

ROADKILL CARCASS COMPOSTING

Guidance Manual



November 2007

Montana Department of Transportation



Starting a Road Kill Compost Facility

Before any composting project can begin, MDT must obtain a license from the Department of Environmental Quality (DEQ) Solid Waste Program. Roadkill Compost Operations are considered to be a Small Composter Waste Management Facility. Currently, there is no fee required to compost road kill. DEQ will maintain a database of our composting facilities to track their progress and to answer questions from MDT and the general public. The licensing process requires a 30 day public comment period after the Environmental Assessment (EA) is completed. The license application and the list of neighbors should be complete to expedite the process. Licensing questions can be directed to the Hazardous Waste Section of MDT's Environmental Services Bureau (Cora Helm, 406-444-7659, Pat Driscoll 406-444-7223). License application forms are available online from the DEQ website at: <http://www.deq.mt.gov/SolidWaste/newapplications/compost.pdf>.

Supervisors and staff considering undertaking this process should visit another MDT facility that is composting road kill to see if it is right for their area of operations and to gain tips on proper facility operations.

Coordination with DEQ is essential for the success of these projects. DEQ also has the authority and responsibility to inspect all waste management facilities in Montana, so expect visits (inspections) from the Solid Waste Program of DEQ. DEQ can also be called upon for license application assistance or help with operational problems. This Guidance Document may be referenced in the license application as the general plan of operations required by the DEQ, but does not have to be submitted to the DEQ as part of the license application since they already have the document. Any changes or site-specific modifications need to be mentioned in the application.

MDT picks up road kill off the highways under an agreement with the Montana Department of Fish, Wildlife, and Parks (FWP), so they are also involved in the process. MDT is currently in negotiations with FWP and the DEQ on the final use of the composted materials. Compost reduces the number of trips required to landfills and reduces the amount of material MDT must place in the landfills. The hope is that MDT can use the compost for local road stabilization projects.

All three agencies are cooperating to protect the environment and reduce costs to the taxpayers.

Location

Site location is critical to the licensing and operation of these facilities. Find a well-drained site with minimal slope, at least 200 feet from waterways and wetlands and 100 feet from residences. Compost site should be set back at least 100 feet from the property line. Siting should consider prevailing wind direction and aesthetic impact on neighbors and passersby. The more remote the site, the better. Objections from neighbors have caused MDT to withdraw two license applications because, above all, MDT prides itself on being a good neighbor.

The original MDT site at Victor was located within about 500 feet of neighbors, but being well operated and out of sight, was run without any complaints for a year as an experiment. During the licensing process the neighbors were notified and complained to DEQ about potential odors, etc., but all complaints stopped when they were informed that the experimental site had been in operation for a year and they were allowed to tour the site. The neighbors were not even aware of the operation while about 700 deer had been composted.

The General Theory

Composting is an organic degradation process under controlled conditions. The MDT process is much like building a sandwich with road kill in the middle that will cook themselves into compost. On the bottom you need a plate to work on and hold the sandwich (base of bin). This is followed by a layer of material to absorb any leakage, a layer to allow air circulation, a layer of composting materials and the deer, and finally a layer of air circulation/odor control materials and the sandwich is complete. (See the diagram on page 11.) Cook, turn, heat again, and the compost is ready for curing.

Because it is an organic process, the bacteria and other microorganisms that make the compost have to be supplied with the right elements for life. A proper balance of carbon to nitrogen in the food is essential. The road kill supplies the nitrogen, so a carbon source like wood chips or partially finished compost, must be added to maintain the balance. All living things also need water and warmth to thrive. This is the reason piles are managed differently in the summer and the winter. Water is added to the piles in the summer when they have a tendency to dry out, and warm compost is used in the winter to start the piles off. Once the piles are going, they are self-heating. The bacteria that produce odor-free compost need air to thrive. Without oxygen, other bacteria take over the degradation process and the smell of rotting meat is the result. Turning the piles provide the needed oxygen.

What You Need at a Site

- Composting material (finished compost, woodchips, sawdust, straw, or combination of materials) – see material types below
- Starter compost material. This can be commercial compost for initial start up or material from a pile that has not been screened for final use.
- 3-4 foot long compost thermometer
- Supply of water, preferably a water tank on site with a hose so you can spray the pile and/or bulking material. In the summer, the truck used to apply magnesium chloride deicer has proven to be an effective water addition tool, especially when used with a water injector,
- A water injector, if water is available from a hose or a pump. See the design later in this document.
- Loader
- Jersey barriers for making the bins
- Millings to prepare the surface of the bins
- Latex or vinyl gloves for handling material
- Composting log book or log sheets. (An example log sheet is provide in this guidance manual.)

Material Types

- Moisture Absorbers—Sawdust is most commonly used, but straw, wood chips, or older finished compost may be used.
- Air Circulation Materials – Materials used at the base of the pile to encourage air circulation, absorb excess moisture, and serve as a marker for turning. Examples include: wood chips, shrub and tree grindings/chippings, coarse compost, or straw.
- Composting Materials – Carbon-rich materials used to compost the carcasses. Examples include: sawdust, straw, spoiled hay, raw compost, and shrub and tree grindings/chippings.

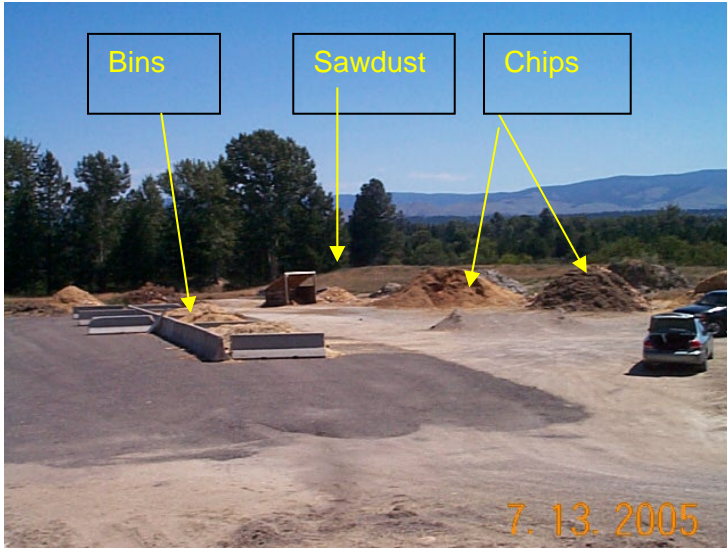
- Odor Absorption Materials – Used to absorb potential odors, control moisture, prevent wind erosion, and insulate pile. Usually wood chips, but coarse compost has been used.

Some Notes on Materials

- Multiple functions—Some materials can serve multiple functions. Wood chips and grindings are the most versatile, followed by coarser compost.
- Compost—Compost produced in this process can be re-used to compost more deer. After the first pass through the bins, the material is still coarse and contains abundant carbon for the process. Once compost has been re-used several times it becomes a rich, dark, loamy material. At this point, the material should be stockpiled for reclamation activities.
- Hay and Straw Bales.—Straw and hay are baled to provide easy collection and material preservation. The baling process compacts the materials into air-tight layers. Unless the flakes are broken up or chopped, good air circulation is impossible.
- Wood chips and grindings—A good source for these materials are the companies that do power line maintenance or local landscaping firms. Using this material diverts yet another source of waste from landfills.

Basic Pile Construction

- Prepare a hard, flat surface (the plate for the sandwich), such as paved asphalt, concrete or compacted millings. Hard ground works too.
- Have an adequate supply of composting materials on-site prior to moving carcasses to the pile.
- Build the bins – see discussion under “Sizing Bins.” Start the bin with a center section of 6 Jersey rails. Individual bins are built by placing additional Jersey rails at about 10 foot intervals on either side of the central rail. Bins will be for the amount of animals you receive in one week and will be separated by a section of Jersey rail. Add sections to the back as needed (see diagram and pictures). About six bins will be needed per side.
- Lay a 6 inch foundation of Moisture Absorbers, followed by a layer of Air Circulation Materials 18 to 24 inches thick in the bottom of the bin. Ensure the base is large enough to allow for 2-ft clearance around the piles. Lay animals in center of bed, back to back in a single layer on the pile. It may be challenging to lay the deer back to back when using a loader, but this configuration will aid in achieving higher compost temperatures. The primary objective is to make sure the deer are in close proximity to each other in order to get the piles to heat up. It may be adequate to simply lay the carcasses on the pile and whack them a few times with the loader bucket.
- Completely cover and surround carcass with at least 6 inches of damp, high-carbon material, such as wood chips or deer compost. For the initial piles, use the commercial compost as a starter material.
- **ANIMALS MUST BE COVERED DAILY.**
- Place an additional layer of carcasses as before and cover with six-inches of compost.
- Leave 6-12 inches between edge of pile and walls of bin
- Cover topmost layer with 12-24 inches of Odor Absorption Material or finished compost.
- Take notes of EVERYTHING YOU DO! See section on “Logbook Notes” below.



Victor, MT

Bins placed on asphalt millings. Stockpiles conveniently located for easy access. This facility has been in operation for 3 years with no complaints from the neighbors. Photo taken shortly after start up.

Warm Weather Operations (Spring, Summer, and early Fall)

- Check temperature as per the temperature section.
- Check for moisture and add water if necessary.
- Estimated time for first turning is 30 to 45 days.
- Bins with larger animals, such as moose, elk, or bison will take longer to drop in temperature and be ready for initial turning.
- Bins with large numbers of animals make take longer, too.
- Add water before turning.
- Place 12 to 24 inches of Air Circulation Material in the bin opposite the bin to be turned.
- Turn the pile from the initial bin into the bin behind it using the loader. This aerates the pile.
- Piles should be turned from the top of the bottom coarse layer and up. This gives the operator sufficient distance to avoid disturbing the bin floor and introducing unwanted material into the compost (such as millings).
- If an additional bin is not available, piles may be turned in place.
- Cover with 12" of Odor Absorption Materials
- Make a new pile of carcasses in the primary bin. If you have a completed pile, i.e material that has been through one turning and two heating cycles, re-use the compost for the new pile.



Chip Delivery from Power Line Clearing Contractor

Contractors are happy to find a place for their chips which they would otherwise have to send to a landfill.

Cold Weather Operations (Late Fall and Winter)

- You can compost in the winter – active piles will continue to heat in the winter. New piles should not be started during the winter unless active, hot compost is available as a composting agent. Smaller piles may not reach ideal temperatures in winter.
- Preparations for winter operations should be done in the late fall when temperatures consistently drop below freezing.
- Instead of turning the piles into the adjacent bin, piles ready for turning should be placed in a larger stockpile so that warm compost is available for winter use.
- This stockpile can be insulated with a 12 inch layer of wood chips/grindings.
- In the winter the foundation layer is built as before but the animals are bedded in a layer of the warm compost. The thickness of the six-inch compost layers should be increased to one foot and the first turning material should be used for the top and bottom layers of composting agent also. The top layer can be covered with additional chips if needed for insulation or erosion control.
- Odor Control materials are added to the top of the pile for insulation.
- New carcasses should not be allowed to freeze, if possible, and should not be added to a pile that has dropped below 60°F.
- Compost pile must be large enough to be self-insulating – a thick layer of bulking agent between the carcasses, floor and walls will insulate microbial activity from cold air.
- Do not turn the pile on extremely cold days
- If a warm stockpile is not available, use material directly from a bin that is ready to turn.
- If the bin does not heat as it should, be patient. The material will heat up as the weather warms.
- Water addition may be needed in the spring for reluctant bins.



February in Victor

154 degrees F in the bin.
Air Temperature 32 degrees F.

Note that the snow is gone from the surface of the pile.

Curing Pile

- Material that has been through one turning and two heat cycles may be placed in a curing stockpile to finish for about 30 days.

- You should see no flesh, and minimal amounts of hair should be visible. If flesh is still visible, the pile needs to go through another heat cycle. You must have documented at least three days at 130+ °F during the process.
- Completed compost will be a dark brown or black; it will have a soil-like texture and very little odor. Bones should be so brittle they are easily crushed. Significant amounts of wood chips may be present, but depending on the next use of the material, this may not be a problem.
- The curing compost can be used to start a new compost pile.
- After the material has cured for 30 days, it is ready for use. Prior to use on the right-of-way, the material may need to be screened, depending on the application and the amount of wood chips allowable. Individual large bones should be removed for aesthetic reasons prior to use.



Curing Pile at Victor

Some bones are visible, but the pile looks like a mulch with a large proportion of coarse wood chips. There are about 200 composted deer in this pile. The pile is about 8 feet tall.

Other Information:

Composting agents

- An ideal carbon to nitrogen ratio (C:N) is 40:1 for compost production. Carcasses are about 3:1. To offset the high nitrogen content of the carcasses, you want a material with a high C:N ratio. Sawdust has a C:N ration (weight to weight) of 450:1, whereas straw has a C:N ratio of about 80:1. Typical wood chips are about 500:1, but if leaves are added, as in power line trimmings, this may be substantially reduced, but the large volume added will make up the difference.
- You can also use finished compost as part of the composting agent in a new pile, which will inoculate the pile with microorganisms.
- In addition to choosing a composting agent with a high C:N ration, you want to choose one with a large enough particle size to allow for air flow, but not so much that it cools the pile.
- If wind erosion is occurring on the pile using sawdust, consider a top layer of coarser chips. The coarser materials will still allow water and air to pass into the pile while controlling wind erosion.

Temperature

- Temperature in the bin should increase to between 125° and 150° F within a week. Once pile reaches 125-130° F, it should remain there for at least a week. Most piles hold temperature at least this high for about two weeks and then gradually decline.
- If the pile does not achieve temperature and remain at the proper level, the most likely cause is insufficient moisture. Unless fluids are evident at the bottom of the pile, try water addition.
- Use a temperature probe (bimetal thermometer) with a four-foot extension. The probe should be placed so readings are taken 12"-36" from the top of the pile in areas where carcasses are located. During the initial trial, temperatures should be taken at several depths and locations in each cell.
- Alternately, you can use a continuous temperature monitoring device. A thermocouple probe, thermistor probe or similar device can be embedded in the compost pile. The device should be connected to a lead wire with a data logger, where temperature variations can be recorded over a period of time.
- For pathogen reduction, it must be shown that the carcasses achieved a temperature of 131°F or greater for 3 consecutive days. **It is very important, when first starting this process, to record these high temperatures on your log sheets.**
- Leave the pile undisturbed until the temperature has subsided to about 115 degrees near the carcasses. After this first heat cycle, the pile is turned, introducing air to increase the aerobic activity. After the temperature subsides a 2nd time, the compost process should be finished and the material ready for curing.

Moisture

- Composting works best when the pile is sufficiently, but not overly moist. The amount of water you add depends on the moisture content of the bulking agent and the carcasses. You may find it easiest to water to the wood chips or recycled deer compost before adding them to the compost pile. A moisture content of about 55% is recommended, which is the point where a handful of material will just begin to stay together when squeezed. (Wear rubber gloves when squeezing compost).
 - Clearwater Junction reports that they water the compost weekly in the dry months at a rate of 50 to 75 gallons per bin to keep the piles active.
- If material falls apart when squeezed, it is too dry, 50% moisture or less. If free water drips from the squeezed material or if a film of water is left on the hand, then the material is too wet (60% moisture or greater). If the material is too wet, spread the material a bit and allow it to air dry, or mix the wet material with drier material to lower the moisture content before adding it to the compost pile.
- If the piles dry out (25-45% moisture), and if piles are too large, spontaneous combustion can occur. This has not been a problem at MDT facilities to-date.



Water Injector

The Columbus facility uses this device to water the interior of the compost piles.

Sizing the bins

- Bin size depends on the size of equipment used to turn the compost and the number and types of animals. Bin width should be at least twice the width of the bucket on the equipment you'll be using.
- Using the estimates in the Minnesota Dept of Ag document, we would need a bin anywhere from 1300 to 2000 ft³ to compost 400 carcasses/year at 120 lbs each. If we make the pile 6 feet high, then our 12 back-to-back bins need to be 16 feet wide (two Jersey rails) and 42 feet long (six Jersey rails). This design requires a total of 20 Jersey rails.

Logbook notes

Recordkeeping is very important and is a requirement of the composting permit. Keep log books and recordkeeping materials on-site or in the closest shop to make them available to the DEQ inspector.

- Record the number and type of carcasses added to the pile along with the date. If setting up multiple piles/bins, there should be a record for each bin.
- Record when bulking agent is added and what type of material is used (i.e., chips, dust, recycled compost).
- Record temperatures within the piles once/day.
 - this is especially important when starting up a facility to document how many days it takes to reach temperature and to document that 131 degrees F is maintained for 3 days. Once the process is established, recording temperatures can be reduced to a few days per week.
- Odors should be recorded. Indicate whether there are odors disseminating in the downwind direction, and if so, estimate how many feet downwind it is noticeable.
- Check moisture, record when water is added.
- Make note of when last carcass is added to the pile.
- Make note of critter-interest, other complaints, or modifications to the method. This information will be used to update this guidance manual.

- When notable animals are added to the pile, take high resolution digital photographs for use in presentations (e.g., bison, elk, moose, bear, horse). Put photos in share directory and notify the District and/or Environmental Services contact people.

Odors/pests/miscellaneous

- Control odors by having an adequate quantity of composting material around the carcass.
- If odors become a problem once a bin is full, add more Odor Absorption Material to the pile.
- A hot, active compost pile, adequately covered will reduce the potential to attract varmints.

Future Work

This guidance document is not intended to be the final word on road kill composting in Montana. The employees of MDT are innovative and will find ways to improve the process. Innovations like the water injection tool developed at Columbus are encouraged. The Environmental Services Bureau should be contacted before any significant changes are made to site operations. Changes to the Operations and Maintenance Plan at Solid Waste Management Facilities, such as these sites, must also be approved by the DEQ.

Acknowledgements

This Guidance Document was prepared under the direction of Ms. Cora Helm and Mr. Pat Driscoll of MDT Environmental Services Bureau. Review and assistance was provided by Mr. Pat Crowley, formerly of the Waste Management Section of the DEQ, now with Crowley Consultants LLC.

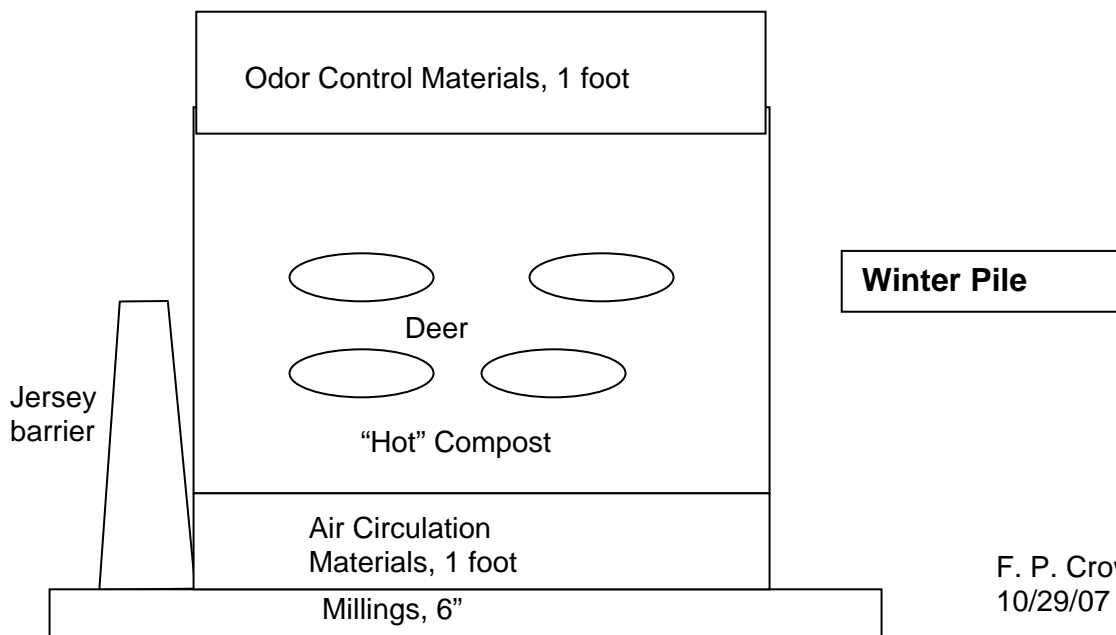
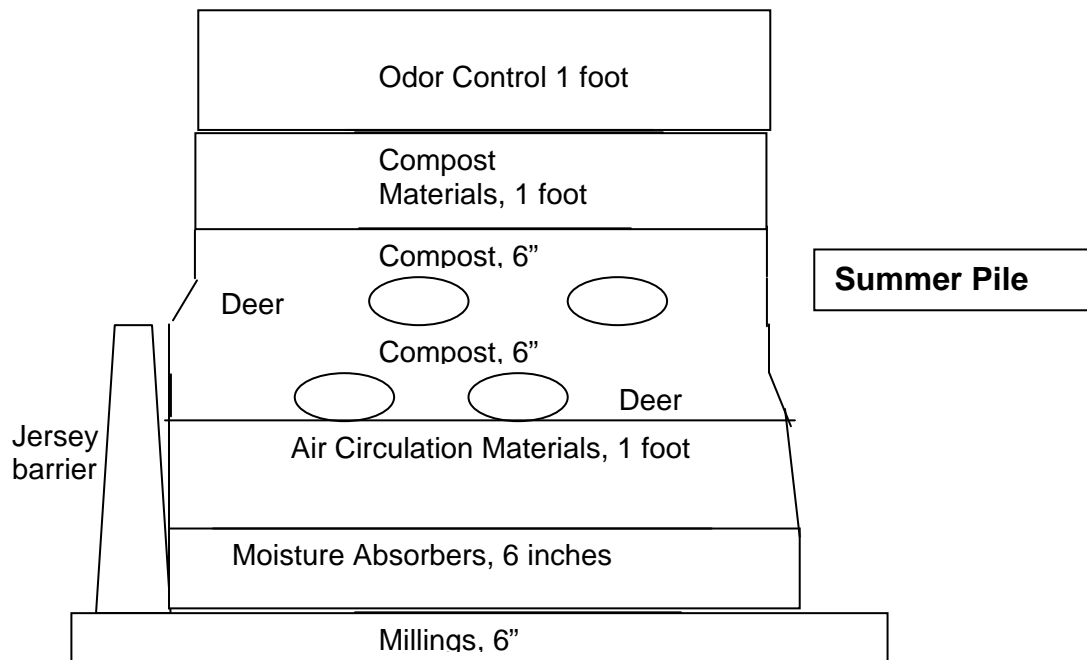
Special thanks go out to Doug Moeller and Scott Reesman for pioneering this process in Victor , to Chris Rasmussen of Columbus for developing the water injector, and to Bruce Friede at Seeley Lake for the cooperative effort and partnering with the Blackfoot Challenge at the Clearwater Junction Facility.

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**DEER COMPOSTING
LOG**

Date and Time	Number of Carcasses Added	Pile Temperature ¹	Air Temperature ²	Odor ³

¹ Temperature in Fahrenheit to be taken 12"-36" from top of pile near carcasses.
² Record outside temperature.
³ If odor is present, record how many feet downwind.



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10/29/07