Composting Roadkill
Research and Implementation by the Virginia Department of Transportation

BRIDGET DONALDSON AND DAVID WILSON

More than 1.2 million deer–vehicle collisions occurred in the United States in 2014. Removing and disposing of the deer carcasses and those of the millions of other animals killed in collisions with vehicles are essential services that transportation agencies provide.

According to a national survey in 2005, the 23 responding states predominantly managed roadkill with a combination of landfills and burial. Common shortcomings cited included the long travel distances to landfills, landfill restrictions, and a lack of viable burial areas (1).

Solution
In 2009, the Virginia Transportation Research Council (VTRC) began a series of research projects to evaluate the environmental implications of composting roadkill and the utility of the practice as an option for managing the carcasses in a way that protects the environment and passes regulatory review. VTRC evaluated three methods (Figure 1, below); the criteria and results are shown in Table 1 (page 48).

Compost Windrows
Researchers constructed windrows with deer carcasses placed side by side between layers of wood chips, a source of carbon. The absorbent, bulky quality of the wood chips helped to maintain the proper moisture levels and oxygen flow for composting, and the high carbon content balanced the high nitrogen content of the animal carcasses.

Virginia’s solid-waste management regulations aim to control the amount of leachate entering water sources from composting operations. Leachate is the product of precipitation that percolates through the compost and contains extracted or dissolved compost material. The VTRC researchers found that the
natural filtration through the soil reduced the leachate constituents to nominal concentrations (2). In addition, the windrows achieved high temperatures that quickly destroyed pathogens (Figure 2, below).

### TABLE 1 Evaluations of Compost Windrows and Vessels: Criteria and Research Findings

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Windrows</th>
<th>Vessels: Rotary Drum and Forced Air System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compost temperatures</td>
<td>150°F and higher; met EPA criteria for pathogen destruction</td>
<td>150°F and higher; met EPA criteria for pathogen destruction</td>
</tr>
<tr>
<td>Pathogens*</td>
<td>Confirmed destruction</td>
<td>Confirmed destruction</td>
</tr>
<tr>
<td>Leachate volume</td>
<td>2 percent of the precipitation that fell on the windrow plots left the piles as leachate.</td>
<td>Not applicable: leachate was contained.</td>
</tr>
<tr>
<td>Leachate contaminants</td>
<td>Filtration through soil reduced contaminants to nominal concentrations.</td>
<td>Not applicable: leachate was contained and recycled within the forced air system.</td>
</tr>
<tr>
<td>Operational performance</td>
<td>Not applicable: no operation required</td>
<td>Performed well with oversight and management</td>
</tr>
<tr>
<td>Plant germination and growth</td>
<td>Not tested</td>
<td>Plants grown with compost grew significantly larger by weight than those grown with soil.</td>
</tr>
<tr>
<td>Maturation time</td>
<td>11 to 12 months</td>
<td>2.5 to 4.5 months</td>
</tr>
<tr>
<td>Cost</td>
<td>Nominal—wood chips are free for some DOTs.</td>
<td>Ranges from $43,000 to $139,000, depending on vessel capacity; the forced-air system is the most expensive option evaluated but is cost-effective with sufficient carcass volume.</td>
</tr>
</tbody>
</table>

* E. coli, Salmonella, and ascarid ova (roundworm eggs).

**Low volumes of leachate are partly the result of the high absorption capacity of wood chips.**

**Compost Vessels**

Static compost windrows are economical and need little maintenance but require a large amount of space; if left unturned, the windrows produce mature compost in 10 to 11 months. The researchers therefore investigated rotary drum and forced-air systems, vessels that have smaller footprints and are designed to contain leachate; moreover, the compost matures relatively quickly.

Rotary drums operate with an electric motor that automatically rotates to aerate and mix the material. The drums also include an aeration system and wireless sensors for the temperature.

The forced-air system has two or more adjoining concrete containers—depending on the roadkill volume requirements for the area—and a three-walled, covered area for storage and curing. A mounted air pump forces air into the composting material through tubes in the container floor.

VTRC evaluated rotary drums and a forced-air system with the criteria listed in Table 1. The compost generated from both systems met all criteria, and with consistent management and oversight, the systems performed well from an operational perspective (3).

**Application**

The VTRC research established that the composting methods evaluated are effective and do not contaminate groundwater or surface water and do not spread pathogens. Virginia DOT and the state’s Department of Environmental Quality executed a joint memora-
Areas, and the area’s volume of carcasses, include the following:

Initiatives under way enhance the potential for greater savings from vessel composting, which replaces a lengthy drive to a landfill. Research found that a vessel can pay for itself if it increases the prospects for Virginia DOT to implement composting, the agreement promotes the reuse of material that otherwise would be placed in a landfill.

VTRC recently completed guidelines for composting, including detailed descriptions of materials, the steps, and the time and the temperatures needed to achieve compost maturity. The guidelines also include beneficial applications for the finished compost.

Virginia DOT currently has five compost vessels that serve 15 maintenance areas. The agency plans to increase windrow composting throughout the state and to locate several additional composting vessels strategically.

The compost method chosen for an area depends on the volume of roadkill and the availability of space. Forced-air composting is the most prevalent method in Virginia, because the technique can handle a large volume of roadkill within a relatively small footprint.

**Benefits**

Research found that the compost methods that were evaluated provide Virginia DOT with a much-needed and more efficient alternative to the current practices for managing roadkill. Composting provides a viable option in maintenance areas that have long travel distances to disposal facilities or that no longer have landfills accepting animal remains. Composting also offers environmental benefits, potential savings, and a practical end product.

In contrast with disposal at a landfill, composting animal carcasses saves valuable landfill space and decreases the volume of organic byproducts, which are known sources of methane, a greenhouse gas.

VTRC researchers expect to find substantial cost savings from windrow composting, which requires no investment for areas that have a free source of wood chips. The initial investment for a compost vessel ranges from $43,000 to $139,000, but researchers found that a vessel can pay for itself if it replaces a lengthy drive to a landfill. Efforts to enhance the potential for greater savings from vessel composting are ongoing. Initiatives under way include the following:

- Ensuring that the size of the vessel matches the area’s volume of carcasses,
- Pooling carcasses with other maintenance areas, and
- Applying finished compost in road projects.

Applications include compost blankets—a layer of composted material spread on the soil—and compost berms, which reduce erosion and stormwater runoff. Virginia DOT will use compost to establish vegetation for site restoration, aesthetics, or general landscaping.

For more information, contact Bridget Donaldson, Senior Research Scientist, Virginia Transportation Research Council, 434-293-1922; bridget.donaldson@vdot.virginia.gov.

**Acknowledgments**

The authors acknowledge Jimmy White, Audrey Moruza, Ed Wallingford, Robert Perry, and Ann Overton for their work on Virginia DOT’s roadkill composting program.

**References**


**Editor’s Note:** Appreciation is expressed to G. P. Jayaprakash, Transportation Research Board, for his efforts in developing this article.

Suggestions for Research Pays Off topics are welcome. Contact Stephen Maher, Transportation Research Board, Keck 486, 500 Fifth Street, NW, Washington, DC 20001 (202-334-2955; smaher@nas.edu).