Novozymes North America, Inc.
Operation & Maintenance Manual
June 2009

Prepared by:
Frank Franciosi
Composting Department Manager
Novozymes North America, Inc.

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Rethink Tomorrow

Novozymes North America, Inc.
PO Box 576
Franklinton, NC 27525-0576
Permit #35-04

Michael Scott
NCDENR
Division of Waste Management
Solid Waste Section
1646 Mail Service Center
Raleigh, NC 27699-1646

Received
JUN 2009
Waste Management

6/11/2009

Dear Michael,

As per NCDENR-DWM composting permit renewal process we have enclosed two (2) copies of the 2009 Operations & Maintenance Manual for our "Large Type 3 Solid Waste Composting Permit". This is a revision of our original manual submitted in November of 2004. If you have any questions or concerns regarding this manual or need additional information regarding our permit renewal, please contact me.

Sincerely,

Frank Franciosi
Composting Dept. Manager
Novozymes North America, Inc.

Enclosure (2)

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OPERATIONS AND MAINTENANCE MANUAL FOR COMPOSTING

Novozymes North America, Inc.

Prepared By
Frank Franciosi
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June 11, 2009

TABLE OF CONTENTS

1. DESCRIPTION of FACILITIES

    A. LAND USE
    B. DESIGN CAPACITY
    C. STORMWATER & LEACHATE MANAGEMENT
    D. SIGNS for INSTRUCTION
    E. WASTE COMPOSTED

2. DESCRIPTION of PRODUCTION

    A. EQUIPMENT and PERSONNEL
    B. METHOD USED
    C. PROCESS FLOW of COMPOSTED MATERIALS

3. QUALITY ASSURANCE PLAN

    A. FEEDSTOCKS
    B. DAILY PROCEDURES
    C. WEEKLY PROCEDURES
    D. MONTHLY/BI-MONTHLY PROCEDURES
    E. QUARTERLY PROCEDURES
    F. ANNUAL PROCEDURES
    G. PERIODIC MAINTENANCE PROCEDURES

4. HEALTH & SAFETY

    A. STATEMENT
    B. CONTINGENCY PLANS & EMERGENCY RESPONSE

5. APPENDIX

    A. JOB DESCRIPTIONS
    B. PRODUCT MARKETING & DISTRIBUTION PLAN
    C. NOVOZYMES- ISO 14001 INTERNAL DOCUMENTS
    D. USCC STA TESTING PROGRAM
    E. SOLVITA MATURITY TESTING
    F. APPLICABLE PERMITS & APPROVALS

1. DESCRIPTION of FACILITIES -

A. LAND USE –

The Novozymes-Nature's GREEN-RELEAF composting operation is located at 445 Old Smith Farm Road, on 35 acres off of State Highway 56 in Franklinton, North Carolina. Approximately 2 acres are used as roads and staging facilities. Berms, buffer zones, drainage ditches, and retention ponds take up an additional 3 acres. This leaves the remaining 30 acres for composting operations. The mixing area will utilize approximately 1/2 acre of space. The compost pad area is made up of 3.0 acres. Feedstock storage is estimated to utilized 1.6 acres. An additional 2.0 acres is available for curing, screening, and storage of product inventory. There are 4 acres in the back 30 acres of this parcel designated as an Emergency Storm Debris site.

B. DESIGN CAPACITY -

The site is designed to handle a starting volume of 64,000 cubic yards/yr (41,600 tons/yr) with future expansion to 168,000 cubic yards/yr (110,000 tons/yr) of feedstock materials. The approximate starting volume in production windrows is 6,500 cubic yards (4,225 tons) this could expand to 28,000 cubic yards (16,800 tons) of material. There are 6,500 -14,000 cubic yards (4,225 - 8,400 tons) of compost product curing and 28,000 cubic yards (16,800 tons) in storage as finished product.

Novozymes Composting Facility Design Capacity	
EQUIPMENT	
(2) CAT 924G Front-end Loader	3.25-6.0 cubic yard bucket
(1) CAT 964 Front-end Loader	4.5-9.5 cubic yard bucket
Rotochopper MC-266 Grinder	100 -150 cubic yards/hour
Water Tank Trailer	6000 gallon tank
Knight Reel Augie 3095 Electric Mixer	35 cubic yards
Backhus 16.43 Windrow Turner with Conveyors	3,000 cubic yards/hour
(2) Hoist Lift Trucks	20-40 cubic yard roll offs (13 tons)
Roll-off Containers	20 - 40 cubic yards
McCloskey 561R Trommel Screen	80 -125 cubic yards/hour
GMT Compost Manager Monitoring Program	N/A
SITE CAPACITIES	
Compost Aeration Capacity	5 -15% oxygen/windrow
Active Composting Period	60 days
Curing Composting Period	30 days minimum
Current Annual Volume	64,000 cubic yards (41,600 tons)
Future Annual Volume	168,000 cubic yards (110,000 tons)
Current Storage Capacity Active Windrows	6,500 cubic yards (4,225 tons)
Future Storage Capacity Active Windrows	28,000 cubic yards (16,800 tons)
Storage Capacity Curing Compost	14,000 cubic yards (8,400 tons)
Storage Capacity Finished Compost	28,000 cubic yards (16,800 tons)

C. STORMWATER & LEACHATE MANAGEMENT SYSTEMS-

STORMWATER MANAGEMENT SYSTEM

The production and storage areas are graded to maintain surface water drainage toward the surface drains that lead to the retention ponds. A 12 inch diameter Compost sock has been installed along the lower perimeter of the site to filter out fine particles and silts from entering drainage ditches. Rock check dams and compost inlet socks are installed and maintained within key points of the stormwater drainage ditches on the site to minimize the flow of silts into the stormwater retention pond. These structures are the first stages of treatment in the stormwater management system and are check after each rain event to observe effectiveness of sediment removal. These structures are periodically cleaned out to maintain a positive flow of surface drainage to the stormwater retention pond. Sediment materials collected is incorporated into new windrows. As a Best Management Practice (BMP) windrows are oriented to minimize surface erosion and to avoid water collecting between rows.

The second stage of treatment consists of a dry retention pond whose primary purpose is to restrict the peak discharge of the 1-yr 24 hr storm to levels predicted for pre-development conditions. In addition the retention system removes TSS loading and nitrogen loading from the stormwater as well as providing a system to remove any floatable material from the compost which might find its way into the stormwater system. The retention pond satisfies the requirements of State Stormwater regulations for water supply water sheds, peak discharge from 1 year – 24 hour from pre-development to post construction. The stormwater retention pond

is checked daily to maintain safe levels of operation. This pond is periodically dredged to remove sediment and to maintain capacity. The third stage of treatment within the system is a Level Spreader designed to provide diffuse flow of all storms up to and including the 10yr-24-hr storm. The conveyance channel on the upstream side of the level spreader provides for a portion of the peak discharge reduction. The level Spreader is made of concrete and is 300 feet in length and discharges into a 50' wide grassed buffer with a maximum slope of 8% then into a forested area and finally into an existing ephemeral stream. The level spreader system satisfies the requirements of diffuse flow of Stormwater through buffers, Stormwater BMP's reduce TSS load by 85%, peak discharge form 1 year – 24 hour storm events, and net export of Nitrogen is limited to 10 lbs/acre/year with a buy-down of an additional 4 lbs/acre/year.

The level spreader is inspected after each rain event to assure that it is working properly. The structure and its components are inspected monthly for maintenance. The riparian buffer strip is mowed to maintain a stable vegetative stand of grass. Weep holes in the structure are cleaned out to maintain seepage to the stone apron. Weed control is applied to the stone apron of the level spreader to maintain sheet flow to the riparian buffer.

Specifics of stormwater management and drainage collection and storage systems:

Stormwater Retention Pond:

Retention Pond Volume	9,537 Cu ft
Total Volume of Retention components (Retention pond and conveyances)	12,087 Cu ft
Max outflow to Level Spreader	19.9 cfs
Bottom Elevation	298 ft
Liner	none

Level Spreader:

Storage Volume of Conveyance system	2550 Cu ft
Length	300 ft
Material	Concrete
Elevation	297
Down-slope cover	Grass
Discharge slope	8% (max)

LEACHATE MANAGEMENT SYSTEM

Due to concerns over long term effects of infiltration of leachate water into groundwater a liner system is installed designed to intercept any rainfall infiltrating the surface layer. The leachate ponds are specially built ponds designed to hold and reuse water that leaches through the compost pad area the compost site. They are lined with 60 mil HDPE liner and are located in the southeast corner of the Compost Facility surrounded by chain linked fence. A water reuse tank is located next to the ponds. The main purpose of this tank is to pump the reuse water back into the Compost Facility for operational use and moisture addition. This tank is also fitted to receive fresh spring water.

The leachate ponds have a limited amount of storage and thus have to be monitored and operated in a way to ensure safety of the pond walls as well as the local environment outside of the Compost Facility. Since the ponds do have a limited amount of storage they need to be check frequently for depth levels. This process is done by visual inspection of the depth chain which is located in the first pond. The visual inspection is taken in the morning and the afternoon. The depth chain is measured in feet and inches. Below one foot is consider empty, Seven foot is where the ponds are consider full and run the risk of breaching the pond walls. At the 5 foot level on the depth chain action needs to be

taken in order to bring the pond's levels back down to a safe zone of operation which is at or below four foot.

A valve is located between the two ponds to help control individual levels of the ponds. The levels of the ponds rise and fall due to reuse of the water back into the Compost Facility and by rain fall onto the Compost Facility.

Novozymes stores all leachate water and monitors it for excessive nutrients. In the event that water quality analysis indicates that the water quality is insufficient for reuse as moisture addition, the volume of water in the retention pond is then pumped or hauled to Novozymes existing wastewater treatment system or to a Municipal Waste Water Treatment Plant.

Specifics of leachate management and drainage collection and storage systems:

Leachate Retention Ponds:	
Volume of Retention Pond #1	15,664 Cu ft
Volume of Retention Pond #2	46,992 Cu ft
Liner	60 mil HDPE

D. SIGNS for INSTRUCTION -

Signs are posted to show traffic flow and hours of operation. Included on the main sign is our permit number and non-acceptance of the following wastes:

1. Hazardous wastes.
2. Asbestos containing wastes.
3. Medical wastes.
4. Painted or treated wood wastes.

E. WASTE COMPOSTED -

Composting is limited to the following waste by-products:

1. Wood waste.
2. Agricultural plant waste.
3. Pre and post consumer food waste.
4. Sludge from industrial enzyme production.
5. Residuals from drinking water treatment.
6. New gypsum dry wall scrap wastes (ground on site).
7. Source separated specialty wastes as approved by NCDENR Waste Management Division.

2. DESCRIPTION of PRODUCTION –

A. EQUIPMENT and PERSONNEL -

1. Equipment – The following equipment is stored and maintained on site.

a. Fixed Capital Equipment

(1) - Mixing Area - 4,200 square foot area for SBM and mixing other organic feedstock.

(1) – 35 cubic yard Electric Mixer

b. Mobile Equipment

(3) Rubber tire loaders

(3-6) 30 & 40 cubic yard roll-off containers

(2) Hoist Lift truck for roll-off containers

(1) Screening plant

(1) Compost turner & hose reel

(1) Grinder

c. Monitoring Equipment

Analog Temperature probes

Digital Temperature/Oxygen probe

PC and Compost Manager Software

Oven

Scales

pH meter

Weather station

All equipment is maintained by Novozymes or contract vendors. Preventive maintenance schedule have been developed to track all work performed on each piece of equipment as recommended by the manufacture. Additional equipment may be added as volumes and efficiency dictates the need. Some of the equipment listed above may

become obsolete or outdated over time and they will then be replaced with suitable alternatives. Laboratory equipment such as scales, pH meter, oven and probes are calibrated annually.

2. Personnel - We have a minimum of three full time trained employees on site during hours of operation. These three employees are capable to run this operation at all times. In the event that all employees leave the site during normal operating hours, the site will be then be closed by securing and locking the entrance gate.

(1) Manager

(3) Equipment Operators

(1) Staff Assistant

Additional personnel may be added as volume dictates the need.

3. Training of Personnel – The Compost Department Manager has been formally trained at Composting Schools conducted by the University of Maryland (1994) and The University of Georgia (1996). All equipment operators are trained by the Compost Department Manager. They may also attend "operator training" courses as they become available from the North Carolina Composting Council or the US Composting Council.

B. METHOD USED -

We use the "Turned Windrow Composting Method" to compost the waste materials identified in section one. Windrows are constructed at approximately 6 feet in height and 12 feet in width. The length of windrows may vary based the location within the compost pad area. The average length of a windrow is 500 feet. Windrow height will shrink to 4 feet during the active composting period. At this time windrows may be combined to utilize compost pad space in the most efficient manner.

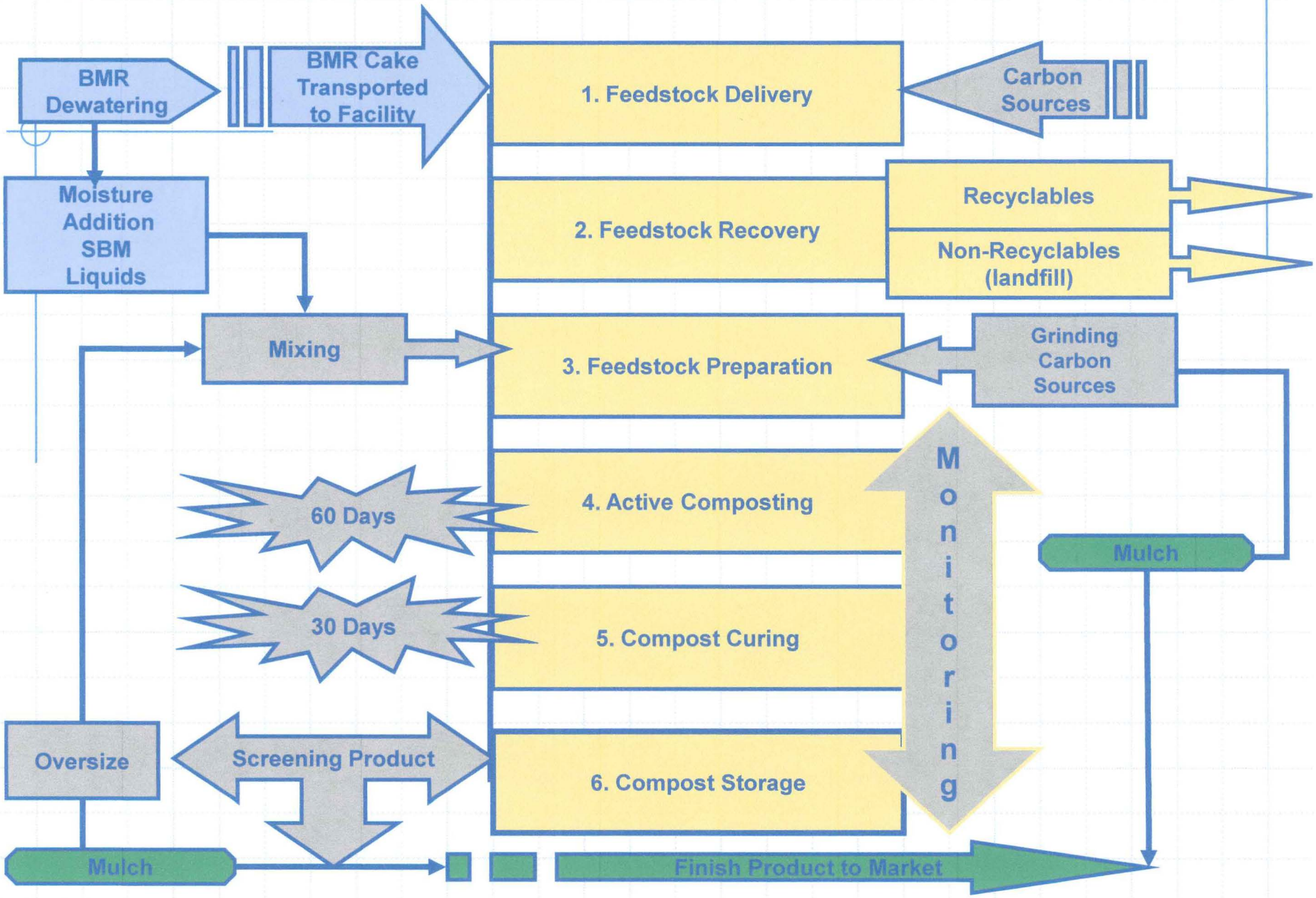
C. PROCESS FLOW of COMPOSTED MATERIALS - (See Flow Chart n the next page)

PROCESS FLOW

The following is a Process Flow description of the six steps of compost production:

1. Feedstock Delivery - Feedstocks enter off of highway 56 and turn down Old Smith Farm Road. Signs direct traffic flow to the office and truck scale. All incoming feedstocks are inspected and weighed prior to unloading. Feedstock materials are then placed at the Feedstock Storage Area for temporary storage. These are stored in bins by feedstock type. Carbon based materials are stored outdoors and separated by type. Certain large wood waste materials are ground to size for mulch or is used as a bulking agent in the composting process. Oversized wood waste feedstocks are unloaded at the *Grinding Area*. All trucks are operated by onsite personnel or unloaded under the direct supervision of site personnel. This assures the homogeneity of materials being delivered. Nitrogen based feedstocks are mixed

Composting Process Flow



with carbon based feedstocks and then incorporated into windrows by the end of the workday or are stored under cover. Precautions are taken to minimize problems with runoff, odors and vectors at the *Mixing Area.*

2. Feedstock Recovery - At the *Feedstock Storage Area*, feedstocks that contain non-biodegradable but recoverable materials are sorted and recycled. All non-recoverable materials are collected and disposed in a permitted landfill. All recyclables are stored in small containers and pickup for recycling on an as needed basis.

3. Feedstock Preparation - At the *Grinding Area* carbon based feedstocks are reduced to appropriate size for composting. A select amount of the higher-grade wood waste material may be ground and sold as a mulch and or boiler fuel product. All of this activity occurs at and around the *Grinding Area.* The *Mixing Area* provides an all weather surface to mix the various components of the compost recipe. Front-end loaders use a 3.25 or 6 cubic yard bucket volume to mix the feedstock components by batching them into an electric powered mixer. Water or liquid Novozymes BMR may be added at this time to increase moisture content if necessary. The mixer will un-loaded the batched mix via conveyor into a roll-off container for transport to the *Compost Production Pad*. Feedstocks are mixed base on recipe design to maintain the following mix parameters.

- A Carbon to Nitrogen Ratio of 20:1
- A moisture rating at 50 - 65%
- An oxygen rating at 5 - 15%
- A pH rating at 5.5-8.0

- A porosity rating of 1.5 – 2.0

Each feedstock material is tested prior to acceptance in the facility and to determine base levels of the above parameters. Initial testing of feedstocks includes the following:

Parameter (mg/kg/dry wt.)	Code 1
Arsenic	41
Cadmium	39
Copper	1500
Lead	300
Mercury	17
Nickel	420
Selenium	36
Zinc	2800

Windrows are constructed at six feet in height and twelve feet in width. Length may vary depending on location within the site. An average length would be approximately 500 feet. Windrows are monitored and tracked by batch number. Newly formed windrows are placed at the far southwest end of the *Compost Production Pad*. Windrows are turned, inverted, mixed and conveyed by using a compost windrow turner with a side conveyor system. The purpose of turning is to homogenize the feedstock mix, provide airspace, hydrate or dehydrate windrows. The side conveyor system is used to index windrows from the starting location to the post process screening and curing areas. This system can pick up one entire windrow in on pass and index one slot over on the *Compost Production Pad*. In the event that the compost windrow

turner becomes non-functional, the front-end loader will then be used to turn windrows. A two-foot access row is left between each windrow for track space for the compost windrow turner. The turner maintains a straight line when turning through each windrow. As the turner approaches the end of each windrow it drives off the area that has membrane and under-drain and drives on to a gravel or concrete turning pad to make a 180 degree turn to circle back and turn the next windrow in line. Turning on these surfaces protects the membrane and under-drain from potential damage by the turners tracks. A twenty-five foot access way is maintained surrounding the *Compost Production Pad* for vehicular traffic and fire control.

4. Active Composting - Mixed feedstocks are actively composted using the "Turned Windrow Method of Composting". Windrows are turned 5 times during the 15-day high temperature period (131°F) by using the compost turner or front-end loader. This maintains homogeneity and porosity during aerobic decomposition and control any pathogens present in the feedstock materials. Turning frequency thereafter is based on moisture and oxygen levels. The monitoring biological activity is accomplished by tracking both pile temperatures and oxygen levels. Pile temperatures are monitored two times per week, by using a four-foot digital probe thermometer. Temperatures are taken at different points every sixty feet along the windrow by inserting the temperature probe half way up the slope of the windrow, and into the windrow the length of the shaft. All readings are recorded as well as the mean temperature. Readings are recorded to achieve the Process to Further Reduce Pathogens (PFRP) specification of for 131°F over 15-day period with a minimum of 5 turnings. In the event that the

sources. An onsite spring, leachate retention ponds, stormwater detention pond, or the Novozymes spray irrigation water.

The pH of the active compost is tested monthly by NCDA Labs. Sampling will occur every sixty feet along each windrow. We use the US Compost Council Test Methods for Examination of Compost as our parameters for sampling and preservation. The detail of this program is enclosed in the appendix of this document. This is accomplished by sampling at a depth of four feet. A composite sample is tested using an electronic pH meter. Composting materials are monitored to maintain a pH rating of 5.5-8.0. If levels change beyond this range corrective measures are taken by increasing the amount of acid or alkaline materials.

5. Compost Curing - After a minimum period of 60 days of active composting the compost product is moved off of the *Compost Production Pad* area to the Screening Area. There it cures in static piles for an additional 30 days or until testing indicates a mature product. Normally this is indicated by lower temperatures, a neutral pH of 7.0, and a lowered carbon to nitrogen ratio. The Solvita Maturity Test is used as an indicator to determine final product maturity. This test uses a color key to measure ammonia and carbon dioxide levels in the cured compost. Our standard for product sales is a final Solvita Index of 6–8 for product distribution. A copy of the Solvita test and the sampling protocol is provided in the appendix. The USCC-STA program verifies this quick test by testing both maturity and stability parameters.

6. Compost Storage - The *Compost Storage Area* is maintained as a large static pile of cured, finished, and screened compost.

digital probe malfunctions spare analog probes are available to use.

Percent oxygen present with in a windrow is monitored weekly using a digital oxygen probe to maintain aerobic decomposition of organic matter. If oxygen levels decline, more bulking materials such as wood chips are added to increase the porosity of the pile. This increases the oxygen levels by increasing convection currents of oxygen being pulled into the pile. Increasing the frequency windrow turning also achieves this same result by increasing the porosity of the windrow. Both temperature and oxygen data are recorded by batch number using a computerized "Compost Manager" software program. In the event that this program becomes non-functional hard copy of the data is recorded manually.

Moisture is checked weekly by grabbing a handful of composting material and balling it up with both hands. If the ball is compacted with no moisture running out, but can be easily broken apart, it will be at approximately 50% moisture. This is verified at the end of each month in the lab by using an oven to determine the dry weight and wet weight of the composting materials. Windrows are watered to maintain the minimum 50% moisture and the maximum of 65%, by using the following method. The irrigation system pumps water through a main PVC line running perpendicular to the windrows. Hydrants come off the mainline. An irrigation reel is attached to the hydrant to access water at one end and the compost turner at the other end. As the turner moves down the windrow it provides moisture addition directly to the compost with minimal run off. The source of water comes from the following

The site has the capacity to maintain a stockpile of 28,000 cubic yards (16,800 tons) for inventory.

a. *Screening*

Screening of finished product occurs in the *Compost Storage Area.* A front-end loader feeds compost product into a screening machine. The screen separates out large oversized material to meet particle size requirements. Fines are conveyed by a stacker and stockpiled for final curing and sale in the *Compost Storage Area*. Oversize product is stockpiled for re-incorporation into windrows as a bulking agent or sold as a mulch product.

The following products are labeled and stored on site in the *Compost Storage Area*:

1. Medium Compost (finished)
2. Coarse Compost (finished)
3. Fine Compost (finished)
4. Special Blends
5. Amendments
6. Mulch and Boiler Fuel

b. *Blending*

Cured and screened finished compost product are mixed by volume, using a front-end loader, with pine bark or other horticultural amendments that do not contain pathogen or heavy metals, such as Topsoil, Perlite, Perma-till, Rock, and Vermiculite. Once mixed, these products are stored as finished products ready for shipping.

3. QUALITY ASSURANCE PLAN

A. FEEDSTOCKS -

New Incoming feedstock materials are monitored and if needed tested by a North Carolina Certified lab for hazardous waste, pesticides, asbestos, heavy metals and organic matter content. Existing feedstock sources are tested quarterly.

B. DAILY PROCEEDURES -

The information below is recorded on a Monitoring Checklist. Data will then be transferred to a database.

1. Date of record and day of the week.
2. Person recording.
3. Tests or activity to be performed
4. Visual check of stormwater and leachate management systems
5. Visual check of evidence of vectors.
6. Odor check
7. Visual check of trash and recycling areas.
8. Inventory Control - The amount of both incoming and outgoing materials will be weighed and or measure by volume and tracked by a computerized database scale system.

C. WEEKLY PROCEDURES –

1. Temperatures for PFRP

Temperatures are monitored three times per week with a three-four foot temperature probe. Temperatures are taken every sixty feet along the windrow. All readings are recorded as well as the mean temperature.

2. Oxygen Content

Percent Oxygen present within a windrow is monitored weekly using a digital oxygen probe to maintain levels at or above the aerobic range. All readings are recorded.

3. Percent Moisture

Percent moisture readings are taken at the end of each week by using the hand check method. We use a 50% minimum and a 65% maximum moisture percentage as our optimum ranges for decomposition. This also gives us an indication for monitoring watering activities. All readings are recorded. The weather station is also be used to gauge rainfall over the same period.

4. Turning of Windrows

Windrows are turned based on PFRP specifications and thereafter on moisture and oxygen levels. Turning frequency is recorded.

5. Watering Amounts

Moisture readings taken weekly determine the frequency of watering. The amount applied in gallons is recorded.

D. MONTHLY/BI-MONTHLY PROCEDURES -

1. Stormwater System Maintenance

The Stormwater System is inspected after each rain event and maintained monthly or more frequently if not operating properly. Monthly activities include the following:

a. Maintaining positive flow to retention pond.

b. Removal of trash and sediment in drainage ditches.

c. Cleaning and clearing weep holes along level spreader.

d. Maintaining a no vegetation zone on stone apron of level spreader.

e. Maintaining grass riparian buffer on down slope of level spreader.

2. Testing Parameters

Novozymes participates in the United States Composting Council's Seal of Testing Assurance Program, NCDA labs and in house testing parameters to monitor for both compost product quality and NCDENR compliance. The USCC guidelines and test methods for sample collection and preservation are included in the appendix of this document. The USCC STA Program goes beyond the North Carolina State requirements for testing therefore; participation in this program assures distribution of a quality "Grade A" compost product. The following chart compares these of testing parameters:

Testing Parameters By Sample Type	NCDENR Requirement Compost Permit Frequency by Facility Capacity 2 X/ year or every 20, 000 tons	US Composting Council STA Program Frequency by Volume of Finished Product Annually 6251 - 17500 tons - 1 per 2 months	Novozymes NA QA & QC Requirement Frequency as Stated Below 6251 - 17500 tons - 1 per 2 months
Feedstocks			
Hazardous Waste	Non applicable	Non applicable	New Feedstocks if warranted
pH	Not required	Non applicable	Quarterly
Soluble Salts	Not required	Non applicable	Quarterly
Nutrients	Not required	Non applicable	Quarterly
Moisture Content	Not required	Non applicable	Quarterly
Organic Matter Content	Not required	Non applicable	Quarterly
Regulated metals	Not required	Non applicable	Quarterly
Carbon: Nitrogen Ratio	Not required	Non applicable	Quarterly
Pathogens	Not required	Non applicable	Quarterly if warranted
Active Compost			
Temperature	2 times/Week	Non applicable	2 times/Week
Turning of Windrows	Based on temperature	Non applicable	Based on temperature
Oxygen	Weekly	Non applicable	Weekly
Moisture Content	Weekly	Not required	Weekly
Final Product			
pH	Required	Bi-Monthly	Quarterly
Soluble Salts	Required	Bi-Monthly	Quarterly
Nutrients	Required	Bi-Monthly	Quarterly
Moisture Content	Not required	Bi-Monthly	Quarterly
Organic Matter Content	Not required	Bi-Monthly	Quarterly
Regulated metals	Required	Bi-Monthly	Quarterly
Maturity	Not required	Bi-Monthly	Quarterly
Stability	Required	Bi-Monthly	Quarterly
Particle size	Required	Bi-Monthly	Quarterly
Pathogens	Required	Bi-Monthly	Quarterly
Solvate Maturity Index	Not required	As needed	As needed
Man-made Inerts	Required	Bi-Monthly	Quarterly
Carbon Nitrogen Ratio	Monthly	Bi-Monthly	Monthly

3. Inventory Control

Daily shipments of finished product and incoming feedstocks are tracked using the scale computer system. An inventory control report is generated monthly.

4. Physical Characteristics Parameters

Grading of the physical characteristics of the finished product is determined as per table one of section .1407 by measuring particle size and percent of dry weight inerts. Particle size will not exceed 1 inch and percent dry weight inerts will not exceed 6%.

5. Chemical Characteristics Parameters

Composite samples of finished and mixed product are tested for the following materials:

Parameter (mg/kg/dry wt.)	Code 1
Arsenic	41
Cadmium	39
Copper	1500
Lead	300
Mercury	17
Nickel	420
Selenium	36
Zinc	2800

6. Mature Degree of Stabilization

Tests of composite samples of finished product are tested to determine PFRP and Reduction of organic matter as per table 3 of section .1407. The Solvita Maturity Test is used as needed to determine final product stability. Details on sampling and testing procedures are provided in the appendix. USCC STA testing confirms both finished product stability and maturity.

7. Soluble Salts

Composite samples of finished compost are tested to determine total soluble salts. USCC STA testing confirms soluble salt levels.

All testing is performed by using methods outlined in table 5 section .1408 of the NCDENR Solid Waste Management Rules.

E. ANNUAL PROCEDURES -

1. Annual Reporting

This is a synopsis of procedures and activities that have taken place over the course of the year. This report is submitted by August 1 of each year to the following address:

State of North Carolina Dept. of Environment,
& Natural Resources
Division of Waste Management
401 Oberlin Road
Suite 150
Raleigh, NC 27605

As per section .1408 (c) of the NCDENR Solid Waste Management Rules an annual report will be submitted to

NCDENR Solid Waste Section on August 1 of each year covering July 1st to June 30th with the following information:

a. The facility name, address, and permit number,

b. The total quantity in tons, with sludge values expressed in dry weight, and type of waste received at the facility during the year covered by the report, including tons of waste received from local governments of origin.

c. The total quantity in tons, with sludge values expressed in dry weight and type of waste processed into compost during the year covered by the report.

d. The total quantity in tons and type of compost produced at the facility by product classification during the year covered by the report.

e. The total quantity in tons and type of compost removed for use or disposal from the facility, by product classification, along with a general description of the market if for use during the year covered by the report.

f. Condensed monthly temperature monitoring to support Rule .1406 (12) (A).

g. Results of tests required in Table 3 of Rule .1408 (a) (1). (d) Condensed yearly totals of solid waste received and composted shall be reported back to the local government of origin for annual recycling reporting.

G. PEROIDIC MAINTENANCE PROCEDURES -

1. Stormwater and Leachate System Maintenance

There is a periodic need for maintenance for both the Stormwater and Leachate System. Sediment in ponds can build up and there is a need to dredge these structures periodically. As this need arises the dredged material is re-incorporated into newly formed compost windrows and or landfilled.

2. Compost Pad Maintenance

There is a need to patch or replace any areas on the compost pad that are low, rutted, or worn due to vehicle traffic. ABC Stone is spread out on these areas and then compacted by a vibratory roller.

4. HEALTH AND SAFETY -

A. HEALTH AND SAFETY STATEMENT -

Safety and Health Services at Novozymes is organized around the full-time Safety and Health Manager and Occupational Health Nurse. In addition, safety and health is very much a part of line management fundamentals with goals aimed at improving hazard recognition/control and eliminating injuries. To accomplish this, we provide frequent training, departmental self-audits, and utilize our expanding Behavior Based Safety program. New employees are given safety orientation, which includes hazard communication, personal protective equipment, emergency procedures, lock-out and tag-out, confined space, and forklift operator training requirements. Written safety programs include all OSHA required subjects such as:

- Proper Use of Fire Extinguishers
- Hazard Communication
- Emergency Action Plan
- Eye Protection
- Hearing Conservation
- Lockout/Tag-out
- Confined Space
- Forklift Safety
- Hot Work
- Electrical Safety
- Respiratory Protection
- Blood borne Pathogens

B. CONTINGENCY PLANS & EMERGENCY RESPONSE -

1. In-climate Weather

In the event of adverse weather conditions we are prepared to shut down operations of the site. The processing of incoming and outgoing materials will cease. If we experience a heavy rainfall period, the site is designed to handle any overflow from the primary retention pond to the secondary overflow structures. In the event that it becomes necessary we have the capabilities of pumping water from the retention pond to the Novozymes waste water treatment plant.

2. Fire

In the event of a fire we are prepared to extinguish and contain any start of fires with fire extinguishers. Emergency phone numbers are posted at all phones to call the local fire department to respond.

3. Spill Response

The following are general guidelines to be followed for a non-hazardous chemical spill.

Non-Hazardous spills or leaks

a. Alert area occupants and supervisor.

b. Check MSDS for hazard determination and spill cleanup method.

c. If the determination is hazardous and contact NZNA Environmental Operations.

d. If the determination is non-hazardous, follow MSDS clean up method and properly dispose the clean up material

The following are general guidelines to be followed for a diesel fuel spill.

Small spill: < than 100 Gallons

a. Alert area occupants and supervisor.

b. Eliminate all ignition sources.

c. Isolate spill or leak area immediately for at least 25 to 50 meters.

d. Remove contaminated people from spill area and flush with water for 20 minutes.

e. Call 911 if First Aid is needed.

f. All equipment used when handling the product must be grounded.

g. Do not touch or walk through spilled material.

h. Stop leak if you can do it without risk.

i. Absorb or cover with dry earth, sand or other non-combustible material.

j. Transfer clean up material with product to containers for proper disposal.

Large spill: > 100Gallons

Immediately alert area occupants and supervisor

a. Call 911 and NZNA Environmental Operations.

b. Eliminate all ignition sources.

c. Initial downwind evacuation for at least 300 meters.

d. Remove contaminated people from spill area and flush with water for 20 minutes.

e. Keep unauthorized people away and stay upwind.

f. Dike far ahead of spill for later disposal.

g. Water spray may reduce vapor.

h.Transfer clean up material with product to containers for proper disposal.

4. Dust, Odor, Noise, Vectors or Traffic

To date we have not experience any complaints due to odor, noise or vector problems. Potential odor and noise problems should not be a factor based on the sites design and operation. There is a natural buffering of noise and wind from the screening of existing trees and vegetation. We monitor odor on a daily basis and use trouble shooting guide establish by the US Composting Council to eliminate the cause of odor generation. This accomplished by managing carbon to nitrogen ratios in mix design, tracking oxygen and moisture levels in windrows, and managing a windrow turning schedule.

Cause of Odor	Action
Lack of oxygen	Turn windrow and or add bulking material
Excess nitrogen	Add carbon and turn windrow
Excess moisture	Turn windrow and or add bulking materials
Compressed windrow	Turn windrow and or add bulking materials

We monitor any conditions that would cause dust problems from particulates. A water wagon and our irrigation system can be used to minimize any potential dust problems. We have limited the operating hours of the facility to minimize any potential noise problems. The presence of vectors is inspected daily as part of the daily monitoring procedures. If we were to experience problems with vectors, we will contact a professional exterminator for

control. Our site location and design should minimize any traffic problems. The site is located of a highway 56 with a marked entrance area sufficient to handle our daily estimated traffic volume. The road entering the facility is a private road and does not receive any local traffic.

5. Non-Conforming Waste

As stated earlier incoming feedstocks are inspected and weighed prior to unloading. It is our intent to screen all materials as they are unloaded. In the event that contamination from a non-conforming waste has occurred the source will be identified and material will then be transported back to its place of origin or sent to an approved landfill.

6. Non-Conforming Product

All non-conforming or off spec product will be reprocessed or disposed in an approved landfill.

Novozymes NA has in place contacts for equipment rental, lease, or contracted labor in the event that our existing equipment breaks down. This is a precaution allows us to continue operations.

5. APPENDIX –

- A. JOB DESCRIPTONS
- B. PRODUCT MARKETING & DISTRIBUTION PLAN
- C. NOVOZYMES- ISO 14001 INTERNAL DOCUMENTS
- D. USCC STA TESTING PROGRAM
- E. SOLVITA MATURITY TESTING
- F. APPLICABLE PERMITS & APPROVALS

JOB DESCRIPTONS

Composting Manager

Level

Exempt

Basic Function

Manage the feedstock procurement, product development, and all sales and marketing functions of the composting operation within budgeted guidelines.

Manage the composting operation to assure quality production at budgeted cost and volumes.

Develop, implement and manage quality control and quality assurance guidelines and testing protocols for the composting operation.

Develop and maintain a public relations program to disseminate information about NZNA Composting to local landowners, community, and other stakeholders in the agronomic reuse of NZNA compost products.

Reports To

Director of Engineering Services

Supervises

Supervise the work of operators and staff assigned to support the composting operation.

Duties and Responsibilities

Manage the feedstock procurement, marketing plan, advertising, public relations, sales promotions, merchandising, and all sales and marketing functions of the composting operation.

Develop, implement and manage quality control and quality assurance guidelines and testing protocol for the composting department.

Oversee compost operations on product improvement and new product development.

Provide professional assessment and planning for short and long term operation of the Composting Facility.

Provide guidance and direction for the composting operation employees in accomplishing short and long term goals.

Develop relationships to procure raw material feedstock customers.

Develop and implement marketing plans for compost product sales.

Ensure conformance to applicable governmental permits/regulations and to applicable Novozymes policies and programs.

Continued on next page

Composting Manager, *Continued*

Duties and Responsibilities *(continued)*

Ensure a constructive dialogue with local and central authorities regarding waste management at NZNA.

Promote active cooperation with other departments to meet current and future needs and to develop more environmentally sound processes.

Coordinate research and development activities with Universities and independent labs.

Develop, implement, measure performance toward, and periodically update compost departmental goals.

Provide input to periodically update a formal long term plan for NZNA biodegradable wastes.

Responsible for all applicable NCDENR and NZNA reporting requirements as they pertain to compost facility operation.

Maintain up-to-date job descriptions for all composting department personnel.

Prepare and administer an annual budget. Review and explain monthly variances.

Make formal internal and external presentations on the beneficial use of NZNA compost.

Interact with appropriate local universities and consultants to improve the efficiency and sustainability of NZNA compost.

Interact with other Novozymes Waste Management departments to share information and experiences and to develop and implement best practices.

Manages sales office activities, including customer service and product support.

Other duties as assigned by the Director of Engineering Services.

Minimum Qualifications

A minimum BS required in Agronomy, Soil Science or related natural sciences.

A minimum of five years general management experience in compost facility operations.

Experienced with NCDENR environmental regulations desirable.

Knowledge of waste treatment and beneficial reuse of waste is also desirable.

A minimum of ten years of experience in sales and marketing.

Must be computer literate and able to utilize relevant software programs.

Continued on next page

Composting Manager, *Continued*

Minimum Qualifications *(continued)*	Physically mobility and visual acuity to inspect equipment and composting operations.
Contacts	Internal: All Departments External: Waste generators, compost product customers, contractors, vendors, appropriate local and state governmental agencies.
Budget	Responsible for all compost facility budgets.
Revisions	N/A

Senior Operator, Environmental Operations

No.: NZNAJD-4.12.11 Version: 1.0 Valid From: 26 July 2004 Document owner: AKM

Level	Wage
Basic Function	The Senior Operator position has primary responsibility for the operation, troubleshooting, and optimization of composting, PWW irrigation systems, and SBM land application. Technical and operational expertise in all 3 areas are required. This position has primary responsibility for responding to and resolving operational problems including weekends, evenings, and holidays.
Reports To	Supervisor, Environmental Operations
Supervises	None
Duties and Responsibilities	**4.1 Composting** The Senior Operator is expected to be technically competent on the maintenance and repair of equipment used in composting operations. The Senior Operator is expected to develop competency in the operation, troubleshooting, and repair of equipment, independently if needed. Senior Operator will be required to acquire, record, and interpret relevant data in support of composting. This position is responsible for daily and weekly production targets as set by the Supervisor and Compost Manager. The Senior Operator is responsible for coordination of loading and delivery of finished products to customers in accordance with schedule set by the Supervisor. **4.2 SBM land application and PWW Irrigation** Senior Operator is expected to be technically competent on the maintenance and repair of equipment used for PWW and SBM reuse. Senior Operator must have demonstrated ability to operate, troubleshoot, and repair equipment, independently if needed. This position is expected to coordinate repairs of equipment with contractors as assigned by the Supervisor. The Senior Operator is required to acquire, record, and interpret relevant data in support of operational decisions for waste reuse. **4.3 Data Management** Relevant data collection, entry, and preparation of reports are required for areas of assigned responsibility. Senior Operators are expected to develop adequate competence in data management to support EO reporting requirements. Competence in site-wide information systems, such as SAP, will be developed as needed to support NZNA operations.

4.4 Other

Operators are responsible to initiate revisions of relevant EO standard operating procedures as needed to ensure that they are accurate. The Senior Operator, in coordination with the EO Supervisor, is responsible for initiation of work orders and ensures that work orders are closed out upon completion of maintenance activities. The Senior Operator will provide support for waste treatment systems as needed by Production. The Senior Operator is expected to maintain knowledge on the operation of the decanter.

Perform job duties in a manner that supports NZNA Quality, Safety and Environmental Policies and regulations, and contribute to improving results in these areas.
Other duties as assigned.

Minimum Qualifications

Senior Operator must have good reading, writing, math, and computer skills necessary for successful performance of job duties. Senior Operator must have knowledge of and experience with relevant environmental systems.

- High School diploma or GED.
- Senior Operator must successfully complete level I Environmental Operations training modules at the NZNA learning center within the first 12 months of appointment. Advancement in this position will require successful completion of level 2 EO training modules in addition to obtaining the certifications indicated above.
- Complete at least 1 compost operator training school within the first 12 months of appointment.
- Minimum of 5 years of prior experience in NZNA environmental operations, with at least 3 years as Operator II. Eight years of relevant work experience outside of NZNA will be accepted.
- Demonstrated knowledge of environmental operations processes at NZNA.
- Physically able to perform all tasks related to the position, to include the ability to walk, bend, climb stairs and ladders, and to lift 50 pounds without assistance. Good visual acuity is necessary, as well as the manual dexterity to enter computer data and retrieve records, and to perform manual repair work on equipment.

Criteria that must be met prior to promotion to Senior Operator – Entry Level:

- Successfully conduct Operator II responsibilities for a minimum of 3 years. Candidate must have demonstrated history of increasing responsibility in the Operator II position.
- Demonstrated independent knowledge of and experience

with operation and troubleshooting of PWW irrigation, SBM land application, and compost systems
- Demonstrated experience in Environmental Operations data entry

Criteria that must be met for promotion to Senior Operator – Senior Level

- Successfully complete all Environmental Operations Training (levels 1 and 2)
- Achieve certification for wastewater spray irrigation operator
- Achieve certification for residuals/biosolids land application operator

Environmental Operations Training Modules

Level I Training Modules

NZNA Learning Center
Basic Skills (B1-B4, B7, B10-B15)
Computer (1,12,19)
Electrical (E1-E2)
Instrumentation (I1-I3, I10-I11, I15, I21-24, I36)
Mechanical Skills (M3-M4)
Operations Science (O5, O10-O11)
WEF Operations Training (Wastewater Treatment)

Level II Training Modules

NZNA Learning Center
Applied Mathematics (B1-B4, B7, B10-B15)
Reading and Writing (B10-B11)
Computer (1,2,12,13, 19, 20)
Electrical (E1-E2, E9-E17, E19-E20, E27)
Instrumentation (I1-I8, I10-I11, I15, I21-24, I36)
Mechanical Skills (M3-M4, M11, M20-M24)
Operations Science (O5, O7, O10-O11, O16)
WEF Operations Training (Pumps; Activated Sludge Process Control)

Contacts

Internal: Maintenance, Technical Operations departments
External: Vendors, contractors, vendors, customers

Budget

This position does not have direct budget responsibility.

Operator I

No.: NZNAJD-4.12.05 Version: 1.0 Valid From: 26 July 2004 Document owner: AKM

Basic Function	Responsible for basic operation of PWW irrigation, SBM application, and **compost** systems.
Reports To	Environmental Operations Supervisor
Supervises	None
Duties and Responsibilities	Basic operation of Spent Biomass (SBM) application to include: operation of SBM application equipment recording necessary information for departmental databases maintaining compliance with pertinent permit operating conditions perform PM procedures for SBM application equipment assist in repair of SBM application equipment. Basic operation of Process Wastewater (PWW) irrigation to include: moving, setup, startup, monitoring, and shutdown of portable spray irrigation equipment startup, monitoring, and shutdown of center pivot irrigation equipment. recording necessary information for departmental databases. maintaining compliance with pertinent permit operating conditions perform PM procedures for PWW irrigation equipment assist in repair of PWW irrigation equipment. operation of irrigation pumps. Basic operation Composting equipment to include: • Operation of front-end loaders • Unloading of raw materials • Assist in operation of grinder and screen • Assist in operation of compost mixer and construction of windrows • Operation of windrow turner • Operation of compost screen • Monitoring of windrow quality parameters • Recording necessary information for departmental databases • Cleaning of compost site • Perform job duties in a manner that supports NZNA Quality, Safety and Environmental Policies and regulations, and contribute to improving results in these areas. • Other duties as assigned by Department Manager and Supervisor

Minimum Qualifications	• High School Diploma or GED required. • Must have good basic reading, writing and math skills related to the performance of all position requirements. • Attendance of training and certification courses in biosolids/residuals land application, wastewater spray irrigation, and composting. • Some computer data entry, record keeping and reporting experience is preferred. • Two years farming experience preferred, including operation of heavy tractors or similar equipment. Being able to operate Heavy Non-Farm Equipment will be considered. CDL. • Must be physically able to perform all tasks related to the position to include the ability to walk, bend, climb stairs and ladders, and to lift 50 pounds without assistance. Good visual acuity is necessary, as well as the manual dexterity to enter computer data and retrieve records, and to perform manual repair work on equipment. • Must be able to work some evenings and weekends as scheduled.
Contacts	**Internal:** None except within the department **External:** Surrounding farmers, contracted truck drivers, compost customers, contractors, and visitors
Budget	Not applicable - has no budgetary responsibility
Revisions	Updated to include compost responsibilities and remove waste treatment responsibilities

Staff Assistant, Composting Department

Level Non-Exempt

Basic Function Provide administrative/clerical support to the Environmental Operations and Composting Department

Reports To Composting Manager

Supervises None

Duties and Responsibilities

Duties Specific to the Composting Department

Acts as initial contact between internal and external customers and department personnel. Must demonstrate the ability to handle customer requests in a timely and efficient manner.

Responsible for all Customer Service related activities for all Nature's GREEN-RELEAF products and feedstock customers. Must maintain a Certified Weigh Master certificate to operate the scale system. Handles all customer phone interactions for feedstock pickup, product sales and monitoring of the compost business phone during normal business hours.

Handles all outgoing billing for Nature's GREEN-RELEAF

Responsible for creating process orders for semi-finished and finished products in SAP.

Creates and maintains customer masters/vendor number assignment.

Creates customer account statements and past due notifications.

Coordinates month-end closing.

Invoices all Nature's GREEN-RELEAF feedstock and products.

Responsible for mailing of all Nature's GREEN-RELEAF feedstock, product invoices and tickets.

Maintains daily input of compost batch mixing.

Files all daily worksheets completed by operators.

Prepares SAP transactions for feedstock, compost, monthly rentals and transportation. Must maintain control of detail and accuracy of reporting.

Monitors workload to facilitate the scheduling of pickup and deliveries by maintaining a dispatch process to ensure all customer orders are picked up or deliveries made according to their convenience.

Tracks contract trucking costs and assigns them to appropriate accounts.

Manages and maintains inventories for the production consumables where appropriate.

Actively supports LEAN activities and initiatives for the business process.

Creates PO's for all feedstock customers annually.

Maintains the Nature's GREEN-RELEAF external web site

Makes arrangements for visitors, tours and other departmental activities as requested.

Will take on other duties as assigned.

Purchasing

Manages purchases including the writing of purchase requisitions, assignment of account numbers, signing purchase requisitions, receiving items. Maintains the necessary paperwork for Finance and Accounting.

Administrative Support

Arranges & coordinates on and offsite meetings.

Acts as a delegate for the TEM MasterCard.

Inputs of Exempt Time

Annually sets up blanket Purchase Orders for vendors that we will be purchasing supplies or parts from regurlaly.

Maintains training files for department employees.

Manages cellular phones as assigned.

Responsible for creating PM notifications for maintenance work as needed or requested.

Responsible for purchasing multiple cost center levels.

Processes E-Vips daily.

Maintains proprietary information/documents as specified in retention time for QMS.

Tracks and assigns a variety of costs to accounts.

Has the ability to work with minimal supervision and must apply absolute discretion in handling and processing of confidential information.

Manages and maintains the inventory for office consumables.

Responsible for assignment of EQCN and CSCN numbers to projects, maintaining databases, closing completed documents and printing reports as needed.

Provides general orientation and office support services to temporary, contracted or consulting personnel.

Maintains a working knowledge of other functional areas to work as backup support when needed.

Distributes correspondence and keep announcements up to date on the bulletin board.

Performs job duties in a manner that supports NZNA Quality, Safety and Environmental Policies and regulations and contribute to improving results in these areas.

Prepares correspondence, reports and documentation in appropriate forms. This information can come from a variety of sources including written, oral drafts, dictated material or raw material sources.

Responsible for management of computer databases where required.

Minimum Qualifications

High School w/associate degree preferred. Computer network operations and proficiency or the ability to become proficient in the following programs: Microsoft Office, Word, Excel, Access, Outlook, Power Point, Front Page and Publisher, SAP, CABIN. Capable of typing a minimum of 50 wpm. Experience in master file and record keeping. Experience in entering computer accounting transactions in a SAP Financial System, previous customer or vendor interface experience. Web page skills preferred. Maintain a Certified Weigh Master certificate.

Contacts

Internal: All NZNA and contract employees

External: Vendors, Compost/Mulch Customers, Transportation of out going Product and incoming Raw Materials (Feedstocks).

Budget

This position has no budgetary responsibility, but has significant responsibility to assure departmental revenues and costs are accurately captured.

Revisions

Updated description

PRODUCT MARKETING AND DISTRIBUTION PLAN

TABLE OF CONTENTS

1. PRODUCTS
2. MARKETS
3. DISTRIBUTION
4. ADVERTISING & PROMOTION

1. PRODUCTS-

Our Certified Compost comes in three forms Coarse, Medium and Fine. This is screened at 1/2inch, 3/8 inch and ¼ inch. Special Blends are derived from mixing, amendments with Certified Compost. Landscape Mulch and Boiler Fuel are derived from grinding and screening clean wood by-products.

Products

Certified Compost

Special Blends

Landscape Mulch & Boiler Fuel

Certified Compost

This product is produced by first selecting clean source-separated biodegradable feedstocks. Strict feedstock selection is an assurance that the finished product will be of desirable characteristics. The other basis for quality product is the participation in the US Compost Council Seal of Testing Program and assurance of quality control of the production process. The compost is carefully monitored to achieve optimum results for the various particle sizes that we will sell to specific end markets. Certified Compost has advantages over both natural occurring soils and municipal yard waste compost. It provide organic matter, it is neutral in pH, low in soluble salts, and has no significant pathogens, weed seeds or diseases. It is mature in age, which provides a stable product to manage in different horticultural applications. These are important characteristics when considering product quality.

Special Blends

The blending of compost plus other select amendments is designed for a specific market niche. An example of this would be a 50/50 mix of compost and screened topsoil that can be used in landscape installation as backfill for planting trees and shrubs. Another example would be a mixture of compost, and aged pine bark that would be used by growers in the container nursery business.

Landscape Mulch & Boiler Fuel

Wood waste is generated in all types of sizes and quality. Some wood wastes are more suitable for composting while others are better suited as a mulch product. Landscape mulch comes in different sizes, and grades. This material is made up of double ground wood wastes such as pallets. Natural landscape mulch is made up of ground bark by-product from the milling of lumber. This product is sold to the ornamental horticulture market. Less desirable and lower quality mulch product is sold as boiler fuel.

2. MARKETS-

The product sales are marketed by direct sales personnel. We accomplished by the management of face- to -face sales calls on the following market segments:

- Soil & Mulch Brokers
- Landscape Contractors
- Nurseries
- Agriculture
- Golf Courses
- Grading Contractors
- Bag Product Companies

3. DISTRIBUTION OF PRODUCT –

Our customers and prospects are easy to reach in person because they are located within a 150 miles radius. In addition, our customers are dependent upon having direct, personal contact with us. In light of these considerations, our design distribution plan relies heavily on the use of sales calls. Novozymes Composting uses contract transportation for outgoing product. All products are shipped F.O.B. our compost plant or are picked up by the customer.

4. ADVERTISING AND PROMOTION –

Our advertising and promotion is based on the following positioning statement:

"We will provide premium quality horticultural products that perform in and on the landscape".

The overall marketing plan for Novozymes Composting is based on the following fundamentals:

- Quality products priced at competitive rates
- Quality control and quality assurance in each product made
- Continued research and development of new products and markets
- Developing partners in growth with customers and the community

The advertising and promotional campaigns are designed to increase customer awareness of our products and educate the end users. This is achieved by developing marketing materials that includes our research data, environmental stewardship, quality control, quality assurance, and proven testimonials. We advertise in Trade Journals, Association Newsletters and on the web. Our point of sale advertising displays is designed to educate the consumer on our product applications. Novozymes NA continues to support the Trade Associations by actively participating in seminars and trade shows. Novozymes maintains a professional trade show booth for such exhibits. We run seasonal promotions and pre-season booking programs to increase sales during slow periods. We schedule press release copy to local newspapers, radio, and the web. Our composting facility is used for tours of area groups such as garden clubs, schools, and civic groups.

NOVOZYMES- ISO 14000 INTERNAL DOCUMENTS

ISO 14001 is an environmental management standard. It specifies a set of environmental management requirements for environmental management systems. The purpose of this standard is to help organizations protect the environment, to prevent pollution, and to improve their environmental performance. Novozymes North America has an ISO 14001 certified Environmental Management System which covers all aspects of the operations, including Composting. ISO 14001 is a worldwide environmental management system standard that requires systems to assure regulatory compliance as well as objectives to continually improve environmental performance.
http://www.fs.fed.us/ems/includes/sum_ems_elements.pdf

The site has been certified since 2000 and was most recently audited by an outside registrar in April, 2009. The audit indicated full conformance with the standard and only a couple of minor recommendations for further improvement.

The following are Novozymes internal forms and documents used to comply with our ISO 14001 certification program.

Compost Quality Records

Purpose

This document is to describe Quality Records for the NZNA Composting Department to insure compliance with QMS 1.05, NZNA 1.06.02 and QMS 1.06.

External Documents

Composting Department uses the Manufacturers manuals of the equipment as operating SOP for equipment. Environmental Operations Supervisor/Environmental Operations Senior Operators are responsible for registering each piece of equipment with manufacturer to insure that any updates to equipment manuals are received. Once received manufacturer's manuals are maintained in Compost Trailer.

Quality Records

Information collected on approved forms, entered into databases, spreadsheets and/or prepared reports are considered as Quality Records if they are used to:

- Document the operation of the Compost Department equipment and processes.
- Meet requirements of stated issued environmental permits and operation permits for which the Compost Department has primary responsibility for assuring compliance.

Control of Records

- Hard copies of all completed forms are stored in binders in Compost trailer for the current year.
- PM documents are kept for 1 year. Forms are located under the relative equipment.
- Electronic data bases and spreadsheets are maintained on the R drive.
- Exception is the windrow monitoring folder which is maintain on the compost computer under C\programfiles\windrowmanaget. Hard copies of reports for the current calendar year are located in the Compost Trailer.

Revision

Document control removed due to document kept in DDD.

Control of Equipment

Purpose

The purpose of this document is to provide requirements to control, maintenance and calibration of equipment to ensure:

- Suitable identification and recording of equipment.
- Suitable maintenance for sustainable process capability.
- Sufficient precision and accuracy of measuring equipment.

Scope

This document is applicable to all Production, SCO, Pilot Plant and Laboratory equipment.

Definitions

Types of equipment are defined:

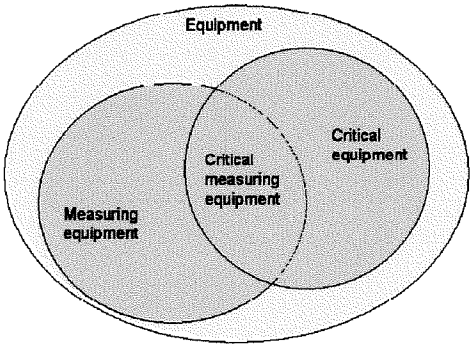
Type	Definition
Equipment	Process equipment and utilities
Measuring Equipment	Measuring instrument, software, measurement standard, reference material or auxiliary apparatus used for measuring and monitoring of process or product data.
Critical Equipment	Process equipment where regular maintenance are necessary to ensure process capability and ❖ Product quality ❖ Environmental impact ❖ Compliance with regulatory requirements.
Critical Measuring Equipment	Measuring and monitoring devices used to demonstrate conformance to specified requirements for ❖ Product quality ❖ Environmental impact ❖ Compliance with regulatory requirements.

This can be illustrated as follows:

Continued on next page

Control of Equipment, *Continued*

Definitions ***(continued)***



Equipment

Local procedures must be available to ensure that:

- Equipment is suitable for intended use.

NOTE: Production and Pilot plant equipment must be evaluated for environmental impact.

- Equipment is categorised, including identification of critical equipment.
- A systematic maintenance schedule is established for critical equipment.

Test of critical equipment

For new critical equipment in production and SCO, the manager must specify the responsibility for (and will assume it himself if not described):

- Considering if a test of new equipment is necessary; and if a test is necessary define extend of test, including compliance with GMP, OH&S and other relevant requirements.
- Conducting the test, if test is necessary.
- Approving the test and equipment being taken into use.
- Documenting the test if test has been made.
- Establishing the necessary schemes for calibration and running/periodic testing.

Continued on next page

Control of Equipment, *Continued*

Critical Measuring Equipment

Local procedures for critical measuring equipment must be available to ensure:

- Registration of critical measuring equipment, including:
  - Identification.
  - Measuring range.
  - Accuracy and precision.
- Safe handling and storage of critical measuring equipment and protection of the calibration.
- Establishment of a calibration schedule, including:
  - Frequency of calibration.
  - Traceability to International or National standards (where possible or relevant) or establishing the basis for the calibration.
  - Acceptance criteria for the calibration.
  - Disposition of out of calibration measuring equipment including assessment of the validity of previous results.
  - Documentation of calibration.
  - Calibration status readily available to the user (e.g. by labelling).

Software in Critical Measuring Equipment

If critical measuring equipment includes computer software this must be tested prior to initial use or upon changes to confirm that the software can be used for the intended purpose with satisfactory results.

Revision

Scope: SCO added. Paragraph on testing of critical equipment in production and SCO added. Author changed from LBJO to LPJ

Compost Inventory Counting

Purpose

This procedure describes the inventory counts of production consumables, compost feed stocks and finished goods

Scope

Compost and NZNA Finance Departments

Requirements

Following table lists the tasks, who is responsible and the frequency of Compost inventory counting:

Task	Responsible	Frequency
Worksheet completion	Operators	Daily
Review of worksheets	Supervisor	Daily
Data entry	Compost Staff Assistant	Daily
Inventory Counts	Supervisor, Sr. Operator	Monthly
Data conversion, entry	Compost Staff Assistant	Monthly
Review on-hand vs. SAP	Supervisor, Sr. Operator	Monthly
Inventory reconciliation	Compost Manager	Monthly
Inventory adjustments	NZNA Finance Dept.	Monthly

Revisions

New document

Compost Operations Training Program

Purpose

The purpose of this document is to describe training background for the Compost Department.

Description

The Compost Operations Department Training Plan should ensure that all Staff and Operators have a basic understanding of processes, relevant quality systems, equipment and procedures in order to conduct their assignments in a safe and effective manner. Since Environmental Operations supplies the Operators for Compost Operations their training is related to Operations within Environmental Operations.

Department Structure

Compost Operations personal are divided into three categories:

- Staff (Compost Operations Manager, Environmental Supervisor, and Staff Assistant).
- Environmental Operations Senior Operator
- Environmental Operations Operators

Training Program

Training programs will be provided for each employee to insure that the needed training to full fill job duties is identified.

Once per year, during the annual review process, the Employee's Supervisor or Manager will review the previous year's training program and amend as necessary. Status of training from the previous year should be documented. This training program will be kept in the employee's training file. When Environmental Operators rotate back into the compost operations they will be re-evaluate on their knowledge of the operation and updated on any parts of the operation that has change. A compost training form is provided for the Environmental Operators so that progress and training can be tracked. (Form CO-010)

Training Records

Environmental Operators:

The Environmental Operations Supervisor is responsible for making sure that each of the operators has an up-to-date training record in their training file. Training files will contain an over-all cover sheet indicating the types of training an operator has had. The file may also contain any state certifications or training, completion of training signatures, training goals and any other certifications that may be beneficial to an operator or the department. Environmental Operations staff assistance keeps the training records in the staff assistance

office. Training records for Environmental Operators working within the Compost Operations is kept with the Environmental Operation Supervisor.

Responsibility The Environmental Operations Supervisor is responsible for defining and implementing the training program on an individual basis.

Revisions IMAP format and loaded into DDD.

OPERATIONS OF WEIGHT SCALE

Purpose

This document is to describe the proper weighing of Incoming raw material and outgoing finish product for billing purposes. The document also covers trouble-shooting. The scope is for the Licensees in the Compost Department.

Description

The present scale is a Cardinal WinVRS model. The location of the scale controls is inside the compost trailer. The operational unit of the scale is located in front of the compost trailer.

In order to operate the weight scale you must have:

- Certified Operator

The Operations of the Weight scale is done by Licensees approve by the North Carolina Department of Agriculture and Consumer Services. The certificate's of the Licensees is located next to the computer scale area in the Compost Trailer.

- Software setup

The setup of the software to operate the scale is the responsibility of the Compost Manager and Compost Staff Assistance. They assign a system with the software so as to recognize the customer's within a data base.

Step	Action
1	The scale is operated in accordance with manufacturing recommendations. The Manufacture's manual is located in the Compost Trailer. Customer's vehicles are weighed as they enter the compost facility.
Step	**Action**
2	Vehicles drive up onto the scale which is located in front of the compost trailer. The beginning weight is recorded into the file of the customer on the scale computer.
Step	**Action**
3	Once the data has been recorded the certified operator turns on the green light on the stop light so that the customer can exit the scale and drive to the appropriated area within the compost facility.

Step	Action
4	Once the customer is loaded or unloaded they return too the scale for weighting out.
Step	**Action**
5	• The certified operator records the end weight into the customer's file on the scale computer. The difference between the beginning and ending weight is your actual weight.
Step	**Action**
6	A carbon copy weight ticket is then issued for the customer.
Step	**Action**
7	The customer takes one copy and two copies of the weight ticket are turned over to the Compost Staff Assistant.

Data Collection

All data collected from the above operation is turned over to the compost staff assistant for further processing.

Troubleshooting

Troubleshooting guidelines are located in the manufacturer's manual.

Revisions

IMAP format and loaded into DDD.

OPERATION OF THE LOADERS

Purpose

Describe the process of normal Operations and troubleshooting of the Loaders

Description

A Loader is a machine designed to load, move and carry material around the compost site. Presently the Compost Operations has two Caterpillar 924G models and one 962H model.

Operations

Step	Action
1	Complete PM Check Sheet before Start-Up Reference: NZNA-CO-002.
2	Start up and operator loader according to manufacture's manual.
3	Shutdown loader according to manufacture's manual.
4	Complete end of day info on PM Check Sheet from step 1
5	Turn completed form into Compost Staff Assistant (CSA).
6	Completed form is filed in binder by (CSA).

Trouble shooting

Troubleshooting of the machine is included in the Maintenance section of the manufacturer's manual.

Revisions

Added Loader.

OPERATIONS OF THE GRINDER

Purpose

To establish a document that covers normal operations and troubleshooting of the Grinder.

Description

A Grinder is a machine that is used to ground bulky raw material into more manageable material that can be use for different functions across the Compost Facility. The present grinding machine onsite is a Rotochopper model MC266 and is located at the rear of the Compost Facility. This particular model comes with the color option for the dying of mulch.

Operations

Step	Action
1	Complete PM Check Sheet before Start-Up Reference: NZNA-CO-003
2	Start up and operate Grinder according to manufacturer's manual.
3	Shut down Grinder according to manufacturer's manual.
4	Complete end of day info on PM Check Sheet from Step 1.
5	Turn complete form into Compost Staff Assistant.
6	Complete form is filed in binder by (CSA).

Troubleshooting

Troubleshooting of the machine is included in the Maintenance section of the manufacturer's manual.

Revisions

IMAP format and loaded into DDD.

OPERATION OF THE MIXER

Purpose

Describe the normal operations and troubleshooting of the Mixer.

Description

The Mixer is multi-use machine designed to mix different material together for the purpose of blending. The compost facility uses a Kuhn Knight mixer for the blending of Raw materials into an unfinished compost mixture.

Operations

Step	Action
1	Complete PM Check Sheet before start-up Reference: NZNA-CO-005.
2	Receive recipe from Compost Manager.
3	Start up and operate Mixer according to manufacturer's manual.
4	Load mixer.
5	Open discharge door.
6	Close discharge door once truck is full.
7	Take truck with batch load to windrow area.
8	Record amounts of raw material in buckets on Form NZNA-CO-004.
9	Shut down Mixer according to manufacturer's manual.
10	Turn complete form into Compost Staff Assistant.
11	Complete form is filed in binder by (CSA).

Trouble-shooting

Troubleshooting of the machine is included in the Maintenance section of the manufacturer's manual.

Revisions

IMAP format and Loaded into DDD.

OPERATION OF THE TURNER and INDEXER

Purpose

Describe normal operations and troubleshooting of the Turner and Indexer.

Description

The Turner is a machine designed to turn composting Windrows in order to provide adequate mixture of oxygen, moisture and help in keeping a control temperature in the compost rows so that the bacterial organisms located in the Windrows can perform the duties of breaking down the carbon sources in the Windrows. Generally the Windrows are turned 1x/wk. The Compost Facility presently uses a Backhus 16.43 Turner with an Indexer. The Indexer is used to move the oldest windrows closer to the screen during the turning process.

Operations

Step	Action
1	Complete PM check sheet before start-up Reference: NZNA-CO-006.
2	Start-up and operate Turner and Indexer according to Manufacturer's manual.
3	Shut down Turner and Indexer according to Manufacturer's manual.
4	Complete end-of-day information on NZNA-CO-001.
5	Turn completed form into Compost Staff Assistant.
6	Completed form is filed in binder by (CSA).

Trouble shooting

Trouble shooting of the machine is included in the Maintenance section of the manufacturer's manual.

Revisions

The Indexer is used to move the oldest windrows closer to the screen during the turning process.

3	A moisture reading between 50-65% is optimum. Above 65% turn the windrow more frequently. Below 50% need to add water to the windrow.
4	pH beyond optimal ranges contact Compost Manager.

Revisions

IMAP format and loaded into DDD.

OPERATION OF THE SCREEN

Purpose

Describe normal operations and troubleshooting of the screen.

Description

The Screen is a machine designed to remove unwanted particles to ensure a consistent uniform product at the end of the screening process. The Compost Facility presently uses a McCloskey Brothers 516E screen for the purpose of screening the compost from the Windrows.

Operations

Step	Action
1	Complete PM Check Sheet before start-up Reference: NZNA-CO-007.
2	Start-up and Operate Screen according to Manufacturer's manual.
3	Take one bucket at-a-time of mature compost from Windrow using a loader. Reference: NZNA-CO-104.
4	Final product is moved to load out area on Compost pad.
5	Oversized material is moved to bulking bin to be reused in future Windrows.
6	Shut down Screen according to Manufacturer's manual.
7	Complete end of day info on NZNA-Co-001.
8	Turn completed form into Compost Staff Assistant.
9	Completed form is filed in binder by (CSA).

Trouble Shooting

Trouble shooting of the machine is included in the Maintenance section of the manufacturer's manual.

Revisions

IMAP format and loaded into DDD.

OPERATION OF WATER REUSE TANK

Purpose

The purpose of this document is to ensure proper operation of the water reuse on the compost site.

Description

The water reuse tank is a 3,000 gallon tank located at the southeast corner of the compost facility. The tank is located on the edge of the two leachate ponds and is white in color. The purpose of the tank is to supply water to certain operations within the compost facility. The water stored in the tank comes from the leachate ponds or from a well that provides fresh water to the compost site.

Operations

Step	Operation of the water reuse tank
1	Operation of the water reuse tank can be done either manually or by a remote control. If done manually, you have to go to the control panel located at the tank and turn the switches into the manual positions and then turn on the start button. The water valve that is being used has to be open in order to supply water to the operation. It is advised that the water valve is open so that you do not have pressure build up behind the water valve that will be used. The water reuse tank can also be operated automatically using the remote control. Leave the switches in the auto position at the tank control panel and use the on and off buttons on the remote.

Trouble-shooting

Step	Tank does not pump

1	• Check to make sure there is power at the tank by looking at the control panel. • The panel should be displaying the tank level in red LCD number. • If there is no power to the panel issue a work order notification for the maintenance department to investigate the problem. • If there is power then check the panel at the tank to see if the pump switch is in the auto or manual position. • If in the manual position push the reset button and then the start button. • If pump starts but you still have no water, check the manual water value under the tank to make sure it is open. • If switch is in the auto position, push the reset button and then the start button. • If pump starts and no water check the manual value under the water tank to make sure it is open. • If pump is running and the manual water value is open but still no water, issue a work order notification for the maintenance department to investigate.
Step	**Water running out of the top of the Tank.**
2	• Check to make sure pump switch is in the automatic position or manual position. If in the manual position turn the switch to off or the auto position. Pump should stop pumping. • If pump switch is in the auto position, high level indicator switch inside the tank has failed. Operators will manually turn off the switch to the stop position on the panel to stop the tank from filling. Then a work order notification is issue for the maintenance department to investigate.

Revisions

IMAP format and loaded into DDD.

PURPOSE OF WINDROWS

Purpose

To give guidelines on how to build windrows for the production of compost.

Description

Windrow building is done in a designated area so that material consisting largely of organic material can be broken down into a reuse material called compost. The Compost Facility is presently designed for 15 windrows with the average length between 500-600 feet long, 5-6 feet in height and 12 foot in width.

Operations

Step	Action
1	Operators will start windrows sequence numbering, beginning with row number 1 and ending with windrow number 15. Variation from this is a verbal approval from the compost manager.
2	Mix material is carried over from the Mixer by either a box truck or a Front-end loader to the South End of the Windrow area and placed in the designated windrow under construction.
3	There are pole markers located at the South and North ends of the windrow area to give the Operators guidance.
4	Building of the windrows will take several days and depends on the recipe mix.

Data Collection

Step	Action
1	Record data of mixture placed on each Windrow Reference: NZNA-CO-001.
2	Enter data into Windrow Manager software program.
3	Turn complete Form into Environmental Supervisor.
4	Review completed form.
5	File Form.

Revisions

IMAP format and loaded into DDD.

WINDROW MANAGEMENT & MONITORING OF WINDROWS

Purpose

Describe how to monitor the maturing process of the windrows by checking the temperature, oxygen and moisture.

Description

Windrows have a maturity date of 90 days. The production activity is monitored throughout the 90 day cycle by checking the temperature and oxygen 3x/wk, the moisture 1x/wk and the pH 1x/month. Presently Environmental Operators use a windrow manager probe and the Operators have to be familiar with operation of this probe and the manufacturer's manual.

Temp. & Oxygen Monitoring & Measurement

Step	Action
1	Take Temperature and Oxygen at different points every 60' along the Windrow, using the connecting probe and IPAQ unit.
2	After all Windrow data is collected, connect IPAQ unit to Compost computer.
3	Download data into the Windrow Manager software page.

Moisture Monitoring and Measuring

Step	Action
1	Collect samples from each Windrow.
2	Take samples to compost lab to determine the dry and wet weight of the Windrows by using compost oven.

pH Monitoring and Measurement

Step	Action
1	Compost sample is taken from the Windrows and shipped to the US Composting Council test methods for examination of compost as our parameters for sampling and conservation. Optimal pH is between 6 & 7.

Troubleshooting Guidelines

Step	Action
1	Windrow temperatures should be over 131 F for a 15 day period. Below 131 F consult Compost Manager for guidance.
2	An oxygen rating between 5-15% is optimum. Above 15% consult compost manager. Below 5% need to turn the windrow more frequently to add porosity, consult compost manager for guidance

MONITORING OF THE LEACHATE PONDS

Purpose

The purpose of this document is to ensure that the leachate ponds are monitored on a routine basis and includes troubleshooting.

Description

The leachate ponds are specially built ponds designed to hold and reuse water that leachates throughout the compost site. They are located in the southeast corner of the Compost Facility. A water reuse tank is located next to the ponds. The purpose of this tank is to pump the reuse water back into the Compost Facility for operational use.

The leachate ponds have a limited amount of storage and thus have to be monitored and operated in a way to ensure safety of the pond walls as well as the local environment outside of the Compost Facility. Since the ponds do have a limited amount of storage they need to be check frequently for depth levels. This process is done by visual inspection of the depth chain which is located in the first pond. The visual inspection is taken in the morning and the afternoon. The depth chain is measured in feet and inches. Below one foot is consider empty, Seven foot is where the ponds are consider full and run the risk of breaching the pond walls. At the 5 foot level on the depth chain action needs to be taken in order to bring the pond's levels back down to a safe zone of operation witch is at or below four foot.

A valve is located between the two ponds to help control individual levels of the ponds. As of present this valve is left open for operational purposes.

The levels of the ponds rise and fall due to reuse of the water back into the Compost Facility and by rain fall onto the Compost Facility.

Monitor and operations

Step	Monitoring and recording Leachate Pond AM
1	A visual inspection of the leachate ponds is done in the morning. Water level is recorded in feet and inches from the depth chain in the first pond on the Compost Dept. Operator worksheet (Form CO-001). If the ponds are at the 5 foot level Environmental Supervisor or Compost manager is notified.
Step	**Monitoring and recording Leachate Pond PM**
2	A visual inspection of the leachate ponds is done in the afternoon. Water level is recorded in feet and inches from the depth chain in the first pond on the Compost Dept. Operator worksheet (Form CO-001). If the ponds are at the 5 foot level Environmental Supervisor or compost manager is notified. Turned in the sheet at the end of the work day to the Environmental Operations supervisor.

Step	Record Keeping.
3	Data associated with the Leachate ponds is recorded on the Composting Dept. Operator Worksheet (Form CO-001). Composting Dept. Operator Worksheet (Form CO-001) is turned into the Environmental Supervisor for review and signature. The Environmental supervisor turns over the form to the Compost Staff assistance for filing into the binder for Composting Dept. Operator Worksheet.

Action

If the leachate pond is at 5 foot pumping should begin and should be done until ponds are at the safe level.To do this use trash pump to pump through the compost site's irrigation line and send the leachate water to Lagoon 3.

Trouble Shooting

Contact the Environmental Operations Supervisor or Compost Manager.

Revisions

IMAP format and loaded into DDD.

Moisture Monitoring - Input Sheet

Windrow Number	Date	Temperature Degrees C	Time In	Date	Time Out	Start Weight	End Weight	Tray Weight
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

1. Turn on oven and set dial to 4.5 = 75 degrees C.
2. Turn on scales and zero out.
3. Mark pans with windrow number.
4. Tare each pan record weight in Tray Weight column.
5. Add approximately 2 grams of compost from each windrow sampled and record weight in Start Weight column.
5. Place all pans inside oven for a minimum 4 hours.
6. Turn off oven before leaving for the day.
7. Return the next day to record weights.
8. Return Input sheet to FrFr

PM Check Sheet For : Cat Loader Model # Loader

All safety information,warnings, and instructions must be read and understood before you perform any operation or any maintenance.

Start of Day - Check:	Ok	Need Attention	/Action Taken
Leaks - any kind			
Engine oil			
Hydraulic oil			
Transmission oil			
Differential and final drive oil level			
Engine air precleaner			
Engine coolant			
Horn			
Lights			
Brakes			
Tire inflation			
Seat belt			
Window washer fluid			
Windows -clean			
Backup-alarm			

Action Items - Before Start	Done
Lubricate - 2 pumps on all ports & front end	
Fuel system water separator - drain	
Start engine - let run for 3 minutes to warm up	

End of Day:	Done
Shut Down - let engine run for 3 minutes to cool down	
Engine air precleaner-clean out bowl	
Clear cab of any trash	
Park loader & apply parking brakes & Lower Bucket	
Check under loader in Park Brake area for material build up	
Lock all doors and remove all keys	
Hand in this sheet before leaving	

Engine Hours	Hours			
Start of day engine hours				
End of day engine hours				
Operator name :				
Date:				
********** No Smoking in Cab of Loader *********				

PM Check Sheet For : Backhus 16.43 Turner

All safety information,warnings, and instructions must be read and understood before you perform any operation or any maintenance.

Start of Day - Check:	Ok	Need Attention	/Action Taken
Leaks - any kind			
Engine oil level			
Hydraulic oil level			
Differential and final drive oil level			
Engine air filter			
Engine coolant			
Horn			
Lights			
Track Tension			
Check around final drives			
Track cleaners for free operation			
Rotor drive seal			
Rotor teeth			
Cab air filters			
Reset water meter			
Seat belt			
Windows -clean			
Fire extinguiser			
Backup-alarm			

Monthly	Done	
Check final drive to drive sprocket bolts		
Start engine - let run for 3 minutes to warm up		

End of Day:	Done	
Shut Down - let engine run for 3 minutes to cool down		
Clear cab of any trash		
Park turner & apply parking brakes & lower rotor		
Lock all doors and remove all keys		
Hand in this sheet before leaving		

Engine Hours	Hours		
Start of day engine hours			
End of day engine hours			

Operator name :

Date:

********** **No Smoking in Cab of Turner** *********

COMPOST DEPARTMENT MIX SHEET

DATE: _____ WINDROW # _____

INITIALS: _____ BATCH # _____

BUCKET TYPE:

SMALL ☐ 3.25 CY RECIPE # _____

LARGE ☐ 6.5 CY

MIXER BATCH #1				
FEEDSTOCK	QTY		RUNNING TOTAL	
BULKING MATERIAL		BUCKETS		LBS
WAS		BUCKETS		LBS
NEW SAWDUST		BUCKETS		LBS
OLD SAWDUST		BUCKETS		LBS
TOTAL		BUCKETS		LBS

MIXER BATCH #2				
FEEDSTOCK	QTY		RUNNING TOTAL	
BULKING MATERIAL		BUCKETS		LBS
WAS		BUCKETS		LBS
NEW SAWDUST		BUCKETS		LBS
OLD SAWDUST		BUCKETS		LBS
TOTAL		BUCKETS		LBS

MIXER BATCH #3				
FEEDSTOCK	QTY		RUNNING TOTAL	
BULKING MATERIAL		BUCKETS		LBS
WAS		BUCKETS		LBS
NEW SAWDUST		BUCKETS		LBS
OLD SAWDUST		BUCKETS		LBS
TOTAL		BUCKETS		LBS

MIXER BATCH #4				
FEEDSTOCK	QTY		RUNNING TOTAL	
BULKING MATERIAL		BUCKETS		LBS
WAS		BUCKETS		LBS
NEW SAWDUST		BUCKETS		LBS
OLD SAWDUST		BUCKETS		LBS
TOTAL		BUCKETS		LBS

PM Check Sheet for Screen

Operator_____

Date_____

Check and/or Perform once daily

Hydraulic oil level. Refill as necessary	☐
Flow control settings	☐
All items running clear & free from obstruction	☐
Conveyor belt aligment. Track belt if necessary	☐
Remove all debris from the machine that may cause build up	☐
Lubricate all 4 tormemmel drum support roller bearings using EP2 Lithium bearing grease	☐
Lubricate all conveyor bearings using EP2 Lithium bearing grease	☐
Ensure trommel cleaning brush bristles project about 1/4" through the screen mesh	☐
Safety inspection of the machine	☐
Hours	☐

Comments:

Soil Control Lab - Chain of Custody Log

STA Laboratory:	Soil Control Lab	*Tel:*	(831) 724-5422
Contact:	Frank Shields	*FAX:*	(831) 724-3188
Address:	42 Hangar Way	*Email:*	Frank@ Compostlab.com
City, State Zip code:	Watsonville, CA 95076		

Client/Reporting Company:		*Tel:*	
Contact Name:		*FAX:*	
Billing Address:		*Email:*	
City, State Zip code:			
Send Results to:			
Company / Name:			
Address:			
City, State, Zip Code:			

LABORATORY USE ONLY - **Storage Locations**

Freezer _____ Cold Room _____ Storage Shelf _____

Sample Condition:

Sample Type: O COMPOSITE O POINT O STRATIFIED

P.O. Number:

Client STA ID:

USCC Member: O YES O NO ID:

Description of Analysis: *Refer to http://tmecc.org/sta for details.*
STA Suite; 503 Rule Tests; Other – Specify additional tests in fields A to D.
NOTE ! *Your selection of **STA Suite** (below) authorizes laboratory personnel to send all required STA analytical results directly to STA program management.*

A	B	C	D

Client Sample Identification (special instructions)	*Collection Date/Time*	*Sample Matrix*	*Sample Container*	*Shipping Temp.*	*Selected Analysis* STA	503	A	B	C	D	*Lab Number*
1	*Date:*	Compost O	Plastic Bag O	Ambient O	O	O	O	O	O	O	
	Time:	Feedstock O	Pail O	Ice O							
	Initials:	O	O	O							
2	*Date:*	Compost O	Plastic Bag O	Ambient O	O	O	O	O	O	O	
	Time:	Feedstock O	Pail O	Ice O							
	Initials:	O	O	O							
3	*Date:*	Compost O	Plastic Bag O	Ambient O	O	O	O	O	O	O	
	Time:	Feedstock O	Pail O	Ice O							
	Initials:	O	O	O							
4	*Date:*	Compost O	Plastic Bag O	Ambient O	O	O	O	O	O	O	
	Time:	Feedstock O	Pail O	Ice O							
	Initials:	O	O	O							
5	*Date:*	Compost O	Plastic Bag O	Ambient O	O	O	O	O	O	O	
	Time:	Feedstock O	Pail O	Ice O							
	Initials:	O	O	O							

Releasing Signature 1	*Date*	*Time*	*Receiving Signature 1*	*Date*	*Time*
Releasing Signature 2	*Date*	*Time*	*Receiving Signature 2*	*Date*	*Time*
Releasing Signature 3	*Date*	*Time*	*Receiving Signature 3*	*Date*	*Time*
Releasing Signature 4	*Date*	*Time*	*Receiving Signature 4*	*Date*	*Time*

W. .e Analysis Information Sheet

North Carolina Department of Agriculture and Consumer Services
Waste Analysis Section, Agronomic Division
4300 Reedy Creek Road
Raleigh, NC 27607-6465

SAMPLE TYPE **Predictive** **Diagnostic**
(circle one / see instructions)

GROWER INFORMATION

Telephone No. ( )

(LAST NAME) (First)

(Address)

(City) (State) (ZIP)

(County)

Check ( )
Money Order ( )
Cash ( )
Escrow _____ Account Name

PAYMENT: $4.00 per sample
Make checks payable to NCDA&CS
No. Samples _____ **Payment** _____

CONSULTANTS TO RECEIVE ADDITIONAL COPIES

Telephone No. ( )	Telephone No. ( )
(LAST NAME) (First)	(LAST NAME) (First)
(Address)	(Address)
(City) (State) (ZIP)	(City) (State) (ZIP)

All Agronomic Division reports are accessible via the internet at www.ncagr.com/agronomi

Farm ID:_____ Sampled by:_____ Date:_____

Lab Num (Lab Use)	Sample ID	Waste Code	Sample Description / Comments	Application Methods		Corresponding Sample ID: Soil	Plant	Solution	Lab Use

HOW TO FILL OUT THE INFORMATION SHEET

Sample Type — Predictive is for a routine check of nutrient content plus interpretation and general recommendations. Diagnostic is for special assistance in solving suspected nutritional problems. Specific interpretation and recommendations are provided.

Grower Information — Print telephone, name, mailing address, county (sample origination) and fee information.

Farm ID — Provide farm identification or location (no more than 16 letters).

Sample ID — Provide sample identification (no more than six digits or letters). Put the same ID on sample containers.

Waste Code — Identify the type of waste in the sample by using codes (see back of information sheet).

Sample Description / Comments — Provide additional descriptive information, especially if a specific waste code is not identified. Give a brief statement of problem or purpose in sampling (necessary for diagnostic samples).

Application Methods — Select one or two application methods from the list at the right for estimation of nutrient availability.

Corresponding Sample ID — List the ID's of any matching soil, plant, and solution samples submitted.

APPLICATION METHODS

BR = Waste broadcast on soil surface and left uncovered for one week or longer

SI = Waste broadcast on soil surface and plowed or disked into soil within two days

IN = Waste injected directly into the soil and covered immediately

IR = Waste applied through irrigation system and left uncovered for one week or longer

Form AD9 March 2003

USCC STA TESTING PROGRAM

Homepage

Conference
--Workshops
--Program
--EquipDemo
--Exhibitor Info
--Registration
--Sponsorships
--Hotel Info
--Showcase

Board Elections

STA
--Program
--Members
--Benefits
--Labs
--News
--Test Params
--Contacts

Compost Week

About USCC
--Board

Membership

Projects

Publications

Training

Calendar

TMECC

Storefronts

FAQs

Help Wanted

Links

Feedback

Search!

Seal of Testing Assurance Program

IF IT ISN'T STA COMPOST
WHAT IS IT?

Dear friend of composting and the environment:
The question posed above may, at first glance, appear to be a bit silly. However, if you really think about making compost, specifying compost or purchasing compost, don't you want to have more information than just the generic word "compost"? No one walks into a supermarket and buys a box of "cereal", or purchases a bag of "fertilizer" from the garden center. They seek out those products that provide them with a product description, a specific list of ingredients or contents AND instructions on how to use the product, where appropriate. Isn't this how every consumer product in this country is packaged and sold? Isn't this the way all commercial products are purchased too? Shouldn't these same common sense standards apply to compost products?

The information contained in this packet explains the details of the United States Composting Council's ("USCC") Seal of Testing Assurance ("STA") program. The USCC's goal is to have all composters participate in this program AND to have compost specifiers, regulators and users accept ONLY STA compost for their specific projects. It is our belief that this program is of immense benefit to both composters and compost users. These reasons will hopefully become clear after reading this letter and the enclosed information.

How does the STA program work?

1. Compost producers regularly sample and test product, using STA Program approved labs, for chemical, physical and biological properties. All of these labs must use the same standardized testing methodologies.

2. Testing frequency is based on the production facilities volume and can be as frequent as monthly for the largest producers, to quarterly for the smaller composter.

3. The laboratory data will be made available to both the USCC (STA program management staff) and the compost producer (who, in turn, will provide it to compost specifiers and customers). Again, the only STA program "standards" placed on the compost products are that they

MEMBERS ONLY
Login or Register

be properly tested – we do not place numerical standards on the actual test results (outside of our health/safety standards, and any applicable state and federal regulations).

4. Compost use directions will be made available to all compost customers by the STA Program participant. These will be included in the STA "Compost Technical Data Sheet" along with the laboratory analysis and the product ingredients. This standard label allows end users and specifiers to compare compost products and make an informed purchasing decision.

5. The USCC will, upon receipt of the laboratory test data, fees and other required program information, certify the program participant's compost as "STA certified compost" and permit the use of the STA logo on all literature and bagged product.

Getting Started

THE STA PROGRAM BROCHURE

THE STA GETTING STARTED CHECKLIST

If you need more information Please contact a program manager.

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Homepage

Conference
--Workshops
--Program
--EquipDemo
--Exhibitor Info
--Registration
--Sponsorships
--Hotel Info
--Showcase

Board Elections

STA
--Program
--Members
--Benefits
--Labs
--News
--Test Params
--Contacts

Compost Week

About USCC
--Board

Membership

Projects

Publications

Training

Calendar

TMECC

Storefronts

FAQs

Help Wanted

Links

Feedback

Search!

EVALUATING COMPOST QUALITY

What do the test results mean?

Since growing conditions and plant requirements vary, compost users can benefit from information that accurately characterizes the compost products they use. This data can improve the utilization of compost in ways to best meet particular needs and to fit a specific situation. The specific characteristics of a compost product determines how, and in which applications it can be best utilized. Characterization data helps the compost user obtain product that is appropriate for use with their project or application.

Pertinent Compost Characteristics

pH pH is the measure of acidity (or alkalinity), or hydrogen ion activity of a soil or compost (on a logarithmic scale). The pH scale ranges from 0 to 14, with a pH of 7 indicating neutrality. A pH change of 1 unit means a 10-fold increase or decrease of acidity. Most composts have a pH of between 6 and 8. Each specific plant species requires a specific pH range. Based on the amount of compost applied, as well as it's pH, its addition can affect the pH of the soil or growing media. Therefore, to estimate the effect, which in turn will affect maintenance practices or system management, pH is a necessary parameter of which to be aware. Soil pH is often adjusted through the utilization of materials such as lime (to raise pH) and sulfur (to lower pH). When liming agents are used in the production of the compost product you use, or are present in the source materials of the compost, it may be more or less appropriate for your specific application (please confer with your compost supplier).

SOLUBLE SALTS (Conductivity) Soluble salts refers to the amount of soluble ions in a solution of compost and water. The concentration of soluble ions is typically estimated by determining the solution's ability to carry an electrical current, i.e., electrical conductivity. The units of measure for soluble salts are either mmhos/cm or dS/m (they are 1:1 equivalent). Plant essential nutrients are actually supplied to plants in a salt form. While some specific soluble salts, (e.g., sodium, chloride), may be more detrimental to plants, most composts do not contain sufficient levels of these salts to be a concern in landscape applications. Plant species have a salinity tolerance rating and maximum tolerable quantities are known. Excess soluble salts can cause phytotoxicity to plants. Compost may contribute to, or dilute, the cumulative soluble salts content of a growing media or soil. Reduction in soluble salts

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content can be achieved through thorough watering at the time of planting. Most composts have a soluble salt conductivity of 1.0 to 10.0 dS/m, whereas typical conductivity values in soil range from 0 to 1.5 in most areas of the country.

NUTRIENT CONTENT (N-P-K) Nitrogen (N), Phosphorus (P, usually expressed as P2O5), and Potassium (K, usually expressed as K20) are the three nutrients utilized by plants in the greatest quantities, and therefore, are the nutrients most often contained in commercial and retail fertilizers. When purchased in bags of fertilizer, these three nutrients are measured and expressed on a dry weight basis, in the form of a percentage (%). In compost, nutrient content may be expressed on a dry, or wet weight (as received) basis. Knowing the content of these nutrients will help you make correct decisions regarding the addition of supplemental fertilization. Although concentrations of nutrients found in compost are typically not high, in comparison to most fertilizer products, compost is usually applied at much greater rates, and therefore, can represent a significant cumulative quantity. The nutrient content of compost products vary widely; however, biosolids and animal manure based composts typically contain more total nutrition. The use of certain composts may reduce or eliminate the necessity to fertilize certain plants during the first 6 –12 months following its application. In general, nutrients found in compost are in an 'organic' form thus released slowly as the compost decomposes. Aside from N, P and K, Calcium (Ca) and Magnesium (Mg) are also monitored in STA Program testing. The content of these nutrients are reported in the STA Compost Technical Data Sheet on both a dry weight basis (just like fertilizers), and on 'as received' or 'wet weight' basis (because composts contain a much higher amount of moisture, than do fertilizers).

ORGANIC MATTER Organic matter content is the measure of carbon-based materials in compost. Organic matter content is typically expressed as a percentage of dry weight. Organic matter in an important ingredient in all soils and plays an important role in soil structure, nutrient availability, and water holding capacity. Being aware of a product's organic matter content is useful for estimating the age and physical properties of the compost. It may also be necessary for determining compost application rates on certain applications, such as turf establishment and agricultural crop production. In these applications, standard agricultural soil test kits are often used to determine recommended application rates of organic matter. However, these application rates are specified as the quantity of organic matter needed on a per acre basis. Therefore, the organic matter content of the compost must be known in order to convert the suggested application rate into a usable form (tons/acre). There is no ideal

organic matter content for compost, and it may vary widely, ranging from 30 to 70%.

MOISTURE PERCENT Moisture percent (content) is the measure of the quantity of water present in a compost product; expressed as a percentage of total weight. The moisture content of compost affects its bulk density (weight per unit volume) and, therefore, affects handling and transportation. Overly dry compost (35% moisture, or below) can be dusty and irritating to work with, while very wet compost (55 to 60%) can become heavy and clumpy, making its application more difficult and delivery more expensive. A preferred moisture percent for finished compost is 40 -50%.

PARTICLE SIZE The way in which compost particle size is measured, and expressed, is typically based on the product's end use. For most applications, merely specifying the product's maximum particle size, or the screen size through which it passes, is sufficient. However, for certain applications, such as golf 'greens' mix or potting media production, a complete particle size distribution may be required. Particle size distribution measures the amount of compost meeting a specific particle size range, by using a series of sieves (screens) to capture compost particles of specific size. A compost product's particle size may also determine its usability in specific applications. For example, a compost product with a maximum particle size of 1/2 inch or greater may not be acceptable as a turf top-dressing, whereas a product with a maximum particle size of 1/4 to 3/8 inch or less could be acceptable. Most composts that are used as soil amendments are screened through a 3/8 or 1/2 inch screen.

MATURITY (BIOASSAY) Maturity is the degree or level of completeness of composting. Maturity is not described by a single property and therefore, maturity is best assessed by measuring two or more compost characteristics. Some immature composts may contain high amounts of free ammonia, certain organic acids or other water-soluble compounds which can limit seed germination and root development, or cause odor. All uses of compost require a mature product free of these potentially phytotoxic components. The bioassay used in the STA Program uses a seed germination and growth test to measure the percent of seed emergence and relative seedling vigor.

STABILITY (RESPIROMETRY) Stability refers to a specific stage or state of organic matter decomposition during composting, which is related to the type of organic compounds remaining and the resultant biological activity in the material. The stability of a given compost is important in determining the potential impact of the material on nitrogen availability in soil or growth media, and maintaining consistent

volume and porosity in container growth media. Most uses of compost require a stable to very stable product that will prevent nutrient tie up and maintain or enhance oxygen availability in soil or growth media.

INERTS Man-made inerts consist of materials created by humans and may be a part of the waste stream. These include: textiles, glass, plastic, and metal objects. When put into the composting process, these materials are not decomposed but may be degraded to some extent in physical characteristics, primarily through size reduction. These materials can decrease the value of the finished compost product because they offer no benefit to the compost and, in many cases, are aesthetically offensive. A common means of controlling man-made inerts is to minimize their entry into the waste stream being composted. Control is also accomplished through separation at the source during feedstock recovery at the composting facility, or during product refinement, (e.g., screening, ballistic separation). Other 'non' man-made inerts, such as stones, rocks, twigs, may also be found in compost and are considered to be aesthetically offensive.

TRACE METALS Trace metals are elements whose concentrations are regulated due to the potential for toxicity to humans, animals, or plants. Regulations governing the heavy metal content of composts derived from certain feedstocks have been promulgated on both the State and Federal levels. Similar limits have even been developed for fertilizers and certain other horticultural and agricultural products. Specific trace elements, often referred to as heavy metals include arsenic, cadmium, chromium, copper, lead, mercury, molybdenum nickel, selenium, and zinc. The quantity of these elements are measured on a dry weight basis and expressed as mg/kg (milligram per kilogram) or ppm (parts per million). Many of these elements are actually needed by plants for normal growth, although in limited quantities. Therefore, measuring the concentration of these elements, as well as other plant nutrients, can provide valuable management data relevant to the fertilizer requirements of plants and subsequent fertilizer application rates. Certain heavy metals and trace elements are also known to cause phytotoxic effects in plants (when available in very high quantities), and specific plant species are known to be more sensitive than others. These elements include boron, manganese, molybdenum, nickel, and selenium. However, these elements are not typically found in compost in detrimental quantities. All composts that contain regulated feedstocks must meet national and/or state safety standards in order to be marketed.

WEED SEED AND PATHOGENS Pathogens are disease causing organisms including, bacteria, viruses, fungi, helminths, and protozoa which may be present in raw wastes or by-products. Both plant and

human pathogens are found in living organisms and are present at some background levels in the environment. Therefore, the composting process must eliminate or reduce pathogens to a level that is below the threshold where the danger of transmitting diseases will occur. Weed seeds and pathogens are inactivated or destroyed by elevated temperatures over a period of time within the composting process. The time-temperature relationship used as the Process to Further Reduce Pathogens effectively destroys weed seeds and pathogens in compost. The time-temperature requirement ensures plant and human pathogen destruction in compost, and is considered an effective means to determine that compost is relatively weed free.

For additional information, or numerical test analysis data regarding any of these compost characteristics, ask your Seal of Testing Assurance compost supplier

Download the STA Sample Collection Protocol & STA Chain of Custody Form

STA COMPOST PRODUCERS

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Test Methods for the Examination of Composting and Compost

JOINTLY PUBLISHED BY THE UNITED STATES DEPARTMENT OF AGRICULTURE AND THE UNITED STATES COMPOSTING COUNCIL

Prepared for:

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01.01 TMECC MANUAL CONTENT

01.01-A PURPOSE

1. Compost Quality Verification

1.1 *Test Methods for the Examination of Composting and Compost*—TMECC provides detailed protocols for the composting industry to verify the physical, chemical, and biological condition of composting feedstocks, material in process and compost products at the point of sale. Material testing is needed to verify product safety and market claims. TMECC provides protocols to sample, monitor, and analyze materials at all stages of the composting process, i.e., prior to, during and after composting to help maintain process control, verify product attributes, assure worker safety, and to avoid degradation of the environment in and around the composting facility.

01.01-B FOREWORD

2. Manual Development

2.1 *Test Methods for the Examination of Composting and Compost*—TMECC is a laboratory manual modeled after *American Society for Testing and Materials (ASTM)*. TMECC provides benchmark methods for compost analysis to enable comparison of analytical results. Each parameter is presented in its own section and generally includes more than one protocol or test method. The manual contains more parameters than might be of concern or interest for a particular situation.

2.2 *The Standards and Practices, and Market Development Committees of the US Composting Council* developed a list of pertinent compost product attributes. Some compost parameters are regulated for the protection of public health, safety, and the environment, while others are product performance attributes that are important for managing specific applications. Other test parameters and their methods are of academic interest for research applications.

2.2.1 Detailed instruction is presented for sample collection, preparation, analysis and reporting to address all phases of composting, feedstock evaluation, the composting process, and final compost product characterization.

2.2.2 Sections are grouped into chapters that cover sampling and sample preparation (02); physical properties (03); inorganic chemical properties (04); organic and biological properties (05); organic contaminants (06); and pathogens (07).

2.2.3 Each section includes a brief description of the parameter's function in the composting process, for safety of the product, or in product performance.

01.01-C REFERENCED METHODS

3. List of Sources

3.1 Testing procedures included in TMECC were adapted for compost analysis and are based upon, or developed from the following reference sources:

Analytic procedures used in US EPA Report SW-846, Test Methods for Evaluating Solid Waste, 3rd Edition, November 1990, as revised.

Association of Official Analytical Chemists (AOAC) Official Methods of Analysis, 1990, 15th edition.

Methods of Soil Analysis, Parts I, II and III. Soil Science Society of America. 1996

North Central Regional (NCR) Publication No. 221 (Revised). Recommended Chemical Soil Test Procedures for the North Central Region Bulletin No. 499 (Revised) October 1988 "Recommended Test Procedures for Greenhouse Growth Media".

Standard Methods for the Examination of Water and Wastewater, 18th Edition, 1992.

The American Society for Testing and Materials (ASTM) Standard Test Methods, 1988.

01.02 THE COMPOSTING PROCESS

01.02-A KEY PROCESS VARIABLES

1. Management of Key Process Variables

1.1 Process control parameters include initial carbon to nitrogen and carbon to phosphorus ratios, pile structure and porosity, pile oxygen percent, pile moisture percent, and pile temperature. Process management includes aggregate size distribution (particle size), additives and amendments, biological activation and microbial diversity, turning and mixing, aeration, pH and pathogen and weed seed reduction. Odor production must be minimized and in many cases treated before discharge. Odor management is discussed in two parts, odor control and odor treatment. The management of process control operating parameters is presented in the *Compost Facility Operating Guide,* US Composting Council, 1994 and in *Municipal-Scale Composting: A decision Makers Guide to Technology Selection - Composting for Municipalities; Planning and Design Considerations,* Natural Resource, Agriculture, and Engineering Service, Cornell University, 1998 (Bulletin NRAES-94).

1.2 *Key Process Variables* define conditions in the pile for composting. The *Key Process Variables* must be managed during the composting process to ensure consistent marketable product in the shortest time see Table 01.02-A1 Management of Key Process Variables.

1.2.1 *Pile Porosity* is a measure of the space between adjacent particles needed for circulation of air and a film of moisture that surrounds particles.

1.2.2 *Feedstock Nutrient Balance* is the carbon to nitrogen ratio [C:N] and initial carbon to phosphorus ratio [C:P] needed for vigorous microbial activity and complete degradation/stabilization.

1.2.3 *Pile Oxygen Percent* indicates the exchange of carbon dioxide and other gasses generated through microbial metabolic activity. An adequate supply of oxygen promotes aerobic activity that minimizes odor generation associated with anaerobic conditions.

1.2.4 *Pile Moisture Percent* is measured to ensure that sufficient moisture is available within and around each particle such that pores are not completely filled with water (leading to anaerobic conditions) but sufficient to create a moisture film around each particle that supports microbial growth and enzymatic activity. Pile moisture above 35% will aid in dust control.

1.2.5 *Pile Temperature* is a measure of heat generation by catabolic activity of thermophilic bacteria. A sustained pile temperature above 55°C kills pathogens and most weed seeds. Eventually, after significant degradation of the readily available organic matter, pile temperatures decrease and a period (curing stage) ensues during which mesophilic microbes (actinomycetes, bacteria, and fungi) begin the slower rate decomposition of the less readily available energy sources (hemicellulose, cellulose, lignocellulose and lignin).

1.2.6 *Retention Time* under various temperature regimes ensures full stabilization of feedstocks, and full degradation of organic phytotoxins that form during the early stages of composting and during the initial stages of curing.

Table 01.02-A1 Management of Key Process Variables.

KEY PROCESS VARIABLES	FEED-STOCK	PROCESSING STEPS						
	Feedstock Collected and Delivered	*Step 1:* Feedstock Recovery	*Step 2:* Feedstock Preparation	*Step 3:* Composting	*Step 4:* Odor Treatment	*Step 5:* Compost Curing	*Step 6:* Compost Screening and Refining	*Step 7:* Compost Storing and Packaging
Pile Porosity	✓	✓	✓	✓	✓	✓	✓	✓
Feedstock Nutrient Balance	✓	✓	✓					
Pile Oxygen Percent			✓	✓	✓	✓		✓
Pile Moisture Percent			✓	✓	✓	✓	✓	✓
Pile Temperature				✓		✓		
Retention Time			✓	✓	✓	✓		✓

2. Product Attribute Check-List

2.1 A check list of product attributes, feedstock choices, and process steps where compost producers can intervene to manage and control product attributes is presented in Table 01.02-A2 Management of Product Attribute Development.

2.2 An appropriate sampling and testing plan must be designed specifically for each process step and each finished product. Refer to *TMECC 02.01 Sample Collection and Preparation* for guidance.

Table 01.02-A2 Management of Product Attribute Development.

PRODUCT ATTRIBUTES	MANAGEMENT OF PRODUCT ATTRIBUTE DEVELOPMENT							
	Feed-Stock	Processing Steps						
	Feedstock Collected and Delivered	*Step 1:* Feedstock Recovery	*Step 2:* Feedstock Preparation	*Step 3:* Composting	*Step 4:* Odor Treatment	*Step 5:* Compost Curing	*Step 6:* Compost Screening and Refining	*Step 7:* Compost Storing and Packaging
SAFETY REQUIREMENTS								
Regulated elements	✓	✓	✓	✓		✓	✓	
Pathogens			✓	✓		✓		✓
MARKET ATTRIBUTES								
Man-made inerts	✓	✓					✓	
Growth screening	✓	✓	✓	✓	✓	✓		✓
Biological stability	✓	✓	✓	✓	✓	✓		✓
Organic matter content	✓	✓	✓	✓	✓	✓		
pH	✓	✓	✓	✓	✓	✓		✓
Soluble salt content	✓	✓						
Water-holding capacity	✓	✓	✓	✓	✓	✓	✓	
Bulk density			✓	✓	✓	✓	✓	✓
Sieve size and Porosity			✓	✓	✓	✓	✓	
Moisture content			✓	✓		✓	✓	✓
Plant nutrient content	✓	✓	✓	✓	✓	✓		✓

3. Process Steps and Test Method Selection

3.1 The composting process can be generally characterized by Fig 01.02-A1 Composting Process Model.

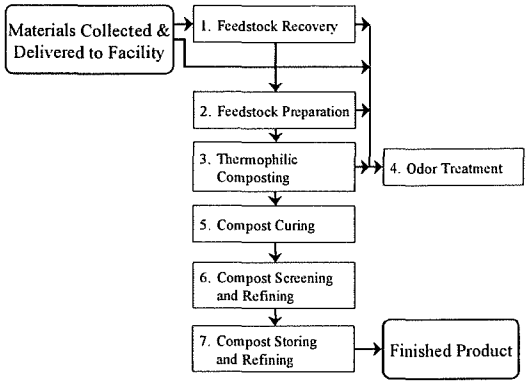

Fig 01.02-A1 Composting Process Model.

3.2 Processing steps 1, 3, 5, 6, and 7 increase the value of finished product, and require some investment in equipment, time and labor. Parts of these steps may include specific criteria to comply with operating permit requirements, (e.g., pathogen treatment during step 3 composting, and perhaps during step 5 compost curing). The optional portions that can increase market value should be undertaken only if the value added can be covered by sales returns. The Composting Products Model (Fig 01.02-A2) shows sources for products that may match customer and user needs without adding unwanted and unnecessary value that will not be compensated with product sales revenue.

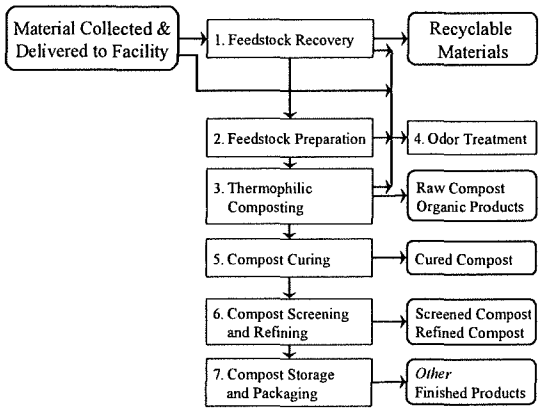

Fig 01.02-A2. Composting Products Model

3.3 Sampling and testing of feedstock and material undergoing biological degradation is required to provide the necessary data for process control.

3.4 Test methods were developed to manage the broad range of data needed by processors and marketers. Each test method is introduced with a header; refer to Table 01.02-A3 Test Method Header. The header shows the Test Method name and Units of measurement and a checklist of Test Method Applications either to the management of process unit operations steps one through seven, and verification of

Product Attributes for compliance with safety standards and market specifications.

Table 01.02-A3 Test Method Header.

Test Method: Parameter. Test Name							**Units:**	
Test Method Applications								
Process Management							**Product Attributes**	
Step 1: Feedstock Recovery	*Step 2:* Feedstock Preparation	*Step 3:* Composting	*Step 4:* Odor Treatment	*Step 5:* Compost Curing	*Step 6:* Compost Screening and Refining	*Step 7:* Compost Storing and Packaging	*Safety Standards*	*Market Attributes*

4. Process Management Discussion

4.1 *Step 1: Feedstock Recovery*—Recovery of feedstock is the separation of compostable material from non-compostable material, hazardous waste, and other contaminants that can impact compliance with compost quality requirements. Recovery can occur at various stages of the process, such as sorting by the generator, collection at curbside, and delivery to a central processing facility where final separation takes place. For example:

4.1.1 Recovery of compostable feedstock from leaves, brush and yard trimmings source-separated by the generator commonly includes the following: (1) accumulation in a separate container by the generator; (2) curbside and other collection and delivery to a central processing facility; (3) opening and removing plastic bags, if present; and (4) removing non-compostable and contaminant material that can accompany leaves, brush and yard trimmings (e.g., lumber scraps, toys, garden hoses, used vehicle oil and air filters, aerosol cans, bricks, concrete and rocks, and plastic bags).

4.1.2 Recovery of compostable feedstock from municipal solid waste is more complex. Two options exist. Option one relies on generators to presort the compostable and compost compatible material (based on a list of acceptable materials provided to them) into a container that is placed at curbside for collection. Collection can be either separate from other recyclable and waste material, or commingled with other waste and secondary resource material. Option two consists of curbside collection of the generator's accumulation of material mixed to some degree (as specified) with other household non-hazardous waste. Collection can be either separate from other recyclable material, or commingled. After delivery to a central processing facility, material received from both options are handled and processed in essentially the same manner, because both include not less than 3 to 11% "mistakes" that must be identified and removed from composting feedstock material. "Mistakes" can include recyclable material and material that can potentially cause compost quality problems.

4.1.3 Recovery includes: (1) collection and perhaps segregation of presorted material at curbside by a matching segregation at the side of the collection truck(s); (2) delivery to a central processing facility; (3) recovery of marketable material for recycling, e.g., old newsprint and corrugated cardboard, ferrous, aluminum, glass, etc.; (4) perhaps recovery of refuse-derived fuel; (5) separation of oversize material; (6) removal of non-compostable materials, e.g., stones and cigarette filter tips; (7) removal of other materials potentially detrimental to compost quality; and (8) recovery of compostable material. (Removal of some non-compostable material can take place after composting is complete, if the material being removed does not cause chemical contamination that prevents compliance with either regulatory or market quality standards.)

4.1.4 Separation at a central facility is generally by a combination of manual and mechanical methods, and is shown on the schematic diagram as separation of recyclables, refuse-derived fuel, and rejects disposal.

4.1.5 After recovery, the feedstock is ready to be prepared for composting. For two compostable feedstock sources, namely source-separated municipal solid waste and mixed municipal solid waste, the recovered feedstock is sometimes called mixed organic material.

4.2 *Step 2: Feedstock Preparation*—The feedstock preparation step may include physical processing and the addition of compost compatible materials which imparoves composting efficiency. Feedstock preparation may include the following:

4.2.1 Addition of carbon, nitrogen and phosphorus sources by mixing two or more feedstocks to establish a desired ratio of carbon to nitrogen, and perhaps carbon to phosphorus, to control odor generation, and to achieve market requirements for product stability.

4.2.2 Adjusting initial porosity to satisfy requirements for free airspace (to aid oxygen and gas exchange) and water-holding capacity (moisture). Reducing the particle size through shredding or tumbling increases surface area, helps creates uniform particle size, improves aeration (if particles aren't too small), and reduces volume. An alternative is particle size selection through screening. Adding a bulking agent, such as wood chips, to increase porosity and aid

air flow through the composting mass is normally necessary.

4.2.3 Adding water to the feedstock to adjust the moisture level to a desirable range.

4.2.4 Adding a small volume of compost that is in its peak heat thermophilic phase can 'jump start' the process by providing a cross-section of biological species for rapid colonization and biological activity.

4.2.5 Mixing to homogenize the feedstock, starter compost, and other additives, to distribute water uniformly, and to break down oversized particles of feedstock.

4.3 *Step 3: Composting*—Composting is a natural biological degradation process that is controlled and accelerated at a composting facility. Composting is the transformation of biologically decomposable material through a controlled process of biooxidation that results in the release of carbon dioxide, water, and minerals, and in the production of stabilized organic matter (compost or humus) that is biologically active. Because the biological process of composting follows a similar course regardless of the organic materials that are present in the feedstock, the schematic diagram (Fig. 01.02-A1) shows composting as a step common to each feedstock and one that may include the following:

4.3.1 Aeration to maintain optimum conditions for aerobic microbial activity, to supply oxygen, to buffer pH and immobilize ammonium, to remove heat, to remove carbon dioxide, to remove moisture, to strip volatile compounds, and to avoid anaerobic conditions and odor generation.

4.3.2 Temperature control to reduce pathogens to background levels and destroy weed seeds, and to maximize the rate of decomposition both during the high temperature thermophilic phase and afterward during the mesophilic phase.

4.3.3 Addition of make-up water to maintain moisture content for aerobic conditions, and to maximize organic decomposition.

4.3.4 Mechanical agitation or turning to thoroughly mix make-up water uniformly throughout the decomposing mass, to break up air channels and clumps, to prevent fly reproduction, and to produce a uniform product.

4.4 *Step 4: Odor Treatment*—Process air is captured and routed through a biofilter or other positive treatment method. In a biofilter, operating conditions must favor porosity, ample oxygen and moisture to ensure conditions highly favorable to active microbial populations that are not associated with odor-causing compounds such as hydrogen sulfide, volatile fatty acids and ammonia.

4.5 *Step 5: Compost Curing*—Customers that require a mature product may specify a greater degree of product biological stability. Compost curing is the last stage of composting that occurs after much of the readily metabolized material has been decomposed. Compost curing provides for additional stabilization, and allows further decomposition of cellulose and lignin. Cured compost is a highly stabilized product that results from exposing compost to a prolonged period of humification and mineralization, ranging from six to eight months.

4.6 *Step 6: Compost Screening and Refining*—Screening is necessary to remove contaminants such as oversized material, stones, metal fragments, glass, film plastic, hard plastic, and sharps. Residue from screening and refining can be recycled, or it might be disposed of at an incinerator or landfill. Screening also enables size classification to suit customer needs. Some customers may require that essentially all man-made inert material is removed from compost to enhance its aesthetic acceptability. Further refining can remove small stones, glass, metal fragments, hard plastic, film plastic, and sharps. This step typically follows the compost curing step so as to retain bulking material in the compost as long as possible as an aid to aeration

4.7 *Compliance with Compost Safety Standards*—Standards to protect public health, safety, and the environment typically focus on the content of trace metals and pathogens in compost. However, soluble salts, pH, man-made inerts, film plastic and organics may also be the focus of compliance standards in some cases. Verification is by standard methods for sampling, preparation and analysis. If a compost product meets the minimum standards for safety, the product is a "General Use Compost" and may be distributed for use as a soil amendment. Although a product may meet minimum requirements for public health, safety, and the environment, it may not, however, suit a particular customer's aesthetic requirements for example, or a customer's requirements for stability or for nutrient value. Product marketing issues will dictate the extent of curing, refining, and amending necessary to meet customers' needs. If the product does not meet the suggested minimum standards, the product may be reprocessed to meet the standards, or may be marketed as a "Designated Use Compost", with specific restrictions on its use appropriate to its characteristics. For example:

4.7.1 A compost which does not meet the minimum standards for compost stability could be (1) composted for another week or more until it is sufficiently stable to meet the stability standard, or (2) used in an application where its relatively low stability would not be harmful.

4.7.2 A compost which contains more film plastic than the standard could be (1) refined to remove the film plastic, or (2) marketed for restricted use where the film plastic content would be acceptable.

4.8 The Composting Schematic Diagram (The Process Model, Fig 01.02-A3) was developed as an aid to a broad understanding of process steps in the manufacture of compost suitable for general distribution or for designated uses.

4.8.1 As noted previously, a product that complies with regulatory standards for safety is suitable for distribution and use as a soil amendment. It is classified "General Use Compost".

4.8.2 "Designated Use Compost", on the other hand, is the classification that does not comply with safety standards and its distribution and use is subject to regulatory control. The authors elected not to show market segments for this class of compost on the model schematic, because use is restricted by local or state regulation. Uses are potentially numerous. It might be used, for example, as landfill daily cover, or refined for land reclamation, and/or cured for other designated, restricted markets.

4.8.3 *General Use Compost* classification is shown as the source of supply for three grades of compost, namely *Raw Compost*, *Refined Compost*, and *Cured Compost*. These three grades of compost are manufactured for reliable and sustainable end markets. Each of the three grades of compost may be amended with supplemental material (amendments) added during composting or to compost, to provide attributes required by customers for certain compost products, such as product bulk, product nutrient value, product pH, and soils blend. Marketing consultants have defined a dozen or more major market segments. Marketers supply compost to many segments and more are being developed.

4.8.3.1 *Raw Compost* is generally suitable for use as landfill cover material and as surface mine reclamation material. It may be suitable for other additional uses.

4.8.3.2 *Refined Compost* is generally suitable for field nursery use, sod production, silviculture, agriculture, commercial landscaping, and specialty applications such as erosion control and for biofilters. It may be suitable for other additional uses.

4.8.3.3 *Cured Compost* may generally be used for high-end landscaping, delivered topsoil, bagged/retail markets, container nurseries, and specialty applications, (e.g., wetlands redevelopment, etc.).

01.03 COMPOSTING TECHNOLOGY GROUPS

01.03-A OPERATION CHARACTERISTICS

1. Technologies

1.1 Technologies used for composting cover a broad spectrum of options. The composting industry recognizes five groups of composting technologies, as shown in the Table 01.03-A1.

Table 01.03-A1 Composting Technology Groups.

Management Strategies *Step 3:* Composting	GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5
Weather Protection	Open	Open	Covered	Covered	Covered
Pile Configuration	Piles	Windrows	Piles and Tunnels	Windrows Trenches Beds and Bays	Tunnel and Vessel Systems
Process	Passive	Active	Active	Active	Active
Management of Key Process Variables					
▪ Pile	Undisturbed	Turned	Static Structure	Turned	Turned
▪ Feedstock nutrient balance	Unmanaged	Initial C:N ratio set	Initial C:N ratio set	Initial C:N ratio set	Initial C:N ratio set
▪ Pile Oxygen and pH	Unmanaged	Convective Aeration	Forced Aeration	Mechanical Aeration	Forced Aeration
▪ Pile Moisture	Unmanaged	Mix in Make-up	Mix in Make-up	Mix in Make-up	Mix in Make-up
▪ Pile Temperature	Unmanaged	Turning Control	Blower Control	Blower Control	Blower Control
▪ Retention Time	12-14 months	2-12 months	2-6 months	2-5 months	2-4 months

1.1.1 The five [5] technology categories are based on the predominant composting unit operation characteristics, a technology classification system devised and peer-reviewed for the *Composting Facility Operating Guide,* US Composting Council, 1994 (http://compostingcouncil.org).

1.2 The composting industry categorization of technologies is generic. Specific technology suppliers offer variations within a technology group. A single technology should offer a combination of alternatives that will address the seven steps of the composting process.

1.3 Sampling and testing plans must be designed to suit the specific approach used in each composting project.

1.4 Sampling and testing marketable product provides the data needed to demonstrate compliance with environmental standards and to provide users with information needed to plan for proper application of compost products.

2. Composting Feedstocks

2.1 Six types of source materials commonly composted:

2.1.1 *Food Processing Residuals*—compostable material remaining after fruit, vegetables, grains, nuts, and meat are processed for consumption.

2.1.2 *Manure and Agricultural By-Products*—generated at racetracks, feedlot and other animal feeding operations, farms, nurseries, and greenhouses. Compost produced from residuals generated from farms, nurseries, and greenhouses can be readily recycled into those operations. However, huge quantities of manure generated at racetracks, feedlots, and swine and poultry confinement facilities can pose a significant challenge to facility operators.

2.1.3 *Forestry and Forest Product Residuals*—includes bark and sawdust, and fiber fines residue and biosolids generated by the papermaking process. Bark and sawdust can be used in the composting industry as a carbon source with other feedstock material or as a bulking material to increase porosity of the feedstock mix.

2.1.4 *Biosolids, or Sewage Sludge*—the solid material generated by the biological treatment of sewage at a wastewater treatment plant. In addition to being composted, sewage sludge can be recycled for beneficial use by direct application onto land as a fertilizer.

2.1.5 *Leaves, Brush and Yard Trimmings (Yard Waste)*—typically consists of leaves, brush, grass clippings, plant trimmings, and plant remains. Historically this material has been collected with municipal solid waste and incinerated or landfilled. Many communities have restricted incineration and landfilling of these materials. Instead, they are separately collected and recycled for beneficial use by directing it to a mulching or composting facility.

2.1.6 *Source Separated Organic Waste (SSOW)*—consists of the compostable and composting compatible fraction of municipal solid waste, accumulated and presorted by the generator, and collected separately from household hazardous material and sometimes non-compostable material. The compostable and composting compatible fraction can be directed to a central composting facility. For example, a compostable organics collection program that relies on source separation by the generator could include leaves, brush and yard trimmings, food scraps, wet and soiled paper, diapers and sanitary products, pet waste, and dry paper packaging that is not recycled because of weak or nonexistent markets. Source-separated organic waste includes residential, institutional and commercial

sources, and can include the domestic portion of the industrial solid waste stream.

2.1.7 *Mixed Municipal Solid Waste (MSW)*—includes various discards from residential, commercial, and institutional sources that are commonly taken to incinerators or landfills. The largest components of mixed municipal solid waste are typically paper and paper products, leaves, brush and yard trimmings, wood, food scraps, glass, plastics, and metals. The composition of mixed MSW varies depending on the characteristics of the waste generators in the service area, but usually from about 50% to 65% is compostable when recovered by separation at a central facility. Mixed municipal solid waste will contain relatively fewer recyclables and a relatively higher fraction of compostable material when an aggressive source-separated recycling collection program operates in conjunction with mixed municipal solid waste collection.

2.2 Market attributes of finished compost product are influenced both by the feedstock used and by composting process control.

2.3 Sampling and testing plans must be designed to suit the specific feedstocks used in each composting project.

3. Compost Product Overview

3.1 A variety of value-added products are developed by processors (Fig 01.02-A2 Composting Products Model).

3.1.1 *Step 1*—Feedstock Recovery involves an inspection of materials received at the tip floor or receiving area to removed unwanted items from the feedstock. This step may also be used to gather items that have commercial value in the traditional recycle markets, such as ferrous, plastics, and clean paper. Equipment and labor for sorting is often required and returns should offset costs.

3.1.2 *Step 2*—Feedstock Preparation involves establishing the initial porosity and degradability, i.e., C:N and C:P ratios, moisture content, etc.

3.1.3 *Step 3*—Thermophilic Composting reduces pathogens, which is a fundamental requirement for feedstock processing and destroys most weed seeds. At this point, markets may be able to accept the material even though it is neither biologically stable nor free of organic phytotoxins that inhibit seed germination and plant growth. (e.g., land applied for sufficient time to reach a level of stability and maturity before planting that benefits crop growth and soil conservation).

3.1.4 *Step 5*—Compost Curing increases biological stability, may further reduce pathogens, and with aeration eliminates organic phytotoxins. The degree of curing should match the intended use of the product. A bagged product will require a high degree of curing because of its potential use as potting soil and garden bed amendment. Product that will be sold in bulk for direct application for agricultural, landscape, roadside, or reclamation settings may not require as much curing as compost used a potting soil.

3.1.5 *Step 6*—Compost Screening and Refining removes oversized material and other unwanted material, and can provide the particle size and texture of product for particular end use requirements. Screening and refining equipment is an investment that should increase product revenues.

3.1.6 *Step 7*—Compost Storing and Packaging deals with seasonal demand patterns that don't match feedstock availability patterns and may generally be inevitable. No degradation of product should be allowed, and if storage is inevitable it can be exploited to add still more value for the highest markets of all that include bagged and amended products.

Test Method: Field Sampling of Compost Materials. Five Protocols							**Units:** *NA*	
Test Method Applications								
Process Management							**Product Attributes**	
Step 1: Feedstock Recovery	*Step 2:* Feedstock Preparation	*Step 3:* Composting	*Step 4:* Odor Treatment	*Step 5:* Compost Curing	*Step 6:* Compost Screening and Refining	*Step 7:* Compost Storing and Packaging	*Safety Standards*	*Market Attributes*
02.01-A	02.01-A	02.01-A	02.01-A	02.01-A	02.01-A	02.01-A	02.01-A	02.01-A
02.01-B	02.01-B	02.01-B	02.01-B	02.01-B	02.01-B	02.01-B	02.01-B	02.01-B
02.01-C	02.01-C							
		02.01-D	02.01-D	02.01-D	02.01-D	02.01-D	02.01-D	02.01-D
02.01-E	02.01-E		02.01-E			02.01-E	02.01-E	02.01-E

02.01 FIELD SAMPLING OF COMPOST MATERIALS

DISCLAIMERS

(1) The methodologies described in TMECC do not purport to address all safety concerns associated with their use. It is the responsibility of the user of these methods to establish appropriate safety and health practices, and to determine the applicability of regulatory limitations prior to their use.

(2) All methods and sampling protocols provided in TMECC are subject to revision and update to correct any errors or omissions, and to accommodate new widely accepted advances in techniques and methods. Please report omissions and errors to the U.S. Composting Council Research and Education Foundation. An on-line submission form and instructions are provided on the TMECC web site, http://www.tmecc.org/addenda.

(3) Process alternatives, trade names, or commercial products as mentioned in TMECC are only examples and are not endorsed or recommended by the U.S. Department of Agriculture or the U.S. Composting Council Research and Education Foundation. Alternatives may exist or may be developed.

1. Source

1.1 This section covers sampling procedures for compost and composting feedstock.

1.1.1 *Method 02.01-A Compost Sampling Principles and Practices* adapted from sampling procedure documents provided by Dr. William F. Brinton, Woods End Research Laboratory, 1996.

1.1.2 *Method 02.01-B Selection of Sampling Locations for Windrows and Piles.*

1.1.3 *Method 02.01-C Sampling Plan for Composted Material*—adapted from the US EPA's Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Third Edition, September, 1986. Consideration and importance was placed on sampling composted solid waste rather than sampling sediments, sludges, or soils for waste analysis. Most information remained unchanged. The majority of the information on sampling was taken from Chapter Nine, Volume II of the U.S. EPA Solid Waste - 846 Manual.

1.1.4 *Method 02.01-D Composting Feedstock Material Sampling Strategies.*

1.1.5 *Method 02.01-E Data Quality Management and Sample Chain of Custody.*

1.2 Values stated in SI units are to be regarded as the standard. Values given in parentheses are provided for information only.

2. Referenced Documents

ASTM D 5231-92, Determination of the Composition of Unprocessed Municipal Waste. *In* Annual Book of ASTM Standards, Vol. 04.08

ASTM D 4547-91, Sampling Waste and Soils for Volatile Organics. *In* Annual Book of ASTM Standards, Vol. 04.08

A Plain English Guide to the EPA Part 503 Biosolids Rule. US EPA Office of Wastewater Management. EPA/832/R-93/003, September 1994.

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. US EPA SW-846. 3rd Edition, September, 1986.

Statistical Quality Control Handbook. Western Electric Company, Inc. 2nd Edition. 1958.

3. Terminology

3.1 *aliquot, n*—a sub-sample of a material prepared for, and subjected to laboratory analysis. A sub-sample size smaller than 1 g may be used to represent more than 1000 kg of compost.

3.2 *attribute verification, n*—a laboratory protocol that includes standard reference materials, checks and blanks to validate analytical determinations.

3.3 *confidence interval, n*—a statistical range with a specified probability that a given parameter lies within that range. The magnitude of the range increases as the specified probability is increased.

3.4 *process monitoring, n*—samples collected at predetermined intervals within the composting process to track the targeted changes in biological, chemical and physical characteristics; key process variables in compost piles that should be monitored include porosity, oxygen percent, moisture percent, temperature, retention time or age.

3.5 *process variability, n*—deviations from optimal management procedures of compost production that

may induce deviations in the desired result and sub-optimal finished compost.

3.6 *product variability, n*—heterogeneity of the chemical, biological and physical characteristics of a compost product attributable to both the composting process and the heterogeneity of input feedstocks.

3.7 *representative sample, n*—a sample that accurately reflects the average chemical, biological and physical characteristics of interest from the source of feedstock, bulk material or compost batch in question.

3.8 *sample collection frequency, n*—retrieval of representative samples at intervals that accurately represent the status within the process step of interest for the bulk of compost in question or batch of concern.

3.9 *statistical validity, n*—determinations made from a sample that accurately represent the average characteristics of the compost of interest.

4. Sampling Collection and the Composting Process

4.1 A generalized model developed to represent the aerobic composting process is presented in Fig 02.01-1 Composting Unit Operations Model.

4.1.1 Market attribute analytical values for a finished compost vary according to the type or blend of composting feedstocks and composting process. Value-added compost products are illustrated in Chapter 01.00 Fig 01.02-A2 Composting Products Model. Sampling and testing plans must be designed to suit the feedstock used in composting, the specific approach to feedstock preparation and composting process management in each composting project, and specifically for each finished product.

4.2 *Selection of Sampling Method:*

4.2.1 *Feedstock Sampling Location*—The sampling location for composting feedstock is after feedstock recovery (step 1) has been completed. Feedstock sampling is performed after routine removal of recyclable and/or problem materials. Samples should be taken before feedstock preparation (step 2), i.e., before shredding or size reduction, and before supplemental nutrients, bulking agents or water have been added. The facility operators can provide the best information for the locations to obtain feedstock samples.

NOTE 1—Once the feedstock preparation, (step 2 of the composting process model), is completed, the actual composting process begins with the material placed in piles, windrows or reaction vessels for composting.

4.2.2 *Prepared Feedstock Sampling*—Samples should be taken after feedstock preparation before composting. Facility operators can provide the best information for the locations to obtain feedstock samples.

4.2.3 *Composting and Compost Curing Process Control Sampling Locations*—The sampling location for process monitoring during composting, step 3, and compost curing, step 6, is indicated in Fig 02.01-B1 Hypothetical Sample Collection Pattern from a Compost Pile.

4.2.4 *Finished Compost Sampling Locations*—Finished compost is expected to match the needs of the customers, and may be obtained from step 3, Composting; step 5, Compost Curing; step 6, Compost Screening and Refining; and step 7, Compost Storing and Packaging as indicated in Chapter 01.00 Fig 01.02-A2 Composting Products Model. Finished compost samples are taken from the actual product that is released for distribution to an end-user.

5. Summary of Methods

5.1 *Method 02.01-A Compost Sampling Principles and Practices*—Review of sampling design schemes adapted from sampling procedure documents provided by Dr. William F. Brinton, Woods End Research Laboratory, Inc.

5.2 *Method 02.01-B Selection of Sampling Locations for Windrows and Piles*—Descriptions of sample collection as sets of compost sub-samples collected and combined to represent the average chemical, physical and biological characteristics of the compost material for a batch windrow or pile of cured or curing compost.

5.3 *Method 02.01-C Sampling Plan for Composted Material*—Review of US EPA SW-846 sampling plan guidelines and statistical procedures for estimating required minimum number of samples.

5.4 *Method 02.01-D Composting Feedstock Material Sampling Strategies*—A representative sample of feedstock is collected to identify its chemical and physical characteristics.

5.5 *Method 02.01-E Data Quality Management and Sample Chain of Custody*—Consideration for third-party sample collection and preparation. Also, an example form and description of the parameters needed for a chain of custody report.

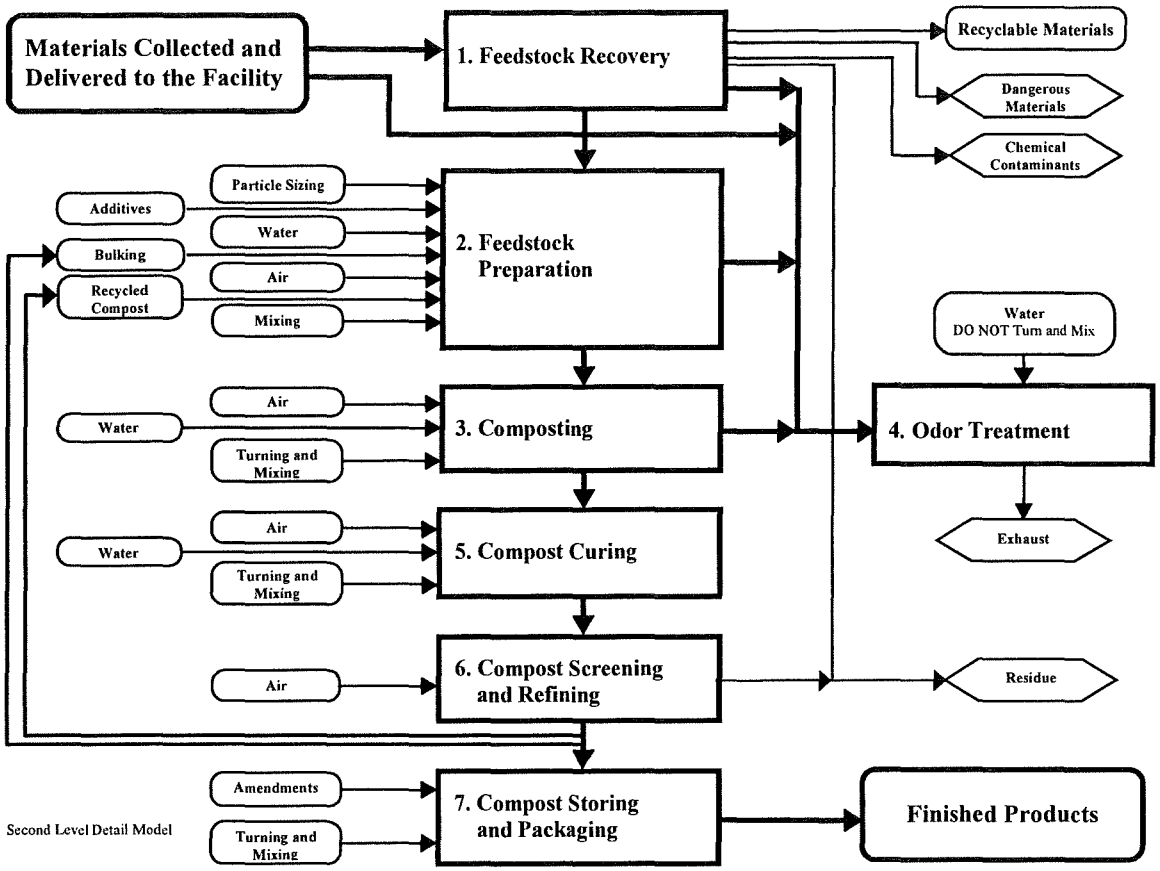

Fig 02.01-1 Composting Unit Operations Model.

6. Significance and Use

6.1 *Method 02.01-A Compost Sampling Principles and Practices*—Source of general guidelines and considerations needed to develop an appropriate compost sampling plan.

6.2 *Method 02.01-B Compost Material Sampling Strategies*—A general guide for compost sample collection and preservation from compost curing piles.

6.3 *Method 02.01-C Sampling Plan for Composted Material (from SW-846 Chapter Nine, part 1)*—The initial, and perhaps most critical element in a program designed to evaluate the physical, chemical and biological properties of a compost is the plan for sampling the material in question. It is understandable that analytical studies, with their sophisticated instrumentation and high cost, are often perceived as the dominant element in a characterization program. Yet, despite that sophistication and high cost, analytical data generated by a scientifically defective sampling plan have limited utility.

6.4 *Method 02.01-D Composting Feedstock Material Sampling Strategies*—A general guide for feedstock sample collection. Specific methods should be modified for differing feedstock materials.

6.5 *Method 02.01-E Data Quality Management and Sample Chain of Custody*—A method of tracking a collected sample from date, time and location of sampling through completion of laboratory analysis.

7. Interference and Limitations

7.1 Analytical error associated with sampling and handling is compounded when multiple properties with conflicting sampling needs are measured from the same sample. For example, it is a good idea to subdivide and remix samples repeatedly if mineral and metal tests are being performed. This improves homogeneity and reduces sample variance. Unfortunately, this same method induces excessive volatilization of some of the compounds, and causes microbial cross-contamination. Therefore, the sampling plan must specify a separate sampling and handling scheme for each test parameter that requires special sampling.

7.2 *Method 02.01-B Compost Material Sampling Strategies*—As compost heterogeneity increases, the number of sub-samples should be increased. If insufficient numbers of samples are collected, analytical results will not represent the compost in question.

7.2.1 Moisture loss or gain during sample handling and splitting may become significant. It is therefore necessary to mix and split a sample under sheltered conditions, such as inside a building where wind, temperature and sunlight or precipitation will not distort the compost moisture.

7.3 *Method 02.01-C Sampling Plan for Composted Material*—Knowledge of or access to statistical procedures is required.

7.4 *Method 02.01-D Composting Feedstock Material Sampling Strategies*—Sample heterogeneity of feedstock may be much higher than that of the finished composted product. It is crucial that all sampling plan collection procedures are followed to maximize the reliability and accuracy of the feedstock sample analytical results.

7.4.1 Moisture loss or gain during sample handling and splitting may become significant. It is therefore necessary to mix and split a sample under sheltered conditions, such as inside a building where wind, temperature and sunlight or precipitation will not distort the feedstock moisture.

8. Sample Handling

8.1 Collect samples from areas of the compost pile that are representative of the general appearance, and avoid collecting atypically moist samples (> 60% moisture, wet basis). If balls form during the process of blending and mixing of point-samples, the compost sample is too wet. Excessively moist compost will cause unreliable physical and biological evaluation.

8.2 For most feedstock or compost samples, use containers made of stainless steel, plastic, glass or Teflon. These materials will not change compost chemical quality. Laboratories provide advice on appropriate sample containers, preservatives and shipping instructions when requested.

8.3 A representative compost sample must be collected from appropriate sampling locations and consist of no less than 15 point-samples. Sampling locations along the perimeter of the compost pile where compost point-samples will be extracted and vertical distances from the ground or composting pad surface shall be determined at random, and shall be representative of the compost on the site.

8.3.1 Determine the number and types of sampling and shipping containers to be used. The composite sample is placed in a sanitized container and thoroughly mixed. Follow proper quality assurance/quality control procedures for sample preservation, storage, transportation and transfer. Sample the cured compost and aliquot 12 L (3 gal) sub-samples from the composite sample and place in a sanitized plastic container and seal.

8.3.2 Utilize the Student's "t"-test with a confidence interval of 80% to statistically analyze the test data. Refer to TMECC 02.01-A, paragraph 9.10 *Sampling Intervals* for guidance in determining sample collection frequency.

8.4 *Test Methods versus Sampling Methods*—The laboratory test method and analytical parameter of interest dictate the method of sample collection, type of container for shipping and storage of samples and sample handling procedures required. Table 02.01-1 provides a partial list of analytical traits that are affected by sample collection and handling. In general, volatile compounds and elements, physical bulk factors and microbiological samples require special considerations when developing the sampling plan.

Table 02.01-1 Partial list of test parameters that require special sampling and handling considerations.

Test Parameter	*Principle Constraint*	*Associated Error*	*Alteration of Sampling for Corrective Action*
Total-N	Volatilization loss of NH_3 during sample handling	Underestimation of total N and volatile N	Place in container quickly with minimal stirring
Volatile fatty acids (VFA)	Volatilization loss of VFA during sample handling	Underestimation of VFA content	Place in container quickly with minimal stirring
Microbiology (pathogens)	Contamination from tools, buckets, air	Over or under estimation of pathogens	Use only clean, sterile containers and implements
Bulk Density	Excess sample moisture	Overestimation of volume/weight	Take large, oversized samples

8.4.1 In each case the determination for a trait of interest can be changed adversely by improper sample collection and handling, and consequently lead to erroneous conclusions. Analytical precision or relative variability may not be affected by inappropriate sampling, but accuracy of the expected determination may be biased and incorrect.

8.5 *Containers, Post-Sample Handling*—For each type of parameter measured after sampling specific containers and holding times should be observed prior

to and during transport to a laboratory (see Tables 02.01-2 through 02.01-6). Use multiple containers to preserve sample integrity as necessary.

8.5.1 Despite the wide variation in sample holding times and condition requirements, all compost samples targeted for general testing should be chilled immediately upon collection and preparation. Refer to Tables 02.01-2 through 02.01-6 to find the most appropriate storage temperature for each test parameter of interest.

8.5.2 When plastic containers are acceptable, use double Ziploc®-type 4-8 L (1-2 gal) bags marked on the exterior with a marking pen with insoluble ink, and placed with several cool-packs in a large polystyrene cooler or similar insulated container.

8.5.3 Ship the samples to the laboratory for delivery within 24 h or less. Request that the laboratory staff store samples at 4°C when delays in lab preparation are anticipated.

8.5.4 Collection and storage of samples for organic compound analysis - polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs) or volatile fatty acids (VFAs) - require glass containers with Teflon lids, or exclusively Teflon containers. Sample containers should be filled to overflowing with material to minimize airspace in the container and reduce volatilization of organic compounds during storage.

8.5.5 Include proper *Chain-of-Custody* information: date, time, name of the sampling entity and name individual responsible for sample. Refer to *Method 02.01-E Data Quality Management and Sample Chain of Custody* for an example form and description of parameters needed to complete a chain of custody report.

Table 02.01-2 *Physical Parameters:* Sampling containers and conditions for compost and source ingredient testing.

Test Parameter of Interest	*Container*	*Conditions*	*Maximum Holding Time Allowed in Lab*
Bulk Density, Hydraulic Conductivity, Porosity, Water Holding Capacity	P, G	4°C	7 d
Temperature	*NA*	*NA*	Immediate, no delay
Total Solids	P, G	4°C	24 h

NOTE 2—P=Plastic; G=Glass

Table 02.01-3 *Organic and Biological Properties:* Sampling containers and conditions for compost and source ingredient testing.

Test Parameter of Interest	*Container*	*Conditions*	*Maximum Holding Time Allowed in Lab*
Respirometry	P, G	4°C	24 h
Organic Carbon	P, G	4°C	14 d
Volatile Fatty Acids	G (2 L CWM)	4°C	14 d
Volatile Solids	P, G	4°C	14 d

NOTE 3—P=Plastic; G=Glass

Table 02.01-4 *Chemical Parameters:* Sampling containers and conditions for compost and source ingredient testing.

Test Parameter of Interest	*Container*	*Conditions*	*Maximum Holding Time Allowed in Lab*
Acidity/Alkalinity (pH), Electrical Conductivity, Kjeldahl Nitrogen, Nitrate Nitrogen (NO_3-N), Nitrite Nitrogen (NO_2-N), Ammonia Nitrogen and Ammonium Nitrogen (NH_3-N, NH_4-N), Sulfide	P, G	4°C	48 h
All other Metals	P, G	4°C	6 months
Chloride, Sulfate	P, G	4°C	28 d
Chromium VI	P, G	4°C	24 h
Mercury	P, G	4°C	28 d

NOTE 4—P=Plastic; G=Glass

Table 02.01-5 *Pathogens:* Sampling containers and conditions for compost and source ingredient testing.

Test Parameter of Interest	*Container*	*Conditions*	*Maximum Holding Time Allowed in Lab*
Enteric Virus	G	-70°C	> 8 h
Enteric Virus	SP, G	4°C	8 h
Coliforms and other bacteria	SP, G	4°C	48 h
Helminth Ova	SP, G	4°C	1 month

NOTE 5—SP=Sterilized Polypropylene; G= Sterilized Glass

Table 02.01-6 *Synthetic Organic Compounds:* Sampling containers and conditions for compost and source ingredient testing.

Test Parameter of Interest	*Container*	*Conditions*	*Maximum Holding Time Allowed in Lab*
Chlorinated Herbicides, and Chlorinated Hydrocarbons, PCB	G, Teflon lined cap (2-1/2 L.A.J.)	4°C	7 d until extraction
Chlorinated Pesticides	16 oz B.R. (2-1/2 L.A.J.)	4°C	7 d until extraction
Dioxins & Furans, Nitroaromatics and Isophorone, and Polycyclic Aromatic Hydrocarbons, PAH	G, Teflon lined cap (2-1/2 L.A.J.)	4°C store in dark	7 d until extraction
Phthalate esters	G, Teflon lined cap	4°C	7 d until extraction
Purgeable aromatic hydrocarbons	G, Teflon lined septum (40-mL Glass V)	4°C	14 d prior lab testing
Semi-Volatile Organics	G, Teflon-lined Septum (2.5-L Jug)	4°C	7 d
TCLP Sample	G, Teflon-lined Septum (2.5-L Jug)	4°C	7 d until extraction
Volatile Organic Compounds (VOC)	G, Teflon lined septum (40-mL Glass V)	4°C	14 d preserved in HCl†

NOTE 6—P=Plastic; G=Glass, HDPE=High Density Polyethylene

†—Evaluation data is being sought to confirm this requirement for curing and finished composts.

Test Method: Compost Sampling Principles and Practices							**Units:** *NA*	
Test Method Applications								
Process Management							**Product Attributes**	
Step 1: Feedstock Recovery	*Step 2:* Feedstock Preparation	*Step 3:* Composting	*Step 4:* Odor Treatment	*Step 5:* Compost Curing	*Step 6:* Compost Screening and Refining	*Step 7:* Compost Storing and Packaging	*Safety Standards*	*Market Attributes*
02.01-A	02.01-A	02.01-A	02.01-A	02.01-A	02.01-A	02.01-A	02.01-A	02.01-A

02.01-A COMPOST SAMPLING PRINCIPLES AND PRACTICES

COMMENT—This section was adapted from sampling procedure documents provided by Dr. William F. Brinton, Woods End Research Laboratory, 1996.

9. Justification for Compost Sampling

9.1 Sampling of compost and compost products is an essential aspect of process monitoring, quality control, marketing and labeling, and regulatory compliance. Like other functions of site management, sample collection involves carefully planned and often labor intensive activities. Four common reasons for compost sampling are described:

9.1.1 *Ingredient Analysis*—basic data on source ingredients are needed for the design of a composting process or identification of an optimal composting feedstock recipe.

9.1.2 *Process Design and Monitoring*—composting process evaluation requires information on material characteristics and process benchmarks. Specific sample collection protocol is designed for each parameter of interest.

9.1.3 *Marketing and Labeling*—specification sheets or product labels for compost are needed to compare product with others in the marketplace.

9.1.4 *Regulatory Compliance*—compost process and product requires periodic testing for compliance with specified traits including certain metals, pathogens, stability and maturity.

9.2 *Use of Sampling Data*—Sampling decisions require an understanding of the need for data collection, specifically how to sample and when to collect samples. The sampling decision tree presented in Fig 02.01-A1 illustrates a decision process to assist in the development of proper sample collection methods, to identify sampling interval and sample size, and the end use of sample data. When regulations do not apply, as is the case for recipe formulation, process monitoring for quality assurance (QA) and internal quality control (QC), it is important to clearly understand the intended use of the data and to determine the appropriate sampling procedures. For example, if C:N ratio interpretation is considered very important, then very low variations in sample carbon and nitrogen determinations become a major consideration and a sample collection process must be designed to support to this requirement.

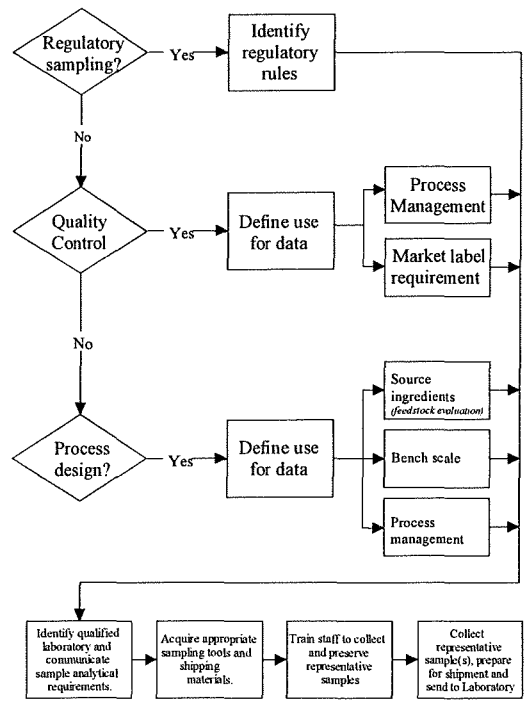

Fig 02.01-A1 Compost sampling decision tree, overview of sampling objectives.

9.3 *Types of Sampling*—Two types of sample collection are used: point-sampling and composite-sampling:

9.3.1 *point sampling*—site-specific sample collection from within the general mass is used to identify and quantify points of extreme variability, hot spots or problem zones. Point-sampling alone should not be used unless special conditions exist.

9.3.2 *composite-sampling*—a single sample for laboratory analysis composed of multiple, well-blended point- or sub-samples uniformly distributed throughout the entire volume that, after mixing, accurately represents an average or median value of the property or trait of interest for a batch or general mass. Properly implemented composite sampling is preferable for most sampling plans because it provides a reliable estimate

of the average or median property or trait of a batch or segment of a continuous stream, rather than a specific spot trait.

9.3.2.1 *stratified sampling*—a modified composite sampling scheme is used to document gradients and define heterogeneity as a function of position within the bulk or general mass of sampled material, where the general mass is subdivided into separate zones and a series of point-samples are collected and composited within each zone. Stratified sampling should be used when heterogeneity of compost is unknown and when regulatory constraints require knowledge of the relative spatial and temporal variability. This is most often based upon the standard deviation and mean; refer to Method 02.01-B for equations applied in calculations for approximating the required number of sub-samples to accurately estimate the average value for the parameter or trait of interest.

9.3.2.2 *interval sampling*—sampling from moving conveyor belts.

9.4 *Sampling Plan*—The constraints of the material and the composting technology must be considered when an optimal sampling plan is designed. Combinations of composite and point sampling are illustrated within the four sampling schemes presented in Fig 02.01-A2. The sampling scheme selected must address limitations of the selected test parameter and should not distort the analytical result.

9.4.1 Stratified sampling (Scenario A, Fig 02.01-A2) is used to determine variability, profile gradients and spatial uniformity characteristics. In most cases, composite sampling (Scenario B, Fig 02.01-A2) is satisfactory when the amount of variability within the mass is known to be insignificant. It involves combining several representative sub-samples into one composite sample that is then thoroughly mixed, then split for shipment to the laboratory. Area or batch sampling (Scenario C, Fig 02.01-A2) and single grab- or point-sampling (Scenario D, Fig 02.01-A2) are for special cases where one sample is collected at one location. Area or batch sampling is typified by a whole mass collected as one sample unit. This method is most appropriate when moving the mass from a vessel to a curing pile. A single point-sample does not provide a representative sample for the bulk mass. Batch sampling and point sampling should be employed to characterize an obvious or potential anomaly at one specific point, time or location within a process. A good example of a single point sample to detect anomalies is shown as X in Fig. 02.01-A2 D, a location referred to as the "toe" of a static aerated pile, and one which is vulnerable to suboptimal temperatures needed to achieve pathogen reduction. For this reason, it is sometimes specifically included to verify pathogen content of compost that has finished the thermophilic phase.

9.5 *Importance of Representative Sampling*—A representative sample defines a material's average characteristic, typical for the entire material being sampled. Under virtually all composting conditions, the mass of compost material is large and heterogeneous. A representative sample of compost is not easily obtained; and sampling must be repeated over time to compensate for naturally high variations. Under proper management and as compost-curing advances, variability within a curing pile or windrow will decrease.

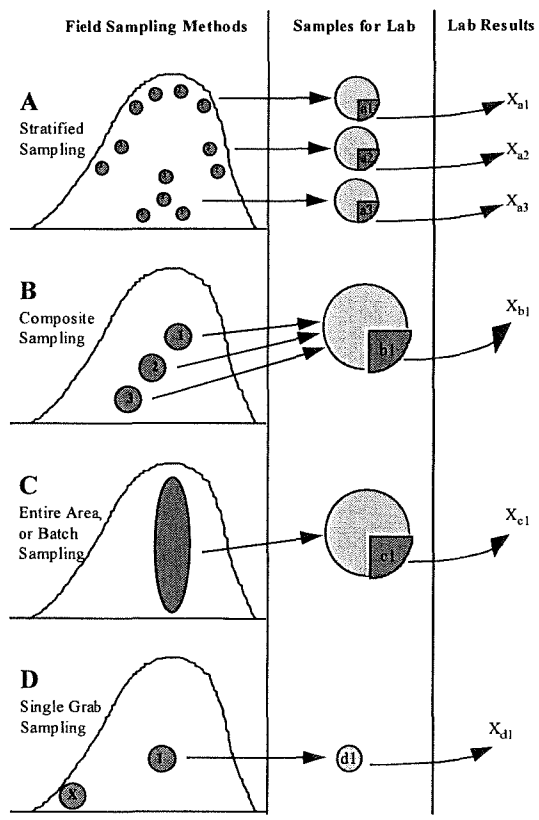

Fig 02.01-A2 The sampling schematic.

9.6 *Variables that Compromise Quality of Sampling*—Sample collection technique and variability of compost and cured compost affect the relative accuracy of sampling and the reliability of laboratory analytical determinations. Failure to adjust sampling protocols according to the nature and source of variations may invalidate test results and lead to inappropriate management or marketing decisions.

9.6.1 *Bias Introduced by the Sampler*—Inaccurate sample collection is often due to systematic or intentionally selective sampling introduced by the sampler. Significant error will result from attempts by the sample collector to counteract perceived variability. Examples include avoiding the collection of sub-

samples from wet pockets or systematically excluding large particles from the composite sample. **Deliberate bias results from an attempt by the sampler to prepare samples that appear superior in a perceived physical trait that does not actually represent the bulk or batch of interest.**

9.6.2 *Sample Heterogeneity*—The following are key sources of non-uniformity that can give rise to significant sampling errors.

9.6.2.1 *Sub-sample size* affects sampling accuracy. In general, a representative composite sample contains large (> 1000 cm^3) and plentiful sub-samples (>15 samples).

9.6.2.2 *Complete and thorough mixing* throughout the composting process improves the quality and ease of sampling. Poor initial mixing effects variability of the parameters throughout the composting process. Repeated use of turning machinery during composting improves homogeneity. However, within days or even hours after turning, mixing or re-piling, the composting mass may develop gradients of stability, moisture, bacteria and ammonia. When pre-mixing, blending or turning are not employed, as in static pile composting or compost curing, the sampling plan should include more sub-samples per composite sample to compensate for inherently high variability within the mass.

9.6.2.3 *Soil and stones* are frequently picked up during routine compost production operations. These pose problems for good sampling. In some cases, the sampler may bias the sample by deliberately excluding gravel and stones present in a compost (soil can not be easily seen). On the other hand, a laboratory that receives a sample containing stones or small gravel may not sub-sample, pre-screen, and grind, resulting in variable results. Staff responsible for sampling must correctly diagnose the situation and advise the analytical laboratory about it. In some cases, laboratories must issue disclaimers about their own sub-sampling technique.

9.6.2.4 *Foreign and non-compostable matter* almost invariability poses problems to the sampler, and also the laboratory. This is most likely the case with municipal solid waste (MSW) and certain industrial by-products where large and variable amounts of such substances are present. The best approach is to take large sub-samples and blend frequently before removing the final sub-sample for examination or testing. There is presently no generally accepted or standard practice for gauging the minimum sample size required in such situations.

9.6.2.5 *Varying particle size* is one of the most common sources of sample variability. For example, a composting feedstock mix may have exactly 27% wood chips, but inability to sub-sample adequately could result in finding anywhere from 11 to 38% wood chips. The error introduced to C:N values for samples of this range is significant.

9.6.2.6 *Layering, compaction and gradients* of composts arise as a result of inadequate initial mixing, infrequent or excessive turning/mixing during feedstock preparation, or during the composting process because of equipment/ventilation actions such as inappropriate selection and use of bulking materials. Any one or more of these can easily confound sampling attempts.

9.7 *Sampling Practice*—Sampling begins with the decision to evaluate materials and proceeds to determining how and in what time frame the sample is needed. Practical steps include identifying the important parameters to be analyzed and working backwards through the decision tree to identify how to obtain a suitable sample for the specific technology and parameter of interest. Following this process, a sampling protocol and sample log is constructed. Technological constraints sometimes present significant challenges for sampling, however, in most cases, reliable samples can be obtained once a thorough analysis of the process plan is conducted.

9.8 *Composting Technology Systems and Sample Collection*—The physical/mechanical nature of the feedstock preparation and composting operation may impose constraints on sampling. Each composting technology imposes specific limitations on sampling. Representative samples may not be obtainable with some technologies. Therefore, a facility's sampling plan must take into account the realistic strategy for obtaining representative samples. In general, highly engineered compost processes impose more constraints on sampling than a simple composting process. For example, outdoor windrows are more easily sampled than large rotating drums.

9.8.1 Ten basic types of composting systems are presented in Fig 02.01-A3 and their associated sampling constraints are outlined in Table 02.01-A1. Each system introduces particular traits or constraints that impact how (and why) samples are collected. New forms of compost technology under development may expand the list, but the generic form of the prescribed models cover most existing composting technologies.

9.8.2 *Sampling Plan Basics*—The two process-focused modes of compost sampling are: i) In-Process sampling for monitoring during a specific composting technology process; and ii) End-Process sampling. There may be multiple steps or multiple processes involved in an overall system. Sample collection for testing commonly occurs at the end of a specific step of the composting process, mostly for convenience and to be certain that the sample is representative of the batch. Sample collection during a process imposes significant constraints because of the inherent variability of in-process materials. Sampling at these points must be

carefully designed to sample across any existing gradient of non-uniformity.

9.8.3 Discussion in the following section identifies technologies and primary constraints or requirements for representative sampling.

9.8.3.1 *Type A. Home Bins* come in many shapes and sizes, from fixed solid containers, loose wooden structures to rotating solid-tanks. The appropriate framework for sampling is to select the material representing the finished product. Some systems provide doors at the bottom of a bin from which samples may be easily removed; other bins require disassembling or removal from the pile and hand-mixing of the mass. Precaution must be taken to assure a homogenous mixture under any circumstance.

NOTE 7—The inclusion of home composting bins in TMECC is not a suggestion or endorsement for regulatory control, but for information and perspective only. While home composting bins are not a mainstay of commercial composting and not currently or likely to be regulated by state or local jurisdictions when the end product is used by the home generator and producer, the principles described in TMECC for assessing overall quality of compost are suitable for use on such products.

9.8.3.2 *Type B. Turned Windrows* are either batch or continuous piles. In the former common case, the entire windrow is made from similar ingredients at about the same time (e.g., within 3 d). In the latter case, materials are added lengthwise over time. In both cases, non-uniformity is observed down the length of the pile and is greatest with continuous modes of composting. Sampling of windrows requires compositing over a discrete length, either the entire pile, or a sub-section identified to have similar age or other characteristics. Windrow turning machines are useful for preparing uniform mixtures suitable for composite sampling; however, a single pass with a turning machine will not result in an evenly mixed pile, 3-4 passes commonly are required. If turning is performed frequently, the need for multiple turns prior to sampling diminishes.

9.8.3.3 *Type C. Static Piles* are recognized for their non-uniformity. These piles exhibit gradients of temperature, aeration and exposure to elements that reduce homogeneity over time. To obtain a representative sample from a static pile, extreme disruption and mixing is required. Breaking down the pile with a bucket loader and re-mixing after removal of the outer cover may be necessary. If mixing is not complete, sub-samples should be taken from each region during pile breakdown, or from the bucket as material is removed. However, if the purpose of sampling is to characterize non-uniformity, then effort must be made to get to the region of concern where a representative sample can be collected. This could be performed using a core sampler, or by breaking open the pile with heavy equipment.

9.8.3.4 *Type D. Agitated-Bed* systems generally move compost along the length of the system at a fixed rate per day. Should sampling be necessary during the process, care must be taken to understand the variability imposed by nature of daily additions to the system. In some cases, the actual technology physically restricts access for various reasons including worker safety. In such situations, samples can be collected at the discharge end where material comes off the bin. Several sub-samples should be taken each day, cooled immediately; and several days' accumulated samples (except for bacteriological and others parameters limited by a 48 h holding time) can be composited to form a bulk sample.

9.8.3.5 *Type E. Enclosed Vessel* reactors are either circular or oblong containers, bins or towers (these systems may or may not contain internal moving parts) and cannot be easily accessed for sampling. Sample collection is best performed at the vessel's discharge end. In-process sampling for quality control and process monitoring is not always practical with these systems.

9.8.3.6 *Type F. Rotating Vessels* are horizontal tanks, usually positioned on a gradient. They are used for continuous and sometimes for batch composting. Most systems do not have ports to access the material during processing, making in-process sampling impractical. As with the enclosed vessel design, sampling is usually performed at the discharge end of the vessel. Rotating vessels are often used during "Feedstock Preparation" for many technology types, and sampling is performed on the download conveyor.

9.8.3.7 *Type G. Cure Piles* are frequently very large and may contain material composited from several piles. Because of their heterogeneity and size, and the typical lack of turning and mixing, they usually display extreme gradients of moisture, maturity and bulk density. Under these circumstances, one effective way to adequately sample is to use a large tractor loader to break into the pile, moving and mixing the materials in the process. The sampling plan must incorporate a stratified sampling scheme and point sampling to distinguish gradients and map spatial non-uniformity.

9.8.3.8 *Type H. Bagged Product* results from a mixing and screening process that is assumed to produce uniform material prior to bagging. Additional mixing of the bulk mass after bagging and prior to sampling is precluded. Therefore, a statistically representative sample must consist of many sub-samples collected from different bags. Additionally, the physical constraint of extracting small sample cores from separate bags that are palletized compounds the problems of collecting proper samples.

9.8.3.9 *Type I. Source Ingredients* are notorious for non-uniformity. Large sub-samples that accurately

represent the distribution of ingredients must be well mixed, and if possible (when appropriate), shredded to reduce the sample size while retaining sample integrity. Large mechanical equipment may improve the sample collection and preparation process.

9.8.3.10 *Type J. Lab Systems* are a special case of composting and are usually handled as a discrete sampling problem on an individual institutional basis. However, with the increasing popularity of bench scale testing, particularly for bioremediation composting, the value of describing sample units and types becomes more obvious. In general, these units contain highly uniform materials and are sometimes so small that the entire unit becomes the sample from which sub-samples are drawn for separate analyses. Because non-uniformity increases with miniaturization, lab systems are usually designed with small openings into discrete sections of tanks to facilitate extraction of small sub-samples. This allows the operator to monitor the formation of gradients and non-uniformity in miniature lab systems.

Table 02.01-A1 Sampling operations, constraints and required tools for ten types of composting technologies.

Type	*Sampling Action*	*Constraints*	*Preferred Tools*
A. Home Bins	Must open bin, remove cover and sides, and mix by hand	Not homogenous, may be hard or impossible to open	Pail and spading fork
B. Turned Windrows	Sample after turning with machine from surface of pile if well mixed	Pile varies along length, turning machine may not homogenize in one pass	5-gal pail, spading shovel, corer
C. Static Piles	Remove chip cover, and dig into depth, may require bucket loader and multiple depth sampling	Extreme non-uniformity, layering and clumping, inadvertent mixing with cover or surface residues; may be sealed inside tube	5-gal pail, spading shovel, corer or auger, bucket loader
D. Agitated-Bed	Sample after turning or agitation event, or sample discharge	Difficult access except at discharge, piles vary along length with age of source	5-gal pail, spading shovel,
E. Enclosed Vessel	Sample from side doors or top port after agitation	Very difficult or impossible access; potential layering	5-gal pail, spading shovel, corer, auger
F. Rotating Vessels	Sample from discharge/output end or take-away conveyor	Difficult or impossible to sample except at discharge; output varies with time	5-gal pail, shovel or scoop
G. Compost Curing Piles	Remove chip cover, and dig into depth, may require bucket loader and multiple depth sampling	Very large piles, non-uniformity, difficult access, compaction and layering; surface cover mixing	5-gal pail, spading shovel, corer, auger, bucket loader
H. Bagged Product	Sample multiple bags, cores drawn	Bag damage, difficult access	5-gal pail, trowel or soil-corer
I. Source Ingredients	Composite from each pile separately, remove surface	Non-uniformity may be great, poorly mixed, difficult access	Large pail, shovel; bucket loader
J. Lab Systems	Open system and remove with core sampler	Small scale, difficult access	5-gal pail, Spatula, trowel, soil-corer

9.9 *Sampling Interval*—There are no process-specific formulas that dictate sampling intervals for source ingredients and compost, except when biosolids are composted (Table 02.01-A2). Sampling intervals of composting materials for reporting purposes may be fixed by certain regulations. It is advisable to consult local or state sampling guidelines. As a general rule, incoming feedstocks should be sampled every two weeks, or every 3,000 to 5,000 tons of finished product.

9.9.1 *Formula to estimate sampling interval, d:*

$$S = T \div F \times R \qquad \textit{Equation 9.9.1}$$

where:

S = sampling interval in days, d
T = sampling threshold in tons (e.g., 4,000 t), t,
F = tons of incoming feedstock per day, t d^{-1}, and
R = weight reduction factor of incoming feedstock, %.

9.9.2 *Weight Reduction Factor, R:*

$$R = C \div F \qquad \textit{Equation 9.9.2}$$

where:

R = weight reduction factor of incoming feedstock, %,
C = mass of finished compost per week, t dw, and
F = mass of incoming feedstock per week, t dw

NOTE 1A—If the actual weight reduction factor is unknown, use 0.70 until the actual value can be determined. Refer to Method 03.09 Total Solids and Moisture for a description of how to determine dry weight of compost and feedstocks.

Table 02.01-A2 Sampling intervals for composted biosolids.

Amount produced (metric tons of biosolids compost per 365-day period)	*Monitoring Frequency for Pathogens and Trace Elements*
< 290	Once per year (1 yr^{-1})
≥ 290 to < 1,500	One per quarter (4 times yr^{-1})
≥ 1,500 to < 15,000	Once per 60 days (6 times yr^{-1})
≥ 15,000	Once per month (12 times yr^{-1})

Adapted from US EPA 40CFR503

9.9.3 *Sampling raw source ingredients—Example 1.* Samples shall be taken from incoming material that has been shredded, tumbled or otherwise reduced in particle size. From the material exiting the shredder/mixer, one point-sample shall be obtained every 2 h, over an operational period of 6-8 h, for a total of 4 samples. Sample size should be approximately 1000 cm^3 (~ 1 qt) per sample. The four samples shall then be thoroughly mixed together (composite), and a portion of the mixture (composite sub-sample) taken for analysis. If point-sampling directly from the shredder or mixing mill is not possible, the incoming material shall be sampled no more than 24 h after passing through the shredding equipment.

9.9.4 *Example 2—Sampling compost materials.* For each sampling event, a single composite sample shall be made up of multiple sub-samples for each pile or batch, unless otherwise directed.

9.9.5 *Example 3—Sample locations.* Construct and label a diagram of sample locations for your composting system. The example provided in TMECC 02.01-B indicates a minimum of fifteen sub-samples per pile. This procedure establishes a composite or general characterization of the attributes in a compost pile.

9.9.5.1 Refer to section 02.01-B for a strategy to sample generic windrows of compost.

9.9.5.2 Samples collected during the composting process are not composited in the same manner as finished samples because point-specific problems must be identified and monitored. Factors such as anaerobic materials and volatile fatty acids (VFA) may need to be determined from point-samples extracted from multiple locations in the same pile.

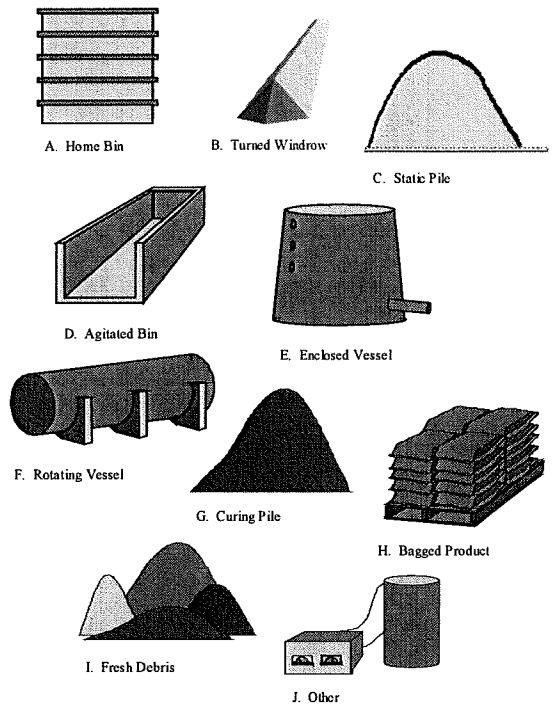

Fig 02.01-A3 Composting technologies.

9.9.6 *Example 4—Sample Variance Exercise.* The coefficient of variation (CV) expresses the relative variability for a parameter of interest across multiple samples. The CV is expressed as a percentage and calculated by dividing the sample standard deviation by the sample mean and multiplied by 100.

9.9.6.1 The ability to distinguish differences between arithmetically similar sample values decreases as the CV increases. It is difficult to draw specific conclusions about analytical results when variability is high. Under circumstances where variability is consistently high either the sampling plan must be redesigned to account for the excessively high variability, or the parameter should be discarded as a standard measure.

9.9.6.2 Consider a hypothetical case where two standard parameters are used to evaluate compost stability, C:N and VFA. Assume that the upper limit of acceptable variability for the parameters are set at 15% for C:N, and 45% for VFA. Low CV thresholds are generally assigned to system and process critical measures, and high CV thresholds are assigned to less critical standard measures.

NOTE 2A—This is a hypothetical case. It may be very difficult to establish meaningful CV limits without a large amount of data from many composts across time for a given test parameter. In addition, depending on the test, an individual test parameter may show a very large CV for repeated analysis of one sample.

9.9.6.3 In the example given in Table 02.01-A2, the CV for VFA testing is greater than the CV for C:N analysis, but the latter is unacceptable, given the use of the data, whereas the former is acceptable. In this hypothetical case, large variations across VFA samples are less significant than smaller variations associated with C:N. This is because variations in VFA's are transient and either readily corrected or do not diminish compost quality relative to its intended use, whereas highly variable C:N ratios indicate potentially serious problems with the composting process and product quality.

Table 02.01-A3 Compost sample data analyzed for variability

Sample	*C:N Ratio*	*VFA mg kg^{-1}*
1	35	12,000
2	19	18,000
3	39	19,000
4	22	25,000
5	42	9,000
Average:	31.4	16,600
Standard Deviation:	10.3	6,268
%CV:	33	38
Acceptable CV:	15%	45%
Suitability of Data:	REJECT	ACCEPT

9.10 *Sampler Devices*—There is no single standardized compost sampling device. Tools and devices for soil and forage sampling are relatively simple and efficient and are useful for compost sampling, but they have severe limitations.

9.10.1 *Slotted Tube Sampler*—Single or double, slotted tube and rod, all slotted ends and a minimum 5-cm (2-in.) diameter. The Pennsylvania State Forage Sampler, or equivalent, is a satisfactory core sampler for composts that do not contain significant foreign objects.

9.10.2 *Shovel*—Standard long, handled, pointed tip; typical horticultural narrow shovel, cleaned well with soapy water, rinsed, and dried between samples.

9.10.3 *Thief Sampler,*

9.10.4 *Trier,*

9.10.5 *Pipe*—PVC or plastic,

9.10.6 *Tarpaulin*—plastic,

9.10.7 *Pail*—16- to 20-L (4- to 5-gal), square pails. Use standard 5-gal plastic pails only when square pails are not available (e.g., square pails are available through Cleveland Bottle & Supply Co.; 850 East 77th Street; Cleveland, OH 44103; telephone: 216 881 3330; FAX: 216 881 7325; URL: http://www.clevelandbottle.com/squrpail.html). Pails must be cleaned well with soapy water, rinsed, and dried between samples.

9.10.8 *Trowel*—Standard garden, high-density polypropylene (HDPP) for sub-sample mixing and bag-filling; trowels must be cleaned well with soapy water, rinsed, and dried between samples.

9.10.9 *Sample Containers*—Use a container that is appropriate for the laboratory analysis to be performed on the collected compost sample. Refer to Tables 02.01-2 through 02.01-6, and Figure 02.01-B3.

9.10.10 Labels and Logbook

9.10.10.1 *Labels*—Name of technician, operator, inspector, facility name, pile identification, date, time, sample number and location in pile using length, width and height coordinates from an identified end and depth from surface measured perpendicular to surface, purpose of sample/test, method of sample preservation.

9.10.10.2 *Logbook*—Name of technician, operator, or inspector; and facility name. Pile data including: pile identification; feedstock-mix; type of pile; date started; weather conditions at time of sampling (for exposed piles only); pile orientation relative to natural drainage. Sample data including: date and time of sample collection; location where samples were collected in pile using length, width and height coordinates from an identified end and depth from surface measured horizontally; description of the sampling point; purpose of sample/test, method of sample preservation, point or composite sample; number and volume of the samples taken; date and time samples were shipped.

Test Method: Selection of Sampling Locations for Windrows and Piles							**Units:** *NA*	
Test Method Applications								
Process Management							**Product Attributes**	
Step 1: Feedstock Recovery	*Step 2:* Feedstock Preparation	*Step 3:* Composting	*Step 4:* Odor Treatment	*Step 5:* Compost Curing	*Step 6:* Compost Screening and Refining	*Step 7:* Compost Storing and Packaging	*Safety Standards*	*Market Attributes*
		02.01-B	02.01-B	02.01-B	02.01-B	02.01-B	02.01-B	02.01-B

02.01-B SELECTION OF SAMPLING LOCATIONS FOR WINDROWS AND PILES

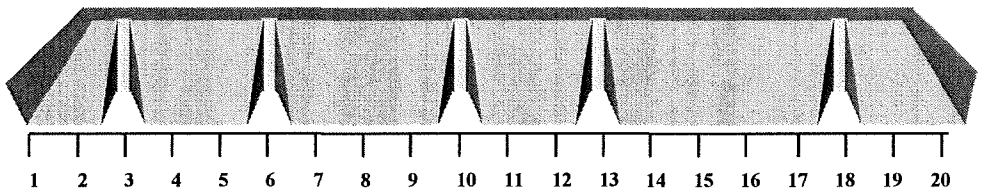

Fig 02.01-B1 Hypothetical sample collection pattern from a compost windrow.

NOTE 1B—In this example, a scale from 1-20 is superimposed on the long dimension of a compost windrow. Five distances (3, 6, 10, 13 and 18 m) are randomly selected to each side of the windrow, (e.g., numbers randomly pulled from a hat), to assign sample collection locations. Point-samples are collected from within three zones at each cutout.

NOTE 2B—The illustrated cut-outs are depicted on one side of the windrow; in a real operation, the cut-outs must be randomly assigned to each side of the windrow. Cone-shaped piles have a circular base. Measure around the base of a cone-shaped pile and randomly assign cutout positions along the pile's meridian, or circumference.

10. Apparatus for Method B

10.1 *Sampling Container*—five 16- to 20-L (4- to 5-gal), plastic (HDPP), glass.

10.1.1 *Organic Contaminant Tests*—For samples to be analyzed for the presence of organic contaminants, please refer to Table 02.01-6 Organic Contaminant Tests: Sampling containers and conditions for compost and source ingredient testing. Modify sample packaging steps presented in this section accordingly.

10.2 *Sampling Device*—silage auger, tilling spade, or other appropriate sampling device.

10.3 *Tractor Loader*—with loader, (e.g., Bobcat, etc.).

10.4 *Trowel*—high-density polypropylene (HDPP), for stirring and mixing composite sample.

10.5 *Pail*—16- to 20-L (4- to 5-gal), square pails, Use standard 5-gal plastic pails for shipping only when square pails are not available (e.g., square pails are available through Cleveland Bottle & Supply Co.; 850 East 77th Street; Cleveland, OH 44103; telephone: 216 881 3330; Fax: 216 881 7325; URL: http://www.clevelandbottle.com/squrpail.html).

11. Reagents and Materials for Method B

11.1 *Plastic Bags*—three 4-L (1 gal) durable bags with seal, (e.g., Ziploc® **Freezer** bags).

11.2 *Plastic Gloves.*

11.3 *Tarp*—clean plastic, canvas, or other type of mixing surface if feedstock is liquid sludge.

11.4 *Cold Packs*—chemical ice packs, or 4-L plastic bags (e.g., heavy duty Ziploc® freezer bags) filled with approximately 0.5 L of water and frozen flat. One ice pack per 4-L sample container of compost to be shipped, (e.g., three ice packs are recommended for three compost 4-L samples).

11.5 *Aluminum Foil*—lining for plastic shipping pail, and

11.6 *Packing Material*—newspaper or other appropriate bulking material to be used as packing or fill to minimize sample movement within the shipping container (square pail) during shipping.

11.7 *Adhesive Tape*—duct tape, 5-cm (2-in.) width.

12. Procedures for Method B

12.1 *Cut into Finished Compost*—Using tractor skid-loader, bobcat or shovel, or sample boring device, cut into the finished compost pile or windrow at five or more randomly selected positions. Collect samples from the full profile and breadth of the compost windrow or pile. Refer to Fig 02.01-B1.

12.2 *Collect Point-Samples*—Samples of equal volume are extracted from the compost pile at three depths or zones measured from the pile's uppermost surface. Collect no less than five point-samples from each of the three depths or zones illustrated in Fig 02.01-B2. The five point samples for each zone must be collected in a manner to accurately represent the horizontal cross-section of the windrow or pile. Use a sanitized sampling tool (a gloved hand, clean shovel or auger) when collecting samples and when transferring samples to the 5-gal sample collection pail.

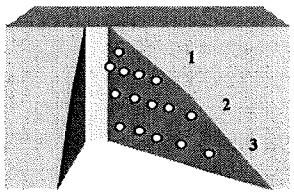

Fig 02.01-B2 Five horizontally dispersed point-samples are collected from each of three depths or zones within each cutout.

NOTE 3B—(1) upper $^1/_3$ of compost profile height; (2) middle $^1/_3$ of compost profile height; and (3) lower $^1/_3$ of compost profile height, where compost pile does not exceed the recommended overall height of 3 m. Create more than three sampling depths or zones within each cutout when the curing pile exceeds a height of 3 m, relative variability is high or the property of interest is found at very low concentrations, near the laboratory detection limit.

12.3 *Composite Point-Samples*—Place all 15 point samples from one cutout together into one sanitized plastic pail. Completely mix the point samples by stirring thoroughly with a sanitized wooden stick or lath, and by covering and shaking the pail to further mix the samples.

12.3.1 Repeat the blending process at least four times until all point samples are thoroughly blended to form one composite sample that accurately represents the compost for the cutout.

12.3.2 Proceed to the next compost sample cutout and repeat this process to collect one thoroughly blended composite sample from each of the five cutouts.

12.3.3 *Composite Sample*—Transfer the five composite samples from the sample collection pails onto a mixing tarp or other appropriately sanitized surface or container, such as into a large pail where all samples can be mixed, blended and then covered to minimize moisture loss. Thoroughly blend the five composite samples to form one large sample that represents the average condition of the entire batch or windrow in question.

12.3.3.1 Quarter the composite sample and thoroughly mix and quarter again. Continue to subdivide and split the sample into quarters and mix as described until sample size reaches approximately 12 L (3 gal).

12.4 *Stratified Sampling*—This sample collection strategy is used to evaluate for the presence of spatial variations or gradients in compost characteristics across and through a windrow or pile.

12.4.1 *Stratified Samples across Cutouts*—Use this sampling strategy to test for differences in compost characteristics between sample cutouts and along the longer dimension of a windrow. Do not composite materials from the five separate cutouts when monitoring for the presence of gradients along the longer dimension of a windrow. Pack and prepare five separate samples (i.e., five separate composite samples, one from each cutout) for shipment as described in step 12.5.

12.4.2 *Stratified Samples within Cutouts*—Use this sampling strategy to evaluate for the presence of spatial variations or gradients that occur with changes in pile depth or distance from the windrow core to its surface.

12.5 Prepare for Shipment and Storage:

12.5.1 Transfer the blended compost to three 4-L (1-gal) sample bags, (e.g., plastic Ziploc® *freezer* bags).

12.5.2 Line the shipment pail with aluminum foil or other reflective material to minimize sample heat-gain. Place the sample bags containing the compost sample into the plastic pail and interleave with ice packs for shipping (refer to Fig 02.01-B3).

12.5.3 Cover the pail with its lid. Seal and secure the lid with a packing tape. Send the sample pail by one-day express delivery service to your selected laboratory for analysis. Include a chain of custody information sheet with environmental regulatory samples (Refer to Method 02.01-E).

NOTE 3B—Maintain cool samples at 4°C (39.2°F) to diminish microbial and chemical activity prior to and during sample shipment.

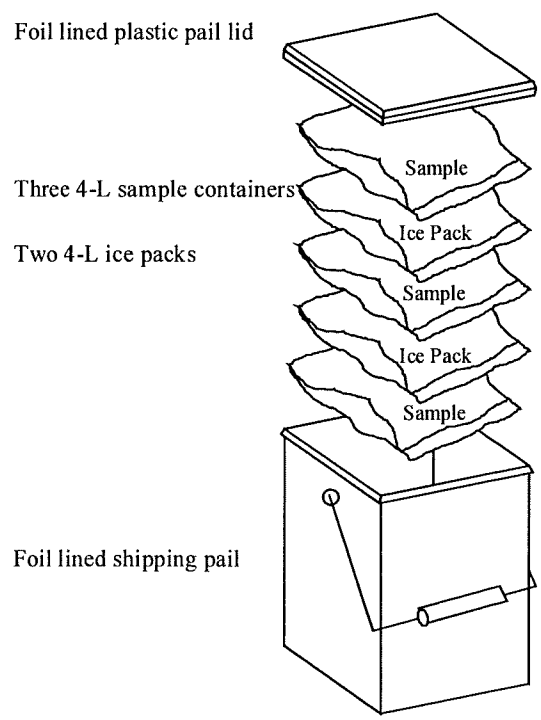

Fig 02.01-B3 Preparation for shipment.

Test Method: Field Sampling Plan for Composted Material							**Units:** *NA*	
Test Method Applications								
Process Management							**Product Attributes**	
Step 1: Feedstock Recovery	*Step 2:* Feedstock Preparation	*Step 3:* Composting	*Step 4:* Odor Treatment	*Step 5:* Compost Curing	*Step 6:* Compost Screening and Refining	*Step 7:* Compost Storing and Packaging	*Safety Standards*	*Market Attributes*
02.01-C	02.01-C	02.01-C	02.01-C	02.01-C	02.01-C	02.01-C	02.01-C	02.01-C

02.01-C FIELD SAMPLING PLAN FOR COMPOSTED MATERIAL

13. US EPA SW-846 Guideline Review and Considerations

13.1 With its hazardous waste management system, the US EPA requires that certain solid wastes be analyzed for physical and chemical properties. In its hazardous waste management system, it is mostly chemical properties that are of concern, and in the case of a number of chemical components, the US EPA has promulgated levels (regulatory thresholds) that cannot be equaled or exceeded.

13.1.1 Regulations pertaining to the management of hazardous waste contain three references regarding the sampling of solid wastes for analytical purposes:

13.1.1.1 Collect representative samples of waste, so that they exhibit average properties of the bulk compost or feedstock.

13.1.1.2 Collect enough samples (but no less than four samples) over a period of time sufficient to represent the variability of the compost or feedstock.

13.2 *Sampling Plan Implementation*—The US EPA manual contains a section on implementation of the sampling plan (SW-846 Chapter Nine, part 2). Within that section there is discussion concerning the sampling program's objectives for evaluating a compost. (Refer to Fig 03.01 Sample fate).

13.2.1 The example suggests the following questions be answered:

13.2.1.1 Is the sampling being performed to comply with environmental regulation?

13.2.1.2 Samples are to be analyzed for which parameters?

13.2.1.3 Why not others?

13.2.1.4 Should samples be analyzed for fewer parameters?

13.2.1.5 What is the end-use of the generated data?

13.2.1.6 What are the required degrees of accuracy and precision?

13.2.2 These questions may or may not be as important for sampling composted solid waste.

13.3 *Sampling Plan Considerations*—The implementation section contains a category entitled Sampling Plan Considerations. The sampling plan is usually a written document that describes the objectives, and details the individual tasks and how they will be performed. The more detailed the sampling plan, the less opportunity for oversight or misunderstanding during sampling, analysis, and data management.

13.3.1 The SW-846 document suggests that a sampling plan be designed with input from the various sectors involved in the project, including the following personnel:

13.3.1.1 *regulatory sampling*—in many cases may require state permits and consultations with state officials.

13.3.1.2 *end-user*—to use the data to attain program objectives.

13.3.1.3 *field team member*—an experienced member of the field team who actually collects samples.

13.3.1.4 *analytical chemist*—to review analytical requirements for sampling, preservation, and holding times that will be included in the sampling plan.

13.3.1.5 *process engineer or equivalent*—it explain details and constraints of the production process being sampled.

13.3.1.6 *statistician*—to review the sampling approach and verify that the resulting data will be suitable for any required statistical calculations for decisions.

13.3.2 *quality assurance representative*—to review the applicability of standard operating procedures and determine the number of blanks, duplicates, spike samples, and other steps required to document the accuracy and precision of the resulting data.

13.3.3 If no one is familiar with the site to be sampled, then a pre-sampling site visit should be arranged to acquire site-specific information. Some modifications of the sampling plan may be necessary. It is necessary to have at least one experienced sampler as a member of a sampling team.

14. Statistical Validity of Sampling Plan

14.1 *Objectives*—The primary objective of a sampling plan for a compost is to collect an appropriate

number of representative samples and subsamples for accurate and precise measurement of the chemical, physical and biological properties of the compost. If the chemical measurements are sufficiently accurate and precise, they will be considered reliable estimates of the chemical properties of the compost.

14.1.1 Generally, high degrees of accuracy and precision are required if one or more chemical components of compost are present at a concentration that is close to the applicable regulatory threshold. Alternatively, relatively low accuracy and low precision can be tolerated if the components of concern occur at levels far below or far above their applicable thresholds. Low sampling precision is often associated with considerable savings in analytical costs, as well as expenses associated with sampling; and is clearly recognizable even in the simplest of statistical tests. However, low sampling accuracy may not entail cost savings and is always obscured in statistical tests (i.e., it cannot be evaluated). Although it is often desirable to design sampling plans for compost to achieve only the minimally required precision (at least two samples are required for any estimate of precision), it is prudent to design the plans to attain the greatest possible accuracy.

14.2 *Composite Sampling*—For composite sampling, a number of random subsamples are initially collected and combined into a single sample, which is analyzed for the chemical constituents of concern. The major disadvantage of composite sampling, as compared with non-composite sampling, is loss of information about the spatial variability of chemical constituents because only a single estimate of the parameter is generated. The benefit is that a credible, general representation of the entire compost pile is generated from a large number of subsamples which are composited.

14.3 *Sampling Quality Assurance/Quality Control (QA/QC):*

14.3.1 Make sure all sampling equipment and containers are clean. If equipment is used to collect multiple samples, provisions for cleaning and decontamination are required between samples.

14.3.2 Properly label all samples and keep accurate records. Record as much information on sample labels as possible prior to arriving at the site. Sample labels and field notes should include material type, location, date, approximate age of compost, sampler's name, special sampling procedures used, analytical procedures to be performed, preservatives added (if any), and any special observations or incidents during the sampling event.

14.3.3 Point-samples must be stored in a refrigerator (4°C) before analysis when delays in shipment to laboratory are anticipated. This preservation is especially important for feed stock samples, compost to be evaluated for stabilization or maturity, or microbiological analysis. Chemical quality changes that may take place due to microbiological activity between sample collection and laboratory analysis should be avoided.

14.3.4 Chain of custody forms and procedures should be used with all environmental samples.

14.4 *Other Sampling Considerations*—Compost samples are taken at each facility for a variety of purposes. Varying levels of expertise and quality assurance are required depending on the sampling purpose or objective. A unique sampling protocol should be developed for each specific objective. This information should be detailed in a facility operation and maintenance (O&M) manual and be accessible to all facility staff.

14.4.1 Key process variables including porosity, nutrient balance, oxygen, moisture, temperature and time are monitored and controlled on a continual or daily basis. Measurements of weight and volume of waste arriving and compost leaving the facility are necessary for planning material movements, personnel and transportation requirements, and maintaining facility aesthetics. Although this is the most frequent type of sampling conducted, the sampling quality assurance requirements are the least significant for these activities. Generally, process control and material handling data do not need to be precise to be useful, (e.g., appropriate application of quick-tests). Regulatory compliance and product attribute data must be highly precise and accurate, (e.g., statistically valid sampling program to accurately estimate the average value of interest).

14.5 *Sampling Frequency*—Operating permits for compost sites require that concentrations of certain constituents of environmental concern be evaluated, (e.g., As, Ba, Cd, Cu, Cr, Hg, Mn, Mo, Ni, Pb, Se, Zn, pathogens such as *Salmonella* and fecal coliform, and organic compounds such as PCB's, PCP's, dioxins, furans, organochlorine and organophosphorus pesticides). Regulatory agencies establish compliance using individual sample results. It is, therefore, very important that sample collection and preparation techniques provide representative samples.

NOTE 1C—As much as 20,000 m^3 of compost may be represented by one subsample as small as 1 g. Because of this, it is vital that the sample be representative of the total material. *Quality control and quality assurance for quarterly testing must be greater than that employed for routine daily monitoring.*

14.6 *Statistical Techniques*—Statistical techniques for obtaining accurate and precise samples are relatively simple and easy to implement. Accurate representations of an entire compost pile or batch may be achieved through random sampling. In random sampling, every unit in the population has a theoretically equal chance of being sampled and

measured. Consequently, statistics generated by the sample (e.g. sample mean and to a lesser degree, standard deviation) are unbiased estimators of true population parameters. That is, the sample is representative of the population. A common method of selecting a random sample is to divide the population by an imaginary grid, assign a series of consecutive numbers to the units of the grid, and select the number to be sampled using a random-numbers table.

NOTE 2C—Haphazardly selected samples are not random and therefore not a suitable substitute for a randomly selected sample. That is because there is no assurance that a person performing undisciplined sampling will not consciously or subconsciously favor the selection of certain units of the population.

14.6.1 Sampling precision is achieved by collecting the appropriate number of samples that are uniformly distributed across the entire volume of compost. Precision is improved by increasing the number of samples, while maintaining a sampling pattern to guarantee a spatially uniform distribution.

14.6.2 If a batch of compost is randomly heterogeneous with regard to its chemical characteristics and if that random chemical heterogeneity remains constant from batch to batch, accuracy and appropriate precision can usually be achieved by simple or systematic random sampling. More complex stratified random sampling is appropriate if a batch of compost is known to be non-randomly heterogeneous in terms of its chemical properties and non-random chemical heterogeneity is known to exist from batch to batch. In such cases, the population is stratified to isolate the known sources of non-random chemical heterogeneity. The units in each stratum are numerically identified, and a simple random sample is taken from each stratum. This type of sampling would be advantageous only if the stratification efficiently divides the waste into strata that exhibit maximum between-strata variability and minimum within-strata variability. In composted solid waste that is frequently turned and mixed, little if any stratification is likely to occur. If little or no information is available concerning the distribution of chemical components, simple or systematic random sampling are the most appropriate sampling strategies.

14.7 *Number of Samples*—The appropriate number of samples to collect is the least number required to generate a sufficiently precise estimate of the true mean concentration of a chemical component of a compost. From the compost producer's perspective, this means that the minimum number of samples needed to demonstrate that the upper limit of the confidence interval for the true mean is less than the applicable regulatory threshold value. It is always prudent to collect a greater number of samples than indicated by preliminary estimates of the mean and variance since poor preliminary estimates of those statistics can result in an underestimate of the appropriate number of samples to collect.

14.8 *Simple Random Sampling*—For convenience, the statistical calculations for simple random sampling (wherein within-batch heterogeneity that may be encountered by a compost producer is low) are provided (adapted from SW-846 Chapter Nine, part 2, pages 13-14).

14.8.1 Obtain preliminary estimate of $\bar{x}$ for each chemical component of compost that is of concern. The above-identified statistic is calculated by Equation 14.8.1.

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \qquad \textit{Equation 14.8.1}$$

where:

$\bar{x}$ = simple random sample mean,
n = total number of sample measurements,
x = variable in question (e.g., mercury),
i = individual samples ranging from 1 to n, and
$\sum_{i=1}^{n} x_i$ = sum of all x's (analytical results for individual samples), from i = 1 through i = n.

14.8.2 Obtain preliminary estimate of variance, s^2, for each chemical component of concern. The above-identified statistic is calculated by Equation 14.8.2.

$$s^2 = \frac{\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2 \Big/ n}{n-1} \qquad \textit{Equation 14.8.2}$$

where:

s^2 = variance of simple random sample,
n = total number of sample measurements,
x = variable in question (e.g., mercury), and
i = individual samples ranging from 1 to n.

14.8.3 Estimate the appropriate number of samples *(n_1)* to be collected from the compost through use of Equation 14.8.3 and Table 02.01-C1. Derive individual values of n_1 for each chemical component of concern *(x)*. The appropriate number of samples to be taken from the compost is the greatest of the individual n_1 values.

$$n = \frac{t_{.20}^2 s^2}{\Delta^2} \qquad \textit{Equation 14.8.3}$$

where:

n = number of samples,

$t_{.20}^2$ = tabulated "t" value for two-tailed confidence interval and a probability of 0.20,

s^2 = sample variance, and

Δ^2 = the square of the regulatory threshold minus sample average, defined by US EPA, (e.g., 100 mg kg^{-1} for barium in elutriate of EP toxicity).

Table 02.01-C1 Tabulated values of Student's "t" for evaluating compost.

Degrees of freedom (n-1)	*Tabulated "t" value*	*Degrees of freedom (n-1)*	*Tabulated "t" value*
1	3.078	16	1.337
2	1.886	17	1.333
3	1.638	18	1.330
4	1.533	19	1.328
5	1.476	20	1.325
6	1.440	21	1.323
7	1.415	22	1.321
8	1.397	23	1.319
9	1.393	24	1.318
10	1.372	25	1.316
11	1.363	26	1.315
12	1.356	27	1.314
13	1.350	28	1.313
14	1.345	29	1.311
15	1.341	30	1.310
		40	1.303
		60	1.296
		120	1.289

14.8.3.1 Randomly collect at least n_1 (or $n_2 - n_1$, $n_3 - n_2$, etc., as will be indicated in step 8) samples from the compost. Maximize the physical size (volume) of all samples that are collected from the strata.

NOTE 3C—Collection of a few extra samples will provide protection against poor preliminary estimates of $\bar{x}$ and s^2.

14.8.3.2 Analyze the n_1 (or $n_2 - n_1$, $n_3 - n_2$, etc.) samples for each chemical component of concern. Superficially (graphically) examine each set of analytical data from each stratum for obvious departures from normality.

14.8.4 Calculate the standard deviation *(s)* for each set of analytical data by Equations 14.8.1, 14.8.2, 14.8.4 and 14.8.5.

$$s = \sqrt{s^2} \qquad \textit{Equation 14.8.4}$$

14.8.5 Calculate $\bar{x}$, s^2, and standard error (s_X) for each set of analytical data by, Equations 14.8.1, 14.8.2, and 14.8.5.

$$s_X = \frac{s}{\sqrt{n}} \qquad \textit{Equation 14.8.5}$$

14.8.5.1 If $\bar{x}$ for a chemical component is equal to or greater than the applicable regulatory threshold (from Equation 14.8.3) and is believed to be an accurate estimator of μ (population mean), the component is considered to be present in the compost at a hazardous concentration, and the study is completed. Otherwise, continue the study. In the case of a set of analytical data that does not exhibit obvious abnormality and for which $\bar{x}$ is greater than s^2, perform the following calculations with non-transformed data. Otherwise, consider transforming the data by the square root transformation (if $\bar{x}$ is about equal to s^2) or the arcsine transformation (if $\bar{x}$ is less than s^2) and performing all subsequent calculations with transformed data.

14.8.6 Determine the confidence interval (CI) for each chemical component of concern by Equation 14.8.6. If the upper limit of the CI is less than the applicable regulatory threshold (applied in Equation 14.8.3), the chemical component is not considered to be present in the compost at a hazardous concentration, and the study is completed. Otherwise, the opposite conclusion is tentatively reached.

$$\text{CI} = \bar{x} \pm t_{0.20} s_x \qquad \textit{Equation 14.8.6}$$

where:

$t_{0.20}$ = referred to in Table 02.01-C1 Tabulated values of Student's "t" for evaluating compost for appropriate degrees of freedom.

14.8.7 If a tentative conclusion of hazard is reached, re-estimate the total number of samples (n_2) to be collected from the compost by use of Equation 14.8.3. When deriving n_2, employ the newly calculated (not preliminary) values of $\bar{x}$ and s^2. If additional $n_2 - n_1$ samples of compost cannot reasonably be collected, the study is completed, and a definitive conclusion of hazard is reached. Otherwise, collect an extra $n_2 - n_1$ samples of compost.

14.8.8 Repeat the basic operations described in Steps 14.8.3 through 14.8.7 until the compost is judged to be non-hazardous or, if the opposite conclusion continues to be reached, until increased sampling effort is impractical.

14.9 *Stratified Random Sampling*—For convenience, the statistical calculation steps for stratified random sampling that must be performed in situations that may be encountered by a compost producer where within-batch heterogeneity is high are provided below (from SW-846 Chapter Nine, part 2, pages 18-19).

14.9.1 Obtain preliminary estimate of $\bar{x}$ for each chemical component of concern. The identified statistic is calculated by Equation 14.9.1.

$$\bar{x} = \sum_{k=1}^{r} W_k \bar{x}_k \qquad \textit{Equation 14.9.1}$$

where:

$\bar{x}$ = stratified random sample mean,

$\bar{x}_k$ = stratum mean, and

W_k = fraction of population represented by stratum k (number of strata *[k]* range from 1 to r).

14.9.2 Obtain preliminary estimate of s^2 for each chemical component of compost that is of concern. The identified statistic is calculated by Equation 14.9.2.

$$s^2 = \sum_{k=1}^{r} W_k s_k^2 \qquad \textit{Equation 14.9.2}$$

where:

s^2 = stratified random sample variance,

s_k^2 = stratum variance, and

W_k = fraction of population represented by stratum k (number of strata *[k]* range from 1 to r).

14.9.3 Estimate the appropriate number of samples *(n_1)* to be collected from the compost through use of Equation 14.8.3 and Table 02.01-A1 Tabulated values of Student's "t" for evaluating compost. Derive individual values of n_1 for each chemical component of concern. The appropriate number of samples to be taken from the compost is the greatest of the individual n_1 values.

14.9.4 Randomly collect at least n_1 (or n_2 - n_1, n_3 - n_2, etc., as will be indicated in step 8) samples from the compost. If s_k for each stratum (see Equation 14.9.2) is believed to be an accurate estimate, optimally allocate samples among strata (i.e., locate samples among strata so that the number of samples collected from each stratum is directly proportional to the s_k for that stratum). Otherwise, proportionally allocate samples among strata according to size of the strata. Maximize the physical size (volume) of all samples that are collected from the strata.

14.9.5 Analyze the n_1 (or n_2 - n_1, n_3 - n_2, etc.) samples for each chemical component of concern. Superficially (graphically) examine each set of analytical data from each stratum for obvious departures from normality.

14.9.6 Calculate $\bar{x}$, s^2, the standard deviation *(s)*, and s_x for each set of analytical data by, respectively, Equations 14.9.1, 14.9.2, 14.8.4 and 14.8.5.

14.9.7 If $\bar{x}$ for a chemical component is equal to or greater than the applicable regulatory threshold (from Equation 14.8.3) and is believed to be an accurate estimator of μ (population mean), the component is considered to be present in the compost at a hazardous concentration, and the study is completed. Otherwise, continue the study. In the case of a set of analytical data that does not exhibit obvious abnormality and for which $\bar{x}$ is greater than s^2, perform the following calculations with non-transformed data. Otherwise, consider transforming the data by the square root transformation (if $\bar{x}$ is about equal to s^2) or the arcsine transformation (if $\bar{x}$ is less than s^2) and performing all subsequent calculations with transformed data.

14.9.8 Determine the confidence interval (CI) for each chemical component of concern by Equation 14.8.6. If the upper limit of the CI is less than the applicable regulatory threshold (applied in Equation 14.8.3), the chemical component is not considered to be present in the compost at a hazardous concentration, and the study is completed. Otherwise, the opposite conclusion is tentatively reached.

14.9.9 If a tentative conclusion of hazard is reached, re-estimate the total number of samples *(n_2)* to be collected from the compost by use of Equation 14.8.3. When deriving n_2, employ the newly calculated (not preliminary) values of $\bar{x}$ and s^2. If additional n_2 - n_1 samples of compost cannot reasonably be collected, the study is completed, and a definitive conclusion of hazard is reached. Otherwise, collect an extra n_2 - n_1 samples of compost.

14.9.10 Repeat the basic operations described in Steps 14.9.3 through 14.9.9 of Fig 02.01-1 Composting Unit Operations, until the compost is judged to be non-hazardous or if the opposite conclusion continues to be reached until increased sampling effort is impractical.

Test Method: Composting Feedstock Material Sampling Strategies						**Units:** *NA*		
Test Method Applications								
Process Management							**Product Attributes**	
Step 1: Feedstock Recovery	*Step 2:* Feedstock Preparation	*Step 3:* Composting	*Step 4:* Odor Treatment	*Step 5:* Compost Curing	*Step 6:* Compost Screening and Refining	*Step 7:* Compost Storing and Packaging	Safety Standards	Market Attributes
02.01-D	02.01-D							

02.01-D BATCH FEEDSTOCK MATERIAL SAMPLING STRATEGIES

15. Apparatus for Method D

15.1 *Sampling Container*—20-L (5-gal), stainless steel, plastic, glass or Teflon.

15.2 *Sampling Device*—wooden spatula or tiling spade, etc.

15.3 *Trowel*—high-density polypropylene (HDPP).

15.4 *Plastic Storage Pail*—20-L (5-gal), square pails, Use standard 5-gallon plastic pails only when square pails are not available (e.g., Cleveland Bottle & Supply Co.; 850 East 77th Street; Cleveland, OH 44103; telephone: 216 881 3330; Fax: 216 881 7325; URL: www.clevelandbottle.com/squrpail.html.

16. Reagents and Materials for Method D

16.1 *Plastic Gloves.*

16.2 *Tarp*—clean plastic, canvas, or other type of mixing surface if feedstock is liquid sludge.

16.3 *Plastic Bags*—three 4-L (1 gal) Ziploc® *freezer* bags.

16.4 *Cold Packs*—chemical ice packs,

16.5 *Aluminum Foil*—lining for plastic shipping pail, and

16.6 *Adhesive Tape*—duct tape, 5-cm (2-in.) width.

17. Procedure for Method D

17.1 *Sample Collection*—Identify and collect an appropriate number of subsamples needed to ensure a reliable analytical result as described in Methods 02.01-A, B or C.

17.1.1 Place each subsample into a sampling (subsample) container.

17.1.2 Transfer the contents of the subsample container onto (into) mixing surface (container) and proceed to the next randomly selected sample point.

17.1.3 Repeat steps 17.1.1 and 17.1.2 until the predetermined number of subsamples is obtained.

17.2 *Sample Mixing*—Place subsamples on clean tarp or other similar mixing platform, mix sub-samples thoroughly using a wooden spatula or comparable sampling tool.

17.3 *Sample Splitting*—Subdivide sample into quarters, thoroughly mixed composite sample into fourths. Repeat steps 17.2 and 17.3 until sample size is appropriate for intended analysis.

17.4 *Sample Storage and Shipping*—Place composite sample aliquot in clean container, preferably a Teflon pail or similar inert material.

CAUTION—Do not use galvanized sheet metal collection or mixing tools. The galvanized coating will contaminate the sample with zinc.

17.4.1 Transfer blended feedstock or compost to fill three 4-L (1-gal) plastic Ziploc® freezer bags.

17.4.2 Line the shipment pail with aluminum foil to minimize heat exchange. Place the plastic Ziploc® freezer bags containing the feedstock samples in the plastic pail and interleave with cold packs for shipping (refer to Fig 02.01-B3).

17.4.3 Seal the square pail with its lid. Seal and secure lid with duct tape. Send the square plastic pail containing samples by two-day express service to the selected laboratory for analysis. Include completed chain of custody forms when necessary.

NOTE 1D—If any delay is anticipated, cool sample to 4°C (39.2°F) to diminish microbial and chemical activity prior to sample shipment.

Test Method: Data Quality Management and Sample Chain of Custody						**Units:** *NA*		
Test Method Applications								
Process Management							**Product Attributes**	
Step 1: Feedstock Recovery	*Step 2:* Feedstock Preparation	*Step 3:* Composting	*Step 4:* Odor Treatment	*Step 5:* Compost Curing	*Step 6:* Compost Screening and Refining	*Step 7:* Compost Storing and Packaging	Safety Standards	Market Attributes
02.01-E	02.01-E		02.01-E			02.01-E	02.01-E	02.01-E

02.01-E DATA QUALITY MANAGEMENT AND SAMPLE CHAIN OF CUSTODY

18. Aspects of Sampling Quality Assurance for Reported Data

18.1 Three critical steps in the sampling process precede laboratory analysis and often dictate data quality.

18.1.1 sample planning and collection;

18.1.2 sample handling and preservation; and

18.1.3 laboratory sample preparation.

18.2 Each step in the sampling process must be properly executed in a timely manner by well informed, trained individuals to ensure that the collected sample accurately represents a compost batch, windrow or pile.

18.3 *Quality Sample Management*—Regulatory and certification systems may dictate that samples are properly collected, preserved and prepared for analysis. Consider the following hypothetical example of sample management where a certified third party is introduced to manage the sampling plan.

18.3.1 The third party assumes all quality assurance and quality control responsibilities associated with:

18.3.1.1 sample planning and collection;

18.3.1.2 sample handling and preservation; and

18.3.1.3 laboratory sample preparation.

18.3.2 Responsibility for rigorous sample collection is transferred from facility management to the third party. Responsibilities associated with sample storage, preparation and laboratory analysis are also transferred from the analytical laboratory to the third party.

18.3.3 One of the principal benefits of the third party sampling system is to diminish deviations in sampling plan interpretation and implementation across separate facilities and laboratories. Third party control can decrease variability by maintaining consistent field sampling protocols across all participating facilities. Field sample collections would be implemented as described in *TMECC 02.01 Field Sampling of Compost Materials*. Consistent sample preparation protocols would also be followed for laboratory analysis as described in *TMECC 02.02 Laboratory Sample Preparation for Analysis*.

18.4 *Tracking Quality*—A sample must be properly collected and prepared for shipment, and then properly manipulated by laboratory personnel who follow specific preparation protocols designed for each analytical methodology. Previous sections emphasized the importance of properly designed and implemented sampling plans. This section introduces a protocol designed to modify data interpretation to interpret sample variability.

18.4.1 Consider the following hypothetical sampling plan that incorporates an additional step to verify accuracy of reported results using cross-validation techniques. One type of a statistically valid sample management plan requires that samples are properly collected at a very high frequency while the actual number of samples submitted for analysis remains small.

18.4.1.1 *Establish Baseline*—A significant number of samples that represent the composting process of a facility are collected over time and sent to a laboratory for analysis. Results from these samples serve to establish a baseline of information that accurately represents the compost produced by the facility and a given feedstock blend.

18.4.1.2 *Track Deviations from Baseline*—After the baseline is established, samples are collected at specified intervals, over time or per unit of compost produced (refer to *TMECC 02.01-A Equation 9.9.1 Formula to estimate sampling interval*), and held in cold storage. After a specified interval, (e.g., quarterly or monthly) a small but statically representative number of prepared samples are randomly selected from the stored samples and sent to a laboratory for analysis. Because multiple samples would be randomly selected from a larger population of samples, a more reliable statistical inference can be generated than by simply directly submitting monthly or quarterly samples for analysis.

18.4.2 Sampling programs of this nature may require that field samples, or samples prepared for laboratory analysis, are submitted to a secure or bonded cold-storage facility where frequently collected samples are inventoried and properly stored. Samples must be retained in storage for a predetermined time period to

safeguard against cases where a need for re-testing may arise.

18.4.3 *Sampling Costs*—Sampling program maintenance costs should be considered when designing an effective monitoring system. It is difficult to weigh the relative importance of data quality when there is no clear relationship between financial outcome and monitoring protocol. Successful implementation will increase when data quality relates to an increased financial incentive, either artificially through incentives offered by the governing regulatory agency or through quality assurance certification programs designed to indirectly increase market share.

02.01 SUMMARY

19. Report

19.1 Chain of custody forms and procedures should be used with all environmental or regulatory samples. A chain of custody form is used to track sample handling from time of collection through laboratory analysis, and data reporting. Suggested information for the chain-of-custody record includes, at a minimum: Collector's name; Signature of collector; Date and time of collection; Place and address of collection; Requested preprocessing (subsampling, compositing, sieving); Requested analyses; Sample code number for each sample (if used); Signature of the persons involved in the chain of possession. Refer to Fig 02.01-E1 Chain of Custody form for an example.

20. Keywords

20.1 accuracy; aliquot; attribute verification; bias; chain of custody; closed vessel system; composite; compost; coefficient of variation; %CV, confidence interval; feedstock; grab-sample; point-sample; point-sampling; open vessel system; precision; process monitoring; process variability; product variability; quality control; quality assurance; representative sample; sample collection frequency; sampling; sampling plan; statistical validity; stratified sampling; windrow.

STA Laboratory: _____ *Tel:* _____
Address: _____ *FAX:* _____
_____ *Email:* _____
City, State Zip code: _____

Client/Reporting Company: _____ *Tel:* _____
Contact Name: _____ *FAX:* _____
Billing Address: _____ *Email:* _____
_____
City, State Zip code: _____

Send Results to: _____
City, State Zip code: _____

Name or Source of sample(s): _____
Name of Sample Collector: _____

LABORATORY USE ONLY *Storage Locations*

Freezer _____ Cold Room _____ Storage Shelf _____

Sample Condition:

Sample Type: O COMPOSITE O POINT O STRATIFIED

P.O. Number: _____
Client STA ID: _____
USCC Member: O YES O NO ID: _____

SELECTION OF ANALYSIS. *Refer to http://tmecc.org/sta for details.*
STA Suite; All 503 Rule Tests; Other – Specify additional tests in fields A through D (below).
NOTE ! *Your selection of **STA Suite** (below) authorizes laboratory personnel to disclose all analytical results AND submit the STA Compost Technical Data Sheet directly to STA program management.*

A	B	C	D

Client Sample Identification (and special instructions)	*Collection Date/Time*	*Sample Matrix*	*Sample Container*	*Shipping Temp.*	*Selected Analysis* STA	503	A	B	C	D	*Lab/Job Number*
1	*Date:*	Compost O	Plastic Bag O	Ambient O	O	O	O	O	O	O	1
	Time:	Feedstock O	Pail O	Wet Ice O							
	Initials:	_____ O	_____ O	Dry Ice O							
2	*Date:*	Compost O	Plastic Bag O	Ambient O	O	O	O	O	O	O	2
	Time:	Feedstock O	Pail O	Wet Ice O							
	Initials:	_____ O	_____ O	Dry Ice O							
3	*Date:*	Compost O	Plastic Bag O	Ambient O	O	O	O	O	O	O	3
	Time:	Feedstock O	Pail O	Wet Ice O							
	Initials:	_____ O	_____ O	Dry Ice O							
4	*Date:*	Compost O	Plastic Bag O	Ambient O	O	O	O	O	O	O	4
	Time:	Feedstock O	Pail O	Wet Ice O							
	Initials:	_____ O	_____ O	Dry Ice O							
5	*Date:*	Compost O	Plastic Bag O	Ambient O	O	O	O	O	O	O	5
	Time:	Feedstock O	Pail O	Wet Ice O							
	Initials:	_____ O	_____ O	Dry Ice O							

Releasing Signature 1	Date	Time	Receiving Signature 1	Date	Time
Releasing Signature 2	Date	Time	Receiving Signature 2	Date	Time
Releasing Signature 3	Date	Time	Receiving Signature 3	Date	Time
Releasing Signature 4	Date	Time	Receiving Signature 4	Date	Time

Fig 02.01-E1 Chain of Custody. Compost sample chain of custody log

STA Laboratory: _____ *Tel:* _____
Address: _____ *FAX:* _____
_____ *Email:* _____
City, State Zip code: _____

Client/Reporting Company: _____ *Tel:* _____
Contact Name: _____ *FAX:* _____
Billing Address: _____ *Email:* _____
_____
City, State Zip code: _____

Send Results to: _____
City, State Zip code: _____

Name or Source of sample(s): _____
Name of Sample Collector: _____

LABORATORY USE ONLY *Storage Locations*

Freezer ____ Cold Room ____ Storage Shelf ____

Sample Condition:

Sample Type: ○ COMPOSITE ○ POINT ○ STRATIFIED

P.O. Number: _____
Client STA ID: _____
USCC Member: ○ YES ○ NO ID: _____

SELECTION OF ANALYSIS. *Refer to http://tmecc.org/sta for details.*
STA Suite; All 503 Rule Tests; Other – Specify additional tests in fields A through D (below).
NOTE ! *Your selection of **STA Suite** (below) authorizes laboratory personnel to disclose all analytical results AND submit the STA Compost Technical Data Sheet directly to STA program management.*

A	B	C	D

Client Sample Identification (and special instructions)	*Collection Date/Time*	*Sample Matrix*	*Sample Container*	*Shipping Temp.*	*Selected Analysis* STA	503	A	B	C	D	*Lab/Job Number*
1	*Date:* *Time:* *Initials:*	Compost ○ Feedstock ○ ____ ○	Plastic Bag ○ Pail ○ ____ ○	Ambient ○ Wet Ice ○ Dry Ice ○	○	○	○	○	○	○	1
2	*Date:* *Time:* *Initials:*	Compost ○ Feedstock ○ ____ ○	Plastic Bag ○ Pail ○ ____ ○	Ambient ○ Wet Ice ○ Dry Ice ○	○	○	○	○	○	○	2
3	*Date:* *Time:* *Initials:*	Compost ○ Feedstock ○ ____ ○	Plastic Bag ○ Pail ○ ____ ○	Ambient ○ Wet Ice ○ Dry Ice ○	○	○	○	○	○	○	3
4	*Date:* *Time:* *Initials:*	Compost ○ Feedstock ○ ____ ○	Plastic Bag ○ Pail ○ ____ ○	Ambient ○ Wet Ice ○ Dry Ice ○	○	○	○	○	○	○	4
5	*Date:* *Time:* *Initials:*	Compost ○ Feedstock ○ ____ ○	Plastic Bag ○ Pail ○ ____ ○	Ambient ○ Wet Ice ○ Dry Ice ○	○	○	○	○	○	○	5

Releasing	Date	Time	Receiving	Date	Time
Signature 1			Signature 1		
Signature 2			Signature 2		
Signature 3			Signature 3		
Signature 4			Signature 4		

Fig 02.01-E1 Chain of Custody. STA sample chain of custody log — CCREF / USCC

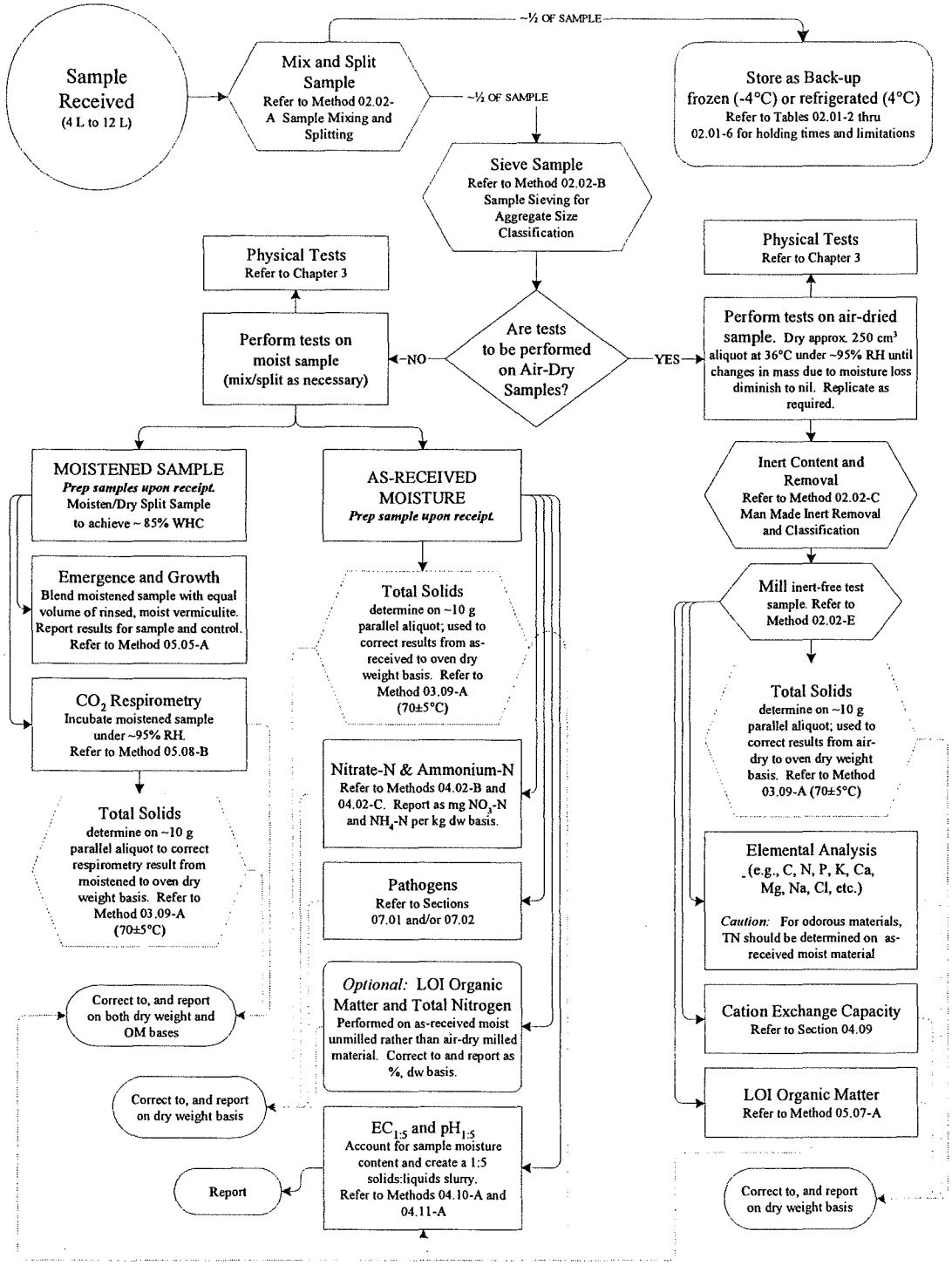

Fig 02.02-1 Flow of sample fate through laboratory sample preparation. Only common routine testing is included in this illustration. Please note that a majority of physical tests (TMECC Chapter 03) are performed on as-received moist material. Notable exceptions include one of the water-holding capacity tests and both wettability tests which call for dried materials. Additional tests performed on as-received moist material not listed in the diagram include all other respirometry methods, bioassays, VFA's, other pathogens and synthetic organic compounds. Refer to specific TMECC sections and methods for detailed descriptions of, or deviations in, sample preparation protocols.

SOLVITA MATURITY TESTING

Vers. 4 - UPDATE 2004

SOLVITA™
by WOODS END® RESEARCH

Recognized WORLDWIDE

OFFICIAL SOLVITA® GUIDELINE COMPOST MATURITY INDEX

The Solvita® procedure is a widely recognized and easy-to-perform compost test that results in a *Maturity Index*. The kit detects carbon-dioxide and ammonia levels which aid interpreting maturity which by common definition means *resistance to further decomposition* and *absence of phytotoxic compounds.*[1]

> THIS MANUAL UPDATES THE FOLLOWING PROTOCOLS:

- MOISTURE: We have downgraded concern about testing overly wet compost as Solvita results appear to be accurate to high levels of moisture.
- COLOR: We now recommend removing paddles from jar to read color.
- DENSITY: We have added a table to estimate packing density in the jar.
- AMMONIA: We have provided tables to estimate ammonia gas hazards.

The Solvita test can be used effectively for the following purposes:

1) To comply with state, governmental or trade standards that specify stability/maturity.[2]

2) For evaluating compost conditions in order to make improvements to the process.

3) To determine suitable end-use prior to distribution and sale of compost products.

Obtaining Satisfactory Test Results

Composts are by nature heterogeneous in terms of ingredients, texture and bulk-density. Therefore, great care should be exercised when obtaining, handling and preparing any sample for testing. If proper and reasonable precautions are taken, there is no reason why the test will not produce highly reliable results. A troubleshooting key is included as Appendix to help understand when results appear to be unusual.

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1. SEE Wang, P, C.M. Changa, M.E. Watson, W.A. Dick, Y. Chen, H.A.J. Hoitink (2004) Maturity indices for composted dairy and pig manures. Soil Biology & Biochemistry. Elsevier. 36: 767-776 (see www.woodsend.org)
2. Solvita is TMECC Test #05-08E (US Composting Council, Compost Test Methods Manual, 2002). Solvita may be used to fulfill 2 of 3 requirements for the California Maturity Index (a C:N test is also required).
** Solvita is approved or required in the following states and regions: CA, CT, ID, IL, KS, OH, MA, ME, MN, NJ, NM, TX, WA. In Europe Solvita is recognized in: DK, S, N, UK, IT. Also listed for EU Eco-Label.

Solvita® is a trademark of Woods End Research Laboratory, Inc.
Protected by one or more of the following patents: 5,320,807 - 6,391,262 - 6,780,646 and DE4416387A1

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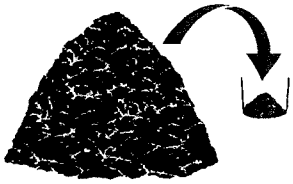
Technical support line 207-293-2457 Fax 293-2488 / Sales 800-451-0337 www.solvita.com

Detailed sampling instructions are available at: www.woodsend.org

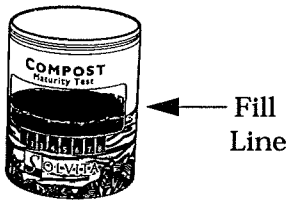
SAMPLE PREPARATION



1. OBTAIN SAMPLE: Make a composite sample by mixing several sub-samples representing the compost to be tested.

2. SCREENING: Remove or screen-out wood chips and large fragments before testing. A $^3/_8$" (10mm) sieve is customary.

3. CHECK MOISTURE: Compost should only be tested when at ideal moisture for proper composting. Compost that is too dry may have suppressed respiration and therefore may give a false positive for maturity. Try the squeeze test[1].

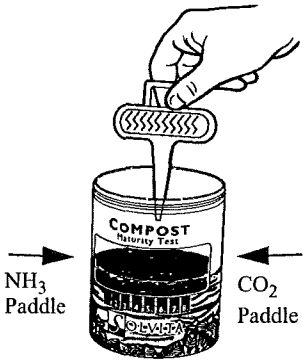


4. LOAD COMPOST: Fill the Solvita jar to the indicated fill line. Samples are meant to be tested at field volume density. When compost is disturbed the porosity may increase. To get the proper density it is useful to sharply tap the jar while observing the fill line. Optionally, the proper weight in grams per jar of suitably moistened compost corresponding to actual field density is found in the table at the left.

lbs/ yd^3	kg/m^3	g / jar
600	300	30
800	400	40
1,000	500	50
1,200	600	60

5. EQUILIBRATION STEP: Let the sample "air-out" in the jar for one-hour prior to starting the test. If the sample was taken directly from a very hot or frozen pile, or if it needed remoistening after being too dry, then let it sit in the test jar overnight with the lid open before starting the test. This improves the reliability of the respiration reading.

6. START TEST: The Solvita test is two tests in one, carried out in the same 4-hour period. Open the individual pouches marked "Compost CO_2" or "Ammonia" and carefully remove each paddle. The gel in the paddles is color-coded: the carbon-dioxide paddle is purple and the ammonia paddle is yellow. *Do not touch the special gel surface, and don't allow compost to touch it.* Once the gelpack is opened, the test should be started within 30-minutes as it will start absorbing gases from the atmosphere.

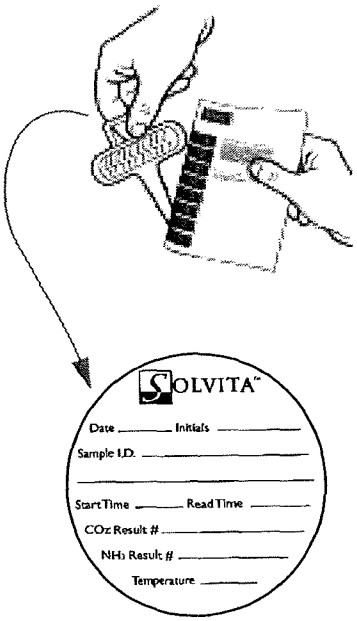


7. INSERT PADDLES: Both paddles are pushed into the sample in the jar according to the cue marks on the jar, and may be observed through the clear back panel. The edges of the paddles can be touching in the middle at about right angles. Push the paddle tips all the way into the compost to the bottom of the jar. Do not jostle or tip the jar which may coat the gel paddles!

---

1. **Squeeze test**: make a fistful of compost. Squeeze very hard. Moisture should appear between fingers but not drip out if compost is at the proper moisture content.

RUNNING THE SOLVITA TEST



For proper documentation, record the results on the removable Solvita jar labels and affix to the log sheet.

8. SCREW THE LID TIGHT, and keep the jar at room temperature (68—77°F or 20—25°C) *out of direct sunlight* for 4 hours.

9. READ THE GEL COLOR. At the correct time (4 hours) after the jar has been sealed, remove the paddles one at a time from the jar and hold next to the correct color chart. Compare the gel color to the numbered color scales, finding the closest match (half shades of color may also be read). Read within 5-minutes after removing from the jar. Color matching is best under fluorescent room light. Mark the results on the lid label on the jar.

10. FILL IN THE VALIDATION FORM: Provided in the kit is a removable lid label to aid in the documentation of the results from Solvita testing. A pre-punched monitoring sheet is provided along with the test kit. The Solvita lid label may be peeled off the jar after the test and affixed to the monitoring sheet and stored in a binder to document the test.

11. FIND THE MATURITY INDEX: Using both paddle numbers from the color chart, read the table below to find the intersection of the CO_2 and Ammonia values. See also Tables 2-3-4 to separately estimate ammonia content and ammonia hazards.

Table 1. Compost Maturity Index Table[a]

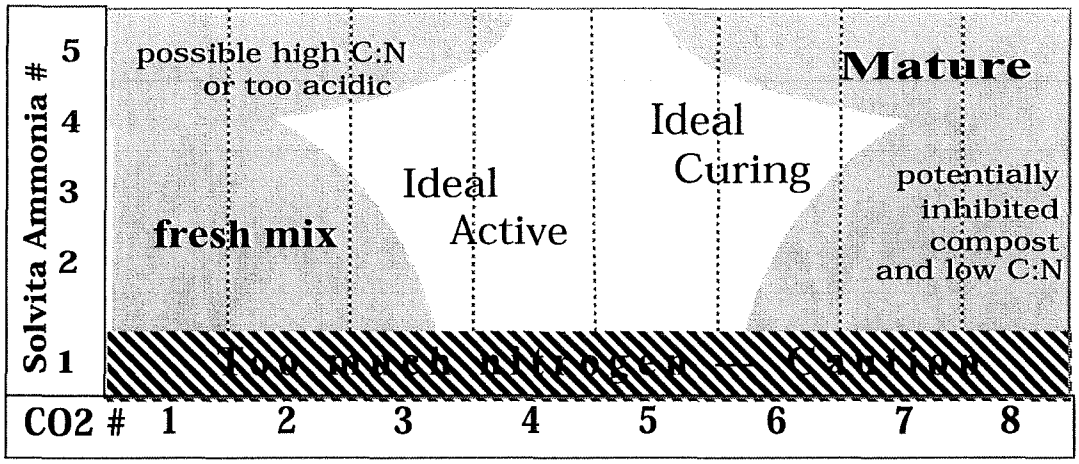
use the Ammonium and CO2 paddle color numbers and read across and down to where the columns meet

Solvita Ammonia Test Result is:		SOLVITA Carbon Dioxide Test Result is: 1	2	3	4	5	6	7	8
5	Very Low NH_3	1	2	3	4	5	6	7	8
4	Low NH_3	1	2	3	4	5	6	7	8
3	Medium NH_3	1	1	2	3	4	5	6	7
2	High NH_3	1	1	1	2	3	4	5	6
1	Very High NH_3	1	1	1	1	1	2	3	4

a. **Example:** If the NH_3 result is 2, and the CO_2 result is 6, then the Maturity Index is: 4

THE STATE OF COMPOST

The Solvita test uses ammonia to partly compensate for the CO2 result which alone may not provide enough information about maturity. The graph below shows how to use both Solvita results together to deduce what the likely state of the compost is. Specific conditions may vary.



IF THE INDEX IS:	COMPOSTING PROCESS IS:	
8.	Inactive, highly matured compost, very well aged, possibly over-aged, like soil; no limitations for usage	"FINISHED" COMPOST
7.	Well matured, aged compost, cured; few limitations for usage	
6.	Curing; aeration requirement reduced; compost ready for piling; reduced management requirements. Solvita *6 and above is commonly recognized as suitable maturity for official uses.*	Curing
5.	Compost is moving past the active phase of decomposition and ready for curing; reduced need for intensive handling	"ACTIVE" COMPOST
4.	Compost in medium or moderately active stage of decomposition; needs on-going management	
3.	Active compost; fresh ingredients, still needs intensive oversight and management	Very Active
2.	Very active, putrescible fresh compost; high-respiration rate; needs very intensive aeration and/or turning	"RAW" COMPOST
1.	Fresh, raw compost; typical of new mixes; extremely high rate of decomposition; putrescible or very odorous material	

BEST USE OF COMPOST BASED ON MATURITY INDEX

There is an indirect relationship between compost maturity or stability and plant performance[1]. Generally speaking, plants perform better the more mature a compost is, unless other nutrient, salt or pH factors dominate. Solvita® Maturity Index can help identify the general best-use category, by consulting the following Table. The table also shows typical associations with other known soil amendments.

SOLVITA MATURITY INDEX	Raw Feedstock- Mushroom Compost	Landspreading on fallow soil; Mulch	Farm Row Crops, Field Cultivation	Hothouse Beds, Greenhouses	Orchards, Pastures, Hay Crops, Turf	Topsoil Substitute Blends	General Gardening	Bedding Plants, Container Media	Potting Mixes, Seedling Starters	Material in this class will be similar to:
8.					✓	✓	✓	✓	✓	soil & peat-based mixes
7.				✓	✓	✓	✓	✓	✓	soil mixes
6.				✓	✓	✓	✓			compost-soil blends
5.			✓	✓	✓					organic fertilizers
4.		✓	✓	✓						un-treated organic fertilizers
3.	✓	✓	✓							dehydrated manures
2.	✓	✓								raw-waste and most manures
1.	✓									raw-waste & some manures

Increase wait time prior to planting

Control Limit, CA, MA,

Control Limit: ID, WA, TX

Note: Factors that also determine how well a compost will perform include nutrients, nitrogen-availability, pH, and salinity. See the web site www.solvita.com for up-to-date information on other aspects of compost testing. The Solvita Ammonia Test may indicate potential to damage crops based only on ammonia levels and oxygen deprivation of growing media. Table 3 below helps estimate this potential. The actual damage depends on the rate of compost usage, the density and moisture at the time of application.

1. See footnote #1, Page 1 See also: Changa et al (2003) Assessment of the Reliability of a Commercial Maturity Test Kit for Composted Manures. Compost Science & Utilization 11:125-143

UNDERSTANDING AMMONIA CONTENT OF COMPOST

The Solvita® test kit separately determines volatile ammonia (NH_3) which is a sign of instability and potential phytotoxicity in compost. It is one cause of the characteristic odor in young composts and especially in manures. It is also a source of significant N-loss during composting. Ammonia results from protein and urea hydrolysis in presence of air and an elevated pH. If ammonia is not taken into account, a CO_2- respiration test alone over-estimates maturity. Ammonia may indicate several traits: the compost may be high in nitrogen or low in C:N ratio; it is immature, it is phytotoxic (i.e. capable to burn plants); and that a compost facility is noxious or hazardous. Table 2 below suggests the potential toxicity based on the Solvita color.

Table 2. Potential Phytotoxicity And Noxiousness Associated with Ammonia Gas

Ammonia Color No:	1	2	3	4	5
Potential Phytotoxicity is:	Very High	High	Medium	Slight	None
Noxious Hazard	Extreme	Severe	Moderate	Slight	None

There are two states of ammoniacal nitrogen in compost- the gas ammonia (NH_3) and the ion ammonium (NH_4). The ratio of the two depends on the pH of the compost. As a gas, ammonia can be fairly noxious and potentially plant toxic. In contrast, the ammonium form is an odorless, water soluble plant nutrient. Due to this dual nature of NH_3 - NH_4, where ammonia is usually just a fraction of total-ammonium, an estimate of total ammonium can be made if the pH and Solvita values are known. With a compost pH less than 8.0, there is usually little or no ammonia gas present. With a pH over 8.0, however, ammonia increases exponentially with each small rise in pH. The following table may be used to estimate the total ammonium-N ($NH_3 + NH_4$) content based on Solvita and pH. For quantitative results, lab tests are required.

Table 3. Estimating Total Ammonium-N ($NH_4 + NH_3$) in Compost, in ppm

Ammonia Color #:	1	2	3	4	5
Compost pH < 8.0	n/a (unlikely value)		up to 7,000	up to 5,000	less than 1,000
> 8.0	up to 30,000	up to 10,000	up to 5,000	up to 3,000	less than 1,000

Table 4. Compost Status Based on Ammonium-N and Solvita NH_3 Values

Ammonium level is:	> 10,000	3,000-10,000	1,000-3,000	< 1,000
Solvita NH3 Level	1 - 2	3	4	5
Compost Condition	Very Active	Med. Active	Curing	Mature

Composts that persist in Solvita ammonia values of 1-2-3 for lengthy periods) should be investigated for pH issues and low C:N ratio (too much nitrogen!). However, if the nitrogen is very low (i.e. high C:N ratio), then Solvita ammonia may be low even if the compost is not mature. ❑

Table Appendix. Compost Maturity Troubleshooting Guideline

Indicated Problem or Result	Possible Explanation	Possible Remedy
Compost is young but test results indicate "mature"	Compost may be very low in organic matter and have low overall respiration	Check organic content; add more organic-rich ingredients; check self-heating
	Compost may be inhibited by low or high pH; very dry or very hot prior conditions; check Solvita ammonia test	Check pH and VOA level; correct moisture; test again 1-2 days later
Compost is old but Solvita results indicate "active" and/or high ammonia levels	Compost may have composted improperly and not advanced significantly, e.g. it is too wet or too dry, too compacted, poor mix of ingredients, not enough air	Turn pile, loosen material, add moisture or "green" materials if needed; if high in ammonia select for field rather than seedling use
Compost has given the same Solvita colors on several tests at 1-2 weeks apart	Compost is not progressing properly— it may be too dry or too compacted, not well mixed; C:N or pH is too high or too low	If pile looks woody add green matter; add moisture if too dry; loosen if too dense
Different parts of the pile give different Solvita colors	Pockets of poorly mixed or poorly aerated material exist	Re-mix entire pile and re-sample and test again
Core is always #1 or #2 on Maturity Scale	Core is anaerobic and/or is not composting properly	Provide coarse structural materials, mix pile or add air; pile may be too large
Solvita colors indicate very "mature" but plants were hurt by compost	Compost contains high levels of salts, VOA or pH is too low	Check pH and conductivity before use; allow to compost more; allow to mature in soil before planting
Color doesn't match the color chart	Package may have leaked air prior to the test or is defective	Discard paddle and request replacement product
Unexpected CO_2 vs. ammonia paddle results	unusual or extreme conditions persist; check paddle quality	See table 2

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Technical support line 207-293-2457 Fax 293-2488 / Sales 800-451-0337 www.solvita.com

CLUES TO UNDERSTANDING COMPOST MATURITY

Compost maturity is commonly characterized as a state of compost that is conducive to good plant performance. Stability on the other hand is often defined as a rate of change with regard to a measured trait (e.g. heat, respiration-rate). Both terms- maturity and stability- are clearly interrelated and Solvita measures both conditions.

The relationship of compost maturity to plant growth, however, is not direct. There is no single property of finished compost that alone predicts plant growth. A compost may be mature but not viable for plant growth, and under some circumstances it may be immature yet produce good plants. The reasons for these varying qualities are factors such as pH, salt content or availability of nutrients, which may "confound" the direct relation of maturity to plant growth. Therefore, maturity in the Solvita sense is interpreted as being indirectly useful for plant growth by association with common traits we associate with finished compost: low respiration and absence of free ammonia. These aspects are commonly recognized by practising horticulturists and growers.

A significant trait of immature compost that does directly and negatively affect plant growth is depletion of oxygen in and around the roots[1]. Oxygen content relates directly to respiration rate measured by the Solvita CO_2- test. When compost is used heavily in containers, garden beds and potting trays, the respiration may produce symptoms typical of air starvation. Another trait of immature compost that acts directly as a toxicant is ammonia gas, which may burn plants and damage roots when present in appreciable amounts. This trait, however, is often remedied by blending compost with a lower pH soil or peat, whereby the gas (NH_3) is rendered to water soluble (NH_4) form, and is significantly less harmful. Therefore, the Solvita NH3 test provides a potential indication of harm, while also suggesting that noxious conditions exist directly in the compost.

Finally, properties of compost that are measured by Solvita may be interpreted to improve understanding of the process of composting, regardless of the use for plants. CO_2 respiration rate should decline significantly during composting as indicated by Solvita, and if it does not it may be a sign of poor and improper composting conditions. Also, ammonia is often high in early stages of composting and should normally decline, particularly in the late cure phase of composting when NH_3 should be converted by microbes to the plant nutrient nitrate form. High ammonia vapors are certainly noxious and are a health hazard. Therefore, the Solvita tests should also be thought of as expressing qualities and traits of compost that have intrinsic meaning for the process and for workers involved in it. ❑

QUALITY CONTROL & STORAGE OF SOLVITA KITS

Solvita kits are packaged to insure highest quality prior to shipping. The gel-paddles should be the "Control Color" when the foil pack is opened (see color chart). If the foil packs have been damaged or the jar is cracked then the test may not work properly. The kits may be used for up to one year from date of purchase. Shelf-life is extended by refrigeration. Do not allow to freeze.

---

1. Brinton, W and E. Evans (2002) Plant Performance in Relation to Oxygen Depletion in Container Media of Varying Maturity. in **Microbiology of Composting**, Ed. Insam, Riddech, Klammer. Springer Press. New York, Paris, Berlin. (Chapter reprint available on the Woods End website: www.woodsend.org).

APPLICABLE PERMITS & APPROVALS

STATE OF NORTH CAROLINA
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF WASTE MANAGEMENT
1646 MAIL SERVICE CENTER, RALEIGH N.C. 27699-1646

Novozymes North America, Inc

is hereby issued a permit for the operation of a

Large, TYPE III SOLID WASTE COMPOST FACILITY

at

445 Old Smith Farm Road
in Franklinton, Franklin County, NC
Permit Number 35-04

in accordance with Article 9, Chapter 130A, of the General Statutes of North Carolina and all rules promulgated thereunder and subject to the conditions set forth in this permit.

James C. Coffey, Chief
Solid Waste Section

12/08/04
Date

Conditions of Permit

1. This facility shall be operated in accordance with the Solid Waste Compost Rules (15A NCAC 13B, Section .1400), the approved plans and the operation and maintenance information submitted with the permit application. Any proposed modifications to the approved operation will require prior approval by the Solid Waste Section. Failure to comply may result in compliance actions or permit revocation.
2. This facility shall be operated in such a manner that erosion and runoff from the site shall be controlled. All runoff control activities, including any leachate discharge shall be conducted in accordance with the plan approved by the Division of Water Quality.
3. Only materials specifically listed in the permit application may be managed at this facility without adequate testing and prior approval of the Division of Waste Management.
4. Wastes with low carbon-nitrogen ratios, such as manure, shall be incorporated into the windrows prior to the waste starting to compost (heat), create odors or attract vectors.
5. Compost produced at the facility shall meet the requirements of Rule .1406(11) and (12) and of Rule .1407 of the Solid Waste Compost Rules, the permit application, and the operation plan. Results of required analysis shall be submitted at least annually with the annual report.
6. **Compost shall not be distributed prior to approval by the Division of Waste Management, in accordance with .1407(e) of the Municipal Solid Waste Compost Facility Rules.**
7. Testing and reporting shall be conducted in accordance with the requirements of Rule .1408 and the permit application. An annual report of facility activities for the fiscal year July 1 to June 30 shall be submitted to the Division by August 1 of each year.
8. The compost operation and the compost pad shall be operated and maintained with sufficient dust control measures to minimize airborne emissions and to prevent dust from becoming a nuisance or safety hazard.
9. This permit shall expire on **December 8, 2009**. Changes in ownership, increase in facility capacity, or receiving additional feedstocks shall require a permit modification.

State of North Carolina
Department of Environment
and Natural Resources
Division of Water Quality

Michael F. Easley, Governor
William G. Ross Jr., Secretary
Alan W. Klimek, P.E., Director

NCDENR
NORTH CAROLINA DEPARTMENT OF
ENVIRONMENT AND NATURAL RESOURCES

September 19, 2003

Mr. Frank Franciosi
Novozymes North America, Inc.
77 Perry Chapel Church Road
P.O. Box 576
Franklinton, NC 2752

Subject: Composting Facility's Stormwater Permitting
Franklin County

Dear Mr. Franciosi:

This letter is in response to your letter requesting direction for your proposed composting facility's stormwater permitting. A review of the provided materials shows that the drainage from the compost facilities and detention pond will be diffused through a level spreader. Since this type of discharge is designed to produce sheet flow rather than a point source discharge it is not subject to stormwater permitting at this time.

If after the system is installed the level spreader does not work properly and does indeed produce a channelized, point source, flow it will become subject to stormwater permitting regulations.

Not requiring a stormwater permit does not preclude the site from requiring any other water permits. Leachate that will be draining from the windrows is considered a wastewater which may require permitting under the nondischarge permit since there will be no point source discharge. For more information about obtaining a nondischarge permit contact Mr. Kim Colson at (919) 733-5083, ext. 540.

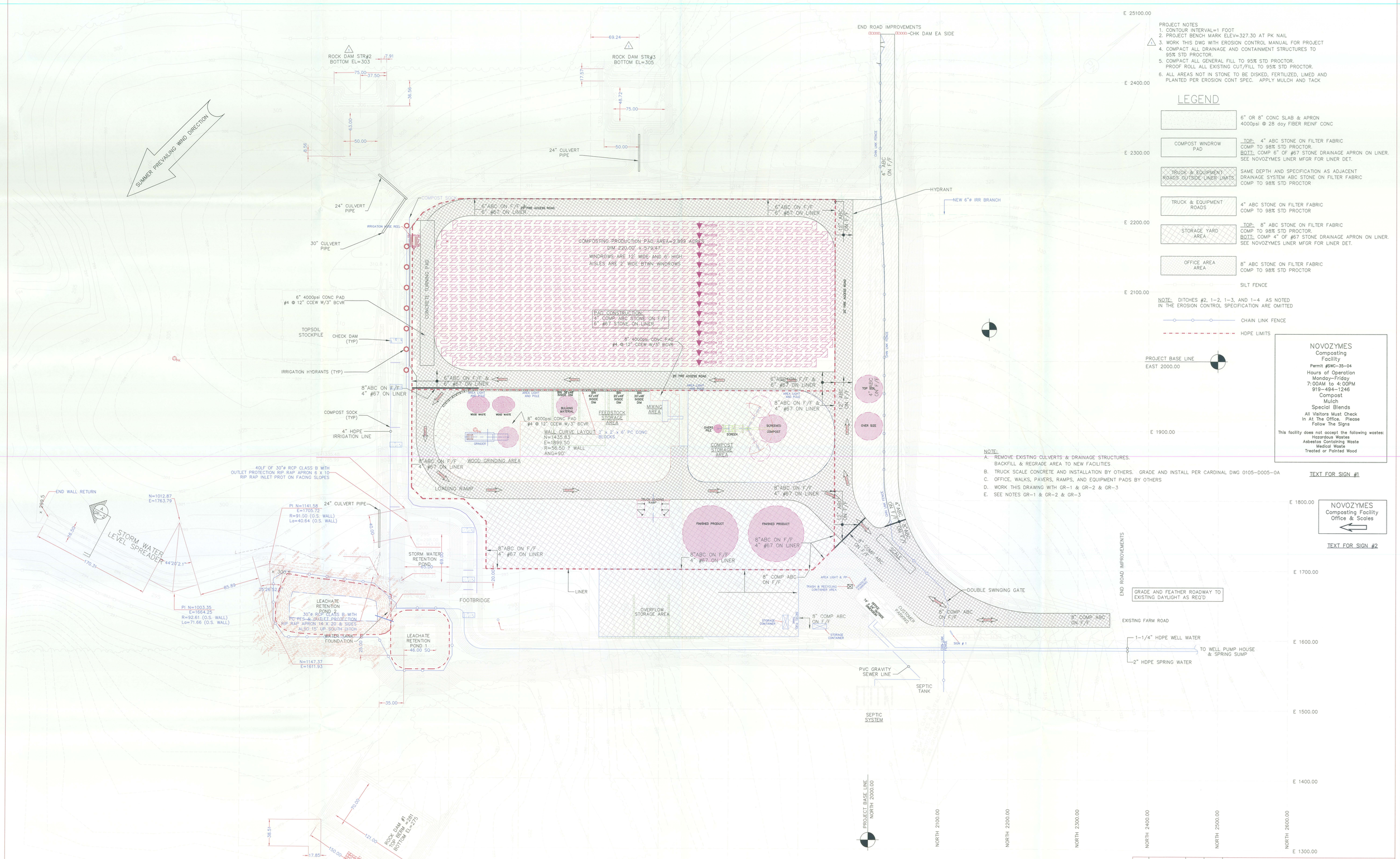
If you have any questions concerning this matter please contact me at (919) 733-5083, ext. 578.

Sincerely,

Aisha H. Lau
Environmental Engineer

cc: Raleigh Regional Office
Stormwater and General Permits Unit
Central Files

SEP 29 2003



PROJECT NOTES
1. CONTOUR INTERVAL=1 FOOT
2. PROJECT BENCH MARK ELEV=327.30 AT PK NAIL
3. WORK THIS DWG WITH EROSION CONTROL MANUAL FOR PROJECT
4. COMPACT ALL DRAINAGE AND CONTAINMENT STRUCTURES TO 95% STD PROCTOR.
5. COMPACT ALL GENERAL FILL TO 95% STD PROCTOR. PROOF ROLL ALL EXISTING CUT/FILL TO 95% STD PROCTOR.
6. ALL AREAS NOT IN STONE TO BE DISKED, FERTILIZED, LIMED AND PLANTED PER EROSION CONT SPEC. APPLY MULCH AND TACK

LEGEND

	6" OR 8" CONC SLAB & APRON 4000psi @ 28 day FIBER REINF CONC
COMPOST WINDROW PAD	TOP: 4" ABC STONE ON FILTER FABRIC COMP TO 98% STD PROCTOR. BOTT: COMP 6" OF #67 STONE DRAINAGE APRON ON LINER. SEE NOVOZYMES LINER MFGR FOR LINER DET.
TRUCK & EQUIPMENT ROADS OUTSIDE LINER LIMITS	SAME DEPTH AND SPECIFICATION AS ADJACENT DRAINAGE SYSTEM ABC STONE ON FILTER FABRIC COMP TO 98% STD PROCTOR
TRUCK & EQUIPMENT ROADS	4" ABC STONE ON FILTER FABRIC COMP TO 98% STD PROCTOR
STORAGE YARD AREA	TOP: 8" ABC STONE ON FILTER FABRIC COMP TO 98% STD PROCTOR. BOTT: COMP 4" OF #67 STONE DRAINAGE APRON ON LINER. SEE NOVOZYMES LINER MFGR FOR LINER DET.
OFFICE AREA AREA	8" ABC STONE ON FILTER FABRIC COMP TO 98% STD PROCTOR
	SILT FENCE

NOTE: DITCHES #2, 1-2, 1-3, AND 1-4 AS NOTED IN THE EROSION CONTROL SPECIFICATION ARE OMITTED

CHAIN LINK FENCE

HDPE LIMITS

NOVOZYMES
Composting Facility
Permit #SWC-35-04
Hours of Operation
Monday-Friday
7:00AM to 4:00PM
919-494-1246
Compost
Mulch
Special Blends
All Visitors Must Check In At The Office. Please Follow The Signs
This facility does not accept the following wastes:
Hazardous Wastes
Asbestos Containing Waste
Medical Waste
Treated or Painted Wood

TEXT FOR SIGN #1

NOVOZYMES
Composting Facility
Office & Scales

TEXT FOR SIGN #2

NOTE:
A. REMOVE EXISTING CULVERTS & DRAINAGE STRUCTURES. BACKFILL & REGRADE AREA TO NEW FACILITIES
B. TRUCK SCALE CONCRETE AND INSTALLATION BY OTHERS. GRADE AND INSTALL PER CARDINAL DWG 0105-D005-0A
C. OFFICE, WALKS, PAVERS, RAMPS, AND EQUIPMENT PADS BY OTHERS
D. WORK THIS DRAWING WITH GR-1 & GR-2 & GR-3
E. SEE NOTES GR-1 & GR-2 & GR-3

THE LINER VENDOR HAS DESIGNED AND RECOMMENDED THE LINER, FILTER FABRIC, AND THE STONE THICKNESS REQUIRED TO INTERCEPT LEACHATE PERCOLATION, AND AS SUCH, IS NOT PART OF THE RESPONSIBILITY OF J.B. CLAUSS, P.E.

Rev.	Rev. date:	Dwg	Chk	Revisions
4	5-26-09	PJPE	FRFR	REVISED & REDRAWN FOR PERMIT RENEWAL
3	12-16-08	PJPE	RG	FIRST ISSUE FOR PROJECT TURNOVER
2	11-8-04	SAME	FRFR	RELEASED FOR REVIEW

Novozymes, North America (NZNA)

Novozymes North America, Inc. State Road 1003 P.O. Box 576 Franklinton, N.C. 27525 USA Tel (919) 494-3000

Est. date: 03/30/03	COMPOSTING FACILITY
Engineer: J.B.CLAUSS,P.E.	GENERAL SITE PLAN
Scale: 1"=50 FEET	
Group no.:	FWC31001
Page no.:	

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