15A NCAC 02T .0113 PERMITTING BY REGULATION

(a) The following disposal systems as well as those in Permitting By Regulation rules in this Subchapter (i.e., Rules .0203, .0303, .0403, .1103, .1203, .1303, .1403, and .1503) shall be deemed to be permitted pursuant to G.S. 143-215.1(b), and it shall not be necessary for the Division to issue individual permits or coverage under a general permit for construction or operation of the following disposal systems provided the system does not result in any violations of surface water or groundwater standards, there is no direct discharge to surface waters, and all criteria required for the specific system are met:

(1) swimming pool and spa filter backwash and drainage, filter backwash from aesthetic fountains, and filter backwash from commercial or residential water features such as garden ponds or fish ponds, that is discharged to the land surface;
(2) backwash from raw water intake screening devices that is discharged to the land surface;
(3) condensate from residential or commercial air conditioning units that is discharged to the land surface;
(4) discharges to the land surface from individual non-commercial car washing operations;
(5) discharges to the land surface from flushing and hydrostatic testing water associated with utility distribution systems, new sewer extensions, or new reclaimed water distribution lines;
(6) street wash water that is discharged to the land surface;
(7) discharges to the land surface from firefighting activities;
(8) discharges to the land surface associated with emergency removal and treatment activities for spilled oil authorized by the federal or state on-scene coordinator when such removals are undertaken to minimize overall environmental damage due to an oil spill;
(9) discharges to the land surface associated with biological or chemical decontamination activities performed as a result of an emergency declared by the Governor or the Director of the Division of Emergency Management, that are conducted by or under the direct supervision of the federal or state on-scene coordinator, and that meet the following criteria:
    (A) the volume produced by the decontamination activity is too large to be contained onsite;
    (B) the Division is informed prior to commencement of the decontamination activity; and
    (C) the wastewater is not radiologically contaminated or classified as hazardous waste;
(10) drilling muds, cuttings, and well water from the development of wells or from other construction activities, including directional boring, except such wastes generated in the construction and development of oil and gas wells regulated by Article 27 of G.S. 113;
(11) purge water from groundwater monitoring wells;
(12) composting facilities for animal mortality if the construction and operation of the facilities is approved by the North Carolina Department of Agriculture and Consumer Services; the facilities are constructed on an impervious, weight-bearing foundation, and are operated under a roof; and the facilities are approved by the State Veterinarian pursuant to G.S. 106-403. In the event of an imminent threat of a contagious animal disease, any emergency measure or procedure related to composting of animal mortality pursuant to G.S. 106-399.4(a);
(13) overflow from elevated potable water storage facilities;
(14) mobile carwashes if:
    (A) all detergents used are biodegradable;
    (B) no steam cleaning, engine or parts cleaning is being conducted;
    (C) notification is made prior to operation by the owner to the municipality or, if not in a municipality, then the county where the cleaning service is being provided; and
    (D) non-recyclable washwater is collected and discharged into a sanitary sewer or wastewater treatment facility, upon approval of the facility's owner, such that no ponding or runoff of the washwater occurs;
(15) mine tailings if no chemicals are used in the mining process;
(16) mine dewatering if no chemicals are used in the mining process;
(17) wastewater created from the washing of produce, with no further processing on-site, on farms where the wastewater is irrigated onto fields so as not to create runoff or cause a discharge; and
(18) discharges to the land surface of less than 5,000 gallons per week of backwash water from greensand filters at potable water wells, not including conventional filters, reverse osmosis, and ion exchange filters, provided ponding or runoff does not occur and the backwash does not exceed the Maximum Contaminant Level (MCL) for radionuclides or arsenic; and

(19) discharges to the land surface of less than 350 gallons per week of backwash water from reverse osmosis, ion exchange filters, greensand filters at private drinking water wells, provided ponding or runoff does not occur.

(b) Nothing in this Rule shall be deemed to allow the violation of any surface water, groundwater, or air quality standards and, in addition, any such violation shall be considered a violation of a condition of a permit. Further, nothing in this Rule shall be deemed to apply to or permit disposal systems for which a state National Pollutant Discharge Elimination System permit is otherwise required.

(c) Any violation of this Rule or any discharge to surface waters from the disposal systems listed in Paragraph (a) of this Rule or the activities listed in other Permitted By Regulation rules in this Subchapter shall be reported in accordance with 15A NCAC 02B .0506.

(d) Disposal systems deemed permitted under this Subchapter shall remain deemed permitted, notwithstanding any violations of surface water or groundwater standards or violations of this Rule or other Permitted By Regulation rules in this Subchapter, until such time as the Director determines that they shall not be deemed permitted in accordance with the criteria established in this Rule.

(e) The Director may determine that a disposal system shall not be deemed to be permitted in accordance with this Rule or other Permitted By Regulation rules in this Subchapter and require the disposal system to obtain an individual permit or a certificate of coverage under a general permit. This determination shall be made based on existing or projected environmental impacts, compliance with the provisions of this Rule or other Permitted By Regulation rules in this Subchapter, and the compliance history of the facility owner.

History Note: *Authority G.S. 130A-300; 143-215.1(a)(1); 143-215.1(b)(4)(e); 143-215.3(a);*
Eff. September 1, 2006;
Amended Eff. March 19, 2015; June 18, 2011;
Readopted Eff. September 1, 2018.

15A NCAC 02T .1303 PERMITTING BY REGULATION

(a) The following systems shall be deemed permitted pursuant to Rule .0113 of this Subchapter provided the system meets the criteria in Rule .0113 of this Subchapter and all criteria required for the specific system by this Rule:

(1) Systems that do not meet the criteria of an animal operation permitted under Rule .1304 or Rule .1305 of this Subchapter and all other systems not specifically mentioned in this Section if:
   (A) the animal waste is land applied at no greater than agronomic rates to land owned by the waste generator or under the waste generator's authority;
   (B) the storage and land application of animal waste is no closer than 100 feet from a well other than a monitoring well;
   (C) animal waste is not applied on land that is flooded, saturated with water, frozen, or snow covered at the time of land application; and
   (D) no animal waste is land applied during precipitation events.

(2) Poultry operations that use a dry litter system with more than 30,000 birds and that do not meet the criteria specified in Rule .1305 of this Subchapter if:
   (A) records are maintained for three years that include the dates the litter was removed, the estimated amount of litter removed, and the location of the sites where the litter was land applied by the poultry operation;
   (B) the waste is applied at no greater than agronomic rates;
   (C) a vegetative buffer of at least 25 feet is maintained from a perennial stream or perennial waterbody for land application sites;
   (D) land application of litter is no closer than 100 feet from a well other than a monitoring well;
   (E) litter is stockpiled no closer than 100 feet from a perennial stream, perennial waterbody, or well other than a monitoring well;
   (F) litter is not stockpiled uncovered for greater than 15 days;
   (G) litter is not applied on land that is flooded, saturated with water, frozen, or snow covered at the time of land application;
   (H) no litter is land applied during precipitation events; and
   (I) if a manure hauler is used, records are maintained of the dates the litter was removed, the estimated amount of litter removed, and the name, address, and phone number of the manure hauler.

(3) Land application sites under separate ownership from the waste generator, that receive animal waste from animal waste management systems that are deemed permitted, when all the following conditions are met:
   (A) the waste is applied at no greater than agronomic rates;
   (B) the storage and land application of animal waste is no closer than 100 feet from a well other than a monitoring well;
   (C) a vegetative buffer of at least 25 feet is maintained from a perennial stream or perennial waterbody;
   (D) animal waste is not applied on land that is flooded, saturated with water, frozen, or snow covered at the time of land application; and
   (E) no animal waste is land applied during precipitation events.

(b) The Director may determine that a system should not be deemed permitted in accordance with this Rule and Rule .0113 of this Subchapter. This determination shall be made in accordance with Rule .0113(e) of this Subchapter.

History Note: *Authority G.S. 143-215.1; 143-215.3(a); 143-215.10A;*
Eff. September 1, 2006;
Readopted Eff. September 1, 2018.

This is a copy of the NC Compost Rules 15A NCAC 13B .1401-.1410 (effective November 1, 2019)
Official rules can be downloaded at http://reports.oah.state.nc.us/

SECTION .1400 - SOLID WASTE COMPOST FACILITIES

15A NCAC 13B .1401 REQUIREMENT FOR PERMIT

(a) No person shall construct, operate, expand, or modify a facility that produces compost from solid waste or solid waste co-composted with other wastes unless it has a currently valid permit issued by the Division for a solid waste compost facility, except as provided in Rule .1402(f) and (g) of this Section. General provisions, siting, design, application, operational, distribution, reporting, and closure requirements shall be in accordance with Rules .1402 through .1410 of this Section.

(b) Plans for a Large Type 3 or Type 4 Solid Waste Compost Facility, as defined in Rule .1402(e) of this Section, or plans for any facility located over a closed-out disposal area, shall be submitted with the permit application in accordance with Rule .0202(a)(3) of this Subchapter.

(c) Compost permits shall be issued for a period of 10 years. An application for renewal of a permit shall be submitted to the Division in accordance with Rule .1405 of this Section no less than four months prior to expiration of the existing permit.

(d) Permit modifications.

(1) The owner or operator shall submit to the Division a permit application in accordance with Rule .1405 of this Section for a major modification to the existing permit issued by the Division, For the purpose of this Section, a major modification means any of the following: a change in the property or facility operator or ownership, a change in facility type as defined in Rule .1402 of this Section, an expansion or relocation of the operations area in the existing permit, or a change to the operations or design plan such as changes in the compost method, waste receipt and handling, feedstock storage, or processing layout. A permit issued by the Division as a result of a permit modification shall be in compliance with Paragraph (c) of this Rule.

(2) The owner or operator shall not be required to submit a permit application to the Division in accordance with Rule .1405 of this Section for a change to a plan that was submitted in accordance with Rule .1405 of this Section if the Division determines that the change does not meet the definition of a major modification provided in Subparagraph (1) of this Paragraph, the change complies with the requirements of this Section, and the owner or operator submits to the Division written notice of the change, including documentation of the updated information such as revised pages or addendums to the plan. The Division shall acknowledge receipt of the change by sending written notice to the owner or operator.

(e) For purposes of this Section, "operations area" means the total area used for mixing, grinding, processing, composting, curing, and wood waste and feedstock unloading and storage. Operations area shall not include buffer areas.

(f) For purposes of the Section, "material onsite" means wood wastes, feedstocks, mixtures, and active and curing compost, but shall not include finished product.

History Note: Authority G.S. 130A-294; 130A-309.03; 130A-309.11; 130A-309.29;
Eff. December 1, 1991;
Amended Eff. May 1, 1996;
Readopted Eff. November 1, 2019.

15A NCAC 13B .1402 GENERAL PROVISIONS FOR SOLID WASTE COMPOST FACILITIES

(a) The provisions of this Rule shall apply to the following facilities:

(1) facilities that produce compost or mulch from yard waste or from residues from agricultural products and processing;

(2) vermicomposting facilities;

(3) anaerobic digestion facilities; and

(4) compost facilities that compost solid waste or co-compost solid waste with sludges that are not classified as a solid waste functioning as a nutrient source.

(b) Facilities that co-compost with sewage sludge shall comply with all applicable federal regulations regarding sludge management in 40 CFR 503, which is incorporated by reference including subsequent amendments and editions. Copies of the Code of Federal Regulations may be obtained from the U.S. Government Publishing Office website at www.gpo.gov at no cost.

(c) The provisions of this Section shall not apply to compost facilities that compost only wastewater treatment sludge with solid waste functioning only as a bulking agent.
(d) Solid waste compost produced outside the State of North Carolina and imported into the state shall comply with the requirements specified in Rule .1407 of this Section.
(e) Solid waste compost facilities shall be classified based on the types and amounts of materials to be composted as follows:

(1) Type 1 facilities may receive yard and garden waste, silvicultural waste, and untreated and unpainted wood waste.

(2) Type 2 facilities may receive pre-consumer meat-free food processing waste, vegetative agricultural waste, source separated paper, and other source separated specialty wastes that are low in pathogens and physical contaminants. Waste acceptable for a Type 1 facility may be composted at a Type 2 facility.

(3) Type 3 facilities may receive manures and other agricultural waste, meat, post-consumer source-separated food wastes, and other source-separated specialty wastes that are low in physical contaminants but may have high levels of pathogens. Waste acceptable for a Type 1 or 2 facility may be composted at a Type 3 facility.

(4) Type 4 facilities may receive industrial solid waste, non-solid waste sludges functioning as a nutrient source or other similar compostable organic wastes, or any combination thereof. Waste acceptable for a Type 1, 2, or 3 facility may be composted at a Type 4 facility.

(5) In determining whether a specific waste stream listed in Subparagraphs (1) through (4) of this Paragraph is acceptable for composting, the Division shall consider the method of handling the waste prior to delivery to the facility as well as the physical characteristics of the waste. Testing for pathogens and physical contaminants shall be required if a determination cannot be made based upon prior knowledge of the waste. Test methods and constituents tested shall comply with Rule .1407(b)(2), (b)(3), (b)(5), and (b)(6) of this Section.

(6) Small facilities.
   (A) Small Type 1 facilities shall have an operations area less than two acres in size and shall be limited to no more than 6,000 cubic yards material onsite at any given time, including finished product.
   (B) Small Type 2, 3, and 4 facilities shall have an operations area less than two acres in size and shall be limited to no more than 1,000 cubic yards material onsite at any given time.

(7) Large facilities.
   (A) Large Type 1 facilities shall have an operations area of two or more acres in size or have more than 6,000 cubic yards material onsite at any given time.
   (B) Large Type 2, 3, and 4 facilities shall have an operations area of two or more acres in size or have more than 1,000 cubic yards material onsite at any given time.

(f) The following operations shall be exempt from the requirements of this Section:

(1) backyard composting;

(2) farming operations and silvicultural operations if the compost is produced from materials grown on the owner's land and re-used on the owner's land or associated farming operations and not offered to the public; and

(3) persons receiving no more than 30 cubic yards of leaves from an offsite source on an annual basis.

(g) The following operations shall be exempt from the permitting requirements in Rule .1401 of this Section:

(1) Small Type 1 Facilities meeting the following conditions:
   (A) notification to the Division prior to operation and on an annual basis as to:
      (i) the facility location;
      (ii) the name(s) and contact information of the owner and operator;
      (iii) type and amount of wastes received;
      (iv) the composting process to be used;
      (v) the intended distribution of the finished product; and
      (vi) for new facilities only, a letter from the unit of government having zoning jurisdiction over the site that states that the proposed use is allowed within the existing zoning, if any, and that any necessary zoning approval or permit has been obtained;

(B) the facility operates in accordance with the operational requirements as set forth in Rule .1406(1) through (11) and (16) of this Section and the setbacks in Rule .1404(a)(1) through (a)(10) of this Section;

(C) the facility operates in accordance with all other state or local laws, ordinances, rules, regulations or orders;

(D) the facility shall not be located over a closed-out disposal site; and

(E) safety measures shall be taken to prevent fires and access to fire equipment or fire-fighting services shall be provided.

(2) Compost facilities meeting the following conditions:

(A) the site receives for composting pre- and post-consumer food waste, manure, vegetative agricultural waste, yard and garden waste, land-clearing debris, untreated and unpainted wood waste, or source separated paper;

(B) material onsite, not including finished compost, shall not exceed 100 cubic yards at any time;

(C) the operations area shall be less than 1.0 acres total;

(D) the site operates in accordance with operational requirements as set forth in Rule .1406 of this Section and the setbacks in Rule .1404(a)(1) through (a)(10) of this Section, except that the buffer between property line and operations area shall be at least 50 feet and the buffer between the operations area and residences or dwellings not owned and occupied by the operator shall be at least 200 feet;

(E) the site is operated to prevent the release of particulates and odors outside of the property boundary, and the site does not attract vectors such as insects and rodents;

(F) for facilities producing compost that is distributed to the public or used in public areas, compost produced from the facility shall meet the pathogen testing and record keeping requirements per Rule .1407(b) and Rule .1408(a) of this Section; and

(G) the site operates in accordance with all applicable State or local laws, ordinances, rules, regulations, or orders.

History Note: *Authority G.S. 130A-294; 130A-309.03; 130A-309.11; 130A-309.29;*
Eff. December 1, 1991;
Amended Eff. May 1, 1996;
Readopted Eff. November 1, 2019.

15A NCAC 13B .1403 GENERAL PROHIBITIONS FOR SOLID WASTE COMPOST FACILITIES

(a) Neither hazardous waste nor asbestos-containing waste shall be accepted at a facility or processed into compost.

(b) Household hazardous waste shall not be accepted by a facility, except in an area designated by facility site plans for storage, and shall not be processed into compost.

(c) Compost made from solid waste that cannot be used pursuant to the requirements of this Rule shall be reprocessed or disposed of pursuant to the requirements of this Subchapter.

History Note: *Authority G.S. 130A-294; 130A-309.03; 130A-309.11; 130A-309.29;*
Eff. December 1, 1991;
Amended Eff. May 1, 1996;
Readopted Eff. November 1, 2019.

15A NCAC 13B .1404 SITING/DESIGN REQUIREMENTS FOR SOLID WASTE COMPOST FACILITIES

(a) A site shall meet the requirements of this Rule at the time of initial permitting and shall continue to meet these requirements throughout the life of the permit only on the site property owned or controlled by the applicant or by the landowner(s) at the time of permitting.

(1) A site located in a floodplain shall not restrict the flow of the 100-year flood, reduce the temporary storage capacity of the floodplain, or result in washout of solid waste, so as to pose a hazard to human life, wildlife, land, or water resources.

(2) A 100-foot buffer shall be maintained between all property lines and compost areas for Type 3 and 4 facilities, 50-foot for Type 1 or 2 facilities.

(3) A 500-foot buffer shall be maintained between compost areas and residences or dwellings not owned and occupied by the permittee, except that Type 1 and Small Type 2 and 3 facilities shall maintain a 200-foot buffer.
(4) A 100-foot buffer shall be maintained between all wells and compost areas, except monitoring wells.
(5) A 50-foot buffer shall be maintained between perennial streams and rivers and compost areas.
(6) A compost facility shall be located in accordance with 15A NCAC 02B .0200, Classification and Water Quality Standards Applicable to Surface Waters in North Carolina.
(7) All portions of a compost facility located over a closed-out disposal area shall be designed with a pad adequate to protect the disposal area cap from being disturbed, as defined in Part (a)(10)(C) of this Rule, and there shall be no runoff from the pad onto the cap or side slopes of the closed out area.
(8) A 25-foot minimum distance shall be maintained between compost areas and swales or berms;
(9) A site shall meet the following surface water requirements:
  (A) a site shall not cause a discharge of materials or fill materials into waters or wetlands of the State that is in violation of Section 404 of the Clean Water Act;
  (B) a site shall not cause a discharge of pollutants into waters of the State that is in violation of the requirements of the National Pollutant Discharge Elimination System (NPDES), pursuant to Section 402 of the Clean Water Act; and
  (C) a site shall not cause non-point source pollution of waters of the State that violates the water quality standards as set forth in 15A NCAC 02B.
(10) A site shall meet the following groundwater and operations area pad requirements:
  (A) a site shall not contravene groundwater standards as set forth in 15A NCAC 02L;
  (B) the operations area of Type 1, 2, and 3 facilities shall have one of the following:
    (i) a soil pad with a soil texture finer than loamy sand. For a Type 1 or 2 facility, the depth to the seasonal high water table shall be maintained at least 12 inches. For a Type 3 facility, the depth to the seasonal high water table shall be maintained at least 24 inches; or
    (ii) a pad in accordance with Part (C) of this Subparagraph;
  (C) the operations area of a Type 4 facility shall have a pad with a linear coefficient of permeability no greater than 1×10^{-7} cm/sec. The pad shall consist of one of the following:
    (i) a non-soil pad, such as concrete and asphalt, designed and constructed to meet the weight requirements of the compost operation and to prevent infiltration of liquids to groundwater; or
    (ii) a soil pad of at least 18 inches constructed in accordance with Rule .1624(b)(8) and Rule .1621 of this Subchapter. A 12-inch soil layer shall be maintained over the pad to protect it from damage and desiccation: and
  (D) finished product shall be stored where the depth to the seasonal high water table is at least 12 inches below ground surface.

(b) For Subparagraphs (a)(2) through (a)(4) and Part (a)(10)(B) of this Rule, alternative minimum buffers or requirements may be modified by the Division, based on the waste type, facility design, and regional topography, if necessary to protect public health and the environment or to prevent the creation of a nuisance.

(c) A site shall meet the following design requirements:
(1) a site shall not allow unauthorized public access;
(2) a site shall meet the requirements of Sedimentation Control (15A NCAC 04);
(3) a site shall meet the requirements of the Air Pollution Control Requirements (15A NCAC 02D) to minimize fugitive emissions and odors; and
(4) a site shall be designed to minimize odors at the property boundary by means such as expanded buffers, consideration of topography and wind patterns, or process layout design.

History Note: *Authority G.S. 130A-294; 130A-309.03; 130A-309.11; 130A-309.29;*
Eff. December 1, 1991;
Amended Eff. May 1, 1996;
Readopted Eff. November 1, 2019.

15A NCAC 13B .1405 APPLICATION REQUIREMENTS FOR SOLID WASTE COMPOST FACILITIES

One paper copy and one electronic copy of a solid waste compost facility permit application shall be submitted to the Division. The following information shall be required for an application for a permit to construct and operate a Large Type 1, Small or Large Type 2 or 3 or all Type 4 solid waste compost facilities:

(1) the name and contact information of the facility owner and operator;

(2) documentation of property ownership, including:

(a) the property owners;

(b) a current property deed; and

(c) a notarized acknowledgement letter from the landowner of use of the property as a solid waste facility if the landowner is not the facility owner or operator.

(3) an aerial photograph or scaled drawing, at a scale of one inch to less than or equal to 400 feet, showing the area within one-fourth mile of the proposed site's boundaries with the following identified:

(a) the entire property owned or leased by the person proposing the facility;

(b) the location of all homes, wells, industrial buildings, public or private utilities, roads, watercourses, and the topography within 500 feet of the proposed facility; and

(c) the land use zoning of the proposed site.

(4) a letter from the unit of government having zoning jurisdiction over the site that states that the proposed use is allowed within the existing zoning, if any, and that necessary zoning approvals or permits have been obtained;

(5) an explanation of how the site complies with siting and design standards required by Rule .1404 of this Section;

(6) a report indicating the following:

(a) the waste types, the source and estimated quantity of the solid waste to be composted including the source and expected quantity of any bulking agent or amendment (if applicable), expected recycling of bulking agent or compost, and seasonal variations in the solid waste type or quantity; and

(b) for facilities that use natural soils as a pad, a soil evaluation of the site conducted by a licensed soil scientist down to a depth of four feet or to bedrock or evidence of a seasonal high water table, evaluating all physical soil properties and depth of the seasonal high water table;

(7) a site plan at a scale of one inch to less than or equal to 100 feet that delineates the following:

(a) the existing and proposed contours, at intervals appropriate to the topography;

(b) the location and elevations of dikes, trenches, and other water control devices and structures for the diversion and controlled removal of surface water;

(c) the designated setbacks and property lines;

(d) the proposed utilities and structures;

(e) the areas for unloading, processing, active composting, curing, and storing of material;

(f) the access roads and details on traffic patterns;

(g) the wetlands, streams, and 100-year floodplains; and

(h) the proposed surface and groundwater monitoring locations, if required.

(8) an operations plan that includes the following:

(a) the name and contact information for the person responsible for the operation of the facility;

(b) a list of personnel and the responsibilities of each position;

(c) a schedule for operations, including days and hours that the facility will be open, preparations before opening, and procedures to be followed after closing for the day;

(d) special precautions or procedures for operating during wind, heavy rain, snow, freezing or other adverse conditions;

(e) a description of actions to be taken to minimize noise, vectors, and air borne particulates;

(f) a description of the use for the finished compost, the method for removal from the site, and a contingency plan for disposal or alternative use of residues or finished compost that cannot be used in the expected manner due to poor quality or change in market conditions;

(g) contingency plan describing actions to be taken for equipment breakdown, unauthorized waste arriving at the facility, spills, and fires;

(h) a discussion of compliance with the operational requirements listed in Rule .1406 of this Section; and

(i) for Large Type 1, Large Type 2, Large Type 3, and all Type 4 facilities, include the following:

(i) a description of procedures for incoming material inspections;

(ii) a description of procedures to meet the final product sampling and analyses requirements specified in in Rule .1407 of this Section;

(iii) a description of procedures to meet the record keeping requirements specified in Rule .1408 of this Section; and

(iv) a copy of all applicable local, state, and federal permits and approvals necessary for the operation of the facility.

(9) a report on the design of the facility, including:

(a) the design capacity of the facility;

(b) a process flow diagram of the entire facility, including the type, size, and location of all equipment used in the compost process, and feedstock flow streams. The flow streams shall indicate the quantity of materials by weight and volume;

(c) a description and sizing of the storage facilities for feedstocks, amendments, and finished compost;

(d) the means for measuring, shredding, mixing, and proportioning input materials;

(e) the anticipated process duration, including receiving, preparation, composting, curing, and distribution;

(f) a description of the location of all temperature and any other type of monitoring points within the compost windrow, and the frequency of monitoring;

(g) a description of how the temperature control and monitoring equipment will demonstrate that the facility meets the requirements in Rule .1406(11), (12), or (13) of this Section, as appropriate for the feedstock;

(h) the method of aeration provided and the capacity of aeration equipment;

(i) a description of the method to control surface water run-on and run-off and the method to control, collect, treat, and dispose of leachate generated;

(j) the separation, processing, storage, and ultimate disposal of non-compostable materials, if applicable;

(k) a description of dust control and other air emission control measures; and

(l) a description of recycling or other material handling processes used at the facility.

(10) Odor Control Plan. Operators of Large Type 2, Large Type 3, and all Type 4 facilities shall prepare, submit to the Division, and implement an odor control plan that details site specific conditions to meet the design requirement in Rule .1404(c)(4) of this Section. Existing facilities permitted prior to the readopted effective date of this Rule shall meet these requirements at the time of permit renewal. The plan shall contain the following:

(a) an identification of all onsite potential odor sources;

(b) a description of onsite weather conditions that may affect odor migration, such as prevailing wind direction, topography, and seasonal variations;

(c) a plan to monitor onsite odor and record odor data for the odor sources with the potential to migrate offsite. Data shall include date, time, site specific conditions, weather conditions, wind direction, and characteristics and intensity of odor;

(d) a description of the facility's odor complaint protocol, including forms used, odor verification by operator both onsite and offsite, what the response will be, and who will be contacted;

(e) a description of complaint record keeping; and

(f) a description of odor control design and operating best management practices to be used onsite, including:
(i) personnel training;
(ii) feedstock characteristics;
(iii) the initial mixing of feedstocks to reach targeted carbon to nitrogen (C:N) ratios and moisture levels;
(iv) maintenance of compost piles for moisture;
(v) aeration methods, frequency, and protocol;
(vi) leachate and liquids management;
(vii) weather monitoring and protocol;
(viii) management of airborne emissions; and
(ix) windrow covering;

(11) engineering plans and specifications for the facility, including manufacturer's performance data for all equipment selected; and
(12) documentation that the local fire protection authority has been notified of the site use.

History Note: Authority G.S. 130A-294; 130A-309.03; 130A-309.11; 130A-309.29;
Eff. December 1, 1991;
Amended Eff. May 1, 1996;
Readopted Eff. November 1, 2019.

15A NCAC 13B .1406 OPERATIONAL REQUIREMENTS FOR SOLID WASTE COMPOST FACILITIES

A person who maintains or operates a solid waste compost facility shall maintain and operate the site to conform with the practices and operational requirements of this Rule.

(1) Plan and Permit Requirements.
(a) Approved plans and conditions of the permit shall be followed.
(b) A copy of the permit, plans, and operational reports shall be maintained on site at all times.

(2) Erosion control measures shall be practiced to prevent on-site erosion and to control the movement of silt or contaminants from the site.
(3) Stormwater shall be diverted from the operations area.
(4) Leachate shall be contained on site or treated prior to discharge. A National Pollutant Discharge Elimination System (NPDES) permit may be required in accordance with 15A NCAC 02B prior to the discharge of leachate to surface waters.
(5) Access and Security Requirements.
(a) Large facilities as defined in Rule .1402(e)(7) of this Section shall be secured to prevent unauthorized entry by means such as gates, chains, berms, or fences.
(b) An operator shall be on duty at the site at all times while the facility is open for public use, and shall prevent unauthorized access to the facility operations area.
(c) The access road to the site shall be of all-weather construction and maintained.

(6) A site shall only accept those solid wastes that it is permitted to receive.
(7) Safety Requirements.
(a) Open burning of solid waste shall be prohibited.
(b) Equipment shall be provided to control accidental fires and arrangements made with the local fire protection agency to provide fire-fighting services when needed.
(c) Personnel training shall be provided to ensure that all employees are trained in site specific safety, remedial, and corrective action procedures.

(8) Reporting Fires. Fires shall be reported to the Division orally within 24 hours of the incident and in writing within 15 days of the incident.

(9) Sign Requirements.

(a) Signs providing information on waste that may be received, dumping procedures, the hours during which the site is open for public use, and the permit number shall be posted at the site entrance.

(b) Traffic signs and markers shall be provided to direct traffic to and from the discharge area.

(c) Signs shall be posted stating that no hazardous waste, asbestos containing waste, or medical waste may be received at the site.

(10) Monitoring Requirements.

(a) Temperature monitoring shall meet the record-keeping requirements in Rule .1408 of this Section.

(b) The temperature of all compost produced shall be monitored sufficiently to ensure that the pathogen reduction criteria are met. Onsite thermometers shall be calibrated annually and records of calibration shall be maintained.

(11) Compost process at Type 1 and Type 2 facilities shall be maintained at or above 55 degrees Celsius (131 degrees F) for three days and aerated to maintain elevated temperatures.

(12) Vector Attraction Reduction (VAR). Types 2, 3 and 4 facilities shall maintain the compost process at a temperature above 40 degrees Celsius (104 degrees F) for 14 days or longer and the average temperature for that time shall be higher than 45 degrees Celsius (113 degrees F).

(13) Process to Further Reduce Pathogens (PFRP). The composting process shall qualify as a process to further reduce pathogens for all Type 3 and Type 4 facilities. The following shall be acceptable methods:

(a) the windrow composting method, in which the following requirements apply:

(i) aerobic conditions shall be maintained during the composting process;

(ii) a temperature of 131 degrees F (55 degrees Celsius) or greater shall be maintained in the windrow for at least 15 days; and

(iii) during the high temperature period, the windrow shall be turned at least five times.

(b) the static aerated pile composting method, in which the following requirements apply:

(i) aerobic conditions shall be maintained during the composting process; and

(ii) the temperature of the compost pile shall be maintained at 131 degrees F (55 degrees Celsius) or greater for at least three days.

(c) the within-vessel composting method, in which the temperature in the compost piles shall be maintained at a minimal temperature of 131 degrees F (55 degrees Celsius) for three days.

(14) Putrescible feedstocks added to the compost process shall be incorporated using methods to minimize odor such as reducing mixing time or the addition of organic material.

(15) The finished compost shall meet the classification, testing, and distribution requirements in Rule .1407 of this Section.

(16) The amount of compost stored at the facility shall not exceed the designed storage capacity.

(17) The site shall be operated to minimize odors at the property boundary by means such as windrow covers, maintaining design process indicator parameters, and maintaining carbon to nitrogen design ratios.

(18) Odor Corrective Action.

(a) If the Odor Control Plan prepared in accordance with Rule .1405(10) of this Section has been followed and the Division determines during a site visit that offsite odors are not being minimized, the owner or operator shall submit to the Division an Odor Corrective Action Report. The report shall contain the following:

(i) a summary of the actions taken in the Odor Control Plan;

(ii) an identification of onsite odor sources, in order of severity;

(iii) an evaluation and identification of odorous feedstocks as they relate to odor complaints;

(iv) an evaluation of current operation process indicators including carbon to nitrogen (C:N) ratio, pH, moisture content, oxygen levels, temperature, porosity, and particle size;

(v) an evaluation of the compost recipe calculation with C:N ratio testing that is performed by an independent laboratory for each feedstock;

(vi) an identification of potential offsite odor receptors based on their proximity to the odor sources and on weather patterns;

(vii) a description of new odor reduction methods, if proposed, and an evaluation of their feasibility, in terms of effectiveness, cost, and equipment needs;

(ix) an evaluation of the elimination of specific odorous feedstocks; and

(x) recommendations for implementing new corrective action measures for odor minimization, including a schedule.

(b) The owner or operator shall implement the new corrective action measures for odor minimization recommended in the Odor Corrective Action Report if the Division determines that the new corrective measures will reduce odors outside of the property boundary and will comply with the requirements of this Section. The Division may require the elimination of specific odorous feedstocks if a facility fails to meet the odor minimization required by Item (17) of this Rule. The Division shall provide written notice to the owner or operator of the determination.

(c) The owner or operator shall develop and implement additional corrective action measures if necessary to meet the requirements of Item (17) of this Rule to minimize odors at the property boundary.

(19) Compost Facility Training Requirements.

(a) Facilities permitted as Large Type 1, Large Type 2, all Type 3, and all Type 4 shall have an operator, supervisor, or manager trained in accordance with the requirements in G.S. 130A-309.25. No less than one trained operator, supervisor, or manager meeting the requirements of this Sub-item shall be onsite during the facility's operating hours or available at a phone number provided in the facility permit.

(i) Training in accordance with G.S. 130A-309.25(c) shall be required every five years.

(ii) Persons who have achieved and maintain compost operator certification by the US Composting Council Certification Commission or equivalent shall be considered as having met the training requirements in G.S. 130A-309.25 for the permitted facility.

(b) Owners or operators shall provide annual training for facility staff, including a review of the operations plan and permit documents.

(c) Documentation of training required in Sub-items (a) and (b) of this Item shall be maintained at the facility and made available to the Division upon request.

(d) Facilities permitted before the readopted effective date of this Rule shall meet the requirements of Sub-item (a) of this Item within three years of the readopted effective date of this Rule. Facilities permitted after the readopted effective date of this Rule shall meet the requirements of Sub-item (a) of this Item within 18 months of permit issuance.

History Note: *Authority G.S. 130A-294; 130A-309.03; 130A-309.11; 130A-309.29;*
Eff. December 1, 1991;
RRC objection Eff. April 18, 1996 due to lack of statutory authority;
Amended Eff. June 1, 1996;
Readopted Eff. November 1, 2019.

15A NCAC 13B .1407 CLASSIFICATION, TESTING, AND DISTRIBUTION OF SOLID WASTE COMPOST PRODUCTS

(a) Compost or mulch that is produced at a Type 1 facility, is free from offensive odor, contains no sharp particles, and, for compost, has met the temperature requirements in Rule .1406(11) of this Section shall be classified Grade A and have unrestricted application and distribution. Compost analytical testing shall not be required for Type 1 compost if temperature requirements in Rule .1406(11) of this Section have been met and documented.

(b) Compost produced from Type 2, 3, and 4 facilities shall be sampled and analyzed as follows:

(1) a composite sample of the compost produced at each compost facility shall be analyzed at intervals of every 20,000 tons of compost produced or every six months, whichever comes first, for metals and pathogens;

(2) compost samples shall be analyzed for the metals listed in 40 CFR 503.13(b)(3), except that analysis for mercury shall not be required for Type 2 and 3 facilities, and analysis for arsenic and selenium shall not be required for Type 2 facilities. The concentration of metals in compost offered for sale or distribution to the public shall not exceed the pollutant concentration limits listed in 40 CFR 503.13(b)(3). 40 CFR 503.13 and 40 CFR 503.32 are incorporated by reference including subsequent amendments and editions. Copies of the Code of Federal Regulations may be obtained from the U.S. Government Publishing Office website at www.gpo.gov at no cost;

(3) compost samples shall be analyzed for pathogens, either for fecal coliform or salmonella bacteria. The concentration of pathogens in compost offered for sale or distribution to the public shall not exceed the concentration limits listed in 40 CFR 503.32(a)(3);

(4) sample collection, preservation, and analysis shall assure valid and representative results. At least three individual samples of equal volume shall be taken from each batch produced in separate areas along the side of the batch. Each sampling point shall be sampled from a depth of two to six feet into the pile from the outside surface of the pile as follows:

(A) metals samples shall be composited and accumulated over a six-month period or at intervals of every 20,000 tons of product produced, whichever comes first; and

(B) pathogens samples shall be a representative composite sample of the compost and shall be processed within a period of time required by the testing procedure;

(5) analytical testing methods shall be in accordance with the procedures of one of the following:

(A) EPA publication SW-846, "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods." This document is incorporated by reference, including subsequent amendments and editions, and may be obtained free of charge at https://www.epa.gov/hw-sw846;

(B) the U.S. Department of Agriculture/U.S. Compost Council publication "Test Methods for the Examination of Composting and Compost" (TMECC). This document is incorporated by reference including subsequent amendments and editions, and may be obtained for a fee of three hundred fifty dollars ($350.00) at https://compostingcouncil.org/tmecc/ or a copy may be reviewed free of charge at the Division of Waste Management, Solid Waste Section office at 217 West Jones Street, Raleigh, N.C. 27603; or

(C) other methods that are approved by the Division as providing equivalent standards of analysis; and

(6) the Division may decrease or increase the parameters to be analyzed or the frequency of analysis based upon monitoring data, changes in the waste stream or processing, or information regarding the potential for the presence of contaminants that are not required to be analyzed in this Paragraph.

(c) Compost produced from Types 2, 3, and 4 facilities that meet the requirements of Subparagraphs (b)(2) and (b)(3) of this Rule shall be classified Grade A compost and shall have unlimited, unrestricted distribution, except as otherwise determined by the Division based on analyses of parameters pursuant to Subparagraph (b)(6) of this Rule.

(d) The facility operator shall be responsible for meeting the requirements of the North Carolina Department of Agriculture and Consumer Services Plant Industry Division Seed and Fertilizer Section concerning the distribution of this product.

History Note: *Authority G.S. 130A-309.11;*
Eff. December 1, 1991;
RRC objection Eff. April 18, 1996 due to lack of statutory authority;
Amended Eff. June 1, 1996;
Readopted Eff. November 1, 2019.

15A NCAC 13B .1408 RECORDKEEPING AND REPORTING REQUIREMENTS

(a) Record Keeping: Facility owners or operators shall maintain records for no less than five years. The following records shall be available for inspection by Division personnel during the facility's normal business hours and shall be sent to the Division upon request:

(1) daily operational records that include temperature data (length of the composting period) and quantity of material processed;
(2) analytical results of compost testing;
(3) the quantity, type, and source of waste received;
(4) the quantity of waste processed into compost;
(5) the odor management records required by Rule .1405(10) of this Section; and
(6) the quantity of compost removed for use or disposal and the market or permitted disposal facility.

(b) Annual Reporting: An annual report for the period July 1 to June 30 shall be submitted by all facility owners or operators to the Division by August 1 of each year and shall contain:

(1) the facility name, address, and permit number;
(2) the total quantity in tons, with sludge values expressed in dry weight, and the type of waste received at the facility during the year covered by the report, including tons of waste received from local governments of origin;
(3) the total quantity in tons of compost produced at the facility during the year covered by the report;
(4) the total quantity in tons of compost removed for use or disposal from the facility during the year covered by the report;
(5) monthly temperature monitoring to support Rule .1406 of this Section; and
(6) the results of analytical testing required by Rule .1407 of this Section.

(c) Yearly totals of solid waste received and composted shall be reported back to the local government of origin for annual recycling reporting.

History Note: *Authority G.S. 130A-294; 130A-309.03; 130A-309.11; 130A-309.29;*
Eff. December 1, 1991;
RRC objection Eff. April 18, 1996 due to lack of statutory authority;
Amended Eff. June 1, 1996;
Readopted Eff. November 1, 2019.

15A NCAC 13B .1409 ALTERNATIVE PROCEDURES, VERMICOMPOSTING, AND ANAEROBIC DIGESTION REQUIREMENTS

(a) An owner or operator of a composting facility subject to the provisions of this Section may request in writing the approval of an alternative procedure for the facility or the compost that is produced. The following information shall be submitted to the Solid Waste Section:

(1) the specific facility for which the exception is requested;
(2) the specific provisions of this Section for which the exception is requested;
(3) the basis for the exception;
(4) the alternate procedure or requirement for which the approval is sought and a demonstration that the alternate procedure or requirement provides equivalent protection of the public health and the environment; and
(5) a demonstration of the effectiveness of the proposed alternate procedure.

The Division shall approve the request if the alternative procedure is equivalent to procedures provided in the rules of this Section and is protective of the public health and the environment.

(b) Vermicompost Facilities. This Paragraph shall be applicable to vermicompost facilities that receive solid waste as defined in G.S. 130A-290. Facilities that receive only animal manure or only municipal wastewater treatment sludge, or both, shall not be subject to this Paragraph.

(1) The following operations shall be exempt from the requirements of this Section:
    (A) backyard vermicomposting; and
    (B) farming operations where the vermicompost is produced from materials grown on the owner's land and re-used on the owner's land.

(2) Vermicompost facilities meeting the following conditions shall be exempt from the permitting requirements in Rule .1405 of this Section;

(A) the site receives pre- and post-consumer food waste, manure, vegetative agricultural waste, yard and garden waste, untreated, unpainted, and uncontaminated wood material, source separated paper, or any combination thereof;

(B) no more than 100 cubic yards of material shall be onsite at any time. This volume shall include feedstock storage, processing, pre-composting, and active vermicomposting, but shall not include finished vermicompost;

(C) outdoor areas of the site used for feedstock storage, processing, pre-composting, or vermicomposting in open areas or open containers or bins shall meet the siting criteria and setback requirements of Rule .1404(a)(1) through (a)(10) of this Section, except that the minimum setback to the property line shall be at least 50 feet and the minimum setback to residences or dwellings not owned and occupied by the owner or operator shall be at least 200 feet;

(D) outdoor feedstock storage, processing, pre-composting, and vermicomposting operations areas, that are enclosed on all sides in containers or bins shall maintain a minimum setback to the property line of at least 25 feet;

(E) the site is operated to prevent the release of particulates and odors outside of the property boundary, and the site does not attract vectors such as insects and rodents;

(F) surface water shall be diverted from the operational and storage areas. Leachate shall be contained onsite and treated to meet the standards of the applicable off-site disposal method;

(G) for facilities producing vermicompost that is distributed to the public or used in public areas, the owner meets the pathogen testing and record keeping requirements of Rule .1407(b) and .1408(a) of this Section for a Type 3 facility; and

(H) the site operates in accordance with all applicable State or local laws, ordinances, rules, regulations, or orders.

(3) A permit shall be required for vermicompost facilities that do not meet the conditions of Subparagraphs (1) or (2) of this Paragraph. A permit application for a vermicomposting facility shall include the information required by Rules .1404 and .1405 of this Section, except that Rules .1405(9)(f) through (9)(h) of this Section do not apply. Operations or parts of operations that are indoors shall be exempt from the siting requirements of Rule .1404 of this Section. Permitted vermicomposting facilities shall be subject to:

(A) Rule .1406(1) through (9), (14), and (16) of this Section;

(B) Rule .1407 of this Section;

(C) Rule .1408 of this Section; and

(D) Rule .1410 of this Section.

(c) Anaerobic Digestion Facilities. This Paragraph shall be applicable to anaerobic digestion facilities that receive solid waste as defined in G.S. 130A-290. Facilities that receive only animal manure or only municipal wastewater treatment sludge, or both, shall not be subject to this Paragraph.

(1) A solid waste management permit shall be required for the areas of the facility that manage solid waste. These areas shall include the incoming waste receiving area, the digestate handling area, and the digestate final disposition and any other areas of the operation where solid waste is exposed to the environment.

(2) A permit application shall contain:

(A) the information required by Rules .1404 and .1405 of this Section, with the exception of Rule .1405(9)(f) through (9)(h). Operations or parts of operations that are in buildings enclosed on all sides shall be exempt from the siting requirements of Rule .1404 of this Section; and

(B) drawings of the following within the waste management areas:

(i) hoppers, bays, or vessels, and all other site-specific features related to solid waste management activities; and

(ii) for indoor operations, plan and profile drawings of the buildings with areas and features labeled.

(3) Permitted anaerobic digestion facilities shall be subject to:
  (A) Rule .1406(1) through (9), (14), and (16) of this Section;
  (B) Rule .1407 of this Section for the digestate;
  (C) Rule .1408 of this Section; and
  (D) Rule .1410 of this Section.

History Note: Authority G.S. 130A-294; 130A-309.03; 130A-309.11; 130A-309.29;
Eff. December 1, 1991;
RRC objection due to lack of statutory authority Eff. April 18, 1996;
Amended Eff. June 1, 1996;
Readopted Eff. November 1, 2019.

15A NCAC 13B .1410 CLOSURE REQUIREMENTS

(a) When the permitted compost facility ceases operations, the owner or operator shall meet the following conditions:

(1) all feedstock and unfinished compost materials shall be removed from the site and taken to a permitted solid waste facility within 180 days;
(2) finished compost materials left onsite shall comply with G.S. 130A-309.05; and
(3) the owner or operator shall notify the Division in writing upon completion of the requirements of Subparagraph (1) of this Paragraph.

(b) When a permitted compost facility has been closed in accordance with the requirements of Subparagraph (a) of this Rule, the permit shall be terminated. Future compost operations at the site shall require submittal of a new permit application in accordance with Rule .1405 of this Section.

History Note: Authority G.S. 130A-294; 130A-309.03; 130A-309.11; 130A-309.29;
Eff. November 1, 2019.

North Carolina Compost Regulations

May 2019

Donna Wilson
N.C. Department of Environmental Quality

Key Points

- Protection of public health and the environment (setbacks, groundwater, surface water)
- Process to further reduce pathogens (PFRP) 131 degrees F (15 days or 3 days)
- Vector attraction reduction (VAR) >113 degrees
- Minimize public nuisance (odor, dust)

North Carolina Compost Rules

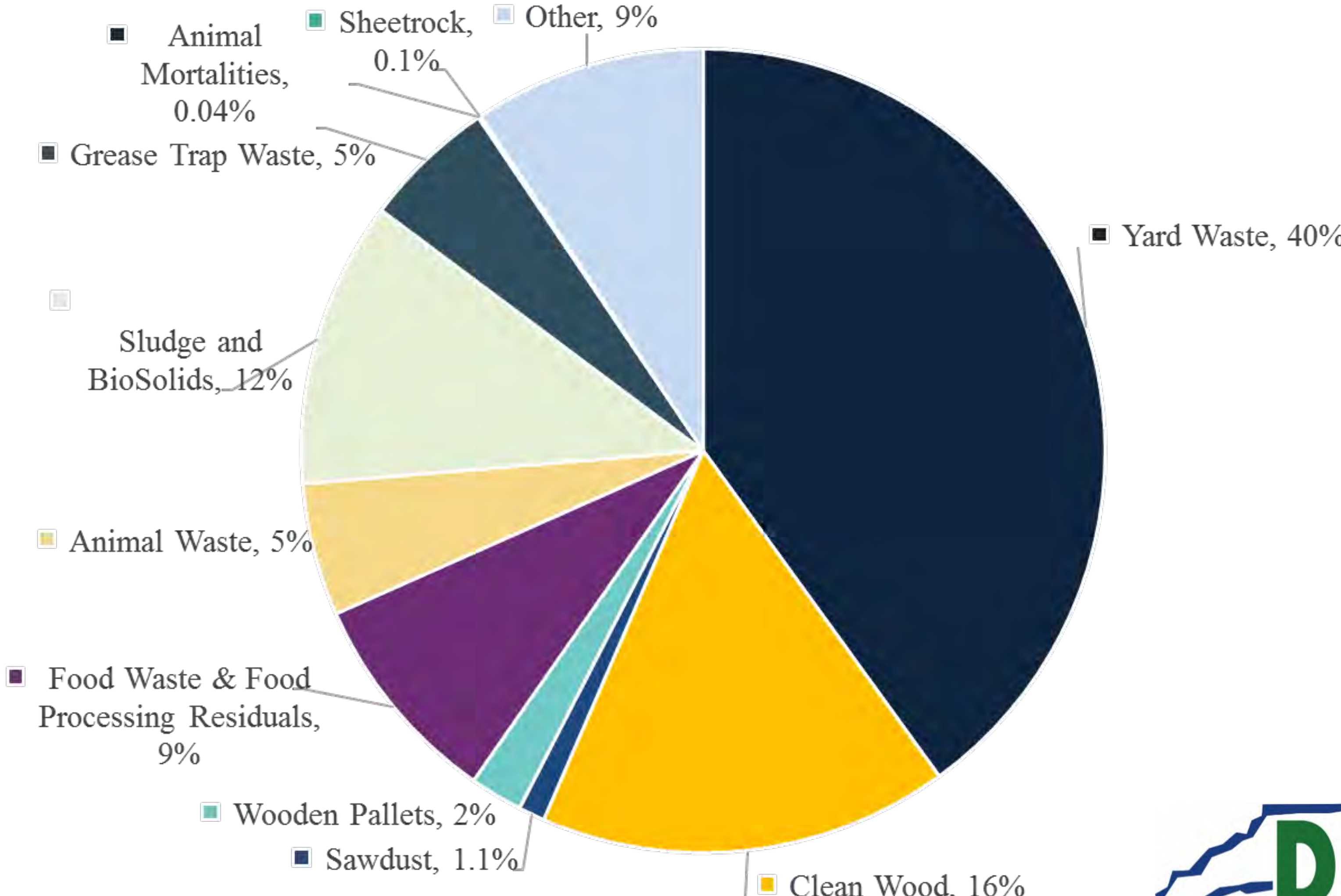
- North Carolina’s solid waste policy reflects the state’s desire to reduce, reuse and recycle before turning to disposal as a management option for solid waste.
- N.C. Compost rules can be found in NCGS .1401 et seq – called the 1400 Rules
- We have been going through rule review over the last 2 years and are proposing changes. More on this at the end of these slides.

North Carolina Compost Rules

- The Compost Rules are on our website: http://deq.nc.gov/about/divisions/waste-management/solid-waste-section/composting

- The website also has links to:
  - Permit application guidance
  - Compost demonstration guidance
  - Testing facilities for analysis
  - Guidance for special cases – composting at residential and summer camps, and composting for urban farms and community gardens

Feedstocks Composted or Mulched
FY 2014/2015



Department of Environmental Quality

North Carolina Facility Types

- Full permit
  - Type 1
  - Type 2
  - Type 3
  - Type 4

- Small and large

- Operations not requiring a permit
  - Yard waste notification
  - Compost demonstrations

Small vs. Large Facilities

- Small facilities
  - Receive less than 1,000 cubic yards of material for composting per quarter (with one exception).
  - AND occupy less than 2 acres of land.

- Large facilities
  - Receive 1,000 cubic yards or more of material for composting per quarter.
  - OR occupy 2 acres or more of land.

Type 1 Facility

- May receive:
    - Yard and garden waste
    - Land clearing waste
    - Untreated and unpainted wood waste

Type 1 Facility

- Small Type 1
  - Processes or stores less than 6,000 cubic yards of material per quarter.

- Large Type 1
  - Processes or stores more than 6,000 cubic yards of material per quarter.

- These two types are exceptions to the small and large facility definition.

Small Type 1

Large Type 1

Type 1 Feedstocks

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Department of Environmental Quality

Small Type 1 – “Notified Site”

- Yard Waste Notified Sites (YWN) are < 2 acres, <6,000 cubic yards per quarter. Permit not required. Applicant is required to submit a notification to the section, that includes:
  - Facility location
  - Name, address, phone number
  - Type and amount of wastes received
  - Composting process
  - Intended distribution of finished product

Small Type 1, continued

- Must meet the same operational and setback requirements of permitted sites (Rules .1404 and .1406)
- Yard waste containing grass, leaves and brush must be composted to kill pathogens and reduce insecticides/pesticides.
- Sites taking only land clearing debris do not have to compost.
- 131 degrees or above for 3 days and aerated to maintain elevated temperatures.
- Operation must be in accordance with other state and local laws, ordinances, rules and regulations.
- Cannot be located over a closed disposal site

Setbacks for Type 1 Facilities

- 100 year floodplain (not within)
- 50 feet to the property line
- 200 feet to residences
- 100 feet to wells
- 50 feet to perennial streams/rivers
- 25 feet to berms or ditches
- Groundwater – Must be at least 12 inches above seasonal high groundwater table

Type 2 Facility

- May receive:
  - Pre-consumer meat-free food processing waste
  - Vegetative agricultural waste
  - Source separated paper
  - Other source separated specialty waste

Type 2 Facility

- Source separated wastes must be low in pathogens (bacteria) and physical contaminants

- Waste composted at a Type 1 Facility can be composted at a Type 2 Facility

Type 2 Feedstocks

Yard & garden waste

Pre-consumer, meat free food waste

Source separated paper

DEQ
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Type 3 Facility

- May receive:
  - Manure
  - Agricultural waste
  - Meat
  - Post-consumer source-separated food wastes
  - Similar source separated wastes

Type 3 Facility

- Acceptable wastes are relatively <u>low</u> in physical contaminants, but may have <u>high</u> levels of pathogens.

- Waste acceptable for a Type 1 or 2 facility may be composted at a Type 3 facility.

Type 3 Facilities

Type 4 Facility

May receive:

- Municipal wastewater treatment sludges*
- Industrial solid waste sludges*
- Industrial solid waste*

*Each waste source must have analysis approved by our office

Type 4 Facility

- Industrial sludge and industrial waste are only acceptable if they function as a nutrient source or if they are compostable organic waste.

- Waste acceptable at Type 1, 2, 3 Facilities are accepted at Type 4 Facilities.

Type 4 Facility

McGill – Merry Oaks

Setbacks for Type 3 and 4 Facilities

- 100 year floodplain (not within)
- 100 feet to the property line
- 500 feet to residences (200 feet for small type 3)
- 100 feet to wells
- 50 feet to perennial streams/rivers
- 25 feet to berms or ditches
- Type 3 - Groundwater – Must be at least 24 inches above seasonal high groundwater table
- Type 4 – Concrete or asphalt pad

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Department of Environmental Quality

Compost Pilots/Demos

- Allowed in the Compost Rules, see 15A NCAC 13B .1409 (b).

- For first time compost operators, we recommend applying for a compost demo, instead of a full permit. The application process is easier because a permit is not required, but an approval is required.

- Must be less than 2 acres, and approvals are usually 1 year, but may be extended to 2 years.

- Application is outlined in the Compost Pilots and Demo Guide, on our website.

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No Permit Required

- Backyard composting - On-site composting of yard waste from residential property by the owner or tenant for non-commercial use.

- Farming and land clearing (silvicultural) operations where the compost produced from materials grown on the owners land are reused on the owners land.

- Small Type 1 Facilities that use a Notification Form.

NORTH CAROLINA
Department of Environmental Quality

Getting Inspected

NORTH CAROLINA
Department of Environmental Quality

Inspections

- Setbacks
- Feedstock locations
- Compost areas
- Runoff control
- Records
- Size of area
- Odors

Proposed changes to the Rules

- Clarifying language that is confusing
- Proposing new permit-by-rule for small food waste compost facilities, max 100 cubic yards onsite at any time
- Adding rules for vermicomposting and anaerobic digesters
- Adding requirement that compost operators receive training
- Requiring more detailed planning for odor control and planning for odor response
- Increasing permit term from 5 years to 10 years

Note - This is a description of the proposed Rules, and may not reflect the final approved Rules

Proposed changes to the Rules

- Public notice and comment is expected to be solicited this summer

- New rules will be in effect, if all goes well, by November 1, 2019

The End

Questions?

Donna Wilson
Permitting Engineer
N.C. DEQ
Division of Waste Management
Solid Waste Section

Phone 919-707-8255
donna.wilson@ncdenr.gov

Hog Barn Compost Siting on Farm

J Craig Williams

jcw17@psu.edu

Photos of PA, Maine, NC

PennState Extension

Cornell Waste Management Institute http://cwmi.css.cornell.edu

Jean Bonhotal

Considerations

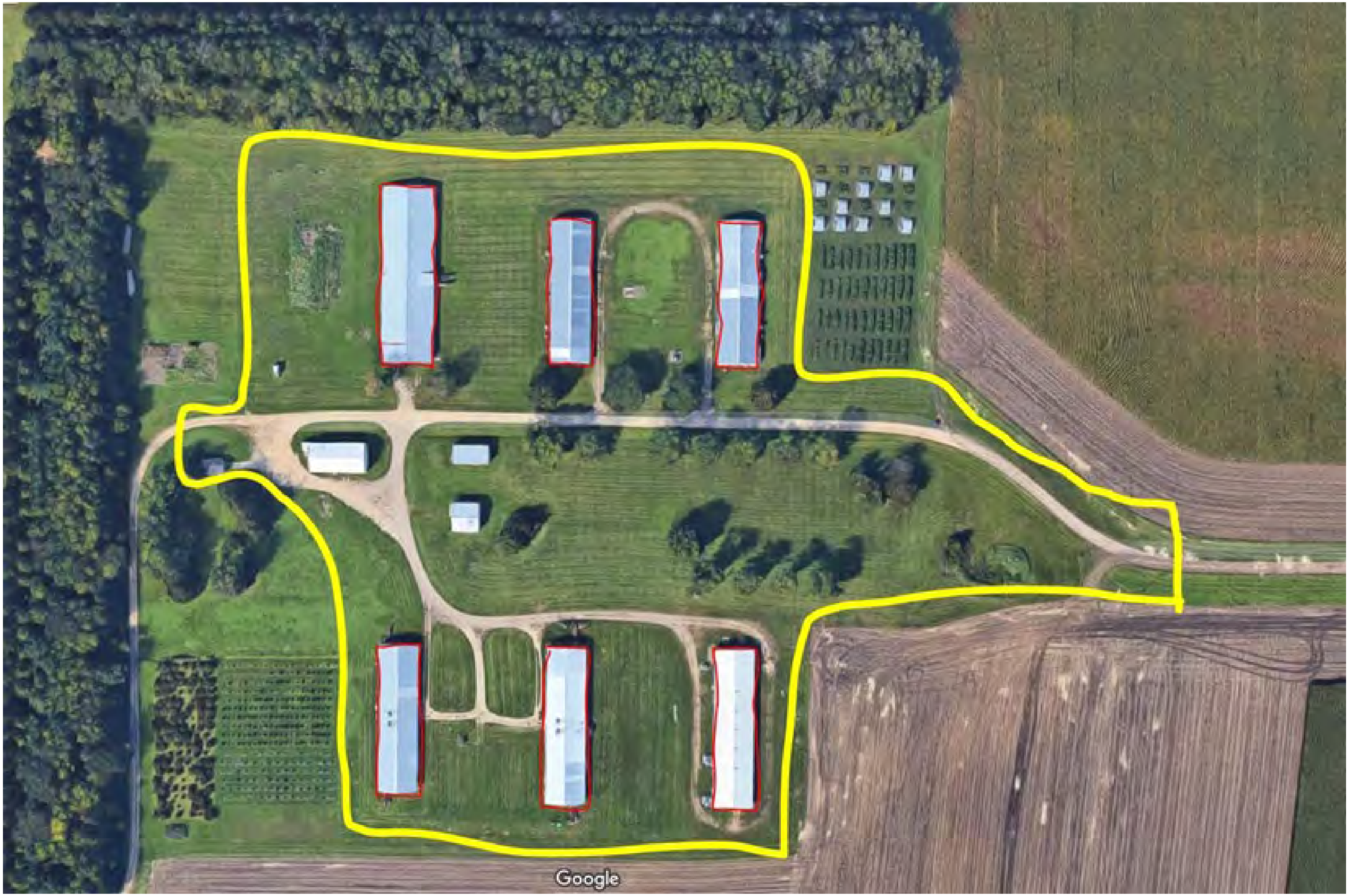
- Close to existing compost barn/bins or new site?
- **Iowa - DNR - Soil Map? Or other State's specific rules**

- Distance to Closest Neighbors/Houses/ Businesses
- Barn Population Density
- Dust
- Traffic/ Noise
- Wind Direction barn - Wind Direction neighbors
- Slope
- Space for Carbon, grinding, equipment, and Windrows
- **Ground and Surface Water- potential flooding?**

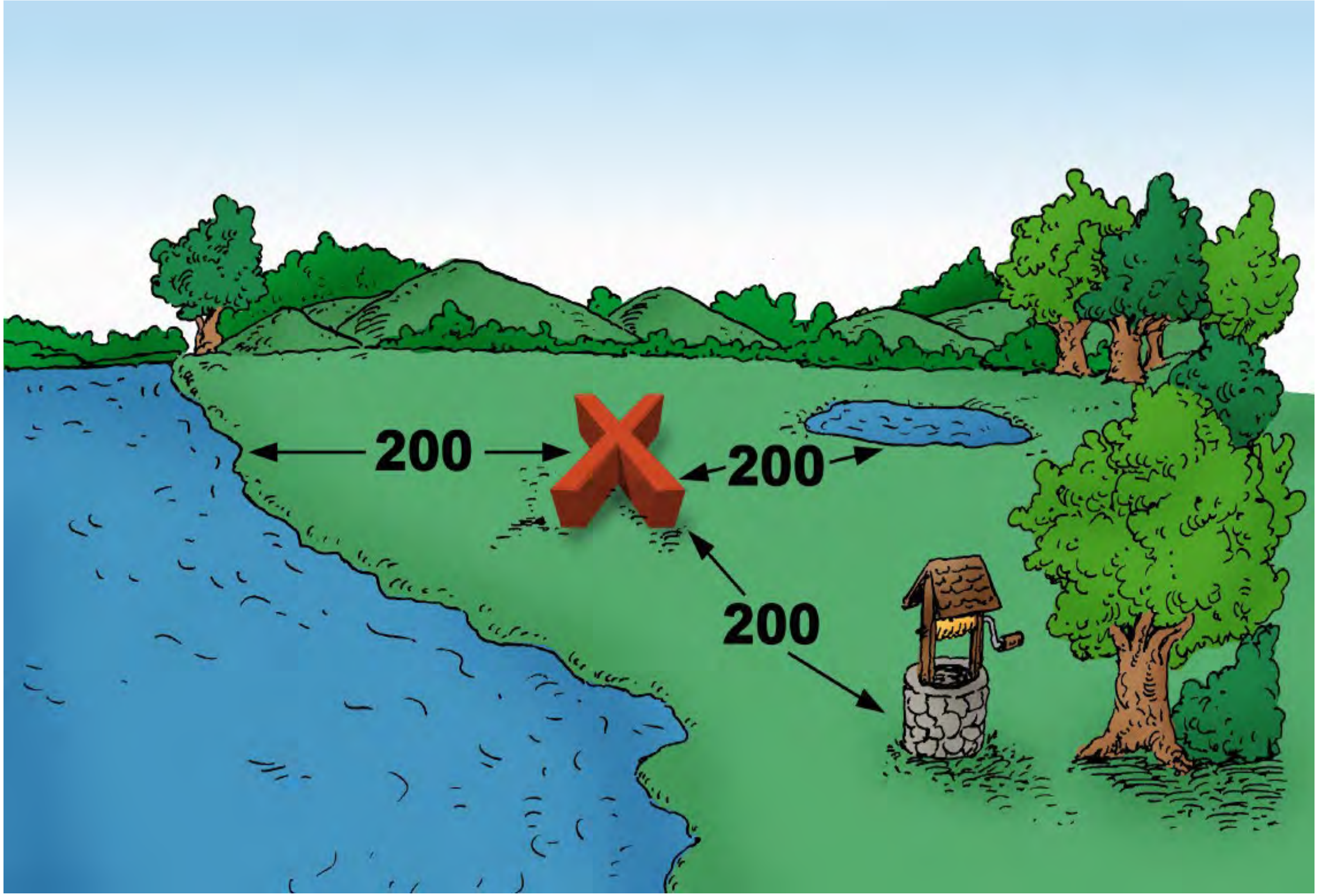
14 bin system already full

Locate Carbon pile, grinder site, windrows site

Travel Routes to Compost site, Barns?

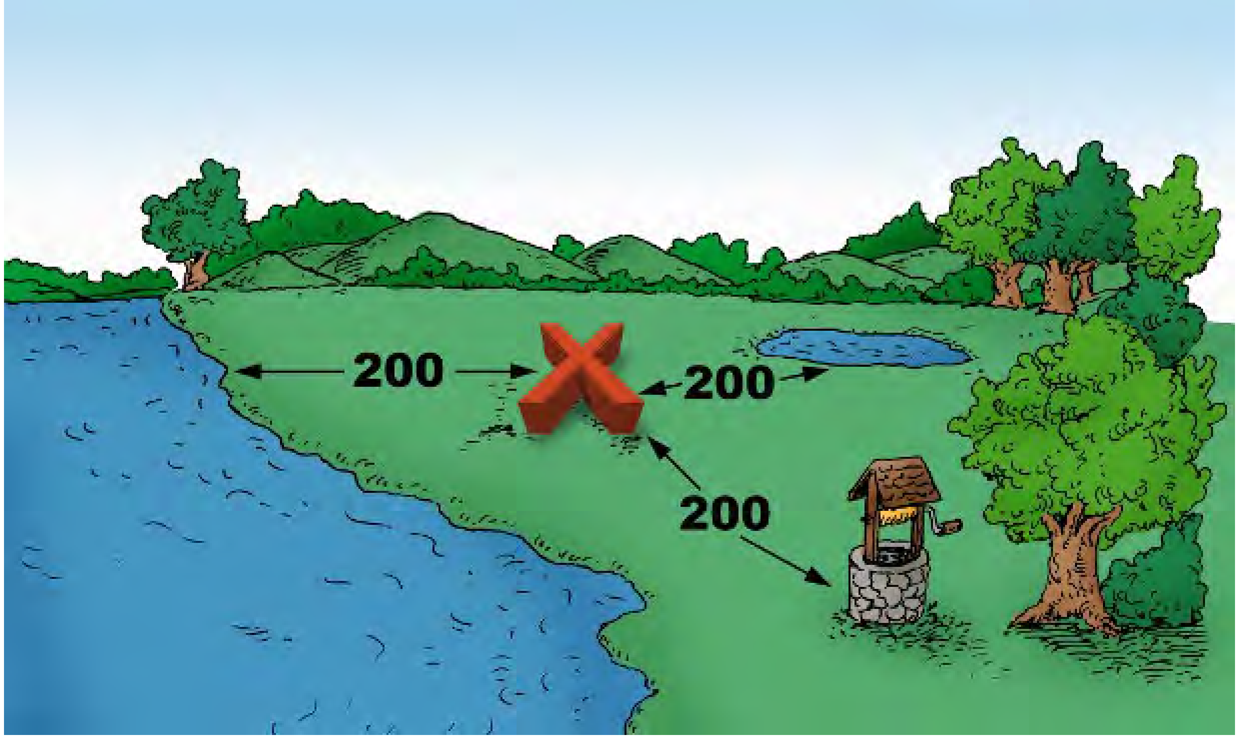


Composting Siting



- Cornell Waste Management Institute http://cwmi.css.cornell.edu
  Jean Bonhotal

Siting for Composting

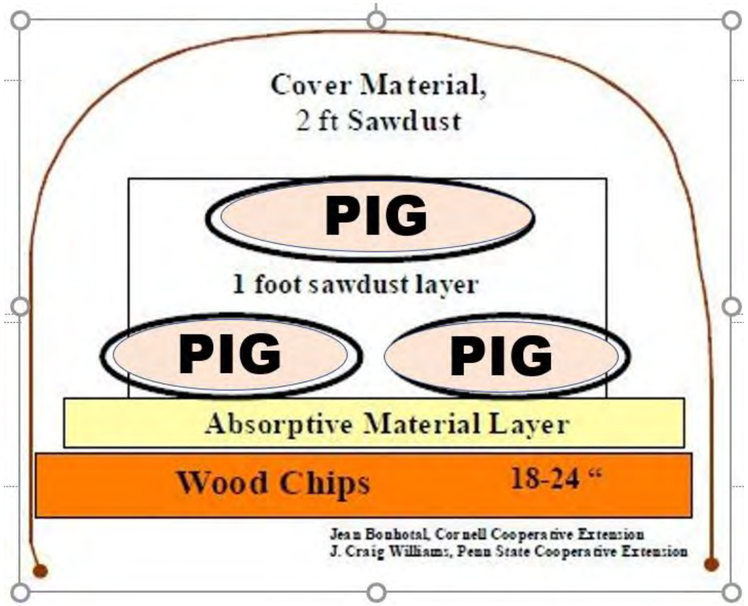


Select site that is well-drained, at least 200 ft from water courses, sinkholes, seasonal seeps or other landscape features that indicate the area is hydrologically sensitive.

Wood Chip Bed

Lay 24-in bed of bulky, absorbing organic material containing some sizeable pieces

(4 to 6-in long). Utility and municipal wood chips work well.



Cover Material,
2 ft Sawdust
PIG
1 foot sawdust layer
PIG
PIG
Absorptive Material Layer
Wood Chips
18-24 "
Jean Bonhotal, Cornell Cooperative Extension
J. Craig Williams, Penn State Cooperative Extension

2001 2 23

Area to Dump Carbon Covering

Cover carcass with dry, high-carbon co-composting material, like old silage, sawdust, or dry stall bedding (some semi-solid manure will expedite the process).

Where to Put Carbon?

Bring in the carbon for the base

Grinding Footprint Planning

Road to windrow site

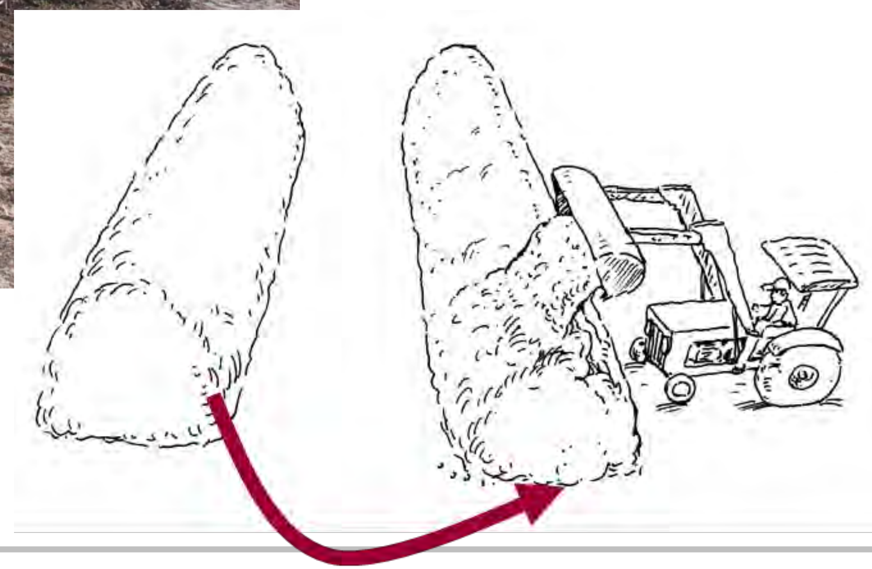
Materials Used for Composting

(MCE, Fact Sheet 717)

- Sawdust (GREEN) +/- wood shavings, shredded leaves, chipped tree trimmings
- Chopped straw +/-
- Spoiled silage some
- Poultry litter
- Chopped cornstalks or old hay
- Old Carbon Compost
- MIX AREA!

Windrows and Siting

Large windrows near each other to turn



Run-off to fix with dry carbon….

Areas on the Farm- aware of slope and traffic

- J Craig Williams Penn State Extension
- jcw17@psu.edu
- PSU Extension Youtube –
- Proper Animal Mortality Disposal
- https://youtu.be/staHoZQ8_ss

Credits & Thank You

Gary Messner and Bear!

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Emergency Carcass Disposal: Environmentally Sustainable Options, Process and Support

Presented by:

University of Maine Cooperative Extension
Mark Hutchinson:
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Gary Flory

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Craig Williams

Iowa Pork Board
Jamee Eggers

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Sustainable Carcass Management:

- Evaluate all viable options: USDA list
- **Compost and Above Ground Burial**

Guidance Documents

- USDA: APHIS documents:
  - “Composting Livestock 2017: Livestock Mortality Composting Protocol”
    - https://www.aphis.usda.gov/animal_health/emergency_management/downloads/nahems_guidelines/livestock-mortality-compost-sop.pdf
  - “Mortality Compost Protocol for Avian Influenza Infected Flocks”, 2016
    - https://www.aphis.usda.gov/animal_health/emergency_management/downloads/hpai/mortalitycompostingprotocol.pdf
- “Best Management Practices for Large Animal Carcass Composting” 2011. https://www.maine.gov/dacf/php/nutrient_management/documents/BESTMANAGEMENTPRACTICESforCarcassComposting-2011Complete.pdf
  - Dr. Bill Seekins: Retired Maine Department of Agriculture, Conservation and Forestry
- Spartan Emergency Animal Tissue Compost Planner Worksheet: https://www.canr.msu.edu/resources/spartan-emergency-animal-tissue-composting-planner-v1-04
  - Dr. Dale Rozeboom Michigan State University

Topics:

- How Compost Works
- Opportunities and Challenges with:
  - Above Ground Burial:
  - Carcass composting: whole and ground
- Site Selection:
- Carbon Feedstock
  - Type
  - Sources
  - Requirements for Each Option
- Windrow Construction
- Windrow Management/Troubleshooting

Compost for herd reduction:

- Same principles as daily routine carcass management: just on a different scale!

Compost Process: The Science

- Biological Process:
  - Microbes = heat!
  - Aerobic process
- Requirements in order of importance
  - Moisture:
    - Allows microbes to feed
    - Cools pile
  - Air:
    - Porosity
  - Food:
    - C:N ratio
  - Structure
    - Shape matters
- Windrow system:
  - Static: set and forget it
  - Aerated: turned

Functioning of a compost windrow/pile

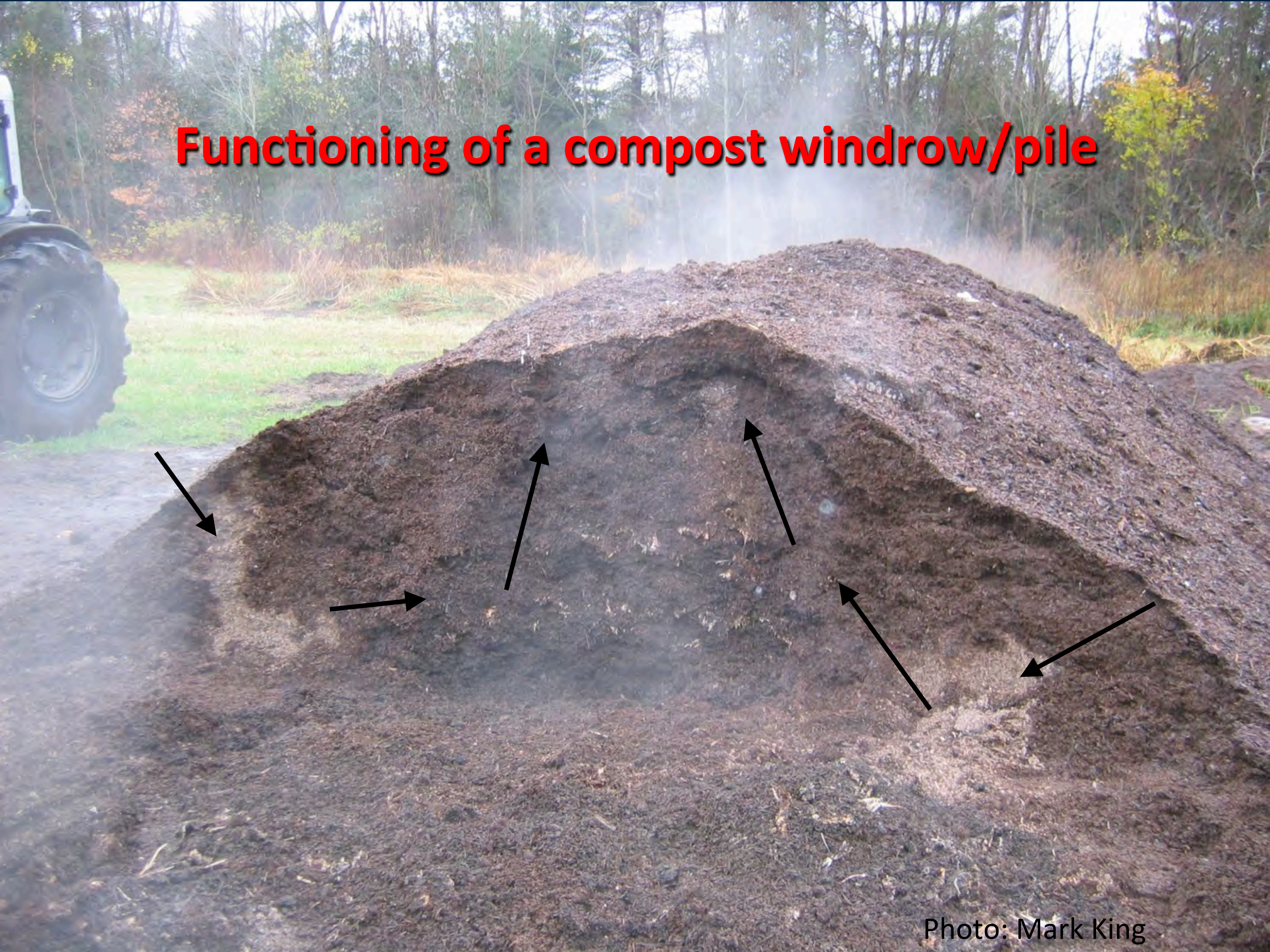

Photo: Mark King

Questions: on compost process

Next: Above Ground Burial: Gary Flory

Whole Carcass Composting

- Opportunities
  - End product has VALUE
  - Faster than burial and grinding
  - Pathogen reduction
  - Cycle time:
    - Static windrows: 6 months
    - Turned windrows: 4 months
  - Less equipment
- Challenges
  - Carbon
  - Pile management
  - Bones from mature animals

Ground Carcass Composting

- Opportunities
  - Particle Reduction:
    - increased surface area
  - Blend carbon and tissue
    - Moisture control
  - Limited pile management
    - No pile collapse
    - Maintain structure
  - No bones
  - Cycle time: 4 weeks
  - Less Carbon:
    - 25-45%
  - Smaller footprint

- Challenges
  - Extra step/time
  - Equipment availability / cost
    - At least two pieces of equipment
  - Training operators
  - Disinfecting/cleaning

Vertical Mixer

- Twin Auger Vertical Mixer: blades cut soft tissue material
- Own power source
- PTO driven
- Truck mounted

Throughput is approximately 3600# of animal tissue per hour

Particle Reduction

Horizontal Grinding

Grinder Contacts

- **Vermeer**: **Iowa**
  - Ted Drikx: national sales manager for Vermeer.
  - tdirkx@vermeer.com 641-629-1589
- **Peterson Corp, Oregon**
  - Steve Jones : steve.jones@petersoncorp.com : covers mid Atlantic
    Derek Izworski <derek.izworski@petersoncorp.com>; Covers Upper Midwest
  - Steve Patton <steve.patton@petersoncorp.com>; Covers west coast
  - Dick Edwards <dick.edwards@petersoncorp.com>Covers central Oklahoma
- **Rotochopper: Minnesota** These are vertical systems.
  - Jeremy Scherping 320-493-5325
- **Post Equipment / Supreme International: Iowa**
  - 712-476-4500
- **Morbark LLC: Michigan**
  - 919-866-2381
- **Bandit Industries: Michigan**
  - 989-561-2270
- **Continental Biomass Industries: New Hampshire**
  - 603-382-0556

Questions: Particle reduction

- Next; Site Selection: Craig Williams

Carbon Feedstocks

- Characteristics of carbon
  - Moisture
  - Particle size
- Amount of carbon
  - Volume or weight?
  - How to calculate:
    - 4-5 cubic yards/animal unit
    - 1 lb. C/1 lb. of mortality

Hot compost mix

Shavings

Wood chips

What carbon sources are regionally available?

- Types of Carbon:
  - Tree trimmings
  - Wood mulch
  - Corn stover
  - Shavings
  - Sawdust
  - Wood chips
  - Straw
  - Horsebedding
  - Calf Manure: NOT milk cow manure (to wet)
  - HOT compost: mixed in core
- Other Materials:
  - Waste feed
  - Finished compost: cover material
- USDA protocol for complete list:

- Sourcing carbon:
  - State list
  - Industry list

CALCULATING CARBON VOLUMES AND SPACE REQUIREMENTS FOR CARCASS COMPOSTING

Dr. Bill Seekins: Faculty Associate University of Maine

April 25th 2020

Yellow is input data needed

Gray is output

DATA REQUIRED	
ANIMAL TYPE	Hogs
NUMBER OF ANIMALS	1000
AVERAGE WGT IN LBS	400
USABLE WINDROW LENGTH (assume 300 ft if unknown)	300
WINDROW WIDTH (assume 12 ft if unknown)	12
ALLEY WIDTH (assume 10 ft if unknown	10
WINDROWS IN GROUP (assume 2 for pairs, 1 for singles)	2
# OF ANIMAL UNITS	400
VOLUME OF CARBON MATERIALS NEEDED (in cu yds) for Cover and Base	1840
WINDROW LENGTH NEEDED (animals only)	1280
NUMBER OF WINDROWS NEEDED (use next whole number)	4.27
NEXT WHOLE NUMBER	5
NUMBER OF WINDROW GROUPS	2.5
WIDTH OF WINDROW GROUPS	25
NUMBER OF ALLEYS BETWEEN GROUPS	3.5
FULL ALLEYS	4
TOTAL WIDTH OF AREA NEEDED	102.5
AREA IN SQ FT	32800
AREA IN ACRES	0.752984389
VOLUME OF MATERIAL NEEDED FOR END CAPS	20
TOTAL VOLUME NEEDED (cubic yards)	1860
FUDGE FACTOR +/- 10% (cubic yards)	186

VOLUME OF CAP MATERIAL NEEDED (for disease outbreaks only)	CUBIC YARDS
4 inch CAP	296.75
6 INCH CAP	441.1
8 INCH CAP	589.5

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Calculated averages for determining carbon cost:

- 1000 head of 250# finishing animals requires approximately 1200 cubic yards of carbon
- 1000 head of 450# sows requires approximately 2100 cubic yards of carbon
- Or:
- Approximately 4.6 yds^3/animal unit
- Sample calculation sheets available:

Questions: Feedstock Material

- Next: Windrow Construction

Windrow Construction

- Layout base: coarse material/ with some fines
  - 18”- 24” base
  - 12-14’ wide and 6-8’ high
- Place animal tissue on the base, this forms the core (2’-3’ feet deep)
- Add 18”-24” of carbon cover material
  - Less with ground material
  - More with whole large animals
  - Windrows should be probed to determine cap depth


CASE

Not every windrow is the same: remember the principles of composting


If you do
Compost works really well

Common windrow construction challenges:

- Equipment driven on windrow
- Not enough base or cover material
- Piles to wide/ tall
- Poor site location

Carcass Degradation

- Holstein cow (~1250#)
- 8 weeks in a static windrow
- No soft tissue
- Bones:
  - most are soft brittle
  - Exceptions:
    - Skull
    - femur

Animal carcass
original location

Questions: Windrow Construction

Troubleshooting

- Temperatures is an indication of biological activity!
- Pile collapse:
  - 2-3 days after initial construction
- Leachate:
  - None if piles are constructed properly
- Vectors:
  - Flies or larva
  - Coyotes
  - Turkey vultures

Top of pile collapses


Pile Toubleshooting
Exposed bird material: approximate 3’ high
Pile Height and Width Over 8-9’ tall x 14-18 ’ base width

Resources for Technical Assistance

- Mark Hutchinson: Extension Professor, University of Maine 207-949-4083, mhutch@mainee.edu

- Craig Williams: Extension Agent, Penn State University 570-433-8943, jcw17@psu.edu

- Gary Flory: Agriculture Program Manager, Virginia Dept. of Environmental Protection, 804-212-7018, gary.flory@deq.virginia.gov

- Keith Warren: President, Advanced Composting Technologies LLC, 828-665-8600, kw@advancedcomposting.com

- Jamee Eggers: Producer Educational Director: Iowa Pork Producers Association, 515-225-7675 jeggers@iowapork.org

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What Help Do You Need?

7-2006

Environmental Impacts of Emergency Livestock Mortality Composting—Leachate Release and Soil Contamination

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Abstract.

A 3-year study was conducted in Iowa to evaluate the feasibility of using composting for emergency disposal of cattle mortalities. During the study, 49 metric tons of 450 kg cattle carcasses were composted in 27 replicated unturned windrow test units constructed during three different seasons of the year. Each test unit contained 1.8 metric tons of carcasses enveloped in one of 5 different materials: corn silage, ground cornstalks, straw/manure, leaves, or a soil/compost blend. Due to their water absorbing capacity and ability to evaporate absorbed water, the volume of leachate released into the soil was generally less than 5% of the 500-600 mm of precipitation that fell on the test units. Chemical analysis of 1.2 m deep soil cores collected from beneath the composting test units prior to and following composting showed statistically significant increases in chloride concentrations at all depths beneath composting test units constructed from silage, cornstalks, straw, and the soil/compost blend. Statistically significant increases in % total carbon (silage test units only) and % total nitrogen (silage, cornstalk, straw/manure test units) were limited to the top 15 cm of soil. Increases in these pollutants were moderate, amounting to less than 5X, 0.2X and 0.4 X respectively of chloride, % total carbon, % total N concentrations prior to composting. Statistically significant increases in total ammonia-nitrogen were noted at depths of up to 90 cm beneath test units constructed with silage or leaves, and at 30 cm and 15 cm depths respectively beneath test units constructed with straw/manure and cornstalks. The ammonia-nitrogen increases were large, ranging from 40-160 X of pre-composting levels of ammonia in the topsoil. When compared with the groundwater pollution potential of carcass burial, however, the estimated total mass of N contained in the composted cattle carcasses was 4-10 X the increases in total N measured in the soil beneath the composting test units.

Keywords. animal carcass, mortality, disposal, composting, environment

Introduction

In the event of a contagious poultry or livestock disease outbreak or agro-terrorism incident, herd or flock depopulation could pose serious environmental problems in Iowa where poultry and livestock populations are among the largest of any state in the U.S. (15,800,000 pigs [#1 in U.S.]; 3,400,000 cattle & calves [# 8]; and 50,000,000 laying hens [#1]).

Anticipating these issues, the Iowa Department of Natural Resources (IDNR) commissioned a three-year study by Iowa State University (ISU) to evaluate the feasibility, environmental impacts, and biosecurity of using composting for emergency disposal of large quantities of livestock or poultry carcasses.

Project objectives included: development and testing of on-farm composting procedures that can be rapidly implemented during an emergency; field scale monitoring of process performance indicators such as internal temperature, internal oxygen concentration, carcass decomposition time; assessment of environmental impacts including odor emissions, leachate production, and soil contamination; and evaluation of process bio-security including the ability to retain and inactivate viral pathogens.

Previous ASABE conference papers presented preliminary findings pertinent to process performance, odor emissions, leachate production, and biosecurity. This paper presents a detailed analysis of soil pollution caused by the emergency composting process.

Literature Review

Groundwater pollution concerns (Ritter and Chirnside, 1988; Glanville, 1993) and the increasing costs of rendering service and other disposal methods led to early trials and adoption of composting for routine disposal of non-disease-related poultry mortalities in the late 1980's and early 1990's (Murphy and Handwerker, 1988; Owings, 1990; Blake and Donald, 1992; Carter, 1993). Successful use of composting in the poultry industry ultimately led to interest in and adoption of composting in the swine production industry as well (Fulhage, 1994, 1995; Hermel, 1992, 1993; Morrow and Ferket, 1993). More recently several projects have been initiated to investigate the practical potential for using composting for non-emergency disposal of cattle, road-kill deer, and other large carcasses (Bonhotal and Harrison, 2005; Kirk et. al., 2005; Mukhtar et. al. 2003, Murphy et. al., 2004; Goldstein, 2004, Singleton, 2002, 2004; Morse, 2001).

The foot-and-mouth disease outbreak in Great Britain in 2001, and more recent worldwide concern regarding the spread of avian influenza in wild and domesticated birds has greatly increased interest in possible use of composting for emergency disposal of large numbers of poultry or livestock in the event of a disease outbreak. Much of the scientific support for this rests on past studies of pathogen inactivation during non-emergency composting of livestock and poultry manure and carcasses. In lab scale studies avian influenza, avian adenovirus, Newcastle disease, and infectious bursal disease viruses were inactivated after passing through a two-stage bin composting process (Senne et al., 1994). Composting procedures studied by Murphy (1990) destroyed *Salmonella enteritidis*, *S typhimurium*, *S sefentenberg*, *Listeria monocytogenes*, *Pasteurella multocida*, and *Aspergillus fumigatus*. In North Carolina studies, mean total coliform counts of more than 300,000 organisms per gram of dry turkey litter solids were reduced to 22,000 during the 1st stage of a three-stage turkey carcass composting process, and to 4,000 and 300 organisms in the second and third stages respectively (Carter, 1993). Swine carcass composting research in North Carolina produced composting temperatures (60 - 70 °C) of sufficient duration to destroy or greatly reduce *Salmonella*, pseudorabies virus, and *Erysipelas rhusiopathiae* (Morrow et al., 1995). Similar work in Michigan showed that viable *Salmonella cholerasuis* could not be detected in the carcasses of experimentally-infected pigs after 7 days, and *Actinobacillus pleuropnumoniae* were inactivated within 35 days (Rozeboom and Siera, 1996, Siera, 1995). Forshell and Ekesbo (1993) reported that composting of cattle manure inactivated *Salmonella dublin*, *S senftenberg*, and *S typhimurium* in less than 7 days while the same organisms survived 183 to 214 days in uncomposted manure. Similarly, *S senftenberg* and *S typhimurium* survived less than 7 days in composted sow manure, and a heat-resistant strain of *S typhimurium* experimentally added to cage layer manure was rapidly destroyed when compost temperatures exceeded 60 C (deGraft-Hanson et al., 1990).

To date, use of composting for emergency disposal of carcasses known to be infected with a contagious disease has been quite limited. Bendfeldt (2005) reported that composting was used to a limited extent during a 2002 avian influenza outbreak in Virginia, and during a similar incident in 2004 in the Delmarva area. The Canadian Food Inspection Service reported successful use of passively aerated windrows for disposal of poultry carcasses during an outbreak of highly pathogenic avian influenza in British Columbia in 2004 (Stepushyn, 2004; Spencer, et. al. 2004). In–depth guidelines for emergency composting of birds are currently being developed by agencies in Australia, Canada, and the U.S. Methods designed specifically for in-house composting have been evaluated for the U.S. Poultry and Egg Association by Tablante et. al. (2003).

While a great deal of composting research and demonstration work has been carried out during the past 15 years, much of it has been done with small quantities of carcasses and cover materials, and using intensively managed (frequently turned) composting procedures. Additional study is needed to further develop composting practices that can be relied on to maintain biosecurity and acceptable environmental impacts while using equipment, materials, and methods that are likely to be employed during emergency conditions.

Study Design & Procedures

After considering potential operating constraints posed by various emergency scenarios, project investigators concluded that unturned windrows offered the simplicity and flexibility needed for successful emergency implementation by livestock producers. Windrow systems are easy to adapt to any size or quantity of carcasses, they can be constructed with on-farm equipment, and windrow maintenance is limited mainly to periodic repair of holes caused by settling or burrowing scavengers.

Those familiar with composting practices will recognize that use of unturned windrows is somewhat unconventional. Most composting windrows are turned periodically to increase organics degradation rates, and to reduce pathogen survival by increasing the amount of material exposed to the core of the windrow where temperatures are typically highest. While turning of mortality composting piles generally reduces carcass decay time, in instances where death is caused by disease turning also can increase biosecurity risks by releasing viable pathogens into the air. Therefore, to fully assess the practical value of composting for emergency situations, it was decided that the benefits and drawbacks of not turning needed to be documented during this research.

Experimental Design

Field trials were conducted using full-scale — 6 m (long) x 5.5 m (wide) x 2.1 m (high) — windrows. Since type of cover material and seasonal weather conditions are critical factors in the performance of mortality composting operations, the experimental design was formulated to facilitate performance comparisons between three potential emergency cover materials operating under three potentially stressful seasonal weather conditions — hot/dry (summer), cold (winter), and cool/wet (spring). To improve the power of statistical analyses, seasonal and cover material combinations were originally planned to be replicated three times (unanticipated failure of one cover material precluded this) resulting in a total of 27 field test units (3 cover materials x 3 seasons x 3 replications).

Each test unit contained four 450-kg cattle carcasses placed on a 60-cm thick absorptive base layer of material and covered with 30-45 cm of the same material. Corn silage, ground cornstalks, and yard waste compost were originally selected for testing. The first two are found on most cattle farms and would normally be available in an emergency.

Though not typically found on crop or livestock farms, yard waste compost was selected for testing because — due to a ban on land filling of yard wastes passed by the Iowa Legislature in the late 1980s — this material is stockpiled by many community or county composting facilities throughout the state and could conceivably provide substantial quantities of organic material that could be used as an emergency cover material. Two seasonal trials using compost from the Iowa State University yard waste composting facility, however, showed that material from this particular facility was a very fine textured soil-like material with high bulk density (hereafter referred to as a “soil/compost blend”) and that it performed very poorly as a mortality composting cover material. It is likely that coarser textured (more mulch-like) yard waste composts available from other composting facilities would have functioned adequately as an emergency cover material but, since this kind of compost would have been costly to haul to the research site, this material was dropped from the study and replaced (trial # 3 only) with dry unprocessed leaves. Although leaves performed similarly to ground cornstalks, the research team subsequently concluded that large quantities of leaves were unlikely to be available on a consistent basis thereby significantly reducing the reliability of leaves as a potential emergency composting material.

Ground oat straw, a material that is likely to be available to cattle farmers throughout much of the year, was selected for use in the remainder of the replicated field tests. To evaluate the feasibility of simultaneous disposal of infected manure, a 15-cm layer of scraped cattle feedlot manure also was placed over carcasses composted in test units constructed with ground straw. Since the straw/manure design was introduced during year two of the study, only two seasonal replications were done with these materials. Table 1 summarizes starting dates, cover materials, and number of trial replications for each of the six seasonal trials conducted during the study.

Table 1. Trials conducted during emergency composting study.

Trial #	Starting Date	Initial Seasonal Conditions	Type and Number of Test Units
1	August, 2002	warm/dry	ground cornstalks (1), corn silage (1), soil/compost blend (1)
2	November, 2002	cold	ground cornstalks (1), corn silage (1), soil/compost blend (1)
3	April 2003	cool/wet	ground cornstalks (1), corn silage (1), leaves(1)
4	June 2003	warm/dry	ground cornstalks (2), corn silage (2), straw/manure (2)
5	November 2003	cold	ground cornstalks (2), corn silage (2), straw/manure (2)
6	April 2004	cool/wet	ground cornstalks (2), corn silage (2), straw/manure (2)

Compost System Operation

Once the windrows were constructed, operating and maintenance procedures during the research were minimal. Since windrows were not turned, it was occasionally necessary to add cover material to prevent carcass exposures caused by pile settling or occasional burrowing animals.

All test units were allowed to compost for approximately one year. During this time, small portions of selected test units were temporarily excavated with a backhoe 3-6 months following construction to photograph and assess carcass degradation.

Leachate Quantity and Quality

During seasonal trials 1- 4, plywood leachate trays (four feet wide by 8 feet long) lined with plastic sheeting were placed beneath each pair of cattle carcasses in a test unit to capture nearly all of the leachate draining from the base of the windrow. The trays were designed to be emptied through suction lines leading to the outer edges of the piles. The trays were plagued by leaks and plugging of the leachate drain tubing. As result, data on leachate quantities in trials 1-4 were deemed unreliable. For the 12 test units included in trials 5 and 6, plywood trays were abandoned and leachate was captured in U-shaped PVC plastic troughs constructed from half-sections of 6-inch diameter PVC water pipe. Two collectors were installed in each test unit —one beneath each pair of carcasses — and each was positioned so as to capture an integrated sample of leachate contributed by the carcasses and the adjacent cover materials. The troughs were mounted on 2x10 treated lumber beams that sloped from the center of the piles toward the outer edges thereby permitting gravity transfer of leachate into 1-liter polyethylene bottles at the edges of the windrow (Figure 1). The leachate collector bottles, which were translucent, made it easy for researchers to tell when they were full and needed to be replaced (Figure 1). After transfer to the lab and storage in a freezer, total leachate sub volume was measured, and sub-samples were tested for total solids, total organic carbon (TOC), nitrate (NO_3), and ammonia-nitrogen (NH_4-N).

Figure 1. Gravity flow leachate collection troughs (left) and polyethylene leachate bottles (right) used to capture leachate samples during trials 5 and 6.

Soil & Quality Monitoring

To evaluate the impacts of the carcass composting process on soil chemistry, four soil cores (3.1 cm diameter X 1.2 m long) were collected from the area beneath each test unit before and after carcass composting. Two of the four post-composting cores were collected near the center of the test units directly beneath the cattle carcasses, and two were collected from locations nearer to the edge of the test units where leachate would originate mainly from the cover material.

All cores were collected and stored in plastic zero-contamination core tube liners that were immediately transported to the lab and frozen. Prior to analysis, each tube was cut into 6 segments. Since it was anticipated that mean contaminant concentrations and variability in the upper half of the tubes were likely to be higher than in the lower half, the top 60 cm of each sample were cut into four 15-cm sections, and the bottom 60 cm were cut into two 30-cm sections. Sub-samples were tested for moisture content, total C and total N via combustion analysis, and for NH_4-N, NO_3-N, and Cl via standard wet chemistry procedures using KCl as the extractant for adsorbed species, and water for extraction of NO_3-N and Cl.

Results and Interpretations

Leachate Quantity

The accumulated depths of leachate captured by collectors beneath each of the 12 test units in trials 5 and 6 are shown in Figure 2. These data indicate that leachate depths were only 1-5% of the accumulated precipitation that fell on the unsheltered test units. Considering that the 1.8 metric tons of cattle carcasses in each test unit contained roughly 1200 liters of water — the equivalent of about 90 mm of depth when spread over the area directly beneath the carcasses — and that an additional 500-600 mm of water was added by precipitation, this result is surprising, and it emphasizes the important liquid storage function of material that is placed over and beneath the carcasses. Not only do these materials temporarily absorb excess water, but they also provide a gas permeable matrix that facilitates evaporation of excess water from the piles. Evidence of this phenomenon — in the form of water vapor leaving the upper surface of the composting windrows — can be seen when periods of active composting coincide with cool external temperatures. As a result of this, the volume of leachate released from the bottom of the piles is much less than combined quantities of water contributed by carcasses and precipitation.

The accumulated depths of leachate show a consistent trend with regard to cover material type. The total amount of leachate produced by test units constructed with corn silage was always greater than that produced by adjacent piles constructed with cornstalks or the straw/manure, and the least amount of leachate was produced by cornstalk test units.

Trial 5 exhibited considerable variability in the amount of leachate released from replicated piles within the same trial. Test units in the west half of trial 5 yielded 3-4 times the volume of leachate produced by similar materials in the east half of the trial. The reasons for this are uncertain. Trial 5 was constructed during a wet and foggy two-day period in early November of 2003, so cover materials used in the west half of the trial may have been wetter than those in the east half. Significant snowfall and drifting in December of 2003 may also have also contributed to uneven water loading on the east and west halves of the trial. Finally, trial 5 was constructed by a different research technician than the other trials and, in general, the total amount of base and cover material used in the trial 5 test units was less than in other trials and this may have contributed to differences in water holding capacity.

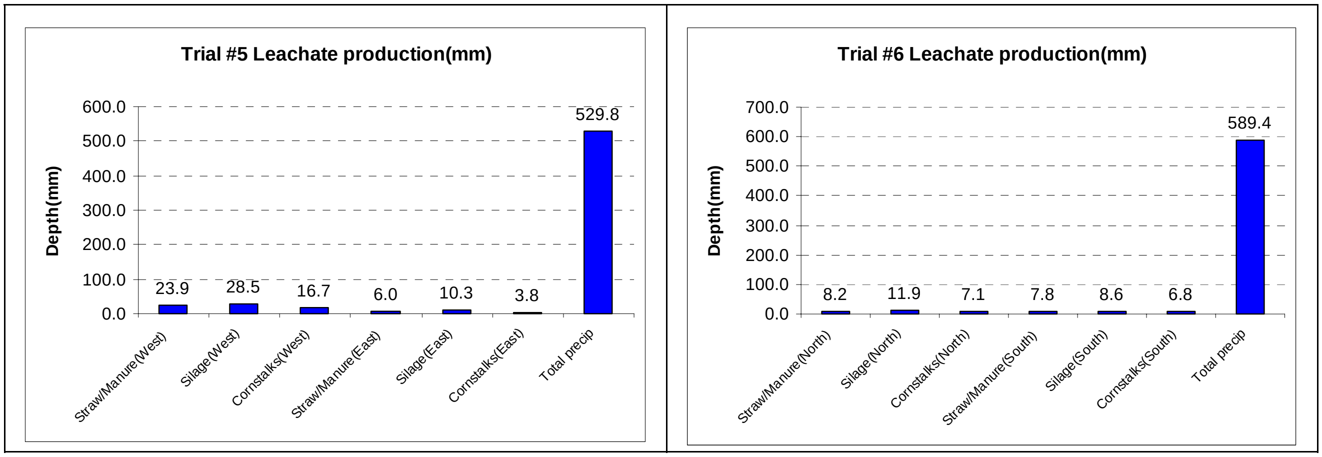


Figure 2. Total depth of leachate captured beneath test units in seasonal trials 5 and 6 compared with concurrent precipitation.

Leachate Quality

As shown by summary data in Table 2, mean nitrate-nitrogen concentrations in leachate from composting trials 5 and 6 ranged from 39 to 268 mg/L with the highest values found in leachate from straw/manure trials and the lowest from silage. Ammonia-nitrogen ranged from 190 mg/L to nearly 1400 mg/L, with the highest values again originating in straw/manure test units and the lowest values in silage. Total solids and total organic carbon (as C) ranged from 5,000 - 30,000 mg/L, and 1,000 - 10,000 respectively. For these two parameters, cornstalk test units produced the lowest concentrations, while maximum values continued to originate in the straw/manure test units.

Table 2. Mean chemical concentrations in leachate collected from trials 5 and 6.

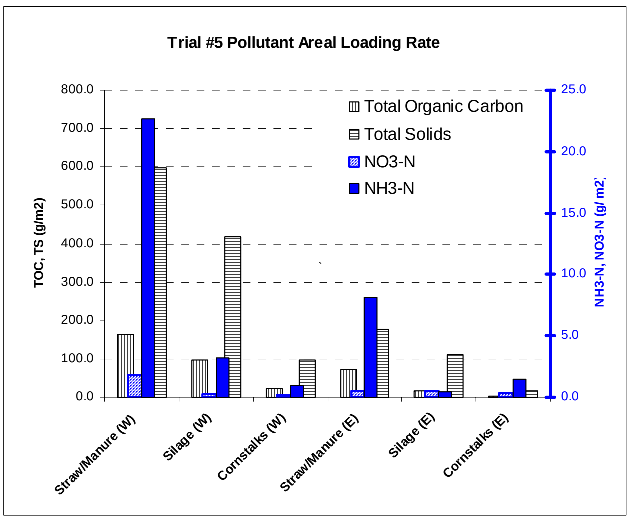
	Trial #	NO_3-N (mg/L)	NH_3-N (mg/L)	Total Solids (mg/L)	TOC (mg/L)
Straw/Manure	**5**	99.1	1361.7	29348.5	10837.8
	6	267.5	478.1	28677.6	7137.9
Silage	**5**	38.9	186.0	15629.8	4230.1
	6	42.0	199.4	21209.6	5229.7
Cornstalks	**5**	64.1	301.4	4969.2	1319.9
	6	121.9	354.2	5677.3	986.1

Figure 3 shows pollutant mass loading rates (g/m^2) calculated from the leachate volume and pollutant concentration data. Release of total solids (dissolved + suspended) was similar for silage and straw/manure test units, but considerably higher than the mass of solids released by cornstalks.

Although total organic carbon concentrations in leachate can be quite high, organic carbon loading does not appear to contribute greatly to soil organic carbon content. Soils with 2%

organic matter content, for example, typically contain about 2000 g/m^2 of organic carbon in the top 15 cm of soil. At the estimated total organic carbon loading rates shown in Figure 3 (10-150 g/m^2) the mass of organic carbon in the topsoil would be increased by less than 8%.

With one exception, calculated nitrogen loading rates were low compared to typical nitrogen fertilizer application rates. Ammonia-nitrogen loading rates from 10 of the 12 test units in trials 5 and 6 were 5 g/m^2 or less, which is equivalent to 50 kg/ha (45 lbs/acre) of N and is well below the 140-170 kg/ha (120-150 lbs/acre) of N typically applied to corn fields. Two straw/manure test units in trial # 5, however, exhibited NH_3-N loading rates of 8 and 23 g/m^2 which are equivalent to 80 and 230 kg/ha of N respectively (71 and 205 lb/acre of N). Since the high N loading rates were observed only in the straw/manure test units, it is believed that they were caused by the cattle manure in these test units, and not by the carcasses. Nitrate-nitrogen loading rates were even lower — typically 1 g/m^2 or less for silage and cornstalks, and 2-3 g/m^2 for straw/manure test units.



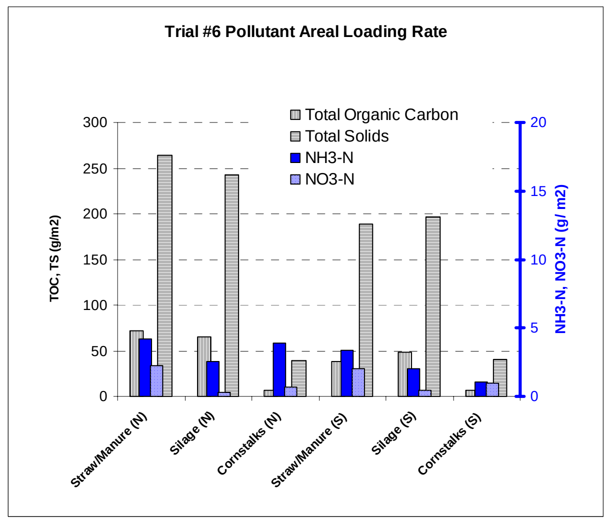


Figure 3. Calculated pollutant loading rates in soil beneath test units in trials 5 and 6.

Soil Contamination

Table 3 summarizes mean soil pollutant concentrations prior to composting, and Tables 4-8 summarize mean pollutant concentration increases (post-composting concentration – pre-composting concentration) and identify those cover materials and depth increments where statistical analysis indicates that the increases are significantly different ($p < 0.05$) from zero.

Total Carbon

As shown in Table 4, the only statistically significant ($p < 0.05$) increase in % total carbon occurred in the top 15 cm (0.5 ft) of soil beneath silage test units, where mean increases in % total carbon averaged 0.4. As indicated in Table 3, mean % total carbon concentrations at this depth prior to composting were about 2.4%, so the 0.4 increase is only 16% of pre-composting concentrations and does not appear to be high enough to cause undesirable environmental consequences.

Total Nitrogen

Like the % total carbon data, statistically significant increases in % total nitrogen (Table 5) were limited to the top 15 cm (0.5 ft) of soil. Unlike the total % carbon data, however, statistically significant increases in % total N were identified beneath cornstalk and straw/manure test units as well as beneath silage. Although not statistically significant, the magnitudes of the % total N increases beneath test units constructed with the soil/compost blend (N=2) or with leaves (N=1) were equal to or greater than those for ground cornstalks. Failure of these values to qualify as statistically significant is believed to be due primarily to the smaller number of trials resulting in higher estimated variability of the mean.

The statistically significant increases in % total N beneath are roughly equivalent to only 10% of pre-composting concentrations (0.21% or 2100 mg/kg) beneath cornstalk test units, but are nearly 40% of those beneath straw/manure and silage units. The 40% increases suggest that environmental consequences may result, but since total N measurements provide no indication of the chemical form or mobility of the N, their pollution-related consequences are difficult to predict.

Ammonia-Nitrogen

Analysis of ammonia-N concentrations (Table 6) indicated statistically significant ($p< 0.05$) increases at depths of up to 90 cm (3 ft) beneath test units constructed with silage or leaves, and up to 30 cm (1 ft) beneath straw/manure test units. These increases — which range from 200 – 800 mg/kg in the top 15 cm of soil — are 40-160 times the mean NH_3-N concentration in the top 15 cm of soil prior to composting (5.2 mg/kg), and are roughly equivalent to N application rates of 360 – 1440 kg/ha.

While the above NH_3-N additions are high, their environmental impacts on shallow groundwater will depend on several mitigating factors. Depending on soil pH, part of the ammonia-N will be in the form of ammonia gas which, since the bulk of the ammonia is in the upper 30 cm of soil, will volatilize into the air above the composting site after the overlying compost has been removed. Ammonia volatilization could also be enhanced by tilling the topsoil during dry weather to increase soil exposure to air.

A portion of the total ammonia in the soil also will exist as ionized ammonia (NH_4-N^+) which is readily adsorbed by the cation exchange capacity of the soil, thereby reducing leaching potential. The effect of this mechanism is further exhibited by the ammonia data in Table 6 which shows no statistically significant increases in ammonia at depths below 90 cm.

Nitrate-Nitrogen

To complete the picture regarding potential nitrogen pollution risks to shallow groundwater, the data in Table 7 show increases in soil nitrate-nitrogen (NO_3-N) that occurred during the composting process. Statistically significant ($p<0.05$) increases in NO_3-N concentrations that were 3-20 times the pre-composting concentrations (6-12 mg/kg) were identified beneath test units constructed with the soil/compost blend. No statistically significant increases, however, were identified beneath test units constructed with cornstalks, silage, straw/manure, or leaves. Furthermore, at all depths from 0 – 120 cm beneath silage and straw/manure test units, and at two depths beneath leaves, the data indicate small (not statistically significant) decreases in mean soil nitrate-N concentrations.

The lack of significant increases in soil NO_3-N (with exception of soil/compost blend test units) indicates that little nitrification of ammonia-N took place in the topsoil beneath the emergency composting units during the 12 month composting period. This may have resulted from suppression of nitrifying organisms in the topsoil caused by chemicals contained in the leachate, or the relatively wet and compacted layer of compost at the base of each test unit may have restricted movement of O_2 into the topsoil. This raises some potential environmental concerns since removal of the compost and subsequent movement of oxygen into the upper soil layers may lead to nitrification and subsequent movement of nitrate-nitrogen into the soil profile or shallow groundwater.

The cause of the high soil NO_3-N concentrations beneath test units constructed with the soil/compost blend is unknown. The soil/compost blend was produced by composting highly carbonaceous campus yard wastes (leaves, grass, chopped wood waste, etc.) that had been mixed with dairy manure from the ISU dairy farm. If excess manure was added to the initial compost mixture the resulting soil/compost blend may have contained relatively high NO_3-N concentrations prior to addition of the cattle carcasses.

A practical assessment of the environmental acceptability of nitrogen-related soil and groundwater pollution risks associated with emergency composting must also consider the likely impacts of other on-farm mortality disposal alternatives. When compared with the groundwater pollution potential of burial — the most common on-farm emergency disposal method — the nitrogen-related groundwater pollution risks described above appear to be much lower. Calculations based on the typical N content of animal meat and bone tissue indicate that the four 450 kg carcasses placed in each test unit contained a total of about 40 kg of N. Based on the increases in % total N shown in Table 5, the mean mass of total N added to the soil beneath the cornstalk, silage, and straw/manure composting test units were 4.2, 9.8, and 6.4 kg respectively, or about 10-25% of the total N that would have gone into the soil had the carcasses been buried. Not only would the total mass of N placed into the soil by burial have been 4 – 10 times greater than that imposed by composting, but the N from burial also would have been placed much closer to the groundwater since most burial occurs at depths of 6 feet or greater. With these facts in mind, it would appear that the risks of shallow groundwater pollution caused by composting are considerably less than those posed by carcass burial.

Chloride

As shown in Table 8, statistically significant increases in chloride concentrations in the soil were identified at nearly all depths from 0 - 120 cm beneath test units constructed with ground cornstalks, silage, straw/manure, and the soil/compost blend. Soils beneath test units constructed with leaves showed no significant increases in chloride in any depth increment.

Chloride increases were greatest in the top 15 cm of soil, ranging from 1.4 – 5 times the mean pre-composting chloride concentration (55 mg/kg) at this depth. At the 90-120 cm depth interval the increases in chloride were slightly less than the pre-composting concentrations (22 mg/kg).

Chloride is widely distributed in the environment in the form of mineral salts. It is not considered a serious water pollutant, but since it is not absorbed by the soil or converted to other chemical forms by soil microbes it is often used as an indicator of water movement. In this case, the significant increases in soil chloride concentrations at depths of 120 cm provide evidence that leachate from the composting process penetrated to this depth even though pollutants of greater concern in the leachate were retained at shallower depths. This emphasizes the importance of careful siting and construction of composting operations, particularly when groundwater or bedrock are near to the surface of the ground.

Soil pollutant loading rates predicted from measurements of leachate volume and pollutant concentrations are considerably lower than the loadings indicated by pollutant concentrations measured in the soil cores. This may have resulted from inaccurate measurement of leachate volumes, loss of chemical pollutants from the leachate, or a combination of these mechanisms.

Loss of volatile compounds, such as ammonia, from collection vessels while in the field is believed to be the most likely source of this discrepancy.

Table 3. Composting-related contaminants in top four feet of soil prior to composting **(N=108)**.

Depth Interval(cm/ft)	Total Carbon (%,d.b.)	Total Nitrogen (%,d.b.)	Chloride (mg/kg, d.b.)	Ammonia-N (mg/kg, d.b.)	Nitrate-N (mg/kg, d.b.)
0-15	2.40±0.69	0.21±0.04	55.0±33.0	5.2±5.1	12.5±9.4
15-30	2.16±0.78	0.18±0.04	56.2±30.5	3.2±2.6	8.4±6.7
30-45	1.41±0.68	0.12±0.03	58.5±38.0	2.9±1.8	6.4±6.7
45-600	0.91±0.70	0.08±0.03	50.9±48.2	2.5±1.5	6.0±6.4
60-90	0.97±1.03	0.04±0.03	25.6±20.3	1.8±1.4	6.5±7.1
90-120	1.20±0.97	0.03±0.02	21.8±15.2	1.6±1.3	7.1±6.7

Table 4. Increase in % total carbon in soil beneath composting test units.

	Change in % total carbon (post composting – pre-composting) (% dry basis)				
Depth interval (cm/ft)	Corn stalks (n=36)	Silage (n=36)	Straw/manure (n=24)	Soil compost blend (n=8)	Leaves (n=4)
0-15	-0.18±0.83	0.42±0.56*	0.18±0.93	-0.08±0.68	0.27±0.25
15-30	-0.06±0.91	0.23±0.69	-0.02±0.87	0.14±0.39	0.15±0.38
30-45	-0.22±0.93	0.24±0.65	0.22±0.72	0.62±0.57	-0.0001±0.42
45-600	-0.17±1.02	0.17±0.74	0.19±0.87	0.50±0.53	-0.16±0.68
60-90	-0.31±0.77	-0.36±0.95	0.11±1.13	0.16±0.43	0.29±0.49
90-120	-0.27±1.04	-0.08±0.91	0.10±1.18	0.48±0.56	0.32±0.89

* Starred and highlighted cells indicate that tabulated increase is significantly different from zero ($p<0.05$)

Table 5. Increase in % total nitrogen in soil beneath composting test units.

	Change in % total nitrogen (post composting – pre-composting) (% dry basis)				
Depth interval (cm/ft)	Corn stalks (n=36)	Silage (n=36)	Straw/manure (n=24)	Soil/compost blend (n=8)	Leaves (n=4)
0-15	0.02±0.05*	0.08±0.06*	0.09±0.05*	0.02±0.03	0.04±0.05
15-30	0.01±0.05	0.02±0.04	0.005±0.02	0.01±0.03	0.02±0.06
30-45	0.01±0.05	0.02±0.03	-0.005±0.02	0.03±0.03	-0.01±0.02
45-60	0.002±0.03	0.02±0.03	-0.005±0.02*	0.02±0.02	-0.01±0.03
60-90	0.01±0.02	0.006±0.02	-0.008±0.03	0.03±0.02	0.006±0.01
90-120	0.002±0.03	-0.008±0.01	0.002±0.01	0.02±0.02	0.005±0.01

* Starred and highlighted cells indicate that tabulated increase is significantly different from zero ($p<0.05$)

Table 6. Increase in ammonia-N concentrations in soil beneath composting test units.

	Change in ammonia (post composting – pre-composting) (mg/kg dry basis)				
Depth interval (cm/ft)	Corn stalks (n=36)	Silage (n=36)	Straw/manure (n=24)	Soil/compost blend (n=8)	Leaves (n=4)
0-15	301.8±376.9*	597.2±563.0*	795.8±496.8*	218.7±360.2	607.7±574.5*
15-30	41.5±60.2	161.5±228.0*	125.1±245.2*	18.3±21.7	250.5±359.3*
30-45	4.8±11.2	51.2±110.7*	14.1±26.7	0.9±2.5	602.9±882.6*
45-600	4.0±13.5	33.2±126.0*	3.7±5.8	0.2±1.5	107.3±211.9*
60-90	0.7±6.2	13.4±50.1*	1.5±3.8	-0.1±0.6	33.6±65.6*
90-120	2.5±14.1	3.3±10.1	0.4±0.9	-0.1±0.4	2.1±3.6

* Starred and highlighted cells indicate that tabulated increase is significantly different from zero (p<0.05)

Table 7. Increase in nitrate-N concentrations in soil beneath composting test units.

	Change in nitrate (post composting – pre-composting) (mg/kg dry basis)				
Depth interval (cm/ft)	Corn stalks (n=36)	Silage (n=36)	Straw/manure (n=24)	Soil/compost blend (n=8)	Leaves (n=4)
0-15	2.8±28.7	-6.4±11.3	-6.9±11.1	45.4±85.2*	10.8±29.8
15-30	6.2±29.1	-6.6±3.9	-5.7±6.5	91.7±104.5*	-1.9±16.7
30-45	7.6±25.6	-4.3±2.5	-4.0±6.6	136.7±152.5*	5.5±18.0
45-600	7.2±23.8	-3.4±4.1	-3.5±6.9	109.0±112.2*	10.1±20.6
60-90	3.7±22.6	-4.2±4.5	-4.0±6.9	52.3±46.5*	4.7±12.2
90-120	1.1±14.8	-4.4±4.5	-5.6±7.9	18.8±27.6*	-7.4±3.9

* Starred and highlighted cells indicate that tabulated increase is significantly different from zero (p<0.05)

Table 8. Increase in chloride concentrations in soil beneath composting test units.

	Change in chloride (post composting – pre-composting) (mg/kg dry basis)				
Depth interval (cm/ft)	Corn stalks (n=36)	Silage (n=36)	Straw/manure (n=24)	Soil/compost blend (n=8)	Leaves (n=4)
0-15	79.2±71.3*	121.8±60.5*	257.4±92.1*	148.6±82.0*	31.9±77.6
15-30	47.4±41.7*	68.7±50.6*	145.3±59.4*	166.8±72.9*	11.8±41.5
30-45	18.7±28.3	32.2±46.6*	72.3±43.9*	142.4±87.8*	23.3±55.8
45-600	31.8±74.1*	14.2±56.7	35.1±25.2*	112.4±86.4*	-57.2±22.7
60-90	25.0±49.6*	24.6±23.4*	23.0±26.6*	67.8±66.7*	-34.1±20.3
90-120	16.5±39.7*	13.3±17.2*	14.8±15.2*	27.8±35.6*	3.7±1.8

* Starred and highlighted cells indicate that tabulated increase is significantly different from zero (p<0.05)

Impacts on Crop Growth

Following dismantling of all test units, soybeans were no-till planted on the project research site in the spring of 2005. As shown in photos taken at the end of the growing season (Figure 4), areas formerly occupied by composting test units exhibited very poor soybean emergence. This may have been caused by chemical contamination of the topsoil, or possibly by compaction. Current literature suggests that sensitive agricultural crops can tolerate chloride concentrations in soil of 350 mg/kg. Since chloride concentrations in the topsoil beneath most composting test units were less than 300 mg/kg (USDA-ARS, 2006), it appears unlikely that the poor soybean emergence was caused by chloride in the topsoil. High concentrations of ammonia in soil are widely recognized as detrimental to seedling emergence and root growth (Brittoe and

Figure 4. Suppressed soybean growth exhibited in areas previously covered by mortality composting windrows.

Kronzucker, 2002, Dowling, 1998). Some literature suggests that soybeans may be among the more sensitive crops to ammonia injury, and that the injury threshold may be in the range of 200-400 mg/kg which is at or well below the concentrations identified in topsoil beneath the composting test units. The adverse impact on crop emergence may have been further exacerbated by use of no-till planting. Had the soil been tilled prior to planting some ammonia-nitrogen would have been lost to volatilization or nitrification, surface compaction would have been reduced, and deeper soil with lower pollutant concentrations would have been mixed into the contaminated topsoil, thereby potentially reducing the adverse effects of phytotoxic chemicals in the topsoil.

Conclusions

Leachate Quantity and Quality

Leachate monitoring results suggest that the mortality composting piles have low potential to impact surface water or shallow soil or groundwater. Due to the relatively high porosity and water holding capacity of the cover materials evidence of runoff from the composting windrows was rarely noted. Mean contaminant concentrations within leachate captured at the base of test units in trials 5 and 6 ranged from 42-267, 199-1,361, 4969-29,348, and 986-10,837 respectively for NO_3-N, NH_3-N, total solids, and TOC (total organic carbon) with the highest concentrations consistently originating in straw/manure test units.

Due to high water holding capacity and ability to temporarily absorb and subsequently evaporate water, the amount of leachate released by the test units was less than 5% of the precipitation (500-600 mm) that fell on them throughout the year. As a result, the total mass loading of chemical contaminants into the soil beneath the windrows appeared to be relatively low in most cases. Organic carbon loadings from leachate were calculated to be less than 8% of the estimated total carbon in the top 15 cm of soil, and NH_3-N loadings were generally less than 40 kg/ha (35 lb/acre) although in one instance the NH_3-N loading was calculated to be equivalent to 188 kg/ha (170 lb/acre).

Soil Pollution

Statistically significant increases in chloride were observed in nearly all depth increments of soil cores collected beneath composting test units constructed from silage, cornstalks, straw, and soil/compost blend. These increases were moderate, ranging from 1.5-5 times pre-composting concentrations in the top 15 cm of soil, and 0.60 - 1.2 times pre-composting concentrations in the 90-120 cm depth interval.

Statistically significant increases in % total carbon, and % total nitrogen were limited to the top 15 cm of soil. Increases in % total carbon were found only beneath silage test units, while significant increases in % total nitrogen occurred beneath silage, cornstalk, and straw/manure test units. Again, the increases in these pollutants were moderate, amounting to less than 20% of pre-composting concentrations of % total carbon, and 10-40% of % total N concentrations prior to composting.

Increases in ammonia-nitrogen appeared to pose the most significant soil pollution hazard. Statistically significant increases in total ammonia-nitrogen were noted at depths of up to 90 cm beneath test units constructed with silage or leaves, and at 30 cm and 15 cm depths respectively beneath test units constructed with straw/manure and cornstalks. Unlike the increases in chloride, carbon, and total nitrogen, the ammonia-nitrogen additions were very large ranging from 200 – 800 mg/kg in the top 15 cm of soil. These are 40-160 times the pre-composting levels of ammonia in the topsoil, and are equivalent to fertilizer or manure nitrogen applications of 360 – 1440 kg/ha.

With the exception of the soil/compost blend (a material judged unsuitable for mortality composting for a variety of reasons), no significant increases in nitrate-nitrogen occurred beneath the mortality composting test units. High residual concentrations of ammonia-nitrogen in the topsoil following composting, however, would ultimately be expected to nitrify following removal of the finished compost from the disposal site. This could lead to subsequent nitrate pollution of the subsoil or shallow groundwater. Further monitoring of soil N at the composting research site is recommended to better understand the dynamics of ammonia dissipation in the soil, and to evaluate mitigation measures that can help to minimize groundwater pollution risks.

When compared with the groundwater pollution potential of carcass burial — the most common on-farm emergency disposal method — the nitrogen-related groundwater pollution risks associated with composting appear to be much lower. The total mass of N contained in the composted cattle carcasses was 4–10 times greater than the increases in N that were measured in the soil beneath composting test units. Furthermore, burial would have placed the carcass N much closer to the groundwater, further increasing the risks of groundwater pollution.

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