debris before marketing. In some areas, sand and muck-type materials are sold as topsoils. Neither of these materials possess properties essential for optimum plant growth. Most topsoils that can be purchased today contain less than 2% organic matter.

Manures from a variety of livestock have been used as a source of nutrients and organic matter on agricultural soils for centuries. Typically these materials have been applied in a fresh form, but are currently available for agricultural and horticultural usage in aged, dehydrated, or stabilized form. Common manure feedstocks include beef and dairy cattle, chicken, turkey, and

horse manures. Raw manures are typically more odorous than composted manures, and may still contain viable pathogens and weed seeds. When raw manures are applied, it is suggested that planting be delayed two-to-four weeks after application and incorporation to allow for stabilization. Since raw manure has not been stabilized, the nitrogen is often readily available and subject to leaching. Its organic matter is also subject to more rapid degradation. Composted manures will contain a more stable form of nitrogen and a lower content of organic matter than will raw manures.

[Source: Adapted from Peat Moss and Peat Substitute, Dr. Francis Gouin, University of Maryland Bulletin]

General Comparison of Compost to Other Horticultural/Agricultural Products*

	Compost	Canadian Peat	Native Peat	Mineral Topsoil	Fresh Manure	Ground Pine Bark
Macronutrients	medium-high	very low	very low	low	high	low
Micronutrients	medium-high	very low	very low	low-medium	medium-high	low
Soluble Salts	low-medium	very low	very low	low	high-very high	low
pH	medium	low-very low	low-very low	medium	medium	low
Bulk Density	medium	low	low	high	high	low
Moisture Holding Capacity	medium	very high	high	low	low-medium	low
Organic Matter Content	medium-high	very high	high	low	medium-high	medium-high
Stability in Soil	good-excellent	excellent	excellent	N/A	low-medium	good-excellent
Microbial Population	good-excellent	poor	poor	poor-good	good	good-excellent

*Note: These are general guidelines. Individual products may vary widely.
N/A = not applicable

Actual Comparison of Compost to Other Horticultural/Agricultural Products

	Compost ¹	Organic Soil ²	Native Peat ³	Canadian Peat ⁴	Aged Chicken Manure
Organic Matter (%)	46.00	12.00	74.00	97.00	43.00
pH	7.40	7.50	5.20	4.20	---
Soluble Salts (mmhos/cm)	2.23	0.64	0.31	0.07	15.10
Bulk Density (lbs/ft ³)	32.16	70.22	14.26	6.98	39.32
Moisture-Holding Capacity (%)	227.00	53.00	428.00	1,307.00	166.00
Cation Exchange Capacity (meg/100g)	17.30	13.60	4.00	3.10	---

1 = represents a biosolids/yard trimmings compost data
2 = represents an organic Florida muck soil
3 = represents a Florida reed sedge peat
4 = represents a Canadian Sphagnum peat moss

Source: E&A Environmental Consultants, Inc.,
in-house

6.0 COMPOST USE ESTIMATOR

Cubic Yards of Compost Required to Cover 1,000 Square Feet

1/4-inch layer	→	approximately 0.75 cubic yards
1/2-inch layer	→	approximately 1.5 cubic yards
1-inch layer	→	approximately 3.0 cubic yards
1½-inch layer	→	approximately 4.5 cubic yards
2-inch layer	→	approximately 6.0 cubic yards
2½-inch layer	→	approximately 7.5 cubic yards
3-inch layer	→	approximately 9.0 cubic yards

Cubic Yards of Compost Required to Cover One Acre

1/4-inch layer	→	approximately 34 cubic yards
1/2-inch layer	→	approximately 67 cubic yards
1-inch layer	→	approximately 134 cubic yards
1½-inch layer	→	approximately 201 cubic yards
2-inch layer	→	approximately 269 cubic yards
2½-inch layer	→	approximately 335 cubic yards
3-inch layer	→	approximately 402 cubic yards

Approximate Number of Pots Filled by One Cubic Yard of Compost Amended Media

Pot Size	# Filled
4 inch	1,210
1 gallon (6 inches)	225
2 gallon (8 inches)	120
3 gallon (10 inches)	80
7 gallon (14 inches)	38
15 gallon (17 inches)	14

Cubic Yards of Compost Required to Cover a Specific Area Formula:

Specific area to cover (expressed as square feet) x amount of compost to apply (expressed as depth in inches) x 0.0031 = equals cubic yards of compost to cover a specific area.

$$(\text{_____ ft}^2 \times \text{_____ inches of compost} \times 0.0031 = \text{_____ yd}^3)$$

Example:

We are interested in determining the amount of compost necessary to cover 5,000 ft² with a one-half inch layer of compost.

$$(5,000 \text{ ft}^2 \times 0.5 \text{ inches of depth} \times 0.0031 = 7.75 \text{ yd}^3)$$

7.0 SOIL/MEDIA TESTING

The most accurate way to obtain data on the pH and nutritional status of our soil or media is by having it analyzed by a reputable agricultural laboratory. Testing can also provide data on the salt concentration, organic matter content, and other characteristics of your soil/media. In addition to providing data on soil/media status, agricultural laboratories also provide recommendations regarding fertilizer application and pH adjustment for crops you intend to grow. Although several suggestions are provided throughout this document regarding the application of fertilizer and pH adjusting agents, the application of these materials should be based on quantitative test data.

The most accurate method of determining soil status and plant requirements is to obtain soil samples one week or more after compost addition (incorporation). This delay allows amended soils to stabilize. Instructions on how to collect soil samples can be obtained through your State's Land Grant University, Cooperative Extension Service, or private agricultural laboratories.

8.0 COMPOST APPLICATION

The method in which compost is applied is typically based on the compost's characteristics, type of application, the size of the project, and field conditions. For small planting or mulching projects, compost may be obtained in bags and spread by hand using a rake. For larger projects, compost may be obtained in bulk, transported to the site in a dump truck or wheelbarrow and spread by hand or by using tractor drawn equipment. Where slopes are being mulched for decorative purposes or erosion control, or compost is being applied to sites that are difficult to access, blower-type units have been used to propel the compost up to 200 feet. Smaller blower-type units have also been developed which propel the compost through a wide hose that can be directed around plants and other objects. A more common method to apply compost for various applications is with a manure spreader or topdressing unit. A manure spreader uses rotating flails (paddles) to project the compost into the air, whereas a topdressing unit uses a rotating, cylindrical brush to project the compost down towards the soil surface. Both units may be calibrated to apply lower (1/4 - 1/2 inch layer) or higher rates (1 inch layer) of compost; however, the application of higher rates is slow and may take more than one pass over the site. Often, when rates of 1 inch or more are applied, piles of compost are strategically placed throughout the site and a grading blade, York rake, or front-end loader/bulldozer blade is used to spread the compost. With experience and care, accurate application rates are achievable. The agricultural community and companies marketing compost have developed efficient methods of applying compost. Side discharge manure spreaders have been used to apply compost inside planting rows and tractor-trailers have been fitted with flails to allow large volumes to be spread. Equipment has even been developed to apply composts to a depth of 1/2-1 inch over a raised nursery bed.

Continued innovations in compost application equipment will increase compost usage. For that reason, equipment is now available for purchase or rental to allow users to more efficiently apply compost. It is important to note that the moisture content and particle size of the compost will affect its spreadability. Standard "box spreaders" and agricultural or commercial fertilizer/lime spreaders often have difficulty spreading coarse or wet compost.

9.0 FERTILIZATION APPLICATION

As discussed in earlier sections, although compost is not typically considered a fertilizer, it can supply a variety of macro- and micronutrients. The quantity and availability of these nutrients is based on the soil type, climate, compost's constituents, its feedstocks, as well as its stability. Source-separated food by-products, biosolids, and manure composts are known for being richer in nitrogen than are yard trimmings and municipal solid waste composts. When incorporated into the soil or a growing medium, composts that are carbon-rich or less stable (less thoroughly composted) may cause nitrogen depletion for a period of time or consume its own supply of available nitrogen. Because all composts contain different quantities of nutrients and plant-available nutrients, it is important to obtain current soil test data. The total nitrogen content should be known, as should the content of water-soluble (NO_3 and NH_4) and insoluble nitrogen forms. Plant available forms of nitrogen, phosphorous, and potassium are expressed as NO_3 , P_2O_5 , and K_2O , respectively. Performing a soil test is also important to allow for proper fertilization application, as well as data regarding the plant's nutrient requirements. Completing a soil test a week or so following compost incorporation will allow for more accurate soil test results.

All fertilizer programs should be designed to meet the requirements of the plant species being grown and complement the nutritional content of the compost being used. Often, chemical fertilizer programs are not altered, even though it is known that the compost that was applied supplies considerable quantities of plant available nutrients. Performing a soil test on the amended soil will aid in determining appropriate fertilizer application rates and reduce potential over fertilization and pollution. Where the plant-available nitrogen, phosphorus, and potassium in the compost are adequate, pre-plant fertilizers incorporated into the soil, raised bed, or growing media may be eliminated or reduced. Often supplemental nutrition, primarily nitrogen, is necessary during spring and fall season because nitrogen in the compost may not be available (mineralized) at rates sufficient to meet immediate crop requirements. Research has shown, however, that it is possible to meet the nitrogen requirements of many plant species by applying compost in successive years, since the quantity of available nitrogen is cumulative. Marginal or low-quality soils are likely to need greater fertilizer applications unless high rates of stable compost are used. The addition of compost at prescribed rates will supply nutrients after the first year of application. It is estimated that the nitrogen content of compost is released for five or

more years following application, with quantities of available nutrients declining each subsequent year. Therefore, compost's slow feeding nature will allow end users to reduce fertilizer application to some degree.

Since nutrients are supplied to plants in the form of salts, a good rule of thumb is to apply only half of the recommended fertilizer rate specified when compost is used on known salt-sensitive plant species. However, completing a soil test is the most accurate method to determine nutritional requirements or soluble salts concentration.

Where stable biosolids composts are used at prescribed rates, as a component to growing media, nitrogen fertilizers should not be applied during the first 2-3 weeks of plant growth, and the addition of micronutrients to the mix should not be necessary. Composts produced from feedstocks other than biosolids and considered stable typically do not need nitrogen fertilizers during the week or two following potting. The need to apply micronutrients will likely be eliminated when using compost at suggested rates in potting media. Composts that are less stable, regardless of the feedstock, will need supplemental nutrition, especially nitrogen and phosphorus, immediately following potting.

If unstable compost is used in field applications, it should be allowed to age in the field before any planting takes place to avoid stunting, potential plant damage, or reduced crop yields. Depending on the compost's degree of instability and time of year, field aging could take a few weeks to a few months or longer. Alternatively, or in conjunction with field aging, fertilizer may be added to help compensate for any nitrogen immobilization. Stunted growth or yellowing vegetation is a symptom of nitrogen immobilization.

10.0 NUTRIENT LOADING ESTIMATOR

The following information is provided to estimate the amount of macronutrients found in a specific quantity of compost. By determining the quantity of macronutrients, proper fertilizer application can be made and environmental impact minimized.

Steps/Formulas:

1. Convert compost application rates from cubic yards to pounds, if necessary.

compost application rate (yd³/area) x compost bulk density (lbs/cubic yard) = lbs of compost/specific area

2. Determine compost application rate (per area) on a dry-weight basis.

application rate (lbs/specific area) x dry solids content of compost (expressed as a percent) = lbs of dry compost applied

3. Determine nutrient loading rate.

lbs of dry compost applied x content (total) of specific nutrient to estimate (expressed as a percent) = lbs (total) of specific nutrient applied

Example

We are interested in determining the amount of total nitrogen applied per 1,000 ft² of area.

Compost has an analysis of 1% nitrogen

Compost is 55% dry solids (45% moisture)

Compost has a bulk density of 1,000 lbs. per yd³

Suggested application rate per 1,000 ft² is 4.5 yd³

1. compost bulk density = 1,000 lbs/yd³ = .5 yd³/ton (2,000 lbs/ton)

$4.5 \text{ yd}^3 \text{ (suggested compost application rate per 1,000 ft}^2) \times .5 \text{ yd}^3/\text{ton} = 2.25 \text{ tons/1,000 ft}^2$.

$2.25 \text{ tons} \times 2,000 \text{ lbs/ton} = 4,500 \text{ lbs/1,000 ft}^2$

2. $4,500 \text{ lbs/1,000 ft}^2 \times 55\% \text{ (dry solids content)} = 2,475 \text{ lbs dry compost/1,000 ft}^2$

3. $2,475 \text{ lbs} \times 1\% \text{ (total nitrogen content)} = 24.75 \text{ lbs}/1,000 \text{ ft}^2 \text{ (total nitrogen applied)*}$

** This figure does not represent Plant Available Nitrogen, only total nitrogen.*

Once the quantity of total nitrogen is determined, an estimate of actual or available nitrogen can be made (see bottom of next page). The quantity of nitrogen available to plants is based on the quantity mineralized. The mineralization rate of nitrogen in compost is based on soil type, climactic conditions, and the stability of the compost.

Rules Of Thumb

1. Nitrogen mineralization rates (availability) of stable composts are greatest the first year following application, and rates reduce each year until they reach background levels. Rapid mineralization occurs in the first 4-8 months following application, then it decreases and drops to a more constant level.
2. Nitrogen mineralization rates are greater in coarse-textured (sandy) soils and less in fine-textured (clay, clay loam) soils.
3. Nitrogen mineralization rates are increased as ambient temperatures and humidity increase; rates are greater in tropic and semi-tropic zones.
4. Stable composts contain more plant-available nitrogen.
5. Unstable composts can cause nitrogen immobilization, and some of its nitrogen content may be lost through volatilization of ammonia.
6. Nitrogen immobilization is less influenced by feedstock than by the compost's characteristics (stability/rating/form of nitrogen).

Although compost nitrogen mineralization rates have been studied for many years, they are difficult to estimate because they are site and compost specific. With this in mind, research suggests that the nitrogen mineralization rate of stable composts during the first year following application is 5%-25%, based on soil type and climactic conditions. Mineralization rates of 20%-25% may occur in deep southern states, while in far northern states rates of 5%-10% are

more likely. Many researchers believe a common mineralization rate for stable compost in large portions of the United States is 10%-15% the first year following compost application. The second year following application, the mineralization rate should be estimated as half of the first season, and the third year, the mineralization rate will be half that of the second year.

For example, research on stable biosolids composts completed at the USDA's research station in Beltsville, Maryland found nitrogen mineralization rates of:

First Season	10%
Second Season	5%
Third Season	2%-3%

Therefore, if a compost has a mineralization rate of 10% the first year and compost is reapplied the next year, the cumulative mineralization rate of the compost is 15%.

Using the example from the previous page, if a compost containing 1% nitrogen was applied at 4.5 cubic yards per 1,00 square feet for two successive years, a total of 3.71 pound of nitrogen will be available during the second season. From the total, 2.475 pounds (10% of 24.75 lbs.) is supplied by the compost applied the second season, and 1.24 pounds (5% of 24.75 lbs.) is supplied by the compost applied the first season.

Research completed by the University of Minnesota on MSW compost found that greater nitrogen mineralization rates may occur the season following application when using unstable composts.

11.0 pH ADJUSTMENT

All plants possess a specific pH range in which they grow and flourish. Knowing this, *green industry professionals* and homeowners adjust the pH of their soils or growing media to meet the requirements of the specific plants. pH is typically increased with lime and decreased with sulphur-based products. Growing plants in their desired pH range allows for optimal growth and proper plant nutrition. A list of desired pH ranges for various plant species can be obtained from agricultural specialists or agricultural/horticultural reference literature.

The addition of compost at recommended rates will usually affect the pH of soils and growing media. The extent to which the pH is influenced depends on the pH of the soil being treated, the pH of the compost, the quantity of compost applied, and the soil type. In most field situations, the addition of compost will increase the pH of soil or growing medium, except when the soil is already alkaline in nature. In alkaline soils, pH may increase gradually with repeat application if the compost pH is greater than that of the soil. Since most finished composts possess a pH of 6.0-7.5, the use of compost does not typically raise soil/media pH above 6.5, unless the compost or its feedstock contains lime. Often, less stable municipal solid waste composts that are rich in cellulose possess an elevated pH. This will cause a short-term rise in soil/medium pH until the compost stabilizes, then the pH will decrease again. Compost also improves the cation exchange capacity (CEC) of soils, thereby improving its buffering capacity, making it more resistant to pH change. Therefore, the addition of compost can have a long-term effect on stabilizing pH. Keep in mind that it is easier to alter the pH of sandier soils than clay or organic soils because sandy soils possess a very low CEC.

An interesting phenomenon occurs in relation to organic matter content and soil pH. It has been shown that as the organic matter of soil increases, the importance of meeting the plants' preferred pH range becomes less relevant. This is because organic matter, and the humic acid it contains, more effectively binds and releases nutrients, making them more available to plants. One of the main reasons for maintaining a desirable pH is to assure that roots are capable of obtaining optimal nutrients. This phenomenon has been well-illustrated in the production of excellent-quality rhododendrons, an acid-bearing species, in soil with a pH of above 6.0 where compost has been used as an amendment.

Although it is impossible at this point to estimate what effect a particular compost product will have on a particular soil, several general statements can be made:

Rules Of Thumb:

1. In most acidic soils, compost will increase soil pH.
2. The greater the calcium and magnesium content of the compost, as well as its CEC, the more it will influence soil/media pH.
3. Research and practical experience has shown that the incorporation of 10-50 dry tons per acre of compost will increase soil pH on acidic soils from 0.5-1.0 unit; whereas, its effect on slightly alkaline soils may be negligible. Therefore, increasing a soil's pH from 5.5-6.0 can typically be achieved through the addition of compost at recommended rates.
4. Where a greater upward pH adjustment is required, compost should be used in conjunction with a liming agent. Preferably, adjust the soil pH to near the preferred value using liming agents, then apply the compost to modify it the rest of the way.
5. Where a downward pH adjustment is required, adjust the soil pH with sulphur to the desired level, then add the compost (it will modify the pH upward to a small degree).

12.0 HEALTH/ENVIRONMENTAL ISSUES

Concerns over potential health and environmental related issues have peaked since the use of municipally generated compost feedstocks (e.g., biosolids, and municipal solid waste) has become common. These concerns are understandable and have been addressed through research. Unfortunately, even though excellent research exists pertaining to health and environmental risks, it is often ignored and negative opinions regarding specific composts are formed based on fear and stigmas.

The Facts

Pathogens: Certain compost ingredients or feedstocks such as biosolids, septage, municipal solid waste, yard trimmings, food by-products, and animal manures can contain plant and animal pathogens. However, specific processes and management techniques have been developed to effectively destroy these pathogens. These processes and techniques are based on a known *time-temperature relationship*. Simply, all living organisms can be killed when exposed to a specific temperature for a specific length of time. The greater the temperature, the shorter the exposure time necessary. The time-temperature criteria for controlling potentially harmful pathogens in biosolids were identified and verified back in the 1970's by the United States Department of Agriculture (USDA) and the United States Environmental Protection Agency (US EPA) when they began biosolids composting research. The time-temperature criteria is also valid for destroying pathogens in other feedstocks, and is effective in destroying other organisms such as nematodes, insects, as well as weed seeds. Since the 1970's, over 250 biosolids and municipal solid waste composting facilities have been in operation, and there has never been a documented case of disease or illness caused by the use of these products. The composting process is very effective for disinfection or pasteurization.

Heavy Metals: Certain municipal (e.g., biosolids and municipal solid waste) and industrial compost feedstocks typically contain low levels of heavy metals. In order to guarantee public safety, a tremendous amount of research has been performed on a national level regarding heavy metals. Heavy metals, so called because of their location on the Periodic Table of the Elements, are trace elements whose concentrations are regulated due to potential toxicity to humans, animals, and/or plants. Similar to the pesticides we use everyday, the mere presence of these elements does not pose a risk. These trace elements are inherently found in almost everything and are only deemed a health risk when we are exposed to them in relatively large quantities.

Keep in mind that many of the trace elements referred to as heavy metals are purchased by the horticultural industry as micronutrients and applied to their crops, because they are necessary for plant growth. Many of these elements are also found in typical fertilizers in greater quantities than that found in composts, and some of these elements are found in human vitamin supplements. It should be noted that products containing biosolids and MSW are heavily scrutinized, while many other soil amendments and fertilizers containing these same trace elements may be produced and marketed with minimal to no regulation and scrutiny. It is important to keep the heavy metal issue in perspective, because only compost derived from feedstocks that are low in heavy metals may be distributed with little or no restrictions. It should also be understood that a landmark health-related risk assessment was recently completed by the USDA and the US EPA, which developed parameters for heavy metals content in biosolids compost. These national *minimum* standards, listed in the *Appendix*, provide an extra layer of safety that can provide end users with a greater sense of confidence.

Nitrogen Loading: Much concern exists regarding the over-use of nitrogen and its effect on the environment. The improper use of nitrogen has caused nitrate runoff and leaching concerns, which are a serious threat to our water resources. The composting industry takes these concerns seriously, as does the USDA and the US EPA, and that is why specific regulations have been developed to address them. To assure that over-fertilization does not occur, maximum compost application rates should be based on the plant's annual plant-available nitrogen requirement. Plant-available nitrogen requirements for plant species are known values and are obtainable through agricultural and horticultural specialists. Plant-available nitrogen content is different from the total nitrogen content of compost and is generally considered to be between 5%-25% available during the first growing season. The quantity of nitrogen available to plants on an annual basis from compost is based on climatic and soil conditions. Most state regulations include methods for determining the nitrogen availability of composts. For instance, the USDA estimated that nitrogen availability (mineralization) from biosolids compost in Maryland was approximately 10% the first year and 5% the second year. That means that the maximum allowable amount of nitrogen that can be supplied to a crop, which has an annual plant available nutrient requirement of 100 pounds per acre, is 1,000 pounds. The nutrient loading estimator found in Section 10 illustrates a methodology to determine total nitrogen loading and a discussion on mineralization rates.

Other: There is some concern over man-made materials or "foreign" materials contained in compost that may cause lacerations. For this reason, several states are restricting the size and quantity of foreign materials allowed in compost. The content of these foreign materials is not considered a major hazard to workers. Wearing gloves during planting if your compost contains "sharps" should eliminate such problems. Also, if the compost is excessively dry when applied (like lime and other agricultural/horticultural products), dust may be produced that can be irritating to eyes and respiratory tract. Protective eyewear and a dust mask should eliminate any such nuisance.

LANDSCAPE ARCHITECTURE/DESIGN SPECIFICATIONS FOR COMPOST USE

Short Format

- Turf Establishment with Compost
- Planting Bed Establishment with Compost
- Compost as a Landscape Backfill Mix Component
- Compost as a Landscape Mulch
- Compost as a Soil Mulch for Erosion Control
- Compost as a Filter Berm for Sediment Control

Specification

Section _____, Turf Establishment with Compost

Description:

This work shall consist of incorporating compost within the root zone to improve soil quality and plant growth. This specification applies to all types of turf establishment methods including seeding, sprigging, sodding, and hydroseeding.

Materials:

Compost shall be a well decomposed, stable, weed free organic matter source. It shall be derived from agricultural, food, or industrial residuals; biosolids (treated sewage sludge); yard trimmings, or source-separated or mixed solid waste. The product shall contain no substances toxic to plants and shall be reasonably free (< 1% by dry weight) of man-made foreign matter. The compost will possess no objectionable odors and shall not resemble the raw material from which it was derived.

Product Parameters:

Parameter*	Range
pH	5.5 - 8.0
Moisture Content	35% - 55%
Particle Size	Pass through 1 inch screen or smaller
Stability	Stable to highly stable, thereby providing nutrients for plant growth
Maturity/Growth Screening	Must pass maturity tests or demonstrate its ability to enhance plant growth
Soluble Salt Concentration	May vary but must be reported, 4.0 dS (mmhos/cm) or less is the preferred salt content for the soil/compost blend

* Recommended test methodologies and procedures are outlined in Recommended Test Methods for the Examination of Compost & Composting (The Composting Council, Alexandria, Virginia).

The soluble salt concentration of the amended soil should not exceed 1.25 dS (mmhos/cm) where seeds, young seedlings, or salt-sensitive crops are to be planted.

Construction Requirements

Compost shall be uniformly applied over the entire area at an average depth of 1 to 2 inches and incorporated to a depth of 5 to 7 inches (for a 20% to 30% inclusion rate) using a rotary tiller or other appropriate equipment. Higher inclusion rates are necessary for upgrading marginal soils. Pre-plant fertilizer and pH adjusting agents (e.g., lime and sulfur) may be applied before incorporation, as necessary. Rake soil surface smooth prior to seeding, sprigging, sodding, or hydroseeding. The soil surface shall be reasonably free of large clods, roots, stones greater than 2 inches, and other material which will interfere with planting and subsequent site maintenance. Water thoroughly after seeding, sprigging, or sodding. Topdress newly seeded and sprigged turf areas with a 1/4 inch layer of fine compost (3/8 inch screen, minus), then water to protect against hot, dry weather or drying winds.

Method of Measurement

Compost will be measured by the cubic yard or the ton at the point of loading.

* The Landscape Architect/Designer shall specify the compost inclusion rate depending upon soil conditions and quality, plant tolerances, and manufacturer's recommendations.

The use of stable, nutrient rich composts will reduce initial fertilizer requirements by the amount of available nutrients in the compost.

<p>Soil Analysis: Before any soil preparation procedures ensue, a soil analysis shall be completed by a reputable laboratory to determine any nutritional requirements, pH and organic matter adjustments necessary. Once determined, the soil shall be appropriately amended to a range suitable for the turf species to be established.</p>

Specification

Section _____, Planting Bed Establishment with Compost

Description

This work shall consist of incorporating compost within the root zone in order to improve soil quality and plant growth. This specification applies to all types of plantings, including trees, shrubs, vines, ground covers, and herbaceous plants.

Materials

Compost shall be a well decomposed, stable, weed free organic matter source. It shall be derived from agricultural, food, or industrial residuals; biosolids (treated sewage sludge); yard trimmings, or source-separated or mixed solid waste. The product shall contain no substances toxic to plants and shall be reasonably free (< 1% by dry weight) of man-made foreign matter. The compost will possess no objectionable odors and shall not resemble the raw material from which it was derived. For acid loving plants, only use a compost that has not received the addition of liming agents or ash by-products.

Product Parameters:

Parameter*	Range
pH	5.5 - 8.0
Moisture Content	35% - 55%
Particle Size	Pass through 1 inch screen or smaller
Stability	Stable to highly stable, thereby providing nutrients for plant growth
Maturity/Growth Screening	Must pass maturity tests or demonstrate its ability to enhance plant growth
Soluble Salt Concentration	May vary but must be reported, 2.5 dS (mmhos/cm) or less is the preferred salt content for the soil/compost blend

* Recommended test methodologies and procedures are outlined in Recommended Test Methods for the Examination of Compost & Composting (The Composting Council, Alexandria, Virginia).

The soluble salt concentration of the amended soil should not exceed approximately 1.25 dS where seeds, young seedlings, or salt-sensitive crops are to be planted.

Construction Requirements

Compost shall be uniformly applied over the planting area at an average depth of 1 to 2 inches*. Incorporate uniformly to a depth of 6 to 8 inches using a rotary tiller or other appropriate equipment. Lower compost application rates may be necessary for salt sensitive crops or where composts with higher salt levels are used. Pre-plant fertilizer and pH adjusting agents (e.g., lime and sulfur) may be applied in conjunction with compost incorporation, as necessary. Rake soil surface smooth prior to seeding, sprigging, sodding, or hydroseeding. The soil surface shall be reasonably free of large clods, roots, stones greater than 2 inches, and other material which will interfere with planting and subsequent site maintenance. Water thoroughly after planting.

Method of Measurement

Compost will be measured by the cubic yard or the ton at the point of loading.

* The Landscape Architect/Designer shall specify the compost inclusion rate depending upon soil conditions and quality, plant tolerances, and manufacturer's recommendations.

The use of stable, nutrient rich composts will reduce initial fertilizer requirements by the amount of available nutrients in the compost.

<p>Soil Analysis: Before any soil preparation procedures ensue, a soil analysis shall be completed by a reputable laboratory to determine any nutritional requirements, pH and organic matter adjustments necessary. Once determined, the soil shall be appropriately amended to a range suitable for all plant species to be established.</p>
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Specification

Section _____, Compost as a Landscape Backfill Mix Component

Description

This work shall consist of excavating a planting hole and blending compost with the excavated soil to improve soil quality and plant growth. This specification applies to all types of bare root, containerized, and balled and burlapped plant material.

Materials

Compost shall be a well decomposed, stable, weed free organic matter source. It shall be derived from agricultural, food, or industrial residuals; biosolids (treated sewage sludge); yard trimmings, or source-separated or mixed solid waste. The product shall contain no substances toxic to plants and shall be reasonably free (< 1% by dry weight) of man-made foreign matter. The compost will possess no objectionable odors and shall not resemble the raw material from which it was derived. For acid loving plants, provide only compost that has not received the addition of liming agents or ash by-products.

Product Parameters

Parameter*	Range
pH	5.5 - 8.0
Moisture Content	35% - 55%
Particle Size	Pass through 1 inch screen or smaller
Stability	Stable to highly stable, thereby providing nutrients for plant growth
Maturity/Growth Screening	Must pass maturity tests or demonstrate its ability to enhance plant growth
Soluble Salt Concentration	May vary but must be reported, 3.0 dS (mmhos/cm) or less is the preferred salt content for the soil/compost blend

* Recommended test methodologies and procedures are outlined in Recommended Test Methods for the Examination of Compost & Composting (The Composting Council, Alexandria, Virginia)

The soluble salt concentration of the amended soil should not exceed 1.25 dS (mmhos/cm) where seeds, young seedlings, or salt-sensitive crops are to be planted.

Composts containing available nutrients, primarily nitrogen, are preferred, while the use of unstable or immature compost is not approved. Care should be given when using composts possessing a basic pH (>7) near acid loving plants.

Construction Requirements

Excavate a planting hole slightly shallower and 2 to 3 times the width of the rootball or container. Set the rootball on firm soil so that the top of the rootball will sit slightly higher than the final grade. Uniformly blend compost and excavated soil at a 1 compost : 2 soil ratio*.

Backfill and firm the soil blend around the rootball within the planting hole. Water thoroughly during and after planting.

Method of Measurement

Compost will be measured by the cubic yard or the ton at the point of loading.

* The Landscape Architect/Designer shall specify the compost inclusion rate depending upon soil conditions and quality, plant tolerances, and manufacturer's recommendations.

Soil Analysis: Before any soil preparation procedures ensue, a soil analysis shall be completed by a reputable laboratory to determine any nutritional requirements, pH and organic matter adjustments necessary. Once determined, the soil shall be appropriately amended to a range suitable for the plant species to be established.

Specification

Section _____, Compost as a Landscape Mulch

Description

This work shall consist of applying compost to the soil surface after planting to help inhibit weed growth, conserve soil moisture, and reduce soil erosion.

Materials

Compost mulch shall be a well decomposed, weed free organic matter source. It shall be derived from agricultural, food, or industrial residuals; biosolids (treated sewage sludge); yard trimmings, or source-separated or mixed solid waste. The product shall contain no substances toxic to plants and be reasonably free (< 1% by dry weight) of man-made foreign matter. The compost will possess no objectionable odors and shall not resemble the raw material from which it was derived. For acid loving plants, only use a compost that has not received the addition of liming agents or ash by-products.

Product Parameters

Parameter*	Range
pH	5.5 - 8.0
Moisture Content	35% - 55%
Particle Size	May vary but must be reported; acceptable size is based on customer preference and mulching objectives
Stability	Moderately to highly stable, thereby providing nutrients for plant growth
Maturity/Growth Screening	Must pass maturity tests or demonstrate its ability to enhance plant growth
Soluble Salt Concentration	May vary but must be reported

* Recommended test methodologies and procedures are outlined in Recommended Test Methods for the Examination of Compost & Composting (The Composting Council, Alexandria, Virginia)

The soluble salt concentration of the amended soil should not exceed 1.25 dS (mmhos/cm) where seeds, young seedlings, or salt-sensitive crops are to be planted.

When using compost for mulching, specific products may be considered more physically or visually acceptable for a given planting area. Since aesthetic preferences are subjective, a

representative sample of compost must be submitted to the Landscape Architect/Designer prior to field use. Coarser-textured compost mulches are more effective in reducing weed growth and preventing water and wind erosion.

Construction Requirements

Compost mulch shall be uniformly applied over the entire area at an average depth of 2 to 3 inches* as soon as possible after weed removal and planting. Avoid placing mulch against the trunk or stem of any plant material. Water thoroughly before and after mulching to saturate the root zone and entire mulch layer. All stones, roots, or other debris larger than 2 inches shall be removed from the surface of the mulched area.

Method of Measurement

Compost will be measured by the cubic yard or the ton at the point of loading.

* The Landscape Architect/Designer shall specify the compost application rate depending upon soil conditions and quality, plant tolerances, and manufacturer's recommendations.

Generally, biosolids composts should not be applied at a depth greater than 2 inches, while most yard trimmings composts can be applied to a depth of 3 inches. Salt sensitive species typically prefer lower application rates.

Specification

Section _____, Compost as a Soil Mulch for Erosion Control

Description

This work shall consist of applying compost to a sloped soil surface to reduce erosion for long term stabilization and to enhance riparian buffer areas.

Materials:

Compost mulch shall be a decomposed, weed free organic matter source derived from yard trimmings or wood/bark. Well decomposed, stable biosolids compost (treated sewage sludge) may also be used. Particle size may vary widely. The compost shall possess no objectionable odors and will be reasonably free (< 1% by dry weight) of man-made foreign matter. The compost product shall not resemble the raw material from which it was derived.

Product Parameters:

Parameter*	Range
pH	5.5 - 8.0
Moisture Content	35% - 55%
Particle Size	May vary but must be reported; acceptable size is based on project objectives
Stability	May vary but must be reported; stable to highly stable product is recommended if binding pollutants is a goal or seeding/planting is planned
Maturity/Growth Screening	Testing not required on unvegetated sites
Soluble Salt Concentration	May vary but must be reported

* Recommended test methodologies and procedures are outlined in Recommended Test Methods for the Examination of Compost & Composting (The Composting Council, Alexandria, Virginia)

The soluble salt concentration of the amended soil should not exceed 1.25 dS (mmhos/cm) where seeds, young seedlings, or salt-sensitive crops are to be planted.

Where planning immediate grass, wildflower, or legume seeding or ornamental planting, use only well composted product that contains no substances toxic to plants. Very coarse composts should be avoided if the slope is to be landscaped or seeded, as it will make planting and crop

establishment more difficult. Composts containing fibrous particles that range in size produce a more stable mat.

Construction Requirements

Compost mulch shall be uniformly applied to a minimum depth of 3 to 4 inches to slopes of up to 1:2 in steepness*. Slopes with problem soils and more runoff will require greater application rates. In areas of lower precipitation, application rates of 2 inches may be acceptable. Spread the compost uniformly, then track (compact) the compost layer using a bulldozer or other appropriate equipment. Alternatively, apply compost using a pneumatic (blower) unit. Project compost directly at soil surface, thereby preventing water from moving between the soil-compost interface. Apply compost layer approximately 3 feet over the top of the slope or overlap it into existing vegetation. On highly unstable soils, use compost in conjunction with appropriate structural and diversion measures. Follow by seeding or ornamental planting if desired .

Method of Measurement

Compost will be measured by the cubic yard or the ton at the point of loading.

* The Landscape Architect/Designer shall specify the compost application rate depending upon soil conditions and quality, plant tolerances, and manufacturer's recommendations.

If seeding onto or planting directly into the compost layer, the product must meet the parameters necessary for normal plant growth of the particular species to be established.

Specification

Section _____, Compost as a Filter Berm for Sediment Control

Description

This work shall consist of constructing a raised berm of compost on a soil surface to contain soil erosion, control the movement of sediment off site, and to filter storm water.

Materials

Compost shall be a decomposed, weed free organic matter source derived from yard trimmings or wood/bark. Well decomposed, stable biosolids compost (treated sewage sludge) may also be used. Particle size may vary widely. The compost shall possess no objectionable odors and will be reasonably free (< 1% by dry weight) of man-made foreign matter.

Product Parameters:

Parameter*	Range
pH	5.5 - 8.0
Moisture Content	35% - 55%
Particle Size	May vary but must be reported; acceptable size is based on project objectives
Stability	May vary but must be reported; stable to highly stable product is recommended if binding pollutants is a goal or seeding is planned
Maturity/Growth Screening	Testing not required on unvegetated sites
Soluble Salt Concentration	May vary but must be reported

* Recommended test methodologies and procedures are outlined in Recommended Test Methods for the Examination of Compost & Composting (The Composting Council, Alexandria, Virginia)

The soluble salt concentration of the amended soil should not exceed 1.25 dS (mmhos/cm) where seeds, young seedlings, or salt-sensitive crops are to be planted.

Where seeding of the berm is planned, use only well composted product that contains no substances toxic to plants. The compost product shall not resemble the raw material from which it was derived. Avoid coarse composts if the berm is to be seeded, as it will make establishment

more difficult. Composts denser in nature and containing particles that range in size produce the most stable berms.

Construction Requirements

Parallel to the base of the slope or other affected areas, construct a 1 1/2 to 2 foot high by 3 to 4 foot wide berm of compost. For maximum water filtration ability, construct a 1 1/2 to 2 foot high trapezoidal berm which is 3 feet wide at the top and 4 feet wide at the base. In extreme conditions and where specified by the Landscape Architect/Designer, a second berm shall be constructed at the top of the slope or silt fencing shall be installed in conjunction with the compost berm. If used, the silt fence fabric shall be laid on the soil surface with the lip facing up slope. The compost berm shall be constructed at the base of the sediment fence and over the fence fabric lip. Where the berm deteriorates, it shall be reconstructed. Do not use filter berms in any runoff channels.

Method of Measurement

Compost will be measured by the cubic yard at the point of loading.

LANDSCAPE ARCHITECTURE/DESIGN SPECIFICATIONS FOR COMPOST USE

Long Format

Seeding and Mulching
Sodding and Sprigging
Trees, Shrubs, and Ground Covers
Erosion and Sediment Control

Using the long specifications will require the Landscape Architect/Designer to provide information in the areas that are **in bold text and in parentheses** within the written text. These areas also provide instruction to the Landscape Architect/Designer.

SEEDING AND MULCHING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The work consists of establishing a stand of grass on slopes, shoulders, lawns, and other areas by seeding as shown on the Drawings. Also included are mulching, fertilizing, watering, and maintenance as required to produce a healthy stand of grass.

1.02 SUBMITTALS

- A. Certification: Certification of seed quality found on the container tag of the producer shall be presented to the Landscape Architect/Designer 10 days prior to use.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Seed: Grass seed shall be a mixture of **(specify grass [and/or additional] species and/or blend ratio)**. The separate types of seed used shall be thoroughly dry mixed immediately before sowing, except for hydroseeding. All seed shall meet the requirements of the **(specify name of state)** Department of Agriculture and all applicable state laws, and shall be approved by the Landscape Architect/Designer before being sown.
- B. Seed Mulch:
1. Straw/Hay: The mulch material used shall be air dry, clean, non-mildewed and crop/weed seed free salt hay or straw, consisting of oat, rye, or wheat straw, or of timothy, rye, fescue, bluegrass, pangola, peanut, coastal Bermuda or Bahia grass hay. Only undeteriorated mulch which can be readily cut into the soil or uniformly distributed over the soil shall be used.
 2. **Compost:** Approved **compost** shall be a well decomposed, stable, weed free organic matter source. It shall be derived from agricultural, food, or industrial residuals;

biosolids (treated sewage sludge); yard trimmings; or source-separated or mixed solid waste. One hundred percent of the product shall pass through a 3/8 inch screen and shall possess a pH of 5.5 to 8.0 and moisture content of 35% to 55% by weight. It shall contain no substances toxic to plants and 1% or less by weight man-made foreign matter. The **compost** will possess no objectionable odors and shall not resemble the raw material from which it was derived. A **compost** sample shall be submitted to the Landscape Architect/Designer for approval prior to being used. **(The Landscape Architect/Designer may modify compost specifications as deemed necessary.)**

3. Hydroseeding Mulch and Tackifier:
 - a. Virgin wood fiber mulch and tackifier - **(specify acceptable products or product specifications)**
 - b. Recycled cellulose fiber mulch and tackifier - **(specify acceptable products or product specifications)**
 - c. Hay/straw mulch tackifier - **(specify acceptable products or product specifications)**

C. Soil Amendment:

1. A soil amendment (**compost**) shall be utilized to improve soil characteristics where the existing soil contains under 6% organic matter, or where deemed appropriate by the Landscape Architect/Designer.
2. Approved **compost** shall be a well decomposed, stable, weed free organic matter source. It shall be derived from agricultural, food, or industrial residuals; biosolids (treated sewage sludge); yard trimmings; or source-separated or mixed solid waste. One hundred percent of the product shall pass through a 1 inch screen and shall possess a pH of 5.5 to 8.0 and moisture content of 35% to 55% by weight. It shall contain no substances toxic to plants and 1% or less by weight man-made foreign matter. The **compost** will possess no objectionable odors and shall not resemble the raw material from which it was derived. A **compost** sample shall be submitted to the Landscape Architect/Designer for approval prior

to being used. **(The Landscape Architect/Designer may modify compost specifications as deemed necessary.)**

D. Fertilizer:

1. Commercial fertilizers shall comply with the state fertilizer laws.
2. The numerical designations for fertilizer indicate the minimum percentages respectively of (1) total nitrogen, (2) available phosphoric acid, and (3) water soluble potash contained in the fertilizer.
3. The chemical designation of the fertilizer shall be **(specify acceptable formulation, e.g. 12-8-8)**. **Compost** use will reduce initial fertilization requirements by the amount of available nutrients in the **compost**. Obtain macro and micro nutrient content information from suppliers.

- E. Water For Seeding: The water used in the sodding or sprigging operation may be obtained from any approved spring, pond, lake, stream, or municipal water system. The water shall be free of excess and harmful chemicals, acids, alkalies, or any substance that might be harmful to plant growth. Salt water shall not be used.

2.02 EQUIPMENT

- A. Fertilizer Spreader: The device for spreading fertilizer shall be capable of uniformly distributing the material at the specified rate.
- B. Seed Spreader: The seed spreader shall be an approved mechanical hand spreader, other approved type of spreader, or an approved hydroseeder.
- C. Soil Amendment Spreader: The soil amendment spreader shall be any approved mechanical device capable of uniformly spreading a soil amendment, including bulldozers, manure spreaders, grading blades, rakes, and pneumatic blowers.
- D. Tillage Equipment: The equipment utilized to incorporate the soil amendment into the soil surface must be approved and have the ability to incorporate to a depth of 6 inches. Tillage equipment may include rotary tillers, rotovators, and disc harrows.

- E. Equipment for Cutting Mulch into Soil: The mulching equipment shall be capable of cutting the specified materials uniformly into the soil and to the required controlled depth. Harrows will not be allowed.
- F. Rollers: A cultipacker, traffic roller, or other suitable equipment will be required for rolling the grassed areas.
- G. Hydraulic Mulcher (Hydroseeder): The mulch shall be mixed in standard hydraulic equipment to form a homogeneous slurry. The equipment shall be capable of spraying the slurry, under pressure, uniformly over the soil surface at the material application rate indicated. A continuous agitation system that keeps all materials in uniform suspension throughout the mixing and distribution cycles is required.
- H. Hay/Straw Blower: The hay/straw blower shall be an approved unit capable of blowing the hay/straw mulch under pressure uniformly over the soil surface at the material application rate indicated.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Soil Analysis: Before any soil preparation procedures ensue, a soil analysis shall be completed by a reputable laboratory to determine any nutritional requirements, pH and organic matter adjustments necessary. Once determined, the soil shall be appropriately amended to a range suitable for the turf species to be established.
- B. In heavily compacted soils, subsoiling to a minimum depth of 12 inches is recommended. Subsoil in 2 directions, at right angles, to create a checker-board appearance on the ground. Subsoiling may be done after the application of soil amendments.
- C. The ground to be seeded shall be prepared by mechanically tilling and thoroughly pulverizing the soil to a depth of 6 inches. A soil amendment shall be added before tilling as necessary. The prepared soil shall be loose and smooth. It shall be reasonably free of large clods, roots, stones greater than 2 inches in size, and any other material which will interfere with the work and subsequent mowing and

maintenance operations. Hand picking may be required. **(Preparation procedures for sloped areas to be seeded may be modified as necessary by the Landscape Architect/Designer.)**

3.02 APPLICATION

A. General:

1. Weather Limitations: Fertilizing, seeding, or seed mulching operations will not be permitted when wind velocities exceed 15 miles per hour. Seed shall be sown only when the soil is moist and in proper condition to induce growth. No seeding shall be done when the ground is unduly wet, frozen, or otherwise not in a tillable condition.
2. Sequence of Operations: The several operations involved in the work shall proceed in the following sequence: Preparation, amending, and fertilizing of the site, seeding, spreading of mulch, cutting-in of mulch, and rolling.

B. Amending: The soil amendment (**compost**) shall be applied to the soil surface at a rate of 135 to 220 cubic yards per acre (1 to 2 inch layer) and incorporated to a 5 to 7 inch depth, resulting in an inclusion rate of 20% to 30%. **(The Landscape Architect/Designer shall specify inclusion rate depending upon soil conditions and quality, plant tolerances, and manufacturer's recommendations).**

C. Fertilizing:

1. The fertilizer shall be spread uniformly over the area to be seeded at the rate of **(specify rate)** pounds per acre, by a spreading device capable of uniformly distributing the material at the specified rate. Immediately after spreading, the fertilizer shall be mixed with the soil to a depth of approximately 6 inches.
2. On steep slopes, where the use of a machine for spreading is not practicable, the fertilizer shall be spread by hand and raked in and thoroughly mixed with the soil to a depth of approximately 2 inches or alternatively, may be hydraulically applied. Where fertilizer is applied hydraulically, it need not be worked into the soil.

D. Seeding:

1. While the soil is still loose and moist, the seed shall be scattered uniformly over the grassing area at a rate of **(specify rate)** pounds per acre.
2. When so directed by the Landscape Architect/Designer, seed of an approved quick growing species of grass, such as rye, **(specify other approved species)** shall be spread at a rate of **(specify rate)** pounds per acre in conjunction with the permanent type seed mixture.
3. Seed may be applied hydraulically and within the hydro mulch slurry only with prior approval by the Landscape Architect/Designer.

E. Seed Mulching:

1. Approximately 1 ton of straw mulch shall be applied uniformly over the seeded area, and the mulch shall be cut into the soil with the equipment specified or secured in place using an approved hay/straw tackifier. Care shall be exercised that the materials are not cut too deeply into the soil.
2. On steep slopes, the straw mulch shall be applied and, in lieu of being cut into the soil, shall be anchored down. Anchoring shall be done by spreading netting over the mulch, using stakes driven flush with the top of the mulch at 6 foot centers and stringing parallel and perpendicular, with diagonals in both directions. Where approved by the Landscape Architect/Designer, approved liquid tackifiers may be used instead of netting.
3. To protect seeded areas against hot, dry weather or drying winds, apply **compost** (3/8 inch screen, minus) within 24 hours of seeding as an alternative to straw mulching. Moisturize after spreading uniformly to a depth of 1/4 to 1/2 inch thick (34 to 67 cubic yards per acre). **(The Landscape Architect/ Designer shall**

specify application rate depending upon soil conditions and quality, plant tolerances, and manufacturer's recommendations).

- F. Rolling: Immediately after completion of the mulching, the entire seeded and mulched area shall be rolled thoroughly with the equipment specified. At least 2 trips over the entire area will be required.
- G. Watering: The areas on which the seed has been placed shall contain sufficient moisture, as determined by the Landscape Architect/Designer, for optimum results. After being applied, the seed shall be kept in a moist condition for at least 2 weeks. Thereafter, the contractor shall apply water as needed until the seed roots start to grow for a minimum of **(specify length of time)** days or until final acceptance, whichever is latest.
- H. Single Hydraulic Application: Using the standard hydraulic mulching equipment, the wood or cellulose fiber mulch, seed, and fertilizer is applied as a combined slurry in a single application, provided that the seed is increased to the rate of **(specify rate)** pounds per acre and the fertilizer is increased to **(specify rate)** pounds per acre.
- I. Dual Hydraulic Application: Using standard hydraulic mulching equipment, the seed and fertilizer is applied as a combined slurry, then the seeded area is mulched with **(specify rate)** pounds per acre of hay/straw. The mulch shall be cut into the soil with the equipment specified or secured in place using an approved hay/straw tackifier.
- J. Maintenance:
1. The contractor shall, at his/her expense, maintain the seeded areas in a satisfactory condition until final acceptance of the project. Such maintenance shall include repairing of any damaged areas where the establishment of the grass stand does not appear to be developing satisfactorily, or where erosion has washed away an area and filling and leveling are required.
 2. Replanting or repair necessary due to the contractor's negligence, carelessness, or failure to provide routine maintenance shall be at the contractor's expense.

Replanting necessary due to factors determined to be beyond the control of the contractor shall be paid for under the appropriate contract pay items.

- K. Mowing: A separate price for mowing will be received. Should mowing be determined necessary by the Landscape Architect/Designer, the contractor shall perform all mowing for the price stated in the Proposal.

SODDING AND SPRIGGING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The work specified in this section consists of the establishing of a stand of grass, within the areas indicated on the drawings, by the furnishing and placing of sprigs or sod, fertilizing, watering, and maintaining the sodded or sprigged areas to assure a healthy stand of grass.

1.02 SUBMITTALS

- A. A certification of sod or sprig quality by the producer shall be delivered to the Landscape Architect/Designer 10 days prior to use.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Sod: Grass sod shall be either **(specify acceptable species)** and shall be well matted with grass roots. The sod shall be taken up in rectangles, a minimum of 12 inch by 24 inch, shall be a minimum of 2 inches in thickness and shall be live, fresh, and uninjured at the time of planting. It shall be reasonably free of weeds and other grasses and shall have a soil mat of sufficient thickness adhering firmly to the roots to withstand all necessary handling.
- B. Sprigs:
1. General: Sprigs shall be harvested with approved implements, in such manner that at least 3 inches of root system shall be lifted intact. The sprigs shall be of suitable size and character and shall be live, fresh, healthy, and uninjured at the time of planting.
 2. Types:
 - a. **(Specify acceptable species)**
 - b. **(Specify acceptable species)**

C. Soil Amendment:

1. A soil amendment (**compost**) shall be utilized to improve soil characteristics where the existing soil contains under 6% organic matter, or where deemed appropriate by the Landscape Architect/Designer.
2. Approved **compost** shall be a well decomposed, stable, weed free organic matter source. It shall be derived from agricultural, food, or industrial residuals; biosolids (treated sewage sludge); yard trimmings; or source-separated or mixed solid waste. One hundred percent of the product shall pass through a 1 inch screen and shall possess a pH of 5.5 to 8.0 and moisture content of 35% to 55% by weight. It shall contain no substances toxic to plants and 1% or less by weight man-made foreign matter. The **compost** will possess no objectionable odors and shall not resemble the raw material from which it was derived. A **compost** sample shall be submitted to the Landscape Architect/Designer for approval prior to being used. **(The Landscape Architect/Designer may modify compost specifications as deemed necessary.)**

D. Fertilizer:

1. Commercial fertilizers shall comply with the state fertilizer laws.
2. The numerical designations for fertilizer indicate the minimum percentages respectively of (1) total nitrogen, (2) available phosphoric acid, and (3) water soluble potash contained in the fertilizer.
3. The chemical designation of the fertilizer shall be **(specify acceptable formulation, e.g. 12-8-8)**. **Compost** use will reduce initial fertilization requirements by the amount of available nutrients in the **compost**. Obtain macro and micro nutrient content information from suppliers.

E. Sprig Mulch:

1. Hay/Straw: The mulch material used shall be air dry, clean, non-mildewed, and crop/weed seed free salt hay or straw, consisting of oat, rye, or wheat straw, or of timothy, rye, fescue, bluegrass, pangola, peanut, coastal Bermuda or Bahia grass hay. Only undeteriorated mulch that can be readily cut into the soil or uniformly distributed over the soil shall be used.

2. **Compost:** Approved **compost** shall be a well decomposed, stable, weed free organic matter source. It shall be derived from agricultural, food, or industrial residuals; biosolids (treated sewage sludge); yard trimmings; or source-separated or mixed solid waste. One hundred percent of the product shall pass through a 3/8 inch screen and shall possess a pH of 5.5 to 8.0 and moisture content of 35% to 55% by weight. It shall contain no substances toxic to plants and 1% or less by weight man-made foreign matter. The **compost** will possess no objectionable odors and shall not resemble the raw material from which it was derived. A **compost** sample shall be submitted to the Landscape Architect/Designer for approval prior to being used. **(The Landscape Architect/Designer may modify compost specifications as deemed necessary.)**

3. Hydroseeding Mulch and Tackifier:
 - a. Virgin wood fiber mulch and tackifier - **(specify acceptable products or product specifications)**

 - b. Recycled cellulose fiber mulch and tackifier - **(specify acceptable products or product specifications)**

 - c. Hay/straw mulch tackifier - **(specify acceptable products or product specifications)**

- F. Water For Seeding: The water used in the sodding or sprigging operation may be obtained from any approved spring, pond, lake, stream, or municipal water system. The water shall be free of excess and harmful chemicals, acids, alkalies, or any substance that might be harmful to plant growth. Salt water shall not be used.

2.02 EQUIPMENT

- A. Fertilizer Spreader: The device for spreading fertilizer shall be capable of uniformly distributing the material at the specified rate.
- B. Soil Amendment Spreader: The soil amendment spreader shall be any approved mechanical device capable of uniformly spreading a soil amendment, including bulldozers, manure spreaders, grading blades, rakes, and pneumatic blowers.
- C. Tillage Equipment: The equipment utilized to incorporate the soil amendment into the soil surface must be approved and have the ability to incorporate to a minimum depth of 6 inches. Tillage equipment may include rototillers, rotovators, and disc harrows.
- D. Equipment for Cutting Mulch into Soil: The mulching equipment shall be capable of cutting the specified materials uniformly into the soil and to the required controlled depth. Harrows will not be allowed.
- E. Rollers: A cultipacker, traffic roller, or other suitable equipment will be required for rolling the grassed areas.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Soil Analysis: Before any soil preparation procedures ensue, a soil analysis shall be completed by a reputable laboratory to determine any nutritional requirements, pH and organic matter adjustments necessary. Once determined, the soil shall be appropriately amended to a range suitable for the turf species to be established.
- B. In heavily compacted soil, subsoiling to a minimum of 12 inches is recommended. Subsoil in 2 directions, at right angles, to create a checker-board appearance on the ground. Subsoiling may be done after the application of soil amendments.
- C. Preparation of Area to Be Sodded: Area over which the sod is to be placed shall be mechanically tilled to a 3 inch depth and then raked smooth. A soil amendment shall be added before tilling as necessary. The prepared soil shall be loose and smooth. It shall be reasonably free of large clods, roots, stones greater than 2 inches in size, and any other material which will interfere with the work and subsequent mowing and maintenance operations. **(The Landscape Architect/Designer may modify compost specifications as deemed necessary.)**
- D. Preparation of Area to Be Sprigged: The ground to be sprigged shall be prepared by mechanically tilling and thoroughly pulverizing the soil to a depth of 6 inches. A soil amendment shall be added before tilling as necessary. The prepared soil shall be loose and smooth. It shall be reasonably free of large clods, roots, stones greater than 2 inches in size, and any other material which will interfere with the work and subsequent mowing and maintenance operations. Hand picking may be required.

3.02 APPLICATION

- A. Amending: The soil amendment (**compost**) shall be applied to the soil surface at a rate of 135 to 220 cubic yards per acre (1 to 2 inch layer) and incorporated to a 5 to 7 inch depth, resulting in an inclusion rate of 20% to 30%. **(The Landscape Architect/**

Designer shall specify inclusion rate depending upon soil conditions and quality, plant tolerances, and manufacturer's recommendations).

B. Fertilizing:

1. The fertilizer shall be spread uniformly over the area to be sodded or sprigged at the rate of (specify rate) pounds per acre, by a spreading device capable of uniformly distributing the material at the specified rate. Immediately after spreading, the fertilizer shall be mixed with the soil to a depth of approximately 6 inches.
2. On steep slopes, where the use of a machine for spreading is not practical, the fertilizer shall be spread by hand and raked in and thoroughly mixed with the soil to a depth of approximately 2 inches or alternatively, may be hydraulically applied. Where fertilizer is applied hydraulically, it need not be worked into the soil.

C. Sprigging:

1. General: The sprigs shall be planted as early as practical after they are dug and shall be kept continuously moist and shaded during the interval between digging and planting by covering with wet burlap or canvas or by other methods approved by the Landscape Architect/Designer. They shall not, however, be kept submerged. Any sprigs which have been dug for more than 48 hours shall not be planted unless specifically authorized by the Landscape Architect/Designer after inspection thereof. Any sprigs which has been permitted to dry out or to become unduly heated, or which for any reason do not clearly indicate a viable condition, shall be rejected. The moisture condition of the soil at the time of planting shall be appropriate, in the opinion of the Landscape Architect/Designer, for optimum results.
2. Broadcast Sprigging: Under this method, the sprigs shall be scattered uniformly over the area, to such effect that, after being cut-in, there will be no square foot of area which contains less than 6 viable sprigs. They shall be promptly cut into the loose soil, to a depth of approximately 2 to 3 inches. The sprigged areas shall be

thoroughly watered immediately after a sufficient number of sprigs has been planted, and shall be kept properly moistened for the duration of the contract period (and in no case less than 2 weeks).

D. Sodding:

1. General: The sod shall be planted within 24 hours of being dug and shall be shaded and kept moist until it is planted.
2. The sod shall be placed on the prepared surface, with edges in tight contact and shall be firmly and smoothly embedded by light tamping with appropriate tools.
3. Where sodding is used in drainage ditches, the setting of the pieces shall be staggered so as to avoid a continuous seam along the line of flow. Along the edges of each staggered area, the offsets of individual strips shall not exceed 6 inches. In order to prevent erosion caused by vertical edges at the outer limits, the outer pieces of sod shall be tamped so as to produce a featheredge effect.
4. On steep slopes, the contractor shall, if so directed by the Landscape Architect/ Designer, prevent the sod from sliding by means of wooden pegs driven through the sod blocks into firm earth, at suitable intervals.
5. Any pieces of sod which, after placing, show an appearance of extreme dryness shall be removed and replaced by fresh, uninjured pieces.
6. Water thoroughly after sodding.
7. Sodding shall not be performed when weather and soil conditions are, in the Landscape Architect's/Designer's opinion, unsuitable for proper results.

E. Sprig Mulching:

1. Approximately 1 ton of straw mulch shall be applied uniformly over the sprigged area, and the mulch shall be cut into the soil with the equipment specified. Care shall be exercised that the materials are not cut too deeply into the soil.

2. On steep slopes, the mulch material shall be applied and, in lieu of being cut into the soil, shall be anchored down. Anchoring shall be done by spreading netting over the mulch, using stakes driven flush with the top of the mulch at 6 foot centers and stringing parallel and perpendicular, with diagonals in both directions. Where approved by the Landscape Architect/Designer, vegetative or approved liquid tackifier may be used instead of netting.
 3. To protect sprigged areas against hot, dry weather or drying winds, apply **compost** (3/8 inch screen, minus) within 24 hours of sprigging as an alternative to straw mulching. Moisturize before or after spreading uniformly to a depth of 1/4 to 1/2 inch thick (34 to 67 cubic yards per acre) and roll to a smooth surface. **(The Landscape Architect/ Designer shall specify application rate depending upon soil conditions and quality, plant tolerances, and manufacturer's recommendations).**
- F. Rolling: Immediately after completion of the mulching, the entire sprigged and mulched area shall be rolled thoroughly with the equipment specified. At least 2 trips over the entire area will be required.
- G. Watering: The areas on which the sod or sprigs have been placed shall contain sufficient moisture, as determined by the Landscape Architect/Designer, for optimum results. After being placed, the sod or sprigs shall be kept in a moist condition to the full depth of the rooting zone for at least 2 weeks. Thereafter, the contractor shall apply water as needed until the sod or sprig roots start to grow for a minimum of (specify length of time) days or until final acceptance, whichever is latest.
- H. Maintenance:
1. The contractor shall, at their expense, maintain the sodded or sprigged areas in a satisfactory condition until final acceptance of the project. Such maintenance shall include repairing of any damaged areas and replacing areas in which the establishment of the grass stand does not appear to be developing satisfactorily.

2. Replanting or repair necessary due to the contractor's negligence, carelessness, or failure to provide routine maintenance shall be at the contractor's expense.
Replanting necessary due to factors determined to be beyond the control of the contractor shall be paid for under the appropriate contract pay items.

TREES, SHRUBS, AND GROUND COVERS

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. The work included in this Section consists of furnishing, planting, watering, fertilizing, mulching, care, and replacement of all plants of the species, size, and quality in the locations indicated on the Drawings or as directed by the Landscape Architect/Designer.

1.02 SUBMITTALS

- A. Prior to starting work, the nurseryman or landscaper shall provide a list of 3 planting projects completed in the past 2 years with names and location of projects, owner and owner's representative in charge of project, and name and phone number of design professional (i.e., Landscape Architect/Designer or Architect). This information must prove that the nurseryman or landscaper is satisfactorily qualified to provide the services to complete this project.
- B. The nurseryman or landscaper shall provide evidence of the on-site planting foreman's experience. Should there be a change of foremen, additional evidence of experience shall be provided.
- C. Maintenance Instructions: Full and complete written instructions for maintenance of the plantings shall be furnished by the Contractor to the Landscape Architect/Designer at least 10 days prior to the final inspection date in order to familiarize him/her with the maintenance requirements for proper care and development of the plant material.
- D. Record Drawings: The Contractor shall also furnish 1 set of record drawings, clearly showing all changes made during the progress of the work to the original contract drawings.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Transportation and Inspection: Plant transportation shall comply with all Federal and State regulations therefore and, upon deliver at the site, all plants shall be inspected

for conformity to Specifications and for handling damage. Rejected plants shall be immediately removed from the site by the Contractor.

- B. Balled and Burlapped: The root ball of these plants shall be properly protected until they are planted. The plant shall be handled and delivered with roots adequately protected against drying out by means of moist straw, mulch, **compost**, or other approved material. Shipping containers shall be opened and plants inspected by the Contractor upon arrival and shall be dampened if necessary. Plants that are not to be immediately planted shall be stored and protected, in an approved manner, in moist soil, peat, **compost**, or other suitable medium, and shall be properly cared for until planting.

1.04 GUARANTEE

- A. The Contractor shall guarantee all planting work for a period of 1 year after the date of provisional acceptance, during which period the Contractor shall continue maintenance of the plants.
- B. During the guarantee period, the Contractor shall replace at no cost to the Owner any plant required under the Contract that dies or is not established 1 year after planting if the causes for such defects are traced to negligence or poor workmanship by the Contractor. Any plants missing or defective due to Contractor's negligence shall be furnished or replaced in a manner satisfactory to the Landscape Architect/Designer. In case of any doubt as to the condition and satisfactory establishment of a plant, the Landscape Architect/Designer may allow such a plant to remain through another establishment (150 days) period at which time the plant in question, if found to be dead, in an unhealthy or badly impaired condition, shall be replaced by the Contractor at no cost to the Owner.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. General:
 - 1. Plants Required: All plants shall conform to standards developed by the American Nurseryman's Association and be representative of the specified plant species.

The Contractor shall furnish all plants, trees, and shrubs of the species and in the quantities shown on the Drawings and listed in the Proposal.

2. Nomenclature: All trees, shrubs, and plants shall be true to name as established by the America Joint Committee on Horticultural Nomenclature publication "Standard Plant Names." The designated authority for the identification of all material shall be the two publications of L. H. Bailey, "Hortus II" and "Manual of Cultivated Plants", and all specimens shall be true to type, name, etc., as described therein.
3. Grade Standards and Quality: All plants shall be nursery grown and shall comply with all required inspection, grading standards, and plant regulations as set forth by the **(specify name of State)** Department of Agriculture. Comply with standards in "American Standard for Nursery Stock," ANSI Z60.1 (latest edition).
 - a. The minimum grade for all trees and shrubs shall be **(specify acceptable grade)** unless otherwise indicated and all plants shall be sound, healthy, and vigorous, well branched and densely foliated when in leaf. They shall have healthy, well developed root systems and shall be free of disease and insect pests, eggs, or larvae.
 - b. All plants shall conform to the measurements specified or indicated on the drawing. Plants larger than specified may be used if approved by the Landscape Architect/Designer, but use of such plants shall not increase the contract price. The spread of roots or ball of earth for larger plants shall be increased in proportion to the size of the plant.
 - c. Each major tree or specimen plant shall be tagged with sealing tag at the nursery site after visual approval of both Landscape Architect/Designer and nurseryman or landscaper. Plants shall be tagged soon after contract is signed, not longer than 90 days; at the sizes which will be contract size within the completion time of the Contract. All other material of landscape size will be tagged by Contractor after 3 sample plants have been approved at the nursery

site to show typical range of acceptance. Contractor shall insure that purchased materials receive proper and normal maintenance by grower during growing period.

B. Plant Materials: With reference to method of cultivation, root system, etc., plants for landscaping shall be classified under the following designations:

1. Balled and Burlapped:

- a. Plants so classified shall be dug with firm natural root balls of earth, or sufficient diameter and depth to include most of the fibrous roots. The root ball of these plants shall be properly wrapped with burlap and remain protected and moist until they are planted. The plant shall be handled only by the earth ball and not by the plant itself. All balled and burlapped plants which cannot be planted immediately upon delivery shall be set on the ground and shall be well protected with moist soil, mulch, peat, **compost**, or other acceptable material. The plants shall be set with the burlap cover intact and with the burlap showing, until inspection. At final inspection the burlap may be cut away to ground level and then completely covered with soil.
- b. As a specific requirement, balled and burlapped materials, 1 1/2 inches or more in caliper, shall be root pruned at least 45 days before being dug and such fact shall be certified on accompanying invoices. Where, in the opinion of the Landscape Architect/Designer following his inspection of the nurserymen's stock, adequate root pruning is being obtained by the nurserymen's general cultivating practices, he may consider such fact as meeting this requirement.

2. Wired, Balled, and Burlapped: Plants grown in soil of a loose texture which does not readily adhere to the root system shall have wire meshing or a basket of adequate strength placed around the burlapped ball upon removal from the excavation. The wire meshing or basket shall be secured around the burlapped ball with enough tension to prevent loosening of the soil around the roots during handling. No synthetic or rot-proof burlap shall be used in conjunction with wire baskets.

Wired, balled, and burlapped plants shall otherwise comply with the requirements for balled and burlapped plants described in Subparagraph B.1. above.

3. Container Grown Plants:

- a. Container grown plants shall have been grown in a container large enough and for sufficient time for the root system to have developed well to hold its soil together firm and whole. No plants shall be loose in the container. Plants that have become pot bound or which possess top growth too large for the size of the container, will not be acceptable.
- b. All containers shall be cut and opened fully, in a manner such as will not damage the root system. Container grown plants shall not be removed from the container until immediately before planting, when all due care shall be taken to prevent damage to the root system.
- c. All rootballs shall be slashed from top to bottom approximately 1 inch deep in at least 4 locations around the rootball before planting.

4. Bare Root Plants:

- a. No bare root plants shall be used unless specifically required by the Landscape Architect/Designer.
- b. Plants designated as bare-root shall have a root spread of at 1/3 greater than the equivalent balled and burlapped plant. The root system shall be well spread, fibrous, and typical of a healthy specimen of the species. These plants shall be dug and delivered with roots adequately protected against drying out by means of moist peat, **compost**, straw, or other approved material. Shipping containers shall be opened and plants inspected by the Contractor upon arrival and shall be moistened if necessary. Plants that are not to be immediately planted shall be stored and protected, in an approved manner, in moist **compost**, soil, or other suitable medium, and shall be properly cared for until

planting. Only **compost** possessing a soluble salt content of 2.5 dS (mmhos/cm) or less may be used as a storage medium.

- c. Deciduous bare root plants shall be handled only when in a dormant or stripped condition and any evidence of fresh growth shall be cause for rejection.

5. Palms:

- a. All plants of the palm species shall have the roots adequately wrapped before transporting except when they are container grown. Burlapping will not be required if the palm is carefully dug from marl or heavy soil that adheres to the roots and retains its shape without crumbling. During transporting and after arrival, root balls of palms shall be carefully protected from wind and exposure to the sun. After delivery to the job site, if the palm is not planted within 24 hours, the root ball shall be covered with moist **compost**, soil, or other approved material.

6. Ground Covers:

- a. Provide ground cover of species and variety shown or listed, established and well rooted in their container and acclimated to outdoor conditions before deliver.

7. Annuals:

- a. Provide healthy, disease-free plants of species and variety shown or listed. Provide only plants that are well rooted in their container and acclimated to outdoor conditions before delivery and that are in bud, not yet in bloom.

8. Perennials:

- a. Provide healthy, field-grown plants from a commercial nursery, of species and variety shown or listed. All containerized perennials shall be well rooted in their container. **(Specify additional crop specific requirements as necessary).**

9. Vines:

- a. Provide healthy vines of species and variety shown or listed. Both field-grown vines and vines grown and well rooted in containers of adequate size, and acclimated to outside conditions are acceptable.

C. Planting Materials:

1. Planting Soil for Tree and Shrub Backfill:

- a. Where native soil at the planting site is free of objectionable foreign matter, stone, and weeds, planting soil for backfill may be manufactured by uniformly blending the soil excavated from the planting hole with **compost**. The blend shall consist of 1 part **compost** to 2 parts soil by volume.
- b. Planting soil may be reused surface soil stockpiled on the site that is friable in nature, possessing a pH of 5.0 to 7.5 and containing at least 8% organic matter. It shall be reasonably free of weeds, subsoil, stones, earth, clods, sticks, roots, or other objectionable extraneous matter or debris. Where stockpiled soil does not meet the minimum organic matter requirements, **compost** may be used to raise its content to acceptable levels.
- c. Natural or manufactured/blended soil may be imported for use as planting soil where it possesses a pH of 5.0 to 7.5, contains at least 8% organic matter, and contains no materials toxic to plant growth. It shall be reasonably free of weeds, subsoil, stones, earth, clods, sticks, roots, or other objectionable extraneous matter or debris. No topsoils obtained by stripping agricultural land, bogs, or marshes shall be imported. Only soil obtained or displaced through construction or mining activities may be used. Where stockpiled soil does not meet the minimum organic matter requirements, **compost** may be used to raise its content to acceptable levels.

2. Planting Bed Soil:

- a. Where native soil at the planting site is free of objectionable extraneous matter and weeds, planting bed soil may be manufactured by uniformly incorporating **compost** into the native soil to a depth of 6 to 8 inches. The blend shall consist of 1 part **compost** to 2 to 4 parts soil by volume (3 to 6 cubic yards per 1,000 cubic feet). (**The Landscape Architect/Designer shall specify planting bed soil blend ratio**).
- b. Planting soil may be reused surface soil stockpiled on the site that is friable in nature, possessing a pH of 5.0 to 7.5 and containing at least 8% organic matter. It shall be reasonably free of weeds, subsoil, stones, earth, clods, sticks, roots, or other objectionable extraneous matter or debris. Where stockpiled soil does not meet the minimum organic matter requirements, **compost** may be used to raise its content to acceptable levels.
- c. Natural or manufactured/blended soil may be imported for use as planting bed soil where it possesses a pH of 5.0 to 7.5, contains at least 8% organic matter, and contains no materials toxic to plant growth. It shall be reasonably free of weeds, subsoil, stones, earth, clods, sticks, roots, or other objectionable extraneous matter or debris. No topsoils obtained by stripping agricultural land, bogs, or marshes shall be imported. Only soil obtained or displaced through construction or mining activities may be used. Where stockpiled soil does not meet the minimum organic matter requirements, **compost** may be used to raise its content to acceptable levels.

3. Soil Amendments:

- a. **Compost:** Provide well decomposed, stable, weed free organic matter source derived from agricultural, food, or industrial residuals; biosolids (treated sewage sludge); yard trimmings; or source-separated or mixed solid waste. One hundred percent of the product shall pass through a 1 inch screen and shall possess a pH of 5.5 to 8.0 and moisture content of 35% to 55% by weight. It shall contain no substances toxic to plants and 1% or less by weight man-made foreign matter. The **compost** will possess no objectionable odors and shall not resemble the raw material from which it was derived. A

compost sample shall be submitted to the Landscape Architect/Designer for approval prior to being used. **(The Landscape Architect/Designer may modify compost specifications as deemed necessary.)**

- b. **Compost:** For acid tolerant trees and shrubs, provide only **compost** that has not received the addition of liming agents or ash by-products. The **compost** shall meet all other requirements described in Section 2.01 C 3 a.
 - c. **Peat:** Peat shall be a naturally occurring carbonaceous organic matter that has undergone partial decomposition in water. It is generally derived from grasses, sedges, rushes, and mosses, and is high in cellulose and low in lignins or woody material. It is often referred to as peat humus.
4. Fertilizer:
- a. Commercial fertilizers shall comply with the State fertilizer laws.
 - b. The numerical designations for fertilizer indicate the minimum percentages respectively of (1) total nitrogen, (2) available phosphoric acid, and (3) water soluble potash contained in the fertilizer.
 - c. The chemical designation of the fertilizer shall be **(specify acceptable formulation e.g. 12-8-8)**. **Compost** use will reduce initial fertilization requirements by the amount of available nutrients in the **compost**. Obtain macro and micro nutrient content information from suppliers.
5. Mulch:
- a. **Organic Mulch:** Provide clean mulch, free from deleterious materials and suitable as a topdressing for trees, shrubs, plants, and ground covers. Organic mulches may consist of **compost**, shredded hardwood, ground or shredded bark, pine straw, wood and bark chips, pine needles/straw, cocoa-bean shells, and other materials approved by the Landscape Architect/Designer. Submit sample for prior approval by Landscape Architect/Designer. **(Modify list of acceptable products and add appropriate product specifications).**

- i. **Compost:** Provide well decomposed, stable, weed free organic matter source derived from agricultural, food, or industrial residuals; biosolids (treated sewage sludge); yard trimmings; or source-separated or mixed solid waste. The particle size of the product may vary and shall possess a pH of 5.5 to 8.0 and moisture content of 35% to 55% by weight. It shall contain no substances toxic to plants and 1% or less by weight man-made foreign matter. The **compost** will possess no objectionable odors and shall not resemble the raw material from which it was derived. A compost sample shall be submitted to the Landscape Architect/Designer for approval prior to being used. **(The Landscape Architect/Designer may modify compost specifications as deemed necessary.)**
 - ii. **Compost:** For acid tolerant trees and shrubs, provide only **compost** that has not received the addition of liming agents or ash by-products. The **compost** shall meet all other requirements described in 2.01 C5a(i).
 - b. Mineral Mulch: Provide stone, rock, or gravel product washed free of loam, sand, clay, and other foreign substances, meeting specified size range and color. **(Provide list of acceptable products and specifications)**. Submit sample for prior approval by Landscape Architect/Designer.
6. Water for Planting: The water used in the planting operation may be obtained from any approved spring, pond, lake, stream, or municipal water system. The water shall be free of excess and harmful chemicals, acids, alkalies, or any substance that might be harmful to plant growth. Salt water shall not be used.
 7. Wrapping Material: Wrapping material shall be first quality, heavy, waterproof crepe paper, or other approved material manufactured for this purpose.
 8. Wire: Wire for the bracing and guying shall be pliable No. 12 or 14 gauge galvanized soft steel wire.
 9. Cable and Fittings: Cable shall be 3/16 inches in diameter, 7 strand, cadmium plated. Cable clamps and turnbuckles shall be of galvanized steel of size and gauge to

provide tensile strength equal to that of the cable. Turnbuckle opening shall be a minimum of 3 inches.

10. Stakes and Ties: Stakes and tree ties shall be provided in accordance with the requirements of Paragraph 3.02.D.3 hereinafter.

2.02 EQUIPMENT

- A. Fertilizer Spreader: The device for spreading fertilizer shall be capable of uniformly distributing the material at the specified rate.
- B. Soil Amendment Spreader: The soil amendment spreader shall be any approved mechanical device capable of uniformly spreading a soil amendment, including bulldozers, manure spreaders, grading blades, rakes, and pneumatic blowers.
- C. Tillage Equipment: The equipment utilized to incorporate the soil amendment into the soil surface must be approved and have the ability to incorporate to a depth of 6 inches. Tillage equipment may include rotary tillers, rotovators, and disc harrows.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Underground Obstructions:
 - 1. Upon request from the Contractor, the Owner shall provide plans showing locations of underground utilities and/or will assist the Contractor in securing underground locations from other public utility companies, such as telephone, electricity, etc.
 - 2. In the event that rock, underground construction work, utility lines, or obstructions out of the ordinary are encountered in any plant pit excavation, alternative locations shall be selected by the Landscape Architect/Designer. Where locations cannot be changed and the obstructions may be removed, the obstructions shall be removed to a depth of not less than 3 feet below grade and no less than 6 inches below bottom of balls or roots when plant is properly set at the required grade.

3. To assure adequate drainage, a standard percolation test should be performed on the planting site prior to further site preparation.

B. Excavation of Planting Beds and/or Plant Holes:

1. Soil Analysis: Before any soil preparation procedures ensue, a soil analysis shall be completed by a reputable laboratory to determine any nutritional requirements, pH and organic matter adjustments necessary. Once determined, the soil shall be appropriately amended to a range suitable for the all plant species to be established.
2. In heavily compacted soils, subsoiling to a minimum depth of 12 inches is recommended. Subsoil in 2 directions, at right angles, to create a checker-board appearance on the ground. Subsoiling may be done after the application of soil amendments.
3. Where excavation encounters soils which are unsuitable for plant growth, existing soils will be upgraded with soil amendments or unsuitable soil shall be removed and replaced with approved backfill or planting bed soil at the direction of the Landscape Architect/Designer.
4. The plant hole shall be roughly cylindrical in shape, with the sides approximately vertical. Plants shall be centered in the hole, with the trunk locations as shown in the Drawings. The planting hole shall be slightly shallower than the root ball and 2 to 3 times as wide. Holes for bare root plants shall be at least 6 inches larger than the maximum root spread.
5. The planting bed area shall be prepared by mechanically tilling and thoroughly pulverizing the soil to a depth of 6 to 8 inches. The prepared soil shall be loose and smooth. It shall be reasonably free of large clods, roots, and stones greater than 2 inches in size, and any other material that will interfere with planting. Hand picking may be required.

3.02 APPLICATION

A. General:

1. Weather Limitations: Planting shall be done only when the soil is moist and in proper condition to induce growth. No planting shall be done when the ground is unduly wet, or otherwise not in a tillable condition.
2. Sequence of Operations: The several operations involved in the work shall proceed in the following sequence: Preparation, amending and fertilizing of the site, planting, spreading of mulch, and watering.

B. Amending Planting Beds and/or Plant Holes: The soil amendment (**compost**) shall be applied to the planting bed area at a rate of 135 to 220 cubic yards per acre (1 to 2 inch layer) or 3 to 6 cubic yards per 1,000 square feet and uniformly incorporated to a 6 to 8 inch depth. To amend plant holes, uniformly blend 1 part soil amendment (**compost**) to 2 parts excavated soil. (**The Landscape Architect/Designer shall specify inclusion rate depending upon soil conditions and quality and manufacturer's recommendations.**)

C. Fertilizing:

1. The fertilizer shall be spread uniformly over the planting area at the rate of (specify rate) pounds per acre or plant. Apply fertilizer by hand or using a spreading device capable of uniformly distributing the material at the specified rate. Where spreading in planting beds, the fertilizer shall be mixed with the soil to a depth of approximately 6 inches. Where fertilizing individual plants, after planting and if necessary, apply fertilizer uniformly around the plant.

D. Planting:

1. Setting of Trees and Shrubs:
 - a. When lowered into the hole, the plant shall rest on the hole bottom such that the top of the rootball slightly above ground level (approximately 10%) and so

oriented such as to present the best appearance. The Contractor, when setting plants in holes, shall make allowances for any anticipated settling of the plants.

- b. When directed in the plans, palms of the sabal species may be set deeper than the depth of their original growth, provided that the specified clear trunk height is attained.
 - c. The backfill shall be made with prepared planting soil as specified hereinbefore and shall be firmly tamped and watered-in, so that no air pockets remain. The quantity of water applied immediately upon planting shall be sufficient to thoroughly moisten all of the backfilled earth. Plants shall be kept in a moistened condition for the duration of the planting period.
2. Planting of Beds:
- a. Excavate planting holes within the prepared planting bed soil large enough to fit the plant rootball/mass. Place the plants into the excavated holes and firm them in place. Plant so the top of the plant rootball/mass is at ground level or slightly above. The Contractor when planting the plants should make allowances for any settling.
 - b. Water in All Plants: The quantity of water applied immediately upon planting shall be sufficient to thoroughly moisten all of the backfilled earth. Plants shall be kept in a moistened condition for the duration of the planting period.
3. Staking and Guying: When called for on the Drawings or directed by the Landscape Architect/Designer, plants shall be staked in accordance with the following provisions:
- a. Small Trees: For trees and shrubs of less than 1 inch caliper, the size of stakes and the method of tying shall be such as to rigidly support the staked plant against damage caused by wind action or other effects. Trees larger than 1 inch and smaller than 2 inch caliper shall be staked with a 2 inch stake, set at

least 24 inches in the ground and extending to the crown of the plant. The plant shall be firmly fastened to the stake with 2 strands of 12 or 14 gauge soft wire, enclosed in rubber hose, or other approved covering. The wire shall be nailed or stapled to the stake to prevent slippage. Proprietary ties must be approved by the Landscape Architect/Designer.

- b. **Medium Trees:** All trees, other than palm trees, larger than 2 inch caliper and smaller than 3 1/2 inch caliper shall be staked with two 2 inch by 4 inch stakes, 8 feet long, set 2 feet in the ground. The tree shall be midway between the stakes and held firmly in place by 2 strands of 12 gauge wire, applied as specified above for single stakes. Tie wires shall be tightened and kept tight by twisting. Proprietary ties must be approved by the Landscape Architect/Designer.
 - c. **Large Trees:** All trees, other than palm trees, larger than 3 1/2 inch caliper, shall be guyed from at least 3 points with double strands of 12 gauge wire. Guy wires shall be anchored to 2 inch by 4 inch stakes, 24 inches long, driven into the ground at least 2 feet and sufficient that the top of the stake is at least 3 inches below the finished ground level. Tie wires shall be securely fastened to the tree by means of a collar of rubber hose, or other approved material. Guy wires shall be tightened and kept tight by twisting.
 - d. **Palm Trees:** Palms shall be braced with three 2 inch by 4 inch wood braces, toenailed to cleats which are securely banded at 2 points to the palm, at a point 1/3 the height of the trunk. The trunk shall be padded with 5 layers of burlap under the cleats. Braces shall be approximately 120 degrees apart and secured underground by 2 inch by 4 inch by 24 inch stake pads.
4. **Pruning:**
- a. All broken or damaged roots, twigs, and branches shall be cut off smoothly.
 - b. Aside from damaged twigs and branches, remove only those that detract from the appearance of the plant.

5. Mulching: Within 1 week after the planting, mulch material shall be uniformly applied to a minimum loose thickness of 2 to 4 inches (**specify rate**), over the entire area of the backfilled hole or planting bed. Avoid placing mulch against the trunk or stem of any plant materials. The mulch shall be maintained continuously in place until the time of final inspection.
6. Watering: The Contractor shall continue watering for as long as it is necessary to properly establish the new plantings. Care shall be taken to prevent staining of new construction where temporary well water is used.

3.03 TRANSPLANTING

A. General: Transplanting shall consist of on site transplanting of existing plant materials from proposed construction areas to a temporary nursery site prior to start of construction and the transplant of this material from the temporary nursery site and other material from undisturbed sites to permanent positions after completion of construction.

1. Phase One: Transplant materials from areas to be disturbed to nursery area. Install overhead irrigation from the Owners water system or from new well. Modify nursery area soil as necessary to assure plant health during storage.
2. Phase Two: Transplant materials from nursery and from undisturbed areas of site to their permanent locations, after building construction is completed. Owner will maintain nursery area during construction period only by watering and grounds maintenance of weeding or mowing. Contractor shall provide for spraying, fertilizing, pruning, and other horticultural practices including regular observation of the nursery area with written notification to Owner's Representative if Owner's maintenance could be improved without altering its scope.

B. Transplanting Operations: The Contractor shall take all precautions to minimize shock of root pruning and transplanting in accordance with nursery trade procedures including the following where time is available.

1. Root prune one third of ball at a time.
2. Leave monocot leaves alone, allowing plant to balance itself. Protect growing point as required.
3. After root pruning, backfill with organic rooting medium, such as the planting soil specified hereinbefore.
4. Mulch to reduce weeds, discourage foot traffic and its compacting effect, conserve moisture and minimize temperature fluctuation.
5. Brace trunk and leave in place until trees are windfirm (minimum of 1 year).
6. Wrap trunks and structural branches of thin-barked trees to protect against sunscald and dehydration. Retain for at least 1 growing season, and through cold season.
7. Fertilize based on plant requirements.

3.04 FIELD QUALITY CONTROL

A. Provisional Inspection:

1. On completion of the work and upon receipt of the written request of the Contractor, the Landscape Architect/Designer shall inspect all planting work for provisional acceptance. The request shall be received from the Contractor at least 3 days before the anticipated date of provisional inspection.
2. The Contractor shall repair or replace all defective work before provisional acceptance of the work.

B. Maintenance:

1. Maintenance shall begin immediately after each plant is planted and shall continue until the completion of the Contract or the provisional acceptance, whichever is latest. Plants shall be watered, mulched, weeded, pruned, sprayed, fertilized,

cultivated, and otherwise maintained and protected for the period of time stated above.

2. Settled plants shall be reset to proper grade position, planting saucer restored, and dead material removed. Guys shall be tightened and repaired.
 3. Defective work shall be corrected as soon as possible after it becomes apparent and weather and season permit. Upon completion of planting, the Contractor shall remove from the site excess soil and debris, and repair any damage to structures, etc., resulting from planting operations.
 4. Pest Control: Set up a good spray program to guard against appropriate plant pests.
- C. Final Inspection: At the end of the guarantee period, inspection of plants will be made by the Landscape Architect/Designer upon written notice requesting such inspection, submitted by the Contractor at least 3 days before the anticipated inspection. All defects discovered shall be repaired or replaced by the Contractor before final acceptance.

3.05 ADJUSTMENT AND CLEANING

- A. Cleaning up the Site: Upon completion of any landscape project, the Contractor must thoroughly clean up the project site. In addition to removing all equipment, unused materials, deleterious material, and surplus excavated material, the Contractor shall fine grade all disturbed areas and the areas adjacent to the new planting to provide a neat and uniform site. All damaged or altered existing structures, as a result of the landscape work, shall be corrected.

EROSION AND SEDIMENT CONTROL

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. The work specified in this Section consists of designing, providing, and maintaining erosion and sedimentation controls as necessary. All existing and foreseeable future conditions that affect the work inside and outside the site limits must be acknowledged as the Contractors responsibility.

- B. Erosion and sediment control techniques include, but are not limited to, grassing, mulching with hay/straw or compost, netting/matting, stone, compost berms, silt fences, barriers, diversions, traps, basins, and appurtenances at the foot of slope surface which will ensure that erosion and sediment pollution will be either eliminated or maintained within acceptable limits as established by the Owner.

- C. Contractor is responsible for providing effective erosion and sediment control measures. Contractor may, with approval from the Landscape Architect/Designer, work outside the construction limits to establish a working erosion control system.

1.02 RELATED WORK DESCRIBED ELSEWHERE

- A. Federal, State, County, and Local erosion and sediment control regulations.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Seed: Grass seed shall be a mixture of **(specify grass species and/or blend ratio)**. Seed which has become wet shall not be used. All seed shall meet the requirements of the **(specify name of state)** Department of Agriculture and all applicable state laws, and shall be approved by the Landscape Architect/Designer before being sown.

- B. Netting/Matting: - **(specify acceptable products)**

C. Soil Mulch:

1. Hay/Straw: The mulch material used shall be air dry, clean, non-mildewed and seed free salt hay or straw, consisting of oat, rye, or wheat straw, or of timothy, rye, fescue, bluegrass, pangola, peanut, coastal Bermuda or Bahia grass hay. Only undeteriorated mulch that can be readily cut into the soil or uniformly distributed over the soil shall be used.

2. Compost:

a. Where planning to delay seeding or planting, use decomposed, weed free organic matter source derived from yard trimmings or wood/bark. Well decomposed, stable biosolids compost (treated sewage sludge) may also be used. The product particle size may vary widely, and it shall possess a pH of 5.5 to 8.0 and moisture content of 35% to 55%. A compost sample shall be submitted to the Landscape Architect/Designer for approval prior to being used. **(The Landscape Architect/Designer may modify compost specifications as deemed necessary.)**

b. Where planning immediate seeding or planting, use well decomposed, stable, weed free organic matter source. It shall be derived from biosolids (treated sewage sludge); yard trimmings, or wood/bark. The product particle size may vary widely, and it shall possess a pH of 5.5 to 8.0 and moisture content of 35% to 55% by weight. It shall contain no substances toxic to plants, shall possess no objectionable odors, and shall not resemble the raw material from which it was derived. A compost sample shall be submitted to the Landscape Architect/Designer for approval prior to being used. **(The Landscape Architect/Designer may modify compost specifications as deemed necessary.)**

3. Hydroseeding Mulch and Tackifier:

a. Virgin wood fiber mulch and tackifier - **(specify acceptable products or product specifications)**

- b. Recycled cellulose fiber mulch and tackifier - **(specify acceptable products or product specifications)**
- c. Hay/Straw mulch tackifier - **(specify acceptable products or product specifications)**
- D. Filter Berm Compost: Approved compost shall be decomposed, weed free organic matter source. It shall be derived from yard trimmings or wood/bark. Well decomposed, stable biosolids compost (treated sewage sludge) may also be used. The product particle size may vary widely, and it shall possess a pH of 5.5 to 8.0 and moisture content of 35% to 55%. A compost sample shall be submitted to the Landscape Architect/Designer for approval prior to being used.
- E. Silt Fence: The silt fence shall be a synthetic fabric containing ultraviolet ray inhibitors which is certified by the manufacturer or supplier as conforming to applicable state regulations.
- F. Filter stone - crushed stone conformed to **(specify state)** Department of Transportation specifications.
- G. Concrete block - hollow, non-load bearing type.
- H. Concrete - exterior grade not less than 1 inch thick.

2.02 EQUIPMENT

- A. Seed Spreader: The seed spreader shall be an approved mechanical or hand spreader or other approved type of spreader.
- B. Hydraulic Mulcher: The mulch shall be mixed in standard hydraulic equipment to form a homogeneous slurry. The equipment shall be capable of spraying the slurry, under pressure, uniformly over the soil surface at the material application rate indicated. A continuous agitation system that keeps all materials in uniform suspension throughout the mixing and distribution cycles is required.

- C. Hay/Straw Blower: The hay/straw blower shall be an approved unit capable of blowing the hay/straw mulch under pressure uniformly over the soil surface at the material application rate indicated.
- D. Compost Spreader: The compost spreader shall be any approved mechanical device capable of uniformly applying the compost at the specified rate, including bulldozers, manure spreaders, grading blades, pneumatic blowers, and rakes.

PART 3 - EXECUTION

3.01 EROSION AND SEDIMENT CONTROL

A. Seeding and Mulching:

1. Scarify slopes to a depth of **(specify depth)** and remove large clods, rocks, stumps, roots larger than 1/2 inch in diameter and debris on slopes where vegetation is to be established. This soil preparation step may be eliminated where approved by the Landscape Architect/Designer or where seeding or planting is not planned.
2. Apply seed within 24 hours after the ground is scarified with either mechanical seed drills, rotary hand seeders, or hydraulically (hydroseeding).
3. Apply straw mulch at a rate of 1 to 2 tons per acre (approximately 1 1/2 inch layer) over the seeded area.
4. Apply netting over mulched areas on sloped surfaces, or where approved by the Landscape Architect/Designer, vegetative or approved liquid tackifiers may be used instead of netting.
5. Roll seeded areas where practicable and water in a manner which will encourage sprouting of seeds and growing of grass or other crop. Reseed areas that exhibit unsatisfactory growth. Backfill and seed eroded areas.

B. Soil Mulching (slopes of up to 2:1 in steepness):

1. Scarify slopes to a depth of **(specify depth)** and remove large clods, rocks, stumps, roots larger than 1/2 inch in diameter and debris on slopes where vegetation is to be established. This soil preparation step may be eliminated where approved by the Landscape Architect/Designer or where seeding or planting isn't planned. Track (compact) slope using a bulldozer before applying compost. **(This step may be eliminated where impractical or where deemed unnecessary by the Landscape Architect/Designer.)**
2. Apply compost at a rate of 400 to 535 cubic yards per acre (3 to 4 inch layer). In areas of low precipitation, compost application rates of 270 cubic yards per acre (two inch layer) may be used if approved by the Landscape Architect/Designer. **(The Landscape Architect/Designer shall specify the compost application rate depending upon soil conditions and quality, plant tolerances, and manufacturer's recommendations.)**
3. Compost shall be uniformly applied using an approved spreader unit. Track (compact) the compost layer using a bulldozer or other appropriate equipment. **(This step may be eliminated where impractical or where deemed unnecessary by the Landscape Architect/Designer.)** Alternatively, apply compost using a pneumatic (blower) unit, and water thoroughly. Project compost directly at soil surface, thereby preventing water from moving between the soil-compost interface. Apply compost layer approximately 3 feet over the top of the slope or overlap it into existing vegetation.
4. On highly unstable soils, use compost in conjunction with appropriate structural measures.
5. Applying seed before final tracking is preferred where dry seeding is specified by Landscape Architect/Designer. Hydraulic seeding may be completed after tracking is completed.

C. Netting and Matting:

1. Approved netting, biodegradable and synthetic matting, and erosion control blankets shall be installed and stapled according to manufacturers recommendations.

D. Filter Berms:

1. Parallel to the base of the slope or other affected areas, construct a 1 1/2 to 2 foot high by 3 to 4 foot wide berm of compost. For maximum water filtration ability, construct a 1 1/2 to 2 foot high trapezoidal berm that is 3 foot wide at the top and 4 foot wide at the base. In extreme conditions, a second berm shall be constructed at the top of the slope or silt fencing shall be installed in conjunction with the compost berm. **(The Landscape Architect/Designer shall specify berm and silt fencing requirements.)**
2. If used, the silt fence fabric shall be laid on the soil surface with the lip facing the slope. The compost berm shall be constructed at the base of the sediment fence (downhill side) and over the fence fabric lip. **(The Landscape Architect/Designer shall specify silt fencing requirements.)**
3. Where the berm deteriorates, it shall be reconstructed.
4. Do not use filter berms in any runoff channels.

E. Silt Fence:

1. Construct the silt fence from approved materials and ensure that its height does not exceed 18 inches above the ground surface.
2. Construct the silt fence from a continuous roll of filter fabric cut to the appropriate length to avoid joints. When joints are necessary, securely fasten the fabric at a support post.
3. Support standard strength filter fabric with wire mesh. Securely fasten the wire mesh to the upslope side of the support posts using wire staples or tie wires. Extend the wire mesh support to the bottom of the trench.

4. Support posts should be spaced a maximum of 8 feet apart when a wire mesh support fence is used. Support posts should be driven securely into the ground to a minimum of 18 inches.
5. Silt fences with extra strength filter fabric and 6 foot post spacing does not require wire mesh support fence. Staple or wire the filter fabric directly to posts.
6. Excavate a trench approximately 4 inches wide and 8 inches deep along the proposed line of posts.
7. Backfill the trench with compacted soil or gravel placed over the filter fabric.
8. Do not attach filter fabric to existing trees.

F. Other Structures:

1. Install and maintain silt dams, traps, barriers, and appurtenances as recommended by the manufacturer. Control systems that deteriorate and filter stone which is dislodged shall be replaced.

3.03 PERFORMANCE

- A. Denuded areas are to be covered as soon as possible with a soil mulch (such as straw, compost, synthetic fiber) and temporary or permanent vegetation established. The method selected shall be initially at the Landscape Architect's/Designer's or Owner's option.
- B. Areas to be developed (3 acres or greater) will require temporary sediment basins used as a positive remedy against downstream siltation. During development, permanent storm water management (detention) ponds may be used in place of temporary sediment basins. Prior to final inspection, accumulated silt and debris shall be removed from the storm water management ponds and pipe outlets.
- C. Floating in stream and land staked silt barriers will be anchored in place to protect against accumulation of silt and sediment upstream and downstream from the work. The silt

barriers will be placed so as to effectively control silt and sediment dispersion under the conditions present on this project. Filter berms and/or silt fences, hay/straw bales, or concrete blocks will be installed where necessary within the limits of the disturbed earth limits or can be installed around catch basins, drop inlet opening, or culvert inlets.

- D. All swales, ditches, channels, retention ponds, and detention areas will be stone armored, sodded, or seeded as required as soon as possible.
- E. Methods used to control erosion and sedimentation will comply with applicable Federal, State, and Local regulations.
- F. Should any of the temporary erosion and sediment control measures employed by the Contractor fail to produce results which comply with the requirements of the State of (specify state), the Owner or Landscape Architect/Designer; the Contractor shall **immediately take whatever steps are necessary to correct the deficiency at their own expense.**

3.04 DUST CONTROL

- A. Execute work by methods to minimize raising dust from construction operations.
Provide positive means to prevent airborne dust from disbursing into atmosphere and surface waters.

LITERATURE CITED/REFERENCES

A bibliography of research articles/papers used to develop the thirteen (13) compost use guidelines is not enclosed in this booklet. However, a full bibliography for each of the guidelines can be found in "Suggested Compost Parameters & Compost Use Guidelines," published by The Composting Council, Alexandria, Virginia.

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APPENDIX 1

Part 503 Sewage Sludge (Biosolids) Regulations Summary of Limits for Land Application

Part 503 Sewage Sludge (Biosolids) Regulations Summary of Limits for Land Application^a

Pollutant	1. Ceiling Concentration (mg/kg)^b	2. Cumulative Pollutant Loading Rate (kg/ha)^b	3. Pollutant Concentration (mg/kg) "Exceptional Quality"	4. Annual Pollutant Loading Rates (kg/ha/365-day period)
Arsenic	75	41	41	2
Cadmium	85	39	39	1.9
Copper	4,300	1,500	1,500	75
Lead	840	300	300	15
Mercury	57	17	17	0.85
Molybdenum ^c	75	--	--	--
Nickel	420	420	420	21
Selenium	100	100	100	5
Zinc	7,500	2,800	2,800	140
Applies To	All biosolids that are land applied	Bulk biosolids and bagged biosolids ^d	Bulk biosolids	Bagged biosolids ^d

Definitions:

1. Ceiling Concentration - the maximum content of heavy metals allowed if the product is to be sold, given away, or otherwise land applied. If any one value is surpassed, then the product cannot be land applied.
2. Cumulative Pollutant Loading Rate - the *maximum* lifetime loading limit of heavy metals permissible in the soil on a given site.
3. Pollutant Concentrations - the maximum allowable heavy metal content for a compost to be called an "Exceptional Quality" product. Exceptional Quality products may be used in any application, including food crops, as far as the US EPA is concerned. Some states, however, do not allow the use of biosolids compost on edible crops.
4. Annual Pollutant Loading Rates - maximum *annual* loading limit of heavy metals permissible on a given site.

a) Table 2-4 Pollutant Limits from A Plain English Guide to the EPA Part 503 Biosolids Rule

b) Dry-weight basis

c) As a result of the February 25, 1994, Amendment to the rule, the limits for molybdenum were deleted from the Part 503 rule pending EPA reconsideration.

d) Bagged biosolids are sold or given away in a bag or other container.

APPENDIX 2

Related Publications

To obtain additional copies of this document, or other quality compost related documents, contact:

The Composting Council
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CWC
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Other Related Publications Include	
Prices available to members of the Council are listed first, followed by non-member prices.	
Publication	Price*
Suggested Compost Parameters and Compost Use Guidelines	\$10/\$20
Compost Information Kit	\$8/\$12
Potential U.S. Applications for Compost	\$25/\$30
Uses and Benefits of MSW Compost: A Literature Review	\$10/\$20
Parts of 40 CFR Part 503 That May Affect Composting	\$2/\$5
Compost Standards	\$2/\$5
Safety Margins in Compost Standards	\$2/\$5
It's Nature's Way (video)	\$7/\$12
Mixed Municipal Solid Waste Composting in the U.S. (video)	\$7/\$12
Field Guide to Compost Use	\$7/\$13
Farmer's Field Guide to Compost Production & Use	\$3/\$5
Compost Facility Planning Guide	\$10/\$20
Compost Facility Operating Guide	\$75/\$125
National Backyard Composting Training Materials	<i>(call)</i>
<i>CWC Publications:</i>	One Price Only
On-Farm Composting Manual and Video (CM-97-3)	\$25
Video only (CM-97-3V)	\$10
Will Composting Work for Us? A Decision Guide (CM-97-6)	\$25
Evaluation of Composting Gypsum Wallboard (CDL-97-4)	\$25
Composting Produce Waste & Wax Coated Cardboard (CM-93-5)	\$25

* *price subject to change without notice.*

APPENDIX 3

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DISCLAIMER

Data outlined in the *Landscape Architecture/Design Specifications for Compost Use* describes processes used successfully by end users and demonstrated effective through research in specific situations and with specific compost products. Data was developed to provide general assistance relative to the use of compost, and the guide should not be considered as formal recommendations for any specific product or project. It should be understood that all compost products, climactic conditions, crop requirements, and field situations are different and may require specific recommendations from experts familiar with those specific field conditions, crops, or compost products. Consultation should be supplied by compost producers and their technical staff and may also be obtained from agricultural institutions and the Cooperative Extension Service of the USDA.

Although the compost application rates outlined within this package have been used successfully with specific products and in particular situations, specific application rates for your field conditions and compost feedstock should be provided by the compost producer or local experts. Since compost application rates and successful usage are based on specific soil characteristics and compost quality, obtaining characterization data pertaining to the compost and soil is helpful, and in many cases, necessary. Performing a soil test is strongly suggested. It should also be understood that although suggested application rates are found within each guideline, states may possess specific regulations regarding compost utilization. These regulations should be consulted to identify the maximum allowable application rates in your state or specific situation, or allowable for specific crops. Maximum compost application rates are based on the treated crops annual available nitrogen requirement, as well as soil loading limits and compost content of specific contaminants. Compost suppliers should also be able to provide relevant data on these issues.

It is recommended that when using compost for the first time in a specific application, or when using a specific type or source of compost for the first time, that it be tested on a small scale. It should be understood that the compost use guidelines are evolutionary documents, based on current research and experience and will be upgraded as additional relevant research is completed or field experience is obtained.

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