

*Virginia Transportation Research Council*

# *research report*

An Assessment  
of the Animal Carcass Disposal  
Practices of the Virginia Department  
of Transportation and Guidance  
for the Selection of Alternative  
Carcass Management Options

[http://www.virginia.gov/vtrc/main/online\\_reports/pdf/10-r7.pdf](http://www.virginia.gov/vtrc/main/online_reports/pdf/10-r7.pdf)

BRIDGET M DONALDSON  
Research Scientist

AUDREY K. MORUZA  
Associate Research Scientist



**Standard Title Page - Report on Federally Funded Project**

1. Report No.: FHWA/VTRC 10-R7	2. Government Accession No.:	3. Recipient's Catalog No.:	
4. Title and Subtitle: An Assessment of the Animal Carcass Disposal Practices of the Virginia Department of Transportation and Guidance for the Selection of Alternative Carcass Management Options		5. Report Date: March 2010	6. Performing Organization Code:
		8. Performing Organization Report No.: VTRC 10-R7	
7. Author(s): Bridget M. Donaldson and Audrey K. Moruza		10. Work Unit No. (TRAIS):	
9. Performing Organization and Address: Virginia Transportation Research Council 530 Edgemont Road Charlottesville, VA 22903		11. Contract or Grant No.: 91889	
		13. Type of Report and Period Covered: Final	
12. Sponsoring Agencies' Name and Address: Virginia Department of Transportation      Federal Highway Administration 1401 E. Broad Street                              400 North 8th Street, Room 750 Richmond, VA 23219                                Richmond, VA 23219-4825		14. Sponsoring Agency Code:	
		15. Supplementary Notes:	
16. Abstract:			
<p>More than 54,000 deer-vehicle collisions occurred in Virginia from 2007 through 2008, the fifth highest number of all U.S. states, and the number of these incidents is increasing each year. Removing animal carcasses from the road and properly disposing of them is an essential service on Virginia roadways, and the Virginia Department of Transportation (VDOT) spent \$4.4 million on carcass removal and disposal work in 2008. Given the magnitude of animal-vehicle collisions in Virginia, some of the carcass disposal methods available to many VDOT maintenance areas are becoming increasingly impractical. On-site burial is becoming a less viable option for many maintenance areas as rural areas become more populated and concern for environmental quality increases. Yet driving the sometimes considerable distances to reach the nearest disposal facility is greatly inefficient in terms of time and labor. Because of such limitations that can increase costs to VDOT, many maintenance areas have an urgent need for viable and cost-effective alternative carcass management strategies.</p> <p>The purpose of this study was to investigate and recommend cost-efficient options that address the growing problem of carcass disposal. Carcass management methods investigated included on-site burial, disposal facilities, contracts for removal and disposal, incineration units, and composting. The results of a survey of VDOT maintenance area staff indicated that 77% use a disposal facility such as a landfill and nearly 50% of disposal facility users travel away from a routine maintenance route to access the facility.</p> <p>Cost models were developed to allow maintenance managers to evaluate costs incurred for various carcass management methods, and a decision tool was developed to guide the selection of the most suitable method. Implementing carcass management at VDOT maintenance areas may be a very effective approach for increasing labor efficiency. Compost windrows, or static-pile composting, is recommended as an easily managed technique that can be performed at the maintenance area. If only the portion of area headquarters that frequently use disposal facilities for carcass disposal were to replace this method with compost windrows, it is estimated that \$515,440 per year could be avoided or reallocated within the maintenance areas. When space for compost windrows is unavailable, an automatic compost vessel can also be a practical option.</p>			
17 Key Words: Animal carcass disposal, animal mortality management, animal composting, static-pile composting, windrow composting, compost vessel, roadkill disposal, animal incineration		18. Distribution Statement: No restrictions. This document is available to the public through NTIS, Springfield, VA 22161.	
19. Security Classif. (of this report): Unclassified	20. Security Classif. (of this page): Unclassified	21. No. of Pages: 44	22. Price:

**FINAL REPORT**

**AN ASSESSMENT OF THE ANIMAL CARCASS DISPOSAL PRACTICES  
OF THE VIRGINIA DEPARTMENT OF TRANSPORTATION AND GUIDANCE  
FOR THE SELECTION OF ALTERNATIVE CARCASS MANAGEMENT OPTIONS**

**Bridget M. Donaldson  
Research Scientist**

**Audrey K. Moruza  
Associate Research Scientist**

In Cooperation with the U.S. Department of Transportation  
Federal Highway Administration

Virginia Transportation Research Council  
(A partnership of the Virginia Department of Transportation  
and the University of Virginia since 1948)

Charlottesville, Virginia

March 2010  
VTRC 10-R7

## **DISCLAIMER**

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Virginia Department of Transportation, the Commonwealth Transportation Board, or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation. Any inclusion of manufacturer names, trade names, or trademarks is for identification purposes only and is not to be considered an endorsement.

Copyright 2010 by the Commonwealth of Virginia.  
All rights reserved.

## ABSTRACT

More than 54,000 deer-vehicle collisions occurred in Virginia from 2007 through 2008, the fifth highest number of all U.S. states, and the number of these incidents is increasing each year. Removing animal carcasses from the road and properly disposing of them is an essential service on Virginia roadways, and the Virginia Department of Transportation (VDOT) spent \$4.4 million on carcass removal and disposal work in 2008. Given the magnitude of animal-vehicle collisions in Virginia, some of the carcass disposal methods available to many VDOT maintenance areas are becoming increasingly impractical. On-site burial is becoming a less viable option for many maintenance areas as rural areas become more populated and concern for environmental quality increases. Yet driving the sometimes considerable distances to reach the nearest disposal facility is greatly inefficient in terms of time and labor. Because of such limitations that can increase costs to VDOT, many maintenance areas have an urgent need for viable and cost-effective alternative carcass management strategies.

The purpose of this study was to investigate and recommend cost-efficient options that address the growing problem of carcass disposal. Carcass management methods investigated included on-site burial, disposal facilities, contracts for removal and disposal, incineration units, and composting. The results of a survey of VDOT maintenance area staff indicated that 77% use a disposal facility such as a landfill and nearly 50% of disposal facility users travel away from a routine maintenance route to access the facility.

Cost models were developed to allow maintenance managers to evaluate costs incurred for various carcass management methods, and a decision tool was developed to guide the selection of the most suitable method. Implementing carcass management at VDOT maintenance areas may be a very effective approach for increasing labor efficiency. Compost windrows, or static-pile composting, is recommended as an easily managed technique that can be performed at the maintenance area. If only the portion of area headquarters that frequently use disposal facilities for carcass disposal were to replace this method with compost windrows, it is estimated that \$515,440 per year could be avoided or reallocated within the maintenance areas. When space for compost windrows is unavailable, an automatic compost vessel can also be a practical option.

## FINAL REPORT

# AN ASSESSMENT OF THE ANIMAL CARCASS DISPOSAL PRACTICES OF THE VIRGINIA DEPARTMENT OF TRANSPORTATION AND GUIDANCE FOR THE SELECTION OF ALTERNATIVE CARCASS MANAGEMENT OPTIONS

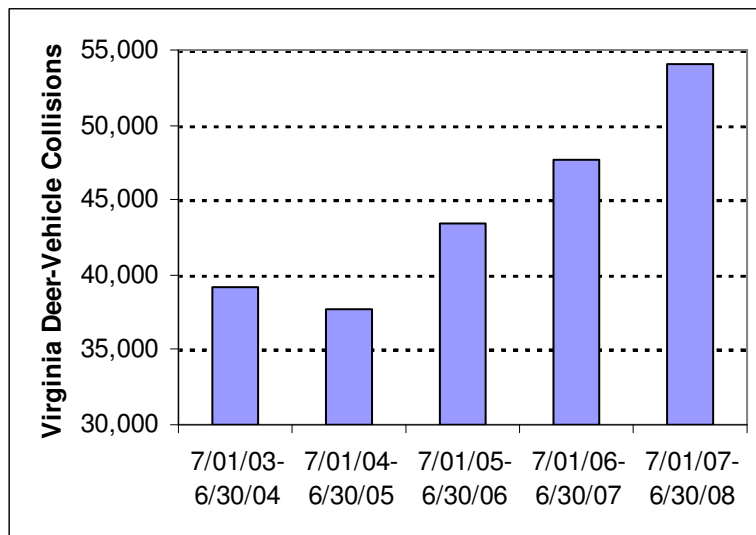
**Bridget M. Donaldson**  
Research Scientist

**Audrey K. Moruza**  
Associate Research Scientist

## INTRODUCTION

The increase of animal-vehicle collisions (AVCs) in the United States is drawing national attention. According to State Farm Insurance claim estimates, more than 54,000 deer-vehicle collisions (DVCs) occurred in Virginia from 2007 through 2008 (see Figure 1), the fifth highest number of DVCs of all U.S. states (M. Miles, personal communication). The DVC problem has intensified in recent years and will likely continue to do so as increased vehicle travel coincides with the growth in the population of white-tailed deer (*Odocoileus virginianus*) (Virginia Department of Game and Inland Fisheries, 2006).

Given the magnitude of AVCs in Virginia, carcass removal and disposal are important services on Virginia roadways. Removing carcasses from the road improves driver safety in



**Figure 1. Deer-Vehicle Collisions in Virginia 2003-2008.** Data for each year run from July 1 to June 30. The data were projected for the entire insurance industry based on State Farm's known auto insurance market share in Virginia. Estimates are based on accidents by drivers that have comprehensive and collision insurance; accidents by drivers with only liability insurance are not included (M. Miles, personal communication).

terms of preventing an additional vehicle accident resulting from a carcass being in the roadway and reducing the likelihood of scavengers entering the roadway. Carcass removal is also important in minimizing the risk of pathogens from entering the soil, groundwater, and streams.

The Virginia Department of Transportation (VDOT) is responsible for the removal and disposal of carcasses along the state's primary and secondary systems. Under Turnkey Asset Management Services (TAMS) contracts currently in effect, interstate maintenance in Virginia was outsourced as of July 2009. VDOT is therefore no longer directly responsible for carcass removal and disposal activities on the interstate system; however, 88% of police-reported deer crashes in 2007 were on primary (57%) and secondary roads (31%; A. Pearson, personal communication). Of the 54,000 estimated DVCs in Virginia in 2008 (M. Miles, personal communication), an estimated 47,600 occurred on VDOT-maintained roadways. This presents a significant effort in terms of labor and costs for removal and disposal, which will increase if the number of deer crashes in Virginia continues to rise.

The VDOT Maintenance Division's *Maintenance Best Practices* instructs that dead animals on the right of way be removed and disposed of at a landfill or rendering plant or composted at the closest area headquarters (AHQ) with such a composting facility (VDOT, 2008). VDOT's *Policy for Removing Dead Animals From VDOT Right-of-Way* adds that animals may be (1) buried along the roadway if allowed in that jurisdiction, (2) transported to incinerators for burning, or (3) carried back to the AHQ for placement into a special dumpster that will later be carried to an animal processing plant (VDOT, 1999). Under Virginia's Underground Utility Damage Prevention Act (*Code of Virginia*, Sections 56-265.14 through 56-265.32), the Miss Utility Notification Center must be contacted prior to any excavation (such as carcass burial), and there may be a 48-hour waiting period before excavation can proceed.

The burial of carcasses is also addressed under a Memorandum of Agreement between the Virginia Department of Environmental Quality (DEQ) and VDOT that is currently under review. The memorandum states that VDOT may bury occasional, individual, animal carcasses on the state right of way without acquiring a permit. It further maintains that "burial shall be conducted in a manner protective of human health and the environment, and that carcasses shall be covered with an adequate quantity of soil" and in accordance with any established VDOT best management practices.

The DEQ provides information on animal carcass management in a waste guidance memo entitled *On-site Composting of Routine Animal Mortality* (DEQ, 2009) written to address livestock mortality but that also applies to road-killed carcasses managed by VDOT. The memo provides a hierarchy of carcass management options that indicates DEQ's preference for environmentally sound animal carcass management in Virginia. The memo states that when feasible, animals should be disposed of in the following order: rendered (where portions of the carcasses can be reused as a product), composted (treated and reused), disposed of at a permitted landfill or incineration facility, or buried on-site.

The method of carcass management varies among VDOT maintenance areas, and the decision for using a particular method is often based on the accessibility and cost of a local landfill

that accepts carcasses (C. Jackson and J. White, personal communication). Evaluating the procedures and costs to implement alternatives could be valuable for VDOT maintenance areas interested in an efficient means of carcass management

With the number of AVCs increasing in magnitude in Virginia, some of the disposal methods available to many maintenance areas, such as disposal facilities and on-site burial of individual carcasses, are becoming increasingly impractical. On-site burial is becoming a less viable option as rural areas become more populated and there is increased concern for environmental quality. Yet driving the sometimes considerable distances to reach the nearest disposal facility is costly in terms of time and labor. Because of such limitations that can increase costs to VDOT, many maintenance areas may benefit from viable and cost-effective alternative carcass management strategies.

## **PURPOSE AND SCOPE**

The objectives of the study were to evaluate VDOT's current carcass management practices with regard to methods of disposal, identify and assess feasible alternatives, and provide a means for maintenance area managers to compare the associated effort and costs of their current carcass management methods to those of alternatives.

The carcass management methods investigated in this study included on-site burial, disposal facilities, the use of contracts for removal and disposal services, incineration units, and composting methods.

## **METHODS**

Five tasks were conducted to achieve the study objectives over the course of 1 year.

1. Survey VDOT maintenance area staff regarding their current means of carcass management.
2. Review VDOT's Financial Management System (FMS) for costs to VDOT districts associated with carcass management
3. Investigate the procedures for and costs of using incineration and composting as carcass management methods.
4. Develop a method to allow VDOT maintenance area staff to determine costs incurred for carcass management in order to compare them to the costs of other methods.
5. Illustrate cost scenarios using case studies from survey respondents, and create a decision tool to guide the selection of a carcass management method.



## **Surveys of VDOT Maintenance Area Staff Regarding Current Means of Carcass Management**

Two surveys were conducted to gain information regarding animal carcass management practices at VDOT maintenance areas. A letter was emailed to 48 VDOT residency administrators describing the purpose of and need for the study; it included a request that they respond with the names of their staff who would be most knowledgeable about the carcass management practices in the residency. The letter is provided in Appendix A. Thirty-three residency administrators responded and provided a total of 88 names of VDOT employees, primarily consisting of transportation operations managers (both maintenance supervisors and superintendents) of individual AHQs.

Survey questions for Survey 1 concerned the method of finding or learning of a carcass in the right of way, the method of disposal, the type of disposal facility (if any) used, the person-hours and costs related to carcass management, and satisfaction or problems with the current carcass management practices. In order to facilitate candid responses to the variety of detailed questions, Survey 1 responses were anonymous. The survey instrument is provided in Appendix A. The survey instrument was posted on an internal VDOT website, and a link to the survey was emailed to these 88 employees on October 20, 2008. Responses were requested by October 28.

Survey 2 was designed to determine the method(s) of carcass disposal used in each residency. (This could not be ascertained by Survey 1 because of its anonymity.) Survey 2 was conducted in April 2009; the same 88 AHQ employees that were sent Survey 1 were contacted via email or telephone (Appendix A). Because of the anonymity of Survey 1, it was unknown whether the respondents to the second survey were the same as the respondents to the first survey.

### **Review of VDOT's Costs Associated with Carcass Management**

VDOT's FMS database was examined for costs associated with carcass management. In this database, expenditures related to this activity are categorized as the "dead animal cost center" (cost center code 1116019). Specific expenditures within this cost center were examined to determine allocation of costs and trends for activities associated with carcass removal and disposal.

### **Investigation of Incineration and Composting as Carcass Management Methods**

Incineration and composting were investigated as possible VDOT carcass management methods. These two methods are the only forms of carcass disposal available to Virginia that VDOT is not currently using and that are acceptable to DEQ (DEQ, 2009).

#### **Incineration**

Incineration information was obtained by conducting two tasks:

1. Product information was obtained from three companies that distribute or manufacture incinerators: APC Products, Inc. (n.d.); Southern Breeze Fabrications, Inc. (n.d.); and Inciner8 International (n.d.). The former two supply incinerators for carcass disposal (primarily to farming operations and veterinary offices) throughout Virginia. The names of these companies were acquired by Internet searches and conversations with DEQ air permit professionals who had experience with incinerators. Information regarding the process and costs of incineration was gathered from product literature and conversations by telephone with sales representatives from each company.
2. Air quality staff at DEQ was contacted to obtain permitting information regarding incineration.

## **Composting**

Composting information was obtained by conducting five tasks:

1. A literature search was conducted by searching the computerized databases and websites containing general composting information and specific procedures regarding animal carcass composting.
2. Product information was obtained from the Ecodrum compost vessel manufacturer. VDOT waste management staff provided preliminary information on these vessels, which are unique in the compost vessel market in that they can accommodate and quickly compost large animal carcasses. Product information was also provided by telephone and email communication with Ecodrum representatives.
3. Based on information gained from the literature, a site visit was made to a composting facility in Hardy County, West Virginia, on May 20, 2009, to gather detailed information regarding the process, costs, and labor involved in carcass composting.
4. Waste management and water quality staff at DEQ was contacted for regulatory information regarding composting.

## **Development of Method to Determine Annual Costs of Carcass Management for Comparison Purposes**

Models were created to quantify the costs (e.g., miles driven in search and disposal of carcasses, number of animals removed, etc.) of each of the investigated management methods to allow VDOT maintenance managers to determine easily the annual cost associated with their area's process for carcass management for comparison with other methods they might choose to consider. The minimum and maximum ranges used to develop the calculations were based on VDOT survey responses regarding the average number of deer carcasses retrieved per month,

number of miles driven during carcass patrols and to carcass disposal facilities, and fees for carcass removal services (for those under contract for dead animal removal).

### **Illustration of Cost Scenarios Using Case Studies and Creation of Decision Tool for Selecting Carcass Management Methods**

Using the VDOT survey responses, cost scenarios were developed to reflect the costs that would be expended or saved if VDOT maintenance managers replaced their current method of carcass management with a different method. A decision tool was also developed to guide those who are dissatisfied with their current method of management in choosing a different method.

## **RESULTS**

### **Surveys of VDOT Maintenance Area Staff**

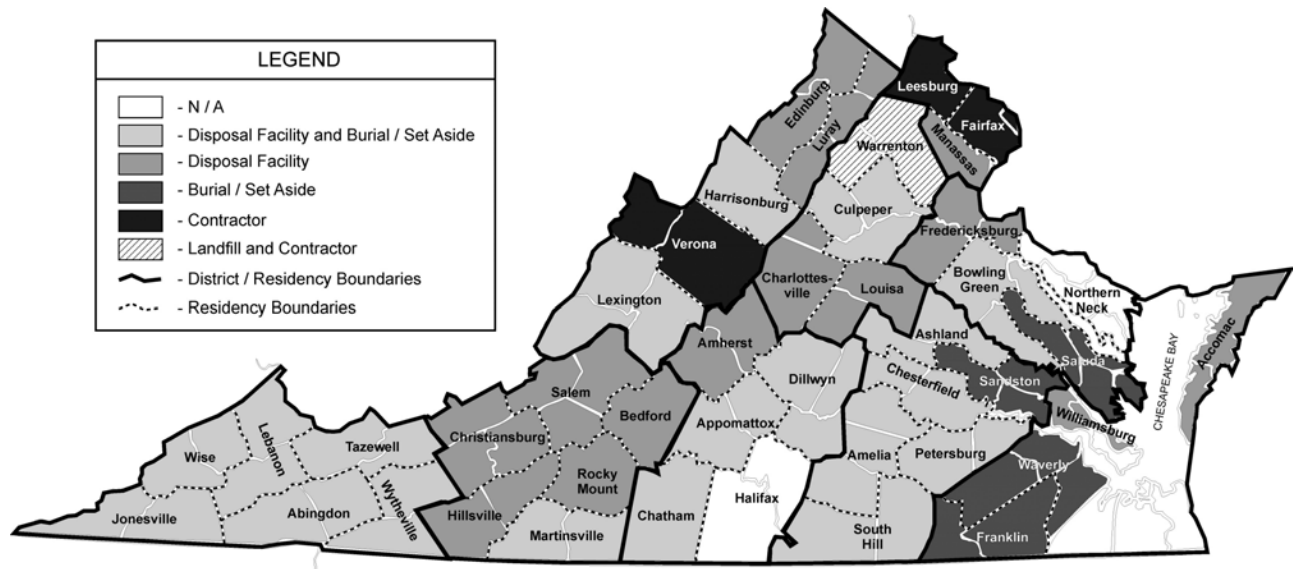
For both surveys, the response percentage for each question provided here is based on the number of responses to that question, as opposed to the number of respondents to the survey. For example, if 50 respondents marked “yes” to a question, 20 marked “no,” and 4 did not respond, the percentage “yes” is 71% (50/70) and the percentage “no” is 29% (20/70). The survey questions are provided in Appendix A. The full survey results are available from the authors upon request.

For simplicity, responses to Survey 2 (regarding the method of disposal in each AHQ) are provided before the more detailed responses from Survey 1.

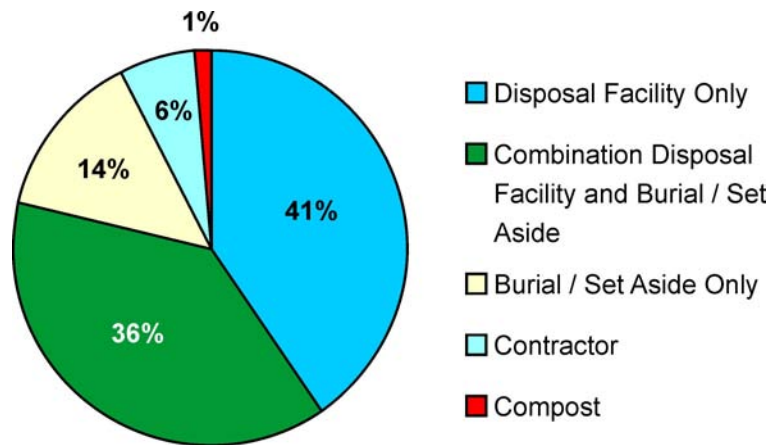
#### **Survey 2**

For this survey, 79 of 88 responses were received (for a response rate of 94%). Four methods of carcass disposal are conducted by VDOT AHQs: burial/set-aside, disposal facility, contract, and composting (conducted by only one AHQ). Many AHQs use more than one method, and the methods used are largely dependent on carcass numbers and availability of disposal facilities within an area. Survey responses were received from AHQs in 42 of the 45 VDOT residencies, and each respondent represented a different AHQ. Although the method often varied among AHQs within the residency, Figure 2 illustrates the majority of the methods used in each VDOT residency based on the survey responses. Figure 3 illustrates the proportion of each method used statewide, and Figure 4 illustrates these proportions within each residency.

Among respondents that use a disposal facility (77%), the facility is their sole method of disposal (41%). The remaining 36% use the facility in combination with the burial or set aside method of carcass disposal. Landfills represent the vast majority (91%) of disposal facilities used (Figure 4). Other facilities in this category include rendering plants for the production of commercial products, a dumpster service, a zoo, and transfer stations (where waste is held before being hauled to a regional landfill).



**Figure 2. Carcass Disposal Method by VDOT Residency According to Majority of Methods Used as of April 2009.** Residencies that are currently under a contract for carcass pickup and disposal but that do not make use of the contract (either by choice or because of a budget-based requirement) are color coded (shaded) based on the method currently used.



**Figure 3. Carcass Disposal Methods Used by VDOT Area Headquarters**

As evident in Figure 3, burial or set aside is the single method of carcass disposal for 14% of AHQ respondents (all of whom represent AHQs along the eastern portion of Virginia; Figure 2). According to the majority of respondents, this is the only viable option available to them; 64% of respondents that use this method maintain that a disposal facility is not within what they consider to be a reasonable driving distance.

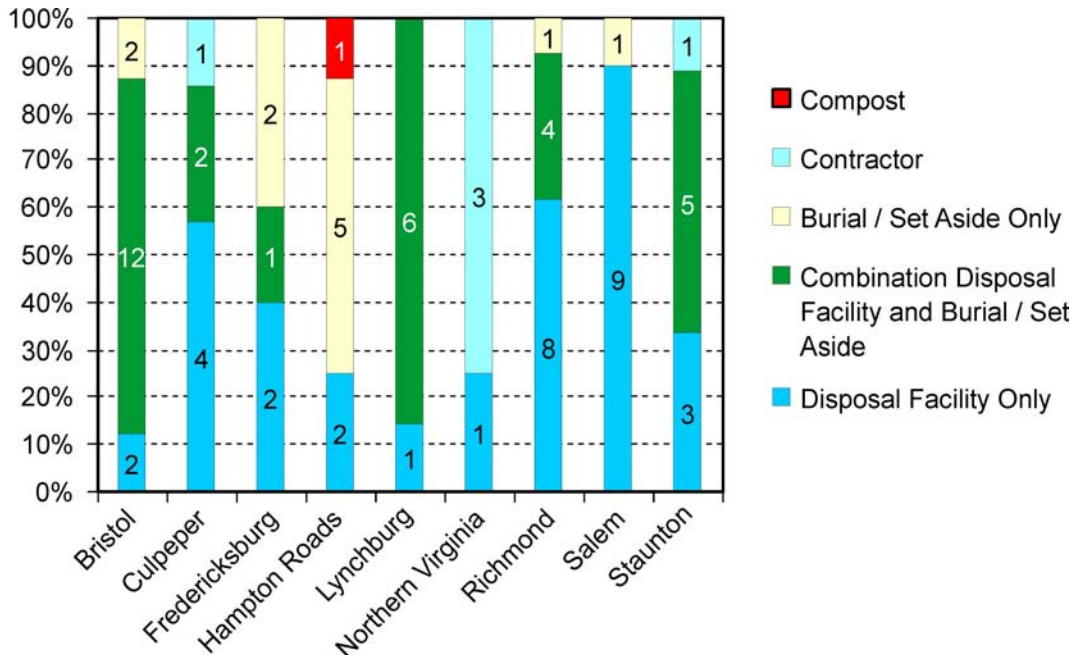


Figure 4. Carcass Disposal Methods Used by VDOT Area Headquarters Categorized by District

## Survey 1

Of the surveys distributed for Survey 1, 74 responses were received (for a response rate of 84%).

### Question 1

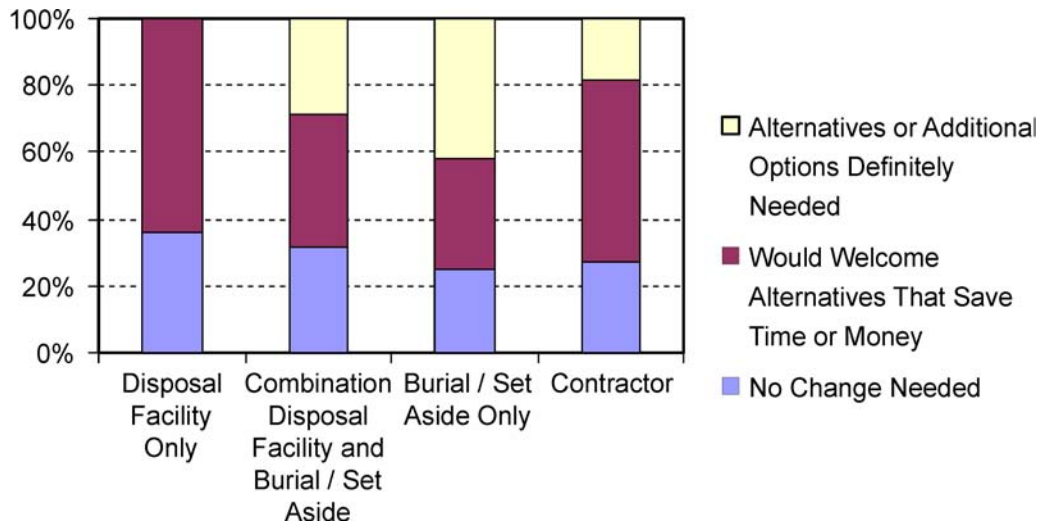
A VDOT maintenance employee learns of a dead animal within VDOT-maintained rights of way by one of three methods: (1) conducting regular driving surveys for animal carcasses along VDOT rights of way; (2) receiving dead animal removal work requests (called-in or emailed requests) posted on VDOT's Asset Management System (AMS); or (3) encountering a carcass while conducting other types of maintenance activities. The majority of respondents (55%) indicated that all three methods are used by their AHQ. Those that conduct regular driving surveys for carcasses conduct them on either a weekly (39%), biweekly (24%), or daily (4%) basis. Of respondents, 25% do not conduct regular surveys along a particular route but learn of carcass locations by requests from AMS and by encountering the carcasses while conducting other maintenance activities.

### Questions 12-17 and 20 (Disposal Facilities)

Of survey 2 respondents that use a disposal facility, the facility is along a routine route traveled for carcass patrol or other maintenance activities for 53%. Of the disposal facilities used by VDOT, 79% do not charge a disposal fee. The remaining facilities charge by weight (ranging from \$29.50 to \$55.00 per ton; 18% or trip (3%). The facility is out of the way for the remaining facility users (47%), adding 21 to 30 mi per facility visit for the majority of this group (33%) and

31 to 40 mi for 22% of respondents. Of respondents, 8% have had to stop using a disposal facility in the last several years because of increased prices or restrictions.

Of those that strictly use disposal facilities, 64% would welcome disposal alternatives that decrease time and/or costs and 36% thought that no change was needed with regard to their disposal options (Figure 5). Many respondents were dissatisfied with the distance required to reach the facility; numerous respondents commented that the time spent driving reduces the time and personnel that can be allocated toward other important maintenance activities. Comments also included the fact that carcasses obtained at the end of the work week are left to deteriorate in cases where facilities are not open on the weekends.



**Figure 5. Survey Responses Regarding Whether Need Exists for Alternatives or Additional Options for Carcass Disposal, Categorized According to Method Currently Used by Survey Respondent**

*Questions 15, 16, and 20 (Burial or Set Aside)*

Of the four groups of carcass disposal methods, respondents that bury or set aside carcasses were the most dissatisfied with their method of disposal and responded that “Alternatives or additional options are definitely needed” more often (42%) than other groups (Figure 5). According to survey comments, the primary complaint with this method is that “it is getting harder finding a place to bury carcasses.” This is often due to the risks of striking underground utilities and finding burial areas that are removed from businesses and residences. Additional difficulties noted include the time involved to receive approval from Miss Utility to bury a carcass in accordance with Virginia’s Underground Utility Damage Prevention Act (*Code of Virginia*, Sections 56-265.14 through 56-265.32) and the time needed to bring equipment (generally a front-end loader) to the site to move or bury large dead animals.

*Question 20 (Contract)*

Contract costs for survey respondents ranged from \$36 to \$58 per animal. Sixty-two percent of respondents would welcome alternatives that decreased time and/or costs (Figure 5). All of those satisfied with outsourcing carcass pick up and disposal responded that it frees a great

deal of VDOT time and labor that can then be allocated to other necessary maintenance activities. All comments associated with contracts were positive, though one respondent noted that contractors should be monitored to ensure honest practices.

## **Incineration and Composting as Methods of Carcass Management**

### **Incineration**

#### *Description and Methods of Incineration*

Incineration involves placing animal carcasses in an incinerator burning chamber where natural gas, propane, or oil fuel is electronically dispensed to incinerate the tissue. Various incineration units have been designed to accommodate animal carcasses of varying sizes.

#### *Product Information*

The use of incinerators results in a reduced volume of waste accumulation, thus preserving landfill capacity and extending the life of a landfill. Publicized concerns over incineration plants have primarily been with regard to the release of emissions and fine particles although these concerns have been significantly lessened by emission control designs and new stringent governmental regulations (S. Foley, personal communication).

Product literature from the companies contacted (APC Products, Inc., n.d.; Southern Breeze Fabrications, Inc., n.d.; and Inciner8 International, n.d.) maintains that the ashes resulting from this process are sterile and can be quickly and easily removed after operation. As discussed later, costs of incineration units vary substantially depending on the unit's capacity and its rate of fuel consumption.

#### *DEQ Regulations for Incineration*

A permit from DEQ is required prior to the construction and operation of an incinerator in Virginia, and although there is no fee for the permit, numerous requirements must be met as a part of the permit application process. The party that purchases and operates the incinerator is responsible for applying for the permit. In addition to the incinerator base unit, additional components are required to comply with DEQ requirements (DEQ, 1998). Incinerators must be equipped with a secondary combustion chamber (an after burner) to minimize emissions and an interlock system to prevent the unit from shutting down prior to total combustion (which can result in visible smoke and odor; S. Foley and G. Flory, personal communication).

Two tests are required to obtain a DEQ permit: an emissions test, whereby the gases in the incinerator stack are analyzed, and a visible smoke test, whereby a technique is used to determine whether smoke emitted is beyond a certain visibility threshold. The emissions test is waived if the same brand and model of incinerator has passed a recent emissions test and if the vendor can supply the test results. For the visible smoke test, the party seeking the permit is

responsible for hiring a consultant to conduct the testing or may use an employee certified in emissions testing (S. Foley; G. Flory, personal communication). Further information regarding DEQ's regulations with regard to incinerators is provided in DEQ's *Incinerator Procedures* (DEQ, 1998).

## Composting

### *Description and Methods of Composting*

As landfill space becomes scarce and expensive, the use of composting to turn organic waste into a valuable resource is expanding rapidly. The process of composting involves the conversion of nitrogenous and carboniferous materials into a stable mixture of humic acids, bacterial biomass, and organic residues called compost. When composting dead animals (which are nitrogen-rich), the animals are added to carbon-rich materials such as sawdust, straw, or wood chips. Naturally occurring bacteria in the mixture then cause the conversion into humic acids, bacterial biomass, and compost. During the curing process, carbon dioxide, water vapor, and heat are generated as by-products. Finished compost can be used as a soil amendment or as a medium to grow plants (U.S. Environmental Protection Agency, 2008).

Composting of dead animals is generally achieved in either (1) confined units (covered bins) that are contained by concrete or wooden walls and a roof or (2) an open windrow system. *Windrows* are passively aerated static piles and, as such, do not require the materials turning needed in the covered bin system. According to literature from the Cornell Waste Management Institute (CWMI) (2007), a program in the College of Agriculture and Life Sciences at Cornell University, in Ithaca, New York, when constructed properly, compost windrows produce minimal to no odor and the degree and duration of temperatures achieved are adequate to reduce pathogen survival greatly and deter scavengers (Figure 6; Bonhotal, 2007).

As determined in the survey of AHQ staff, VDOT currently operates one composting site, and it is used by two AHQs in the Hampton Roads District's Williamsburg Residency. Because



**Figure 6. Composting Windrows.** Photo credit: Cornell Waste Management Institute. Accessible at <http://cwmi.css.cornell.edu/roadkillfs.pdf>. Used with permission.

space for burying carcasses is becoming scarce in some areas of this district, the AHQ



maintenance supervisor began composting carcasses on an empty VDOT lot that was formerly used for equipment training sessions. Composting is done in piles using woodchips obtained from VDOT chipping machines. According to the maintenance supervisor, the process works well and is an effective and cost-efficient alternative to their former burial method. Another option potentially available at a local level involves collaborating with a local composting service. One such business in Waverly, Virginia, can supply maintenance areas with composting media and a roll-off container; no VDOT maintenance areas are currently using this service (B. Broom, personal communication). Once VDOT maintenance staff fills the container with layers of carcasses and composting media, the service disposes of the contents.

Composting can also be conducted with a relatively new technology that entails a large polyethylene vessel or drum specially designed to compost dead animals. Information was obtained from a representative from one such system, the Ecodrum (Figure 7; B. Irwin, personal communication). These vessels are equipped with a timer and a motor that allows for automatic rotation (one turn per hour). Vessels run entirely on electricity (220 volts) and include wireless temperature, moisture, and oxygen sensors and an aeration system that is recommended but not required. Carcasses and the carbon source (woodchips) are added in equal volume at one end of the vessel, and the resulting compost emerges automatically from the other end. Carcasses are fully composted 7 to 10 days after being added to the vessel. Ecodrum suppliers maintain that of the mass that is put into the vessel, approximately one third is produced in the form of compost (B. Irwin, personal communication). The compost can be used as a soil amendment for any application. Minimal maintenance is required, which includes greasing the bearings once a year and adding oil to a gear box that rotates the vessel. Ecodrums have a 10-year warranty and an estimated life of 25 years (B. Irwin, personal communication).



**Figure 7. Composting Vessel for Animal Mortality (Ecodrum). Illustration credit: Ecodrum. Used with permission.**

### *Site Visit to Composting Facility in West Virginia*

The site visit to the composting facility in Hardy County, West Virginia, was useful in gaining information on the covered bins and windrows methods of composting. The West Virginia DOT began composting in 1996 and now operates one compost facility in each of seven counties along the state's eastern border (B. Robinette, personal communication). The West Virginia DOT's composting sites are generally composed of six covered bins, each measuring 12 ft deep by 12 ft wide by 4 ft high. Because the number of deer kill in these counties has

increased over the years, the capacity of these bins has become insufficient to meet the counties' disposal needs. As a consequence, West Virginia DOT maintenance employees met with a composting expert at CWMI. CWMI conducts research, outreach, training, and technical assistance programs in solid waste disposal and has conducted extensive research on the windrow method of dead animal composting. This method has thus far been adopted by the Montana DOT and the New York State DOT (J. Bonhotal, personal communication). The West Virginia DOT will be adopting this method in conjunction with their covered bins from 2009 through 2010 to accommodate their growing numbers of dead deer.

*DEQ Regulations for Composting and Guidelines for Composting Using Windrows (Static Piles)*

Because of its environmental benefits over other carcass management methods, composting is a preferred method by DEQ, and the approval process is fairly flexible in that it may vary depending on specific applications (G. Flory, personal communication). For compost bins or windrows, DEQ will soon be implementing a "permit by rule" process, whereby a permit will be granted if the compost site meets particular requirements and environmental considerations (G. Flory, personal communication). Criteria for windrow composting are provided in a DEQ waste guidance memo (DEQ, 2009). For a compost vessel, given that it is a contained unit, the approval process is further simplified. VDOT maintenance areas can seek approval for composting by contacting the waste program manager at the local DEQ office (G. Flory, personal communication).

Based on studies developed by CWMI, the following are general guidelines for windrow composting (Bonhotal, 2007; CWMI, 2007). More detailed information is provided in DEQ's waste guidance memo on composting (DEQ, 2009); CWMI's website on mortality composting (CWMI, 2007); and the *New York State Department of Transportation Region 8 Road Kill Composting Operation and Maintenance Manual* (New York State DOT, 2006):

1. Select a well-drained site that is not subject to flooding. The site should be at least 100 ft from surface water and 200 ft from a drinking water source, residence, or public facility. The space required depends on site conditions and the number of animals to be composted.
2. To determine whether adequate space exists for deer, the windrow length (assuming a deer height of 3 ft and two layers of deer) may be determined by Equation 1:

$$\text{Length} = (3 * X) / 2 + 4, \text{ where } X \text{ is the number of deer being composted.} \quad [\text{Eq. 1}]$$

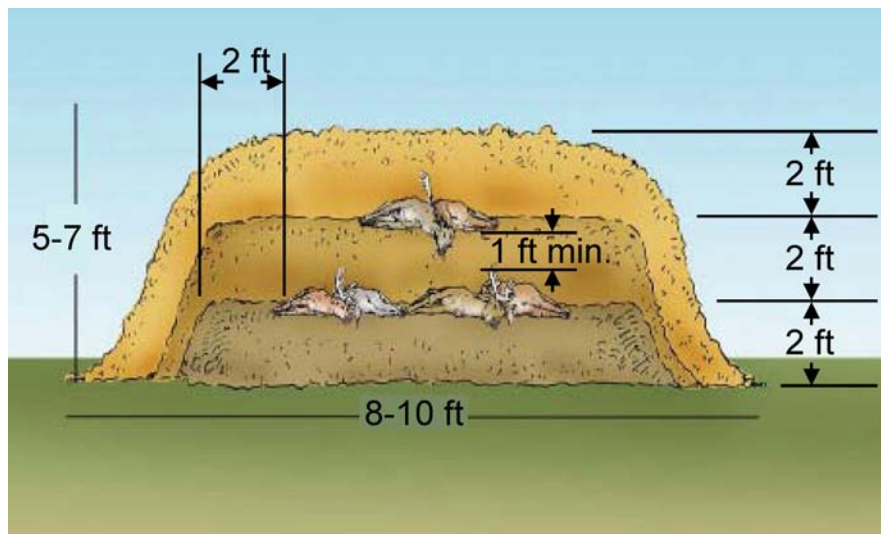
For example, for 30 deer:  $\text{Length} = (3 * 30) / 2 + 4 = 49 \text{ ft.}$

Use pairs of windrows to save space on the pad, with a 1-ft space between windrows and enough space between *pairs* of windrows for equipment.

3. Begin with a hard surface made of paved asphalt, concrete, or compacted millings. Other prerequisites are a sufficient supply of fresh wood chips or other course

amendment, a compost thermometer, and a loader. If starting the pile in dry conditions, wet the chips while building the pile.

4. Prepare an initial 24-in bed of absorbent organic materials. Wood chips from tree chipping operations work well (preferably 2 in or larger). Ensure the base is large enough to allow for a 2-ft clearance around the carcass (Figure 8).
5. Lay animals in the center of the bed. Place deer carcasses back to back, and layer small animals in a manner similar to stair steps.
6. Completely surround and cover the carcasses woodchips. Place animals weighing less than 150 lb in two layers and cover them with a 12-in layer of wood chips. Place animals weighing 150 lb or more in one layer, and cover the layer with a 24-in layer of wood chips (Figure 8).
7. Layer animals and woodchips up to a finished height of 5 to 7 ft. The top layer should be composed of 24 in of woodchips, which should curtail odor and dissuade scavengers (Figure 8).
8. Monitor temperatures regularly. The internal temperatures should be between 120° F and 150° F during the active composting phase. For pathogen reduction, the carcasses must achieve a temperature of 131° F or greater for 3 consecutive days.
9. Add water as necessary. The woodchips should look and feel damp and should be moderately moist (40% to 60%).



**Figure 8. Cross Section Illustration of Windrow with Recommended Dimensions and Spaces Surrounding Carcass Layers.** Illustration credit: Cornell Waste Management Institute. Accessible at <http://cwmi.css.cornell.edu/roadkillfs.pdf>. Used with permission.

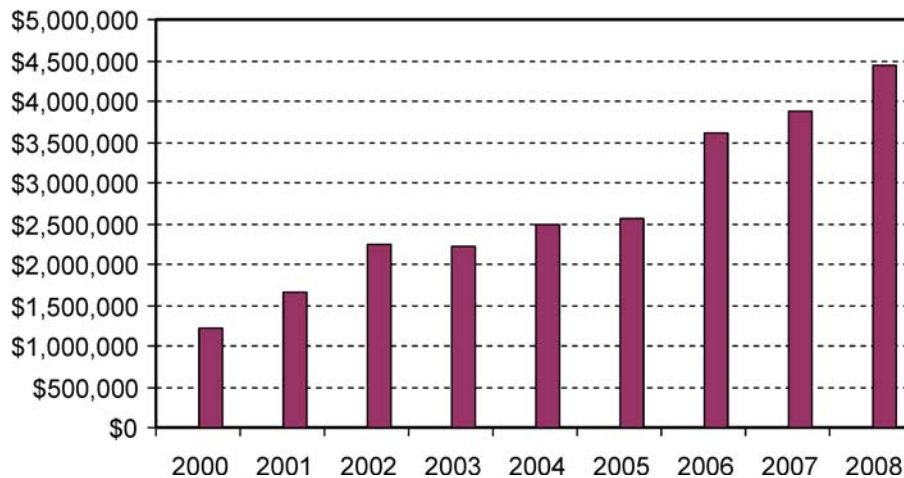
10. Let the pile sit for 4 to 6 months after the last carcass is added and the pile heats to a temperature of at least 110° F; check to see if the animals are degraded. Dated flags can be placed in the pile to keep track of the age windrow sections. Turning the pile is not required, but after 3 months it is an option and will speed the curing process. If the compost process worked well there should be only clean bones and some hair. Any parts not fully decomposed should be covered with clean woodchips.
11. Once the material is fully composted, it can be reused as the base of new compost piles or used for other projects outside the compost area. The remaining bones add structure to the base material for improved aeration.

It is important to note that these guidelines are intended for background information only. In addition to following more detailed guidelines (CWMI, 2007; DEQ, 2009), any applicable VDOT safety and health guidelines, such as VDOT’s *Policy for Removing Dead Animals From VDOT Right-of-Way* (VDOT, 1999) and VDOT’s *Maintenance Best Practices* (VDOT, 2008), must be followed. Any additional environmental controls that may be required by the local DEQ office will also be necessary to consider before a composting site is implemented.

### VDOT’s Costs Associated with Carcass Management

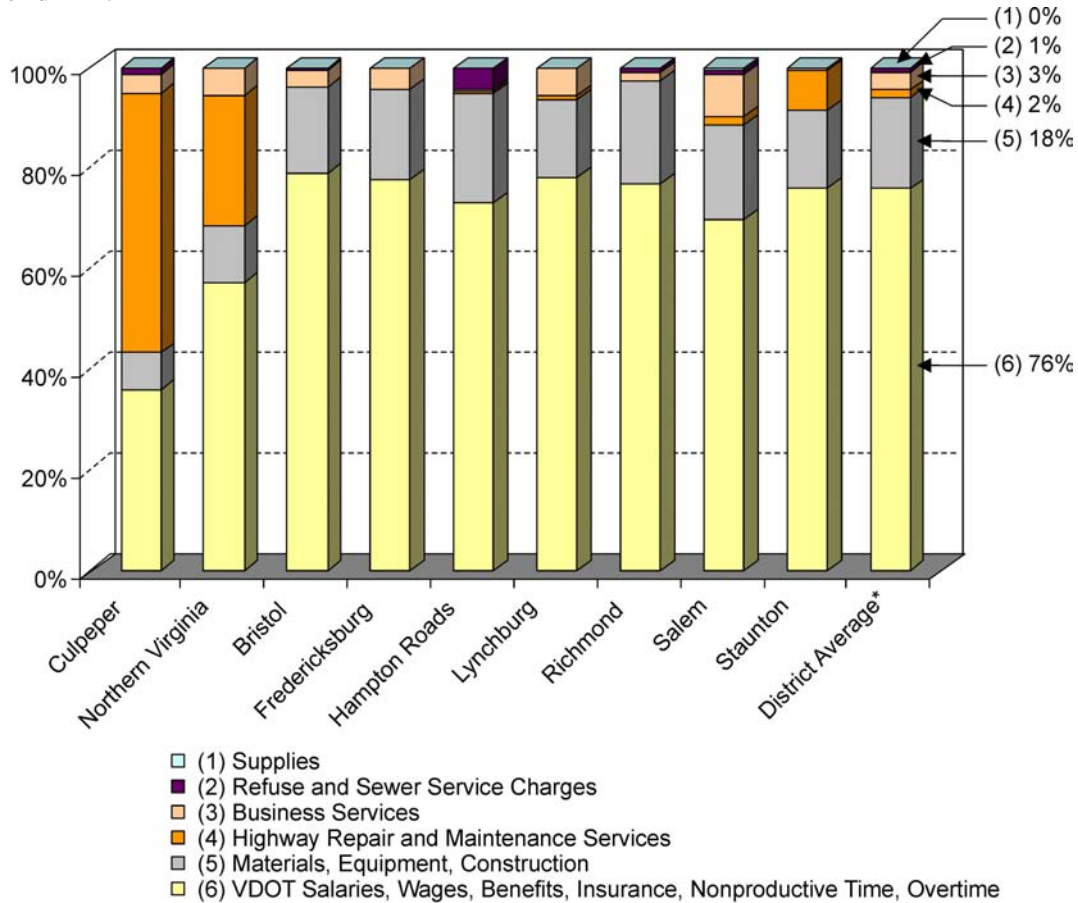
According to VDOT’s FMS, statewide costs allocated to “dead animal removal” in FY 2008 were \$4.4 million, which is more than 3.5 times the costs in FY 2000, which were \$1.2 million. From FY 2000 through FY 2008, costs charged toward dead animal removal increased by an average of 14% per year (Figure 9).

FMS data suggest that all current non-contract carcass management practices are labor-intensive relative to other resources involved. Figure 10 provides the breakdown between labor costs and other costs in each district over a 4-year period in addition to a district average for those with non-contract carcass management practices.



**Figure 9. Costs for Dead Animal Removal According to VDOT’s Financial Management System Database, FY 2000 through FY 2008**

With the exception of districts that have predominantly held contracts for dead animal removal services (Northern Virginia and Culpeper), classified salary-based expenses were the largest expenditure in the dead animal cost center each year during FY 2005 through 2008 (see Figure 10). A more detailed list of the top 12 expenditures charged to this cost center is provided in Appendix B.



\* Excludes Culpeper and Northern Virginia districts (residencies that predominantly held contracts for dead animal services)

**Figure 10. District Expenditures in VDOT's Financial Management System's Dead Animal Cost Center, FY 2005 through FY 2008**

### Method to Determine Annual Costs of Carcass Management for Comparison Purposes

Although FMS data provide an overview of VDOT's costs associated with dead animal removal, a more detailed analysis of expenditures within the dead animal cost center (e.g., salaries, refuse service charges, vehicle repair, etc.) showed considerable inconsistencies across years and districts. Because it was difficult to use FMS data to compare specific costs associated with different carcass management methods, cost models were created that would allow for equal comparisons among methods.

Although the costs included in the calculations differed depending on disposal method, four groups of costs were considered:

1. travel costs (in fuel and labor) to off-route disposal facilities (i.e., facilities outside the routine maintenance or carcass patrol route)
2. disposal facility fees
3. contract fees for carcass removal and VDOT labor costs that could be avoided (and reallocated) if a contract for carcass removal was acquired
4. costs to purchase and operate the primary piece of disposal equipment (e.g., incinerator or compost vessel).

Costs for purchasing or repairing vehicles and equipment used for carcass patrol and transport were not included in the calculations because these vehicles and equipment are used for a variety of VDOT maintenance activities. When the contract costs for dead animal removal services were calculated, labor costs incurred during routine patrols for carcasses were explicitly considered, as a contract is the only method that could eliminate the need for these patrols by VDOT.

To simplify calculations, only costs for deer were considered. VDOT survey results indicated that deer are more commonly hauled to disposal facilities than are smaller species, and maintenance areas can more easily estimate or track the monthly number of deer than that for all species.

Appendix C provides the equations and assumptions used to develop the cost models.

### **Burial/Set Aside Method**

Depending on the methods used to bury or set-aside a carcass, this approach may incur no monetary costs to VDOT beyond labor and fuel. In accordance with Virginia's Underground Utility Damage Prevention Act (*Code of Virginia*, Sections 56-265.14 through 56-265.32), proper burial, however, requires that Miss Utility be contacted first; a response from Miss Utility may not be received for up to 2 days. Whether a carcass is buried or set aside, survey responses indicated that this method is becoming a less viable option given the decrease in available spaces for carcasses and an increased concern for environmental quality.

### **Disposal Facility Method**

As mentioned previously, disposal facilities (particularly landfills) used in conjunction with carcass burial or set aside is the method overwhelmingly used by VDOT to remove and dispose of dead animals in the right of way, and 47% of AHQ survey respondents travel off-route (i.e., outside the routine maintenance or carcass patrol route) to reach the disposal facility. Costs incurred for these activities vary greatly among AHQs, and these variations are primarily based on the area's number of carcasses, the off-route miles (if any) driven to and from disposal facilities, and disposal facility fees (Table 1). As evident in Table 1, costs increase substantially as the number of off-route miles driven to a disposal facility increases. Table 1 also

**Table 1. Annual Costs Incurred by VDOT Maintenance Areas That Use Disposal Facilities for Deer Carcass Disposal**

Monthly No. of Deer Carcasses <sup>a</sup>	Disposal Facility Costs/Ton (\$) <sup>a</sup>	Off-Route Miles Driven/Trip to Facility <sup>a</sup>	Annual Fuel and Disposal Facility Costs (\$) <sup>b</sup>		Annual Labor Costs (\$) <sup>b</sup>		Total Annual Costs (\$) <sup>b</sup>		Annual Labor-Hours of Off-Route Travel <sup>b</sup>	
			Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
0-30	No charge	0-20	No deer	1,273	-	6,144	-	7,417	-	213
	20-40			2,029	-	6,144	-	8,173	-	213
	40-60			2,407	-	6,144	-	8,551	-	213
0-30	No charge	20-40		2,547	1,229	12,288	1,229	14,835	43	427
	20-40			3,303	1,229	12,288	1,229	15,591	43	427
	40-60			3,681	1,229	12,288	1,229	15,969	43	427
0-30	No charge	40-60		3,820	2,458	18,432	2,458	22,252	85	640
	20-40			4,576	2,458	18,432	2,458	23,008	85	640
	40-60			4,954	2,458	18,432	2,458	23,386	85	640
31-60	No charge	0-20	-	1,273	-	6,144	-	7,417	-	213
	20-40		391	2,785	-	6,144	391	8,929	-	213
	40-60		781	3,541	-	6,144	781	9,685	-	213
31-60	No charge	20-40	255	2,547	1,229	12,288	1,483	14,835	43	427
	20-40		645	4,059	1,229	12,288	1,874	16,347	43	427
	40-60		1,036	4,815	1,229	12,288	2,265	17,103	43	427
31-60	No charge	40-60	509	3,820	2,458	18,432	2,967	22,252	85	640
	20-40		900	5,332	2,458	18,432	3,358	23,764	85	640
	40-60		1,291	6,088	2,458	18,432	3,748	24,520	85	640
61-90	No charge	0-20	-	1,273	-	6,144	-	7,417	-	213
	20-40		769	3,541	-	6,144	769	9,685	-	213
	40-60		1,537	4,675	-	6,144	1,537	10,819	-	213
61-90	No charge	20-40	255	2,547	1,229	12,288	1,483	14,835	43	427
	20-40		1,023	4,815	1,229	12,288	2,252	17,103	43	427
	40-60		1,792	5,949	1,229	12,288	3,021	18,237	43	427
61-90	No charge	40-60	509	3,820	2,458	18,432	2,967	22,252	85	640
	20-40		1,278	6,088	2,458	18,432	3,736	24,520	85	640
	40-60		2,047	7,222	2,458	18,432	4,504	25,654	85	640
91-120	No charge	0-20	-	1,273	-	6,144	-	7,417	-	213
	20-40		1,147	4,297	-	6,144	1,147	10,441	-	213
	40-60		2,293	5,809	-	6,144	2,293	11,953	-	213
91-120	No charge	20-40	255	2,547	1,229	12,288	1,483	14,835	43	427
	20-40		1,401	5,571	1,229	12,288	2,630	17,859	43	427
	40-60		2,548	7,083	1,229	12,288	3,777	19,371	43	427
91-120	No charge	40-60	509	3,820	2,458	18,432	2,967	22,252	85	640
	20-40		1,656	6,844	2,458	18,432	4,114	25,276	85	640
	40-60		2,803	8,356	2,458	18,432	5,260	26,788	85	640

<sup>a</sup> Values are shown in ranges for simplicity.

<sup>b</sup> Minimum to maximum cost ranges are based on a minimum of 4 trips/month (1/week) to a maximum of 20 trips/month (5/week) to the disposal facility.

demonstrates the labor effort expended exclusively during off-route travel that could be reallocated to other maintenance tasks if replaced by a method located at the maintenance area or along a routine maintenance route.

Values in Table 1 are shown in ranges for simplicity. To obtain a more specific cost within one of the ranges, Eqs. C1 and C3 in Appendix C should be used. For an example for using Table 1, a maintenance area encounters an average of 30 deer/month and incurs a fee of \$40/ton from the landfill. Maintenance employees must travel off-route for 60 mi round trip to reach the landfill and do so 5 times/week. This maintenance area will spend \$4,576/year on fuel and landfill charges and \$18,432/year in labor charges. Disposal options located at the maintenance area or along a routine maintenance route would free an estimated 640 labor-hours/year for other maintenance tasks.

### Contracting Method

Table 2 provides a means for maintenance areas considering contracting dead animal services (i.e., carcass removal and disposal work) to estimate annual contract costs. Several survey respondents who were dissatisfied with using the landfill and/or burial methods commented that their time and labor could be used more efficiently toward other needed road maintenance activities if a contract for dead animal services were obtained. Table 3 was therefore developed to represent the effort by VDOT maintenance staff that could be reallocated toward other necessary maintenance activities if such a contract were obtained.

For example, a maintenance area that sets aside an average of 90 deer/month currently travels an average of 5,400 mi/month (or a residency’s four AHQs each travel 1,080 mi/month) for carcass management. This maintenance area spends \$100,133/year on labor and mileage (and 2,880 labor-hours/year; Table 3). If they were to obtain a contract for dead animal services with a fee of \$50/deer and 90 deer/month, they would spend \$54,000/year on the contract (Table 2). These tables allow managers to decide whether the reallocation of the \$100,133 in labor costs/year and the equivalent 2,880 labor-hours/year is worth (if the funds are available) the \$54,000 out-of-pocket expense for a contract.

**Table 2. Annual Costs of Contract for Carcass Management Services**

Monthly No. of Deer Carcasses	Contractor Fee/Deer (\$)	Annual Costs (\$)	
		Minimum	Maximum
0-30	40	-	14,400
0-30	50	-	18,000
0-30	60	-	21,600
31-60	40	14,880	28,800
31-60	50	18,600	36,000
31-60	60	22,320	43,200
61-90	40	29,280	43,200
61-90	50	36,600	54,000
61-90	60	43,920	64,800
91-120	40	43,680	57,600
91-120	50	54,600	72,000
91-120	60	65,520	86,400



**Table 3. Annual VDOT Costs and Labor-Hours That Could Be Reallocated with Contract for Carcass Services**

Monthly Miles Driven for Carcass Search/Pick-up	Minimum <sup>a</sup> Annual VDOT Labor and Fuel Costs That Could Be Reallocated		Annual VDOT Labor-Hours That Could Be Reallocated	
	Minimum	Maximum	Minimum	Maximum
0-1,800	\$ -	\$3,378	0	950
1,801-3,600	\$3,396	\$6,755	961	1,920
3,601-5,400	\$66,774	\$100,133	1,921	2,880
5,401-7,200	\$100,152	\$133,511	2,881	3,840

<sup>a</sup> Assumes no disposal facility fee.

Eq. C2 in Appendix C can be used to obtain a more specific cost within one of the ranges shown in Table 3.

The ranges of fees per animal used in Table 2 were based on survey responses from those with contracts for carcass removal and disposal services. The fees for deer removal and disposal charged by contractors currently employed generally range from \$40 to \$60/deer, although one contract (held in Fairfax County) charges \$65/animal. Because some contractors charge one fee for small animals and another for large animals such as deer, it is important to note that Table 2 applies only to deer removal for a more equal comparison to Table 1. Including removal and disposal costs of smaller animals may therefore add a considerable amount to the costs shown in Table 2. Contract charges include any disposal fees charged by facilities and costs associated with driving to and from carcass sites.

### **Incineration and Composting Methods**

Incineration and composting can be implemented at the maintenance area (provided that site conditions are met [G. Flory, personal communication]). For those who currently use a disposal facility, it is therefore necessary to consider that the labor and fuel expenses incurred during any off-route travel to and from the facility (calculated in Table 1) would be eliminated if the current method were to be replaced with either incineration or composting.

#### *Incineration*

Three incinerator manufacturers that supply units to Virginia were contacted to compare prices and features of incineration units: Consutech Systems (from APC Products, Inc; C. Traywick, personal communication), Southern Breeze Fabrications, Inc. (n.d.), and Inciner8 International (n.d.). Table 4 was created using information from the company (APC Products, Inc., n.d.) with units that come equipped with required environmental components and that have met testing requirements in Virginia. Table 4 includes time and monetary values particularly relevant to the unit operator.

Fuel cost calculations in Table 4 were derived from Eq. C4 in Appendix C. As evident in Table 4, not only do incinerators have a high initial cost for the unit itself, but the fuel required for operation is also a continuous expense. In addition, the approval process to obtain an incinerator permit is often substantially more difficult than that for composting and requires the additional expense of emissions tests.

**Table 4. Incinerator Costs and Running Time for Two Incinerator Capacities**

Monthly No. of Deer Carcasses	Incinerator Capacity (Recommended Based on Monthly No. of Deer)		Burn Time per Capacity (hr)	Fuel Costs/ Carcass	Start-Up Cost (Includes Unit, After-Burner, and Permit) <sup>a</sup>	Annual Fuel Cost	
	Lb	Equivalent No. of Deer				Minimum	Maximum
0-60	600	5.7	8.0	\$10.38	\$40,000	\$0	\$7,472
61-120	1,600	15.2	8.0	\$7.78	\$60,000	\$8,406	\$11,208

<sup>a</sup> Incinerator cost information provided by C. Traywick from APC Products, Inc. (personal communication). Cost does not include freight charge or emissions test fees

*Composting*

Composting costs were estimated for the windrow system and for compost vessels. Because the process of composting using covered bins is similar to that using windrows but requires materials purchase, facility construction, and labor to turn the piles (CWMI, 2007; B. Robinette, personal communication), composting costs using covered bins were not investigated.

**Composting Windrows.** Composting using the windrow method described in this report requires no additional cost, assuming that wood chips can be obtained from existing VDOT supplies and that off-route travel is not required to access windrows. Equipment needed for composting (typically front-end loaders) is generally already available to maintenance areas.

**Composting Vessels.** Ecodrums run entirely on electricity (220 volts), which is estimated to cost less than \$1/day for the recommended hours of operation (3 to 4 hr; B. Irwin, personal communication). Table 5 shows the prices of various models of the Ecodrum units, obtained from an Ecodrum sales representative (B. Irwin, personal communication) but excludes electricity costs. Drum prices increase with their capacity; Table 5 includes units that can handle from 4 to more than 10 deer in 1 day.

In addition to compost windrows and composting vessels, maintenance areas can investigate the availability of a local composting service. Depending on the exact service provided, this may be a cost-efficient and low maintenance method of disposal. Because of the limited availability of this service to maintenance areas, cost information is not discussed in this report.

**Table 5. Costs of Three Models of Ecodrum Composting Vessel**

Monthly No. of Deer Carcasses	Compost Vessel Daily Capacity		Cost <sup>a</sup>
	Lb	Equivalent No. of Deer	
0-30	370	3.5	\$29,000
31-60	570	5.4	\$37,000
61-90	570	5.4	\$37,000
91-120	740	7.0	\$46,000
121-150	1110	10.6	\$68,000

<sup>a</sup> Costs shown are for Ecodrum model numbers 260, 360, and 460 (with daily capacities of 370, 570, and 740 lb, respectively). Costs include the aeration system (\$2,000) but not the freight charge (B. Irwin, personal communication).

## Cost Scenarios and Decision Tool for Selection of Carcass Management Method

### Cost Scenarios

The majority of survey respondents (77%) use a disposal facility at least occasionally to dispose of carcasses. Table 1 was developed as a means to obtain cost estimates from this method, and Table 6 expands on this information to illustrate the cost scenarios if the disposal facility method were replaced by disposal alternatives that take place at the maintenance area or along a routine maintenance route (referred to as “on-site” in Table 6).

Assuming that labor and locations for carcass management are available at the maintenance area or along a routine route, estimates may be made using the annual savings incurred from eliminating disposal facility fees and travel costs (i.e., fuel and labor) incurred from off-route trips to disposal facilities. Table 6 depicts these estimates in the form of (1) annual savings from static (windrow) composting and (2) the number of years required for the initial investment and operating costs of new composting or incineration equipment to be offset by the savings from eliminating disposal facility fees and off-route travel costs. Table 6 also includes the monthly VDOT labor-hours that would be saved and potentially reallocated if off-route trips to disposal facilities were replaced with methods located at the maintenance area or along a routine maintenance route. The scenarios were drawn from the survey responses that indicated either that “a change is needed” from current disposal practices or “a change is desirable if it would decrease time or cost.”

As evident in Table 6, the five maintenance areas represented by the case studies would reap an annual savings in off-route travel costs if they were to replace the landfill disposal method with windrow composting. If they were to purchase an Ecodrum, the cost would be offset by off-route travel costs well within the 25-year lifetime of the Ecodrum. The use of incinerators would take substantially longer to offset costs. As shown in Figure 10 and Table 1, labor represents the largest expense incurred from carcass removal and disposal work and employee time is primarily spent in the vehicle. Those who travel the greatest distances off-route to reach a disposal facility would therefore reap the most savings (or the least number of

**Table 6. Cost Scenarios If Off-Site Disposal Facility Method Replaced by On-Site Method**

Case Study <sup>a</sup>	Annual No. of Deer Carcasses	Disposal Facility Cost	Estimated Off-Route Distance to Disposal Facility (mi)	Annual Savings with Compost Windrows <sup>a</sup>	No. of Years to Offset Equipment and Operating Costs		Reallocable Labor-Hours per Year From On-Site Disposal
					Composting Drum	Incinerator <sup>b</sup>	
1	192	No charge	15	\$2,225	21.6	-	64
2	150	\$32/tom	20	\$2,487	17.9	-	67
3	332	\$55/ton	25	\$7,460	4.4	14.1	184
4	250	\$0.50/deer	40	\$7,543	4.4	10.6	222
5	200	No charge	30	\$4,450	8.1	37.9	133

On-site = either at the maintenance area or along a routine route.

<sup>a</sup> Savings in labor, fuel, and disposal facility fees are included in the calculation (refer to Eq. C1 in Appendix C).

<sup>b</sup> Dashes indicate that current carcass management costs are too low to offset incinerator costs (within the parameters of the model used).

years to offset equipment costs) if they were to switch to a management option located at the maintenance area or along a routine maintenance route. Appendix C provides the equations and assumptions used to develop Table 6.

## **Decision Tool**

The flowchart in Figure 11 is a decision tool to guide a maintenance supervisor or manager in his or her consideration of an alternative carcass disposal method. The flowchart was developed based on information gained from the VDOT surveys, the results of the cost models, and environmental considerations (DEQ, 2009; U.S. Environmental Protection Agency, 2008; G. Flory, personal communication). All carcass disposal methods discussed in this report are included in Figure 11 with the exception of incineration, which is not a recommended form of carcass management based on (1) their high costs (for both the unit itself and the continuous expense for fuel [Table 4]) and (2) the complicated approval process compared to that for composting.

## **DISCUSSION**

The VDOT surveys established that (1) VDOT maintenance areas vary within and between themselves in methods of animal carcass management, and (2) local circumstances play a primary role in determining the main management method(s) for a maintenance area. Except for those that can regularly set aside carcasses in the right of way, the survey results indicate that a maintenance area is generally dependent on a third party to complete a carcass disposal process. This dependence may take the form of a contract outsourcing carcass disposal, the availability of a landfill facility in reasonable proximity to the maintenance area, or information from Miss Utility for burying operations in accordance with Virginia's Underground Utility Damage Prevention Act (*Code of Virginia*, Sections 56-265.14 through 56-265.32).

Of survey respondents, 71% saw a need for or a benefit from having additional carcass management options, particularly options that could reduce costs and/or labor. The majority of respondents (77%) dispose of carcasses at a disposal facility (predominantly landfills), and 36% of those that use a facility also bury or set aside carcasses at least occasionally. Although some respondents were satisfied with these methods of disposal, there were numerous complaints by others. Landfill users often must travel out of the way to reach a facility that accepts carcasses, and waiting for landfills to open results in further deterioration of carcasses. The burial or set aside method of disposal is becoming a less viable option for many respondents.

FMS data show that salaries and salary-related expenses account for the majority of the charges in VDOT's dead animal cost center for all districts not predominantly under carcass removal contracts. Cost models developed in this study verified that labor represents the largest expense incurred from carcass management activities. Management options located at the maintenance area or other VDOT property would reduce in-vehicle time by maintenance personnel and therefore have potential to reduce labor and associated costs for maintenance areas with distant or expensive disposal facilities. Methods located at the maintenance area would also

## Carcass Disposal Method Currently Used

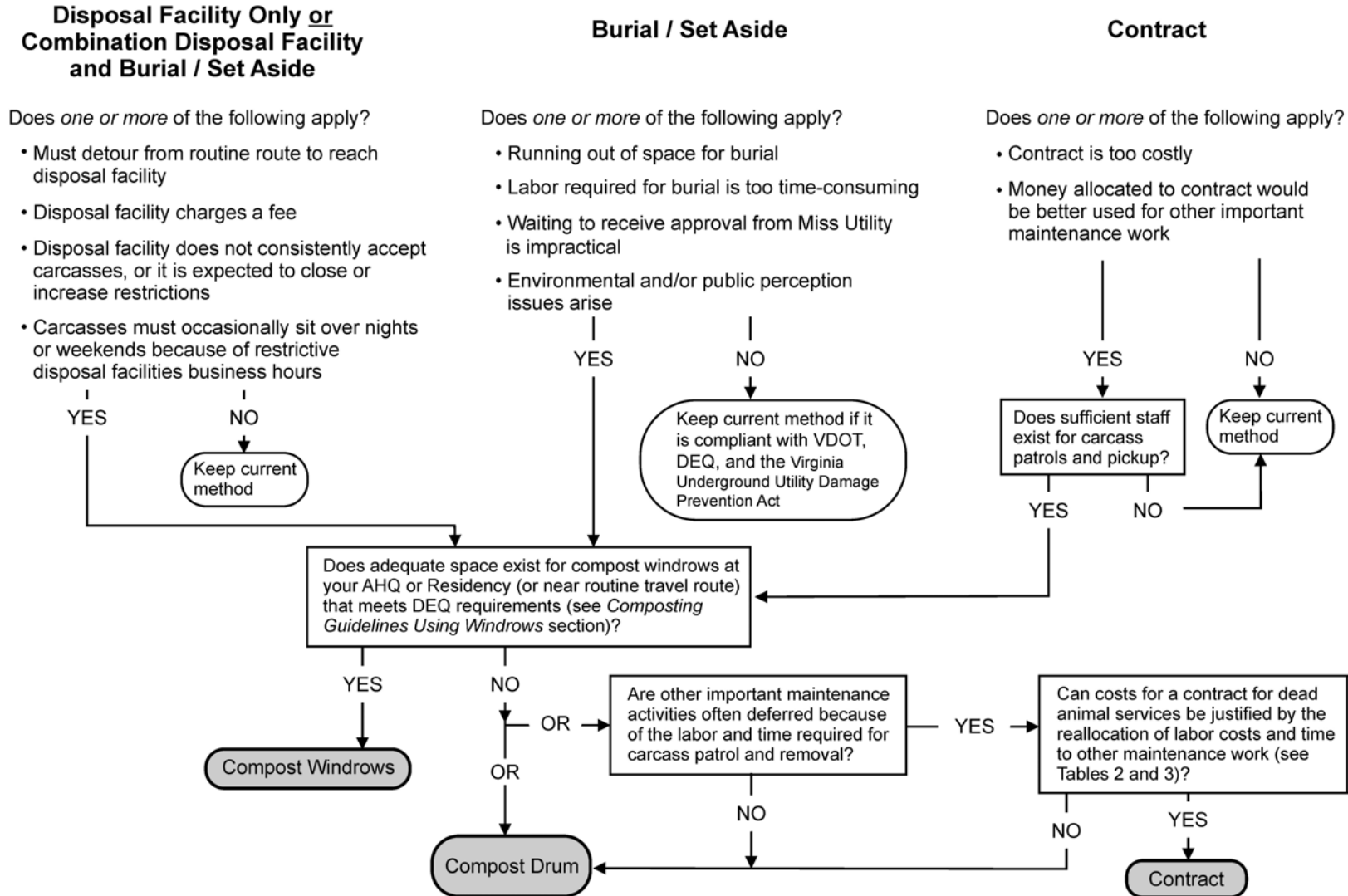


Figure 11. Decision Tool for Selection of Carcass Management Option

reduce costs in cases where travel to disposal facilities entails overtime pay. Table 1 estimates the costs that current landfill users would no longer charge to the FMS dead animal cost center if a management option is located at the maintenance area were adopted. More important, it illustrates the magnitude of the resources (labor wages and time) that would be available for more valuable uses elsewhere in the maintenance area.

Compost windrows or static-pile composting is a low-maintenance method of carcass management that would eliminate the aforementioned costs and obstacles. By proper construction of the compost pile to allow for adequate natural aeration, composting can be completed on intact animals without physically turning and mechanically aerating the pile. Compost windrows would pose no added costs to VDOT, as this method does not require construction of covered bins and the carbon source (wood chips) can be supplied by routine wood chipping operations.

For many maintenance areas, replacing their current management method with an alternative may be a necessity despite the initial cost. When space for compost windrows is unavailable, an automatic compost vessel can be a practical option. If the initial cost is a deterrent, it is important to consider the time in labor that can be reallocated to other maintenance tasks if the equipment can replace the need to travel off-route to a disposal facility. According to the case studies developed from survey responses (Table 6), the cost of a compost vessel would be offset by off-route travel costs within its 25-year lifetime, and in most of the case studies, the cost would be offset in as few as 4 to 8 years.

Similar to compost drums, incinerators are convenient in that they are a contained system that can be located on VDOT property. However, incinerators have the following characteristics: (1) they are generally more expensive (particularly those equipped with the additional components required by DEQ); (2) they must comply with additional DEQ regulations because of their pollution potential; and (3) they have more maintenance and operations requirements than composting drums.

Some survey respondents indicated that other important maintenance activities are often deferred because of the labor and time required for carcass patrol and removal. For maintenance areas that incur a great deal of mileage for carcass disposal activities and that have difficulty completing all maintenance tasks, management may consider whether the costs for a contract for dead animal services can be justified by the reallocation of labor and time to other maintenance work.

Beginning July 2009, VDOT began renegotiating interstate maintenance contracts to help meet the reduced budget requirements. VDOT-maintained disposal sites such as composting provide an opportunity for negotiating lower contract fees for dead animal services, as this could reduce driving costs and disposal facility fees paid by contractors.

## CONCLUSIONS

- *VDOT maintenance personnel have a high level of interest in cost-effective and labor-saving alternative carcass management methods. Common problems with the predominant methods currently used (landfill and burial) include long travel distances to landfills, landfill restrictions, and lack of viable burial areas.*
- *Compost windrows or static-pile composting is an easily managed technique that can be located at the maintenance area or other VDOT property, thus decreasing travel costs and other difficulties associated with landfill disposal. Since they are low (or no) cost and low maintenance, compost windrows are highly applicable for transportation departments.*
- *VDOT AHQs could save \$2,200 to \$7,500 per year or could reallocate up to 222 labor-hours per year if compost windrows replaced off-route travel to reach a disposal facility.*
- *When space for compost windrows is unavailable or other site requirements for compost windrows cannot be met, an automatic compost vessel may be a practical option. If the initial cost is a deterrent, it is useful to consider the savings in fuel costs and the personnel time that can be reallocated to other maintenance tasks if a compost vessel can replace the need to travel off-route to a disposal facility.*
- *Incineration units involve significantly higher costs and strict regulatory requirements as compared to composting as a means of carcass management.*

## RECOMMENDATIONS

1. *VDOT maintenance managers who seek a more cost effective means of carcass management should compost carcasses using the windrow or static pile method if windrows can be located at the maintenance area or along a routine maintenance route. Compost windrows will reduce expenses, free labor for other important maintenance activities, and create a useable product.*
2. *If space is inadequate or other site requirements for compost windrows cannot be met, VDOT maintenance managers should consider an automatic compost vessel located at the maintenance area or along a routine maintenance route.*
3. *The Virginia Transportation Research Council should conduct a pilot composting study in order to provide a more detailed composting guidance document and increase implementation prospects. Such an implementation study has been approved by the Federal Highway Administration and will begin in March 2010.*
4. *For maintenance areas that incur a great deal of time for carcass disposal activities and therefore have difficulty completing other important maintenance tasks, VDOT maintenance*

*managers should weigh the costs for a contract for dead animal services against the benefits of the reallocation of VDOT labor and equipment to other maintenance work.*

- 5. During negotiations for interstate maintenance contracts, VDOT maintenance managers that plan to provide a VDOT-maintained disposal method (i.e., composting) should negotiate lower contract fees for dead animal services, as this could reduce contractor driving costs, labor, and disposal facility fees.*

## **IMPLEMENTATION PLAN**

Using information gained from the surveys conducted in this study and from discussions with VDOT maintenance managers, the Virginia Transportation Research Council will identify locations appropriate for a pilot composting study. Windrow composting will be conducted in at least two VDOT maintenance areas that seek an alternative disposal method and that have sufficient space that meets site requirements. An automatic compost vessel will also be acquired and placed at a VDOT maintenance area. The number and type of carcasses composted will be documented at each compost site, and each site will be regularly monitored. During or immediately following the pilot study, assistance will be sought from VDOT's Learning Center and CWMI to hold composting training sessions with VDOT maintenance staff.

## **COSTS AND BENEFITS ASSESSMENT**

The use of compost windrows for animal carcass disposal is a primary recommendation of this report, as it is an easily managed method with minimal to no cost to VDOT. This report provided information on estimated costs and savings for individual maintenance areas if their current management method were replaced with an alternative. The following calculations were developed to estimate the total annual VDOT savings if a portion of VDOT maintenance areas that currently use a landfill were to replace this disposal method with one located at the maintenance area or along a routine maintenance route. This was achieved by using information from survey responses and applying them to AHQs statewide.

Of survey respondents, 54% reported using a disposal facility "always" or "often" when given the choices of "always," "often," "sometimes," and "never" in terms of deer carcass disposal (Appendix A, survey question 7); 21% reported "sometimes" and 18% "never" using a facility. The analysis that follows calculates the total annual savings if only 54% of the VDOT AHQs that frequently ("always" or "often") use a disposal facility were to replace this method with windrow composting located at the maintenance area or along a routine maintenance route. Within this group of "always" or "often" facility users, there were differences in terms of whether disposal facility fees are incurred and whether off-route travel is required to reach the facility. Table 7 provides these survey results when extrapolated to VDOT's 189 AHQs. As represented in Table 7, 46 AHQs from this group are incurring costs in disposal facility fees and/or off-route travel (28 + 5 + 13) which may be avoidable given the composting option.



**Table 7. Area Headquarters (AHQ) Carcass Management Scenarios Used for Statewide Savings Calculations**

<b>AHQ Carcass Management Scenario</b>	<b>No. of AHQs</b>
AHQs that “always” or “often” use disposal facility for animal carcass disposal	102 (54%)
Free landfill, no off-route travel	43 (42%)
Free landfill with off-route travel	28 (27%)
Priced landfill, no off-route travel	5 (5%)
Priced landfill with off-route travel	13 (13%)
No landfill or travel information	13 (13%)

The following averages can also be drawn from the survey respondents who “always” or “often” use a disposal facility:

- Of AHQs reporting free facility but off-route travel, the average travel is 20 mi.
- Of AHQs reporting priced facility but no off-route travel, the average fees are \$35/ton and the average annual number of deer carcasses is 930.
- Of AHQs reporting priced facility and off-route travel, the average fees are \$29/ton, the average off-route travel to facility is 27 mi, and the average annual number of deer carcasses is 665.

Extending these averages across 189 VDOT AHQs, current carcass disposal practices consisting of landfill, off-route labor, and off-route fuel costs result in a statewide annual cost of about \$515,440. These resources could be avoided or reallocated within AHQs or residencies if current practices were replaced by windrow composting at the 46 AHQs that (1) frequently (i.e., “always” or “often”) use a disposal facility and (2) travel off-route to reach the facility or pay a fee to use the facility. This estimate would be substantially higher if the 21% of AHQs that “sometimes” use a landfill were included in the calculation.

This estimate assumes composting can be achieved at a VDOT maintenance area or along a routine maintenance route with existing staff and equipment at hand. It also assumes two-person patrols traveling at 45 mph during normal business hours; a fuel economy figure of 9.5 mpg; an average deer weight of 105 lb (N. Lafon, personal communication); a diesel price of \$2.52/gal (U.S. Energy Information Administration, 2009); and an upper threshold of two carcasses per landfill trip but not exceeding 20 trips/month. Such constraining assumptions suggest that the costs of current practices are underestimated here, particularly the labor component, which in FMS is shown to represent considerable overtime expense excluded categorically from this analysis.

In addition, if all AHQs that travel off-route to disposal facilities composted carcasses at a VDOT maintenance area, the fuel and carbon emissions expended from an estimated 252,000 mi/year of driving could be eliminated. This estimate is based on the average miles driven off-route to a disposal facility by the 47% of survey respondents that do so and assumes an average of 2.5 trips/week to the disposal facility.

## ACKNOWLEDGMENTS

The authors extend their appreciation to several individuals who provided data and insights essential for this report. Bob Amtower, Jean Bonhotal, and Bill Robinette provided information on composting. Bill Jones and David Wilson provided information regarding equipment and regulations. Review comments were provided by Mike Fitch, Amy O’Leary, Jimmy White, and David Wilson. Editing was provided by Linda Evans, and graphics were provided by Randy Combs.

## REFERENCES

- APC Products, Inc. *Consutech Systems: Pathological Destruction Animal Crematory Systems*. Ashland, VA, n.d.
- Bonhotal, J., Harrison, E.Z., and Shwarz, M. *Composting Road Kill*. Cornell Waste Management Institute, Ithaca, NY, 2007. <http://cwmi.css.cornell.edu/roadkillfs.pdf>. Accessed May 27, 2009.
- Cornell Waste Management Institute. *Composting: Mortality Composting*. 2007. <http://cwmi.css.cornell.edu/composting.htm>. Accessed July 12, 2009.
- Inciner8 International. *Inciner8: Animal and Waste Incinerators*. Southport, England, n.d.
- New York State Department of Transportation. *New York State Department of Transportation Region 8 Road Kill Composting Operation and Maintenance Manual*. Poughkeepsie, 2006. [https://www.nysdot.gov/divisions/engineering/environmental-analysis/repository/deer\\_c\\_manual.pdf](https://www.nysdot.gov/divisions/engineering/environmental-analysis/repository/deer_c_manual.pdf). Accessed May 27, 2009.
- Southern Breeze Fabrications, Inc. *The Eliminator*. Camilla, GA, n.d.
- U.S. Energy Information Administration. *Short-term Energy Outlook*, May 12, 2009. <http://www.eia.doe.gov/steo>. Accessed May 29, 2009.
- U.S. Environmental Protection Agency. *Wastes – Resource Conservation – Reduce, Reuse, Recycle – Composting*. 2008. <http://www.epa.gov/waste/conserve/rrr/composting/index.htm>. Accessed July 20, 2009.
- Virginia Department of Environmental Quality. *Incinerator Procedures*. Richmond, 1998. [http://www.townhall.state.va.us/L/GetFile.cfm?File=E:\townhall\docroot\GuidanceDocs\440\GDoc\\_DEQ\\_2196\\_v2.pdf](http://www.townhall.state.va.us/L/GetFile.cfm?File=E:\townhall\docroot\GuidanceDocs\440\GDoc_DEQ_2196_v2.pdf). Accessed June 18, 2009.
- Virginia Department of Environmental Quality. *On-site Composting of Routine Animal Mortality*. Waste Guidance Memo No. 02-2009. Richmond, 2009.

[http://www.townhall.state.va.us/L/GetFile.cfm?File=E:\townhall\docroot\GuidanceDocs\440\GDoc\\_DEQ\\_3968\\_v1.pdf](http://www.townhall.state.va.us/L/GetFile.cfm?File=E:\townhall\docroot\GuidanceDocs\440\GDoc_DEQ_3968_v1.pdf). Accessed June 25, 2009.

Virginia Department of Game and Inland Fisheries. *Virginia Deer Management Plan, 2006-2015*. Wildlife Information Publication No. 07-1. Richmond, 2006.

Virginia Department of Transportation, Maintenance Division. *Maintenance Best Practices*. Richmond, 2008.

Virginia Department of Transportation, Workforce Safety and Health Division. *Policy for Removing Dead Animals From VDOT Right-of-Way*. Richmond, 1999.

## APPENDIX A

### SURVEYS

#### Survey 1

#### Letter Requesting Names of AHQ Staff to Send Carcass Survey

VDOT  
Virginia Transportation Research Council  
530 Edgemont Rd.  
Charlottesville, VA 22903  
October 8, 2008

To: VDOT Residency Administrators or Residency Engineers

The Virginia Transportation Research Council is conducting a study on the animal carcass disposal practices among VDOT AHQs, and we are seeking your help in encouraging staff to complete a brief online survey.

Disposal options for VDOT are decreasing as landfills and rendering facilities are increasing their restrictions and/or prices on carcasses. Given the increase in deer-vehicle collisions in Virginia over the last few decades, present problems or inefficient practices concerning VDOT's carcass disposal are expected to increase if not addressed and managed.

The survey will include questions such as:

- Disposal facility (if any) used
- Approximate distance of disposal facility to the AHQ
- Price of disposal (per animal or weight), if known
- Information on costs per year for carcass disposal, if available
- Problems/issues with disposal

Information from the survey will be used in order to:

- (1) Increase the options available to AHQs for carcass disposal. This may include localized composting units or hiring carcass management services.
- (2) Reduce costs in carcass disposal fees and associated travel expenses.

This study has received a great deal of support throughout VDOT Residencies, and we are hoping for as much participation in survey completion as possible.

We are requesting that you email (address is below) the name of the most appropriate staff member(s) in your Area Headquarters so that we can directly provide the staff with a link to the online survey.

Your help is greatly appreciated –

Bridget Donaldson  
([bridget.donaldson@vdot.virginia.gov](mailto:bridget.donaldson@vdot.virginia.gov))  
Virginia Transportation Research Council

## **Email with Link to Survey 1**

**From:** Donaldson, Bridget M.  
**Sent:** Monday, October 20, 2008 2:23 PM  
**Subject:** Animal Disposal Survey- please respond by Oct.28

As you may know, you have been designated by your Residency Administrator or Resident Engineer to respond to the survey regarding animal carcass disposal practices in your area.

The study for which this survey was designed is intended to provide VDOT AHQs additional and more efficient options for animal carcass disposal. This study has received a great deal of support throughout VDOT Residencies, and we are hoping for as much participation in survey completion as possible.

This survey is set up to be confidential, so no names will be associated with the results. It should take you no more than 10-15 minutes and your answers are important to getting results that truly reflect field necessities.

Please go to the link below, and click on "Respond to this Survey" at the top of the page. When you have completed the survey, click on Save and Close at the top of the page. You can return to the link to see incoming results if you would like.

Here is the link:  
[http://insidevdot/sites/KM\\_Surveys/Lists/Animal%20Carcass%20Disposal/overview.aspx](http://insidevdot/sites/KM_Surveys/Lists/Animal%20Carcass%20Disposal/overview.aspx)

**Please respond by Tuesday, October 28, 2008. Thank you, in advance, for your help with this.**

**Bridget Donaldson**  
Research Scientist  
**Virginia Transportation Research Council**  
Virginia Department of Transportation  
530 Edgemont Rd./Charlottesville, VA 22903  
phone 434/293-1922 fax 434/293-1990  
<http://vtrc.virginia-dot.org/>

## **Carcass Removal and Disposal Survey (Survey 1)**

The study for which this survey was designed is intended to provide VDOT AHQs additional and more efficient options for animal carcass disposal. The number of deer roadkill, in particular, is increasing each year throughout the state, yet the options for disposing of these carcasses are decreasing among many AHQs. This survey is set-up to be CONFIDENTIAL, so names will not be associated with the results. When you see the term "SPECIFY YOUR OWN VALUE," this leaves a space for you to provide a response not already listed. PLEASE RESPOND TO THIS SURVEY BY TUES., OCTOBER 28.

1. What is the process for finding animal carcasses to remove from roadways in your AHQ? (Select all that apply):
  - Bi-weekly runs around a particular route
  - Weekly runs around a particular route
  - Respond to calls/requests for pick-up
  - Remove carcasses seen while doing other road maintenance activities
  - Other \_\_\_\_\_
  
2. Please provide a best estimate of the approximate number of person hours spent each week or month on carcass removal/disposal in your Maintenance area:
  
3. Have you noticed any change over the past few years in the number of DEER roadkill along your roads?
  - Increase in deer carcasses
  - Decrease in deer carcasses
  - Have not noticed a change
  
4. If possible, please provide an AVERAGE of approximately how many DEER carcasses are removed from your roads on a weekly, monthly, or annual basis:
  
5. When you remove DEER carcasses from the road, does one of your disposal methods include burying them in the right-of-way?
  - Always
  - Often
  - Sometimes
  - Never
  
6. When you remove DEER carcasses from the road, does one of your disposal methods include setting them aside off the roadway?
  - Always
  - Often
  - Sometimes
  - Never
  
7. When you remove DEER carcasses from the road, does one of your disposal methods include taking them to a disposal facility?
  - Always
  - Often
  - Sometimes
  - Never
  
8. Do you have particular difficulties with removing or disposing of other kinds of animals (besides deer)? If so, please explain:
  
9. If you use a disposal facility, what is the name of the facility that you use? If you do NOT use a disposal facility, go to question 15.

10. What type of facility is it?
- Landfill
  - Rendering plant
  - Other \_\_\_\_\_
11. Do you primarily use this disposal facility for disposing of:
- Deer carcasses
  - Smaller animal carcasses
  - About equal numbers of both
12. How much does this facility charge for carcass disposal (per animal or per pound, etc.)?
13. Is this facility
- Along a routine route that you travel for animal pick-up or other maintenance activities
  - Out of the way, increasing your overall travel time and mileage each visit
14. If your disposal facility is out of the way, how many extra miles or minutes does it add to your schedule?
15. Are you generally satisfied with your current process for carcass disposal?
- Yes
  - No
  - Other \_\_\_\_\_
16. If you answered “No,” what aspect(s) of your carcass disposal process leave you dissatisfied?
17. Has your AHQ had to stop using or change disposal facilities in the last several years because of increased prices or restrictions?
- Yes
  - No
  - Not sure
18. In your area, are carcass management services contracted to an outside vendor?
- Yes
  - No
19. If you answered “Yes,” what service do they provide and what is the cost?
20. Would your AHQ benefit if provided with carcass disposal alternatives or additional options? Alternatives might include a composting unit (Maryland and West Virginia do this) or incinerator on the AHQ lot, or a contracted company to provide disposal services.
- No need for alternatives or additional options
  - Alternatives or additional options are definitely needed
  - Would welcome alternatives only if they were to decrease our workload and/or cost
  - Other \_\_\_\_\_

## Survey 2

### Email/Phone Survey to Determine Disposal Method at Each AHQ

**From:** Donaldson, Bridget M.  
**Sent:** Wednesday, April 1, 2009 3:20 PM  
**Subject:** Animal Carcass Disposal

Most of you have filled out an online survey on the animal carcass disposal practices in your AHQ or residency. We're doing this study in order to provide VDOT AHQs additional and more efficient options for carcass disposal. Your survey responses have been a huge help - and we couldn't do this study without you. We've learned that while some of you are satisfied with how carcass removal and disposal is going in your area, there are some areas that could definitely use alternative options that are more cost effective and/or less labor intensive.

I'm hoping you could answer just a couple simple and quick questions so we can further narrow down which areas in Virginia use which types of disposal. We now know that most of you use a combination of landfills and carcass burial/set aside, but since the surveys were confidential, we don't have a good handle on which areas of the state use each type of methods.

1. What is your VDOT Residency?
2. Is there a landfill available within your county (or within a reasonable driving distance) that will accept carcasses? (YES or NO)
3. Which method of carcass disposal do you use?
  - a. landfill only
  - b. combination of landfill and burial/set aside
  - c. burial/set aside only
  - d. contractor
  - e. other (please describe)

A response by next Wed, April 8 would be greatly appreciated.

**Bridget Donaldson**  
**Virginia Transportation Research Council**  
Virginia Department of Transportation  
530 Edgemont Rd./Charlottesville, VA 22903  
phone 434/293-1922 fax 434/293-1990  
<http://vtrc.virginia-dot.org/>





## APPENDIX B

### VDOT'S FINANCIAL MANAGEMENT SYSTEMS DATA FOR THE DEAD ANIMAL COST CENTER FOR FY 2005 THROUGH FY 2008

VDOT's Financial Management System data for Fiscal Years 2005 through 2008 show widely varying charges across VDOT districts for the dead animal cost center. For all districts together during this period, the cumulative top 12 charges are shown in Table B1.

**Table B1. Dead Animal Cost Center Data from VDOT's Financial Management System**

Dead Animal Cost Center Accounts	FY 2005	FY 2006	FY 2007	FY 2008	Total
Classified salaries (1123)	917,255	1,445,662	1,540,557	1,654,244	5,557,718
Veh Repair & Maint Materials (1355)	445,987	491,004	696,369	723,994	2,357,354
Indirect Cost-Non-Productv Time (1119)	336,062	502,257	556,055	668,793	2,063,167
HWY Rpr & Maint Services (1255)	266,368	305,564	231,525	393,425	1,196,882
Med/Hospital Insurance (1115)	149,309	245,816	275,073	291,457	961,655
Employer Retir Contributions (1111)	113,470	179,532	222,469	250,429	765,900
Manual Labor Services (1266)	129,936	121,429	81,794	116,412	449,571
Fed Old-Age Insura for Sala ST (1112)	73,868	113,982	119,840	129,608	437,299
Salaries, Overtime (1125)	62,734	66,071	52,356	71,105	252,266
Wages, General (1141)	17,606	50,176	41,027	41,550	150,360
Refuse Service Charges (1543)	26,148	49,245	15,246	21,649	112,288
Skilled Services (1268)	13,252	22,799	18,444	20,780	75,276
Total of These Charge Codes	2,551,994	3,593,538	3,850,757	4,383,446	14,379,735
Total for Fiscal Year	2,564,571	3,619,517	3,881,620	4,444,029	15,509,737



## APPENDIX C

### COST CALCULATIONS AND COST ASSUMPTIONS

#### Disposal Facility (Table 1)

Estimates of annual cost (TAC) figures in Table 1 were calculated in accordance with Eq. C1:

$$\begin{aligned} \text{TAC} &= (\text{Disposal facility costs} + \text{Monthly off-route fuel costs} + \text{Monthly off-route labor costs}) * 12 \text{ Months} \\ &= [(D * 105 \text{ lb}/2000 \text{ lb} * \text{DF}) + (M/9.5 \text{ mpg} * T * \$2.52 \text{ per gallon}) \\ &\quad + S * (M * T/45 \text{ mph}) * 2 \text{ employees}] * 12 \end{aligned} \quad [\text{Eq. C1}]$$

where

- D = number of deer carcasses per month
- DF = disposal facility cost (if any) per ton
- M = miles driven off-route per trip to disposal facility
- T = number of trips per month to disposal facility
- S = hourly salary \* 1.8 (overhead).

In the calculation of disposal facility costs, most of the facilities that charge for disposal do so by the ton. An average deer weight of 105 lb was therefore used to calculate monthly disposal facility costs. This average weight was based on Virginia Department of Game and Inland Fisheries deer harvest data from a sample size of more than 113,000, including fawns (N. Lafon, personal communication).

For the fuel cost calculation, a fuel economy figure of 9.5 mpg was used. This figure was based on the average mileage figures from eight trips during 1 month from a 2005 Ford F350 “ton truck” used by VDOT’s Fairfield AHQ. The diesel fuel cost was obtained from the website for the U.S. Energy Information Administration’s Short-term Energy Outlook, which forecasts the diesel price not to exceed \$2.52/gal before 2011 (U.S. Energy Information Administration, 2009).

The monthly labor cost calculation is based on employee time spent within the vehicle during off-route travel to and from the disposal facility and assumes an average vehicle speed of 45 mph and two-person patrols. The calculation uses an hourly rate of \$16, which is derived from the statewide average salary of a VDOT transportation operator of \$33,282. VDOT’s labor additive rate (the value of a benefits package for a VDOT employee) of 1.8, or 80% of the employee salary, was added to the base salary. Labor figures are conservative estimates because although employees in this position conduct the majority of this work for VDOT statewide, this is the lowest salaried position among the three positions that perform dead animal removal work. Transportation operation managers (TOM I and II), with a statewide average salary of \$41,187

and \$49,779, respectively, also perform this work in many areas. The calculation assumes that two employees are in the vehicle and the vehicle travels at an average speed of 45 mph..

**Contract (Table 3)**

Total annual cost (TAC) figures including labor in Table 3 were calculated in accordance with Eq. C2:

$$\begin{aligned} \text{TAC} &= (\text{monthly patrol fuel costs} + \text{monthly patrol labor costs}) * 12 \text{ months} \\ &= [(M/9.5 \text{ mpg} * \$2.52 \text{ per gallon}) \\ &\quad + (M/45 \text{ mph} * \$16/\text{hr} * 1.8 * 2 \text{ employees})] * 12 \end{aligned} \quad [\text{Eq. C2}]$$

where

M = miles driven per month.

As with the fuel calculation in Eq. C1, a fuel economy figure of 9.5 mpg and a diesel price of \$2.52/gallon was used (U.S. Energy Information Administration, 2009).

The patrol labor cost calculation is based on employee time spent within the vehicle during patrols for animal carcasses and/or trips to and from the disposal facility. As in Eq C1, the calculation uses an hourly rate of \$16 and assumes that two employees are in the vehicle and the vehicle travels at an average speed of 45 mph.

*Reallocable Labor-Hours*

To estimate the labor-hours that can be saved and potentially reallocated to other maintenance tasks if a contract were acquired (Table 3) or if the off-route trips to disposal facilities were eliminated (Table 1 and Table 6), Eq. C3 was used:

$$\begin{aligned} \text{Reallocable labor-hours per year} &= \text{Number of miles traveled per year} * 2 \text{ employees} \\ &\quad * 45 \text{ mph} \end{aligned} \quad [\text{Eq. C3}]$$

**Incineration (Table 4)**

Total annual fuel cost (TAFC) figures including labor in Table 4 were calculated by Eq. C4:

$$\begin{aligned} \text{TAFC} &= \text{Burn time for carcasses} * \text{Incinerator fuel consumption} * \text{Fuel price} \\ &= \text{IC/BR} * \text{FC} * \$5.33 \text{ per Mcf} \end{aligned} \quad [\text{Eq. C4}]$$

where

IC = incinerator capacity (lb)  
BR = burn rate (lb/hr)

FC = fuel consumption (Mcf/hr).

Annual fuel costs in Table 4 were calculated based on the burn rate (lb/hr) and fuel consumption (Mcf/hr) provided by a company representative (C. Traywick, personal communication). Calculations are based on the average deer weight of 105 lb (N. Lafon, personal communication) and a natural gas fuel cost of \$5.93/Mcf projected in 2010 (U.S. Energy Information Administration, 2009).

### **Case Studies Illustrating Cost Scenarios of On-site Disposal Methods (Table 6)**

The savings incurred from on-site compost windrows were based on Eq.C1 and accompanying assumptions.

The reallocable labor hours/year from onsite disposal were based on Eq. C3 and accompanying assumptions.

The number of years to recoup costs in Table 6 was calculated by Eq.C5:

$$NPV = I + OC (df) - AC (df) \quad [Eq. C5]$$

where

NPV = net present value

I = investment, or cost of equipment

OC = annual operating costs of new equipment, such as fuel costs

AC = annual costs of current practices

df = discount factor =  $f(i, n)$ , where  $i$  = interest rate or discount (0.05) and  $n$  = number of years.

The calculations in Table 6 were based on multiple assumptions. Because most surveys implied that small animals are often set aside or buried and large animals are taken to a disposal facility, it was assumed that all deer are taken to a landfill. Based on the number of deer carcasses provided by survey respondents, two or three trips to the landfill were assumed per week. As with other calculations, fuel costs were based on a diesel fuel price of \$2.52/gal (U.S. Energy Information Administration, 2009) and reallocable labor-hours were based on two-person patrols traveling 45 mph. Equipment costs were based on the capacity recommended to accommodate the monthly number of deer carcasses.

### **Reference**

U.S. Energy Information Administration. Short-term Energy Outlook, May 12, 2009.  
<http://www.eia.doe.gov/steo>. Accessed May 29, 2009.