Tennessee Department of Transportation
Office of Internal Audit

Government Accountability Professionals

Audit of the Salt Management Process

FINAL REPORT

Date Issued:
April 7, 2014

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The mission of the Office of Internal Audit is to provide objective analysis and information critical to better decision making and enhancing the overall governance capability within the Tennessee Department of Transportation.

EXECUTIVE SUMMARY
April 7, 2014

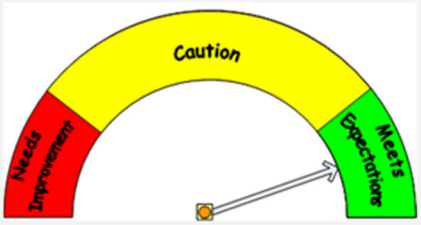
Results in Brief	Recommendation
A Performance Audit of TDOT's Salt Management process was conducted. Key audit objectives and conclusions were as follows: • *Do extended driving hours increase TDOT's accident rates?* **Generally no**. TDOT accident rates compare favorably to FHWA benchmarked studies. However, incorporating policies and procedures to specifically restrict excessive driving hours during snow response events could result in improved operations and increased safety. **See Observation A**	**Internal Control Evaluation**  *Indicates processes are managed or optimized.* **Key recommendations of this report include:** • Develop a policy that restricts excessive driving hours during snow and ice events. **Appendix A includes a process improvement evaluation that would enable TDOT to realize potential cost savings by revising current salt contracting and purchasing methodologies.**

TABLE OF CONTENTS

INTRODUCTION

AUDIT INITIATION

The audit of the Salt Management Process was initiated as part of the amended 2013-2014 annual audit plan presented to, and approved by, the former Chief Operating Officer for the Tennessee Department of Transportation. For this Performance Audit, we evaluated existing salt management, policies, procedures, processes, and operations, as well as other related activities, in existence during the three-year period of July 1, 2010 through June 30, 2013.

BACKGROUND

TDOT's Maintenance Division is responsible for the administration of statewide highway and bridge maintenance services. Their work helps to ensure the safety, user convenience, and conservation of the aesthetic qualities of Tennessee's roads and bridges.

Although TDOT's maintenance operations are relatively decentralized between the four regional offices, TDOT Headquarters' Maintenance Division provides the overarching direction, guidance, support, and assistance to field maintenance forces.

Headquarters' Maintenance Division is responsible for oversight functions of the road salt management process; these include:

- Developing Standard Operating Guidelines for all winter maintenance processes to improve consistency and uniformity of maintenance activities across the state.
- Providing budgetary planning and financial oversight for a cost effective statewide maintenance program.
- Support of the Maintenance Management System (MMS), as well as collecting and analyzing data to insure cost-effective maintenance efforts across the state.
- Working with the Environmental Compliance Office on maintenance issues related to the environment.

The four regional offices, in conjunction with their district and county offices are responsible for the following winter weather maintenance functions:

- Maintaining the appropriate inventory levels of salt and snow fighting equipment.

- Developing snow removal plans, maintain and calibrate equipment, assign routes, and train employees.
- Performing snow and ice fighting functions when a snow event occurs, including producing salt brine, loading brine and salt onto trucks, and distributing it as necessary until the snow event has ended.

TDOT's maintenance personnel deploy a variety of innovative methods and materials to help prevent snow and ice formation and promote safe travel on Tennessee state highways. However, due to the dynamic and varied nature of winter weather events and the resulting road conditions, the relative outcomes of snow and ice control operations will vary depending upon several factors, namely: the severity and type of winter weather events, topography, traffic levels and speeds, and proximity to support facilities (i.e. liquid chemical storage tanks and salt stockpiles). While snow and ice fighting effectiveness can be measured in a variety of ways, it is ultimately the motoring public that measures TDOT's maintenance efforts in terms of road conditions before, during, and immediately after winter weather events.

Operational Information

Winter maintenance activity is a year-round process. Preparations for the next snow-fighting season begin shortly after the end of the outgoing winter. First, county and district offices utilize this time to plan and determine the type and amount of any additional inventory for the next winter season. Secondly, and after the needs are enumerated, salting equipment and materials such as sodium chloride (rock salt), calcium chloride, beet juice, and potato juice are ordered and delivered to locations across the state. The county maintenance offices also use this time to assign snow routes and to train new personnel on standard operating procedures

Once the winter season is underway, the maintenance facilities conduct three basic activities related to either a preemptive or a reactive snow/ice response, namely: anti-icing (spreading brine), de-icing (spreading solid salt), and snow/ice plowing. These activities are controlled at the regional, district, and county office level depending on the area affected.

Preparation is the key to an effective snow/ice response effort. The process begins with diligent monitoring of prevailing weather conditions. Accurate prediction shortens lead-time needed to initiate anti-icing activities. Primary responsibility for monitoring inclement weather lies with the Regional Maintenance Manager in each of the four regional offices. Once inclement weather is expected, the regional offices and the headquarters Maintenance Division participate in a joint conference call to discuss the characteristics of the storm, the potential effects in each region, and the most effective response strategies. The Regional

Maintenance Manager puts all maintenance offices in the region "on notice" as necessary and employees report to their pre-assigned locations. At this time, salt brine is prepared, tanks are filled with the solution, trucks are loaded with salt, and equipment is inspected and fueled.

Once it has been determined that snow or icing is likely, the Regional Maintenance Manager gives the order to begin applying brine to roads in the region. Some regional offices will add either beet juice or potato juice to the brine solution. The additives increase the brine solution's ability to effectively adhere to the road. When ice and snow begin to accumulate on roads, the control of the activity shifts to each District's Maintenance Supervisor, who makes the decision whether to spread salt or continue to apply brine depending on road conditions in his district. Anti-icing and de-icing activities continue each day until the roads are clear.

During a specific snow event, salt usage is affected by factors such as ambient temperature, precipitation type (snow/ice/sleet), duration of the precipitation, and pavement temperatures. Salt usage is also affected by the composition of the terrain, which varies significantly within and among the regions - mountainous vs. level, urban vs. rural, interstate vs. local highway. Geography also influences the amount of road salt used during winter. Generally, Region 1 (Knoxville) will have the most snow events and salt usage. Region 2 (Chattanooga) and Region 3 (Nashville) use approximately the same amount, and Region 4 (Jackson) uses the least. Unused salt is carried over from one year to the next.

Exhibit A – Regional Snow and Ice Assets

	Region 1	Region 2	Region 3	Region 4	Totals
Number of Counties	24	24	26	21	95
Number of Lane Miles	9,178	7,631	11,158	9,625	37,592
Number of Area Salt Bins	30	38	34	29	131
Lane Miles per Salt Bin	306	201	328	332	**n/a**
Number of Salt Trucks	215	180	244	152	791
Lane Miles per Salt Truck	43	42	46	63	**n/a**

Source: 2013 "TDOT Snow and Ice Facts"

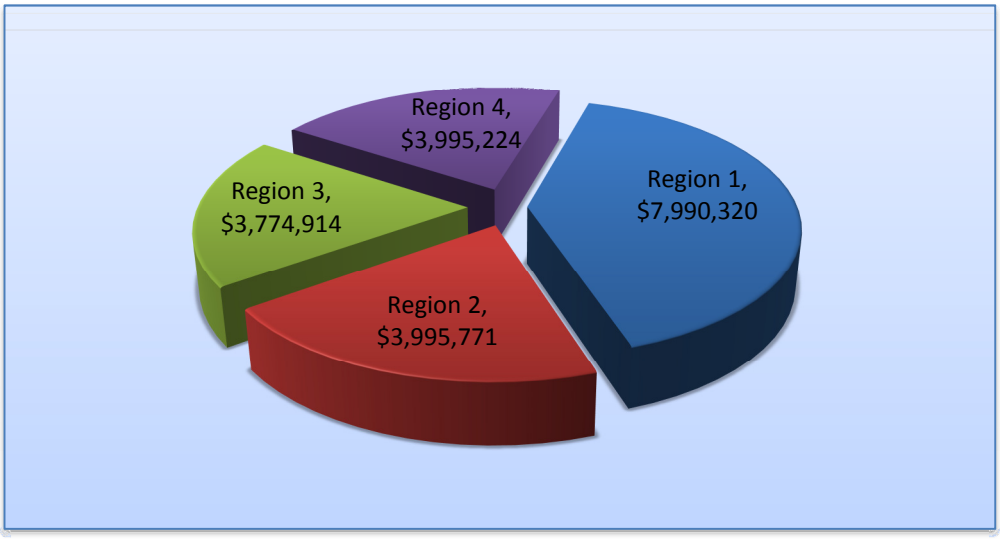
Financial Information

Budgeting annual expenses related to salt usage is very difficult because snow and ice removal equates to big dollars. Costs and spending fluctuate with the severity and mildness of the winter. Throughout the state, the work involved for snow and ice affects both the overall budget from material needs, fuel, equipment, and personnel costs.

To simplify the salt budgeting process, TDOT utilizes an annual fixed budget for snow and ice activities set at slightly less than $20 million for FY 2013; this amount uses the expenses incurred during the heavy snow winter of 2010-2011 as the basis. Of this $20 million, roughly $12.4

million is allocated to materials (salt, beet juice, calcium chloride, etc.) The budgeted amount is allocated 40 percent to Region 1 and 20 percent for Regions 2, 3, and 4.

Exhibit B – FY 2013 Snow and Ice Budget per Region



Source: 2013 "TDOT Snow and Ice Facts"

Actual expenses associated with snow and ice operations depict the fluctuations brought about by variations in the severity of winter weather. During the audit period assessed, TDOT's road salt expense varied widely from year to year. During the severe winter of FY-2011, the cost for road salt hit a five-year high of $14.6 million but fell to $2.3 million the following year. Road salt is purchased through a statewide two-year contract.

Exhibit C – Five -Year Salt Usage by Region in Tons

	Region 1	Region 2	Region 3	Region 4	Totals
FY- 2009	34,886	11,848	12,311	12,442	71,487
FY- 2010	65,620	42,169	33,454	17,726	158,969
FY- 2011	62,029	57,874	42,429	17,880	180,213
FY- 2012	14,712	5,960	3,505	781	24,958
FY- 2013	35,058	12,751	8,652	2,559	59,020
Five -Year Average	**42,461**	**26,120**	**20,007**	**10,278**	**98,929**

Source: MMS

Exhibit D – Five-Year Snow and Ice Labor and Equipment Expenses

	Region 1	Region 2	Region 3	Region 4	Totals
FY- 2009	$ 2,866,590	$ 1,122,179	$ 1,340,151	$ 1,035,749	$ 6,364,669
FY- 2010	4,900,364	2,310,408	2,584,742	1,685,614	11,481,128
FY- 2011	5,219,544	3,313,639	3,792,235	2,238,867	14,654,285

FY- 2012	2,180,780	1,318,578	847,400	566,282	4,913,040
FY- 2013	3,163,601	2,007,617	1,766,342	1,018,311	7,955,871
Five -Year Average	**$3,666,176**	**$ 2,014,484**	**$ 2,066,174**	**$ 1,326,965**	**$ 9,073,799**

Source: MMS

Exhibit E – Five-Year Snow and Ice Materials Expenses

	Region 1	**Region 2**	**Region 3**	**Region 4**	**Totals**
FY- 2009	$ 2,778,340	$ 737,080	$ 797,741	$ 684,348	$ 4,997,509
FY- 2010	5,799,854	2,688,571	2,376,305	1,322,356	12,187,086
FY- 2011	5,757,935	4,185,900	3,266,633	1,394,998	14,605,466
FY -2012	1,327,236	563,502	317,896	77,348	2,285,982
FY -2013	2,936,446	1,336,126	733,969	337,060	5,343,601
Five -Year Average	**$ 3,719,962**	**$ 1,902,236**	**$ 1,498,509**	**$ 763,222**	**$ 7,883,929**

Source: MMS

Commendable Achievements

The Maintenance Division's winter maintenance activities are essential to the safe movement and transport of people and commodities throughout the state. The Maintenance Division and the 12 Super District offices have the unenviable task of clearing the roadways and making travel less hazardous. The following highlights TDOT's best practices during winter maintenance activities:

- The Maintenance Division's coordinated and proactive monitoring of roadway conditions as well as the prioritization of route clearances during winter storm events help increase motorist safety and ease of travel.
- The proactive approach of utilizing anti-icing measures to help prevent freezing roadways before anticipated snow and ice events.
- Anti-icing measures also reduce the amount of rock salt used, thereby making winter maintenance more economical.
- TDOT's innovative use of brine additives has garnered praise and recognition from various local governments and other state DOTs.
- The use of ground speed controllers, which limit salt distribution to a predetermined rate per lane mile, has resulted in increased efficiency of salt usage.
- The Maintenance Division is expanding its capability to distribute road salt that is pre-treated with calcium chloride, thereby improving melting effectiveness and road safety at temperatures below 25 degrees.

OBJECTIVES AND CONCLUSIONS

1. *Do extended driving hours, during snow response events, increase accident rates for TDOT?*

Generally no. TDOT Property Damage Accident Reports were analyzed for calendar years 2011 and 2012. The information from the accident reports were cross-referenced with information obtained from MMS regarding snow and ice events. Using this methodology, a total of 37 of 444 accidents were identified as associated with snow and ice response. The number of accidents represented an 8.3 percent occurrence rate, which compares favorably to an 11-year FHWA accident study issued in 2005. The accident study showed that 6.3 percent of nationwide accidents occurred during snow, slush, sleet, or ice response conditions.

Numerous factors can contribute to vehicular accidents such as: prevailing weather conditions (fog, rain, snow, and ice), terrain, vehicular speed, equipment condition, roadway design, roadway maintenance, and driver behavior. In most instances, it is a combination of these factors that is responsible for an accident. However, regardless of the causative factors, TDOT's marginally higher rate than those shown in the national study could be indicative of opportunities to improve operational processes.

In that regard, we noted an instance where internal processes could be enhanced. It was noted that TDOT could benefit by creating a standard operating policy that restricts excessive hours during snow/ice response events. Incremental improvements in this area could translate into decreased accident rates, improved safety, and improved cost control. (See Observation A)

2. *Are controls in place to ensure the physical security of TDOT assets and salt inventory at remote storage locations?*

Generally yes. As part of assessing the salt inventory practices, we conducted random site visits to 31 salt bin locations across the state. We noted variances in the implementation of physical security measures for both the salt storage bins as well as TDOT equipment at those locations. Of the 31 sampled locations, 5 were unfenced, unmanned, or had minimal security in place. Of the 26 locations, which were fenced, we found eight offices (31%) that were either unlocked or had a dummy lock in place with no staff on site. This condition placed the security of the salt inventory and TDOT's equipment at risk. Although salt inventory was considered a medium level risk in those unlocked and unmanned locations, equipment security poses a higher level of risk because of the value of the equipment. Our analysis indicated that the risk exposure has an approximate collective value of $4.4 million in those eight

locations. Because of the immediate need to safeguard TDOT assets, Internal Audit addressed this issue shortly after conclusion of the site visits. An email memorandum was circulated to the respective Regional Directors, and their maintenance operations group to address security concerns. We will follow-up on subsequent site visits to ascertain whether the planned responses were implemented.

Exhibit F – Security at Fenced and Unfenced TDOT Storage Facilities

Source: TDOT Internal Audit Site Assessment

3. *Are controls in place to ensure the accuracy of snow response information within MMS?*

Generally yes. MMS is the primary computer application used by the Maintenance Division to plan service for maintenance activities. MMS keeps a running total of inventory including equipment, salt, other materials, used for snow response activities. MMS enables TDOT to systematically measure and monitor maintenance budget and performance data as well as develop annual work plans based on accurate projections of work force and equipment needs. The accuracy of MMS data is critical for the efficient and effective management of the operation.

Determining the accuracy of system information was conducted by examining whether data was recorded for compliance with specifications outlined within the Maintenance Division's Standard Operating Guidelines (SOG). The guidelines specify that only activity codes 461 - De-Icing (Rock Salt) and 463 - Anti-Icing (Salt Brine) have recorded data

for material usage. Activity code 460 - Plowing Snow and Ice, should not reflect material usage within the system. Our reviews of 21,235 Daily Work Reports (DWR's) associated with snow response codes, from all 95 counties, indicated an 8 to 8.5 percent error rate in recorded information. The results indicate that information was usually recorded in the appropriate activity code. No other issues were noted.

4. *Is the use of outsourced services for snow plowing and anti-icing service in Region 3 cost effective?*

Yes. Analysis of the fee structure for Infrastructure Corporation of America (ICA) indicates that it is currently cost effective to use ICA to supplement TDOT capabilities for snow response activities in Region 3.

TDOT Region 3 has contracted with ICA to provide 19 salt trucks and drivers on an on-call basis for plowing and salting service, during times of maximum stress on the system. Usage figures for the first year of ICA's contract with TDOT (FY 2013) shows that ICA billed 1,356 total hours at a total cost of $105,609. TDOT's total cost of using ICA for snow fighting activities in FY 2013 was compared to the cost of using TDOT employees to perform the same work. Breakeven analysis shows that the number of hours billed by ICA would have to extend to 4,798 hours annually before it becomes more cost effective to provide these services in-house.

The ongoing process of merging the Maintenance and Construction operations should result in additional existing TDOT employees having a Commercial Driver's License (CDL). In turn, the resulting condition would enhance the Department's capacity to perform snow response activities. The merger may also allow a reduction in the frequency of using outside contractors to provide snow response services.

OBSERVATIONS AND RECOMMENDATIONS

A – Ad Hoc Driving Hour Policies Need Improvement.

TDOT practices across the state regarding the extent of employee driving hours during snow response events vary significantly between regions. Analysis of 34,156 records of MMS Report of Hours Worked, related to driving during snow fighting events, showed 5,600 instances where drivers logged 16 or more hours for a given day. The review also noted 1,043 instances where drivers worked as many as 24 consecutive hours during snow event periods.

A benchmarking review of policies from five other state DOTs, as shown below, reveals varying policies in setting maximum numbers of driving hours. Taking into account management's need for flexibility, and the foreseeable process improvements due to the merger of the construction and maintenance groups, it would still be beneficial to institute defined policies that restrict daily maximum driver hours. Establishing policies for maximum driving hours would increase TDOT's safety margin, enhancing employee welfare and the safety of the motoring public.

Exhibit G – Benchmarked Policies from Other State DOTs

State	Policy Source	Policy
Connecticut	Bureau of Engineering and Highway Operations	17 hours maximum, followed by a 3-hour rest break.
Indiana	Human Resources	12-hour shifts for snow-fighting. Except in unusual and/or emergency circumstances, employees will neither be required nor allowed to work a shift more than 16 hours. After working a 16-hour shift, an employee must be off for a minimum of 8 hours prior to returning to work.
Pennsylvania	Maintenance Performance Division	Standard 8-hour shift with an additional four hours allowed for intense events
Washington	Maintenance	No more than 15 consecutive hours, followed by a rest period of eight consecutive hours.
Virginia	Maintenance	12-hour shifts for snow fighting.

Source: Internal Audit Benchmarking Procedures

Criteria:

- Policies and procedures guides from other states' Department of Transportation.
- TDOT Maintenance Management System.
- Prudent business practice.

Risks:

- TDOT employee accidents pose a safety risk to employees and the driving public.
- Employee accidents increase the risk of property damage and liability costs to TDOT.

Recommendation:

Implementation of a statewide standard for driving hours and rest times during snow response activities would provide controls that balance operational needs with the safety of TDOT drivers and provide a safe and reliable transportation system for the public during snow events.

GENERAL AUDIT INFORMATION

STATEMENT OF COMPLIANCE WITH GAGAS

We conducted this performance audit in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the work to obtain sufficient, appropriate evidence to provide a reasonable basis for our observations and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our observations based on our audit objectives.

SCOPE AND METHODOLOGY

The audit of the Salt Management process was conducted from September 2013 to March 2014. The audit period focused primarily on transactions covering the period July 1, 2010 through June 30, 2013.

The methodology employed throughout this audit was one of objectively reviewing various forms of documentation including financial information, written policies and procedures, contracts, and data in various forms.

CRITERIA

In conducting this audit, the existing processes were evaluated for compliance with:

- Tennessee Department of Transportation, Standard Operating Guidelines.
- U.S. Highway Crashes in Adverse Road Conditions (2005), USDOT, Federal Highway Administration.
- Policies and procedures guide from other states' Department of Transportation.
- The Committee of Sponsoring Organizations Internal Control Integrated Framework.
- Prudent business practices.

STAFF ACKNOWLEDGMENT

Anne Carlisle, MBA – In Charge Auditor
Grant Gouveia, CFE – Audit Manager
Danny Hall, CFE – Audit Support
Mel Marcella, CPA, CMA, CIA, CISA, CFE – Quality Assurance

APPENDIX A. COST SAVING OPPORTUNITIES

Background

The Central Procurement Office of the Department of General Services provides centralized procurement functions for the state government, including the administration of Statewide Contracts in general and Statewide Contract 507-Rock Salt in particular. The TDOT Maintenance Division provides material and delivery specifications to the Central Procurement Office (CPO) as part of the rock salt contract award process performed by the CPO. (See Contracting Negotiation Timeline at the conclusion of this appendix). Tennessee currently has existing contracts with two providers of rock salt, Morton Salt Inc. and North American Salt Company, for delivery of rock salt to salt bins across the state. The current contracts run for a two-year period, May 16, 2013 through May 15, 2015.

The amount of rock salt used per year in Tennessee has varied widely over the past five years, from a low of 24,958 tons in FY 2012 to a high of 180,213 tons in FY 2011. Similarly, the cost of materials has ranged from a low of $2.3 million to a high of $14.6 million annually.

TDOT Rock Salt Contract Specifications

TDOT provides potential vendors with no annual minimum or maximum purchase quantities in the contract specifications. Delivery is required to the specified salt bin within seven working days of receipt of the purchase order. The flexibility in material purchase quantities and delivery specifications provide TDOT with the maximum flexibility in the delivery of rock salt when and where it is needed.

TDOT's total cost of rock salt is inclusive of both material and delivery costs. Transportation accounts for approximately 21% of total rock salt cost statewide, or $1.1 million based on the 2013 total snow and ice materials expense. Transportation percentages vary from 15% in Region 3 to 27% in Region 4.

The Ohio Model

The changes in procurement specifications that the Ohio Department of Transportation recently initiated are illustrative of the potential for cost savings in the cost of rock salt. Ohio purchases approximately 600,000 tons of rock salt annually. After consultation with their vendors, the Ohio DOT revised their purchase specifications from an "on-demand" system, similar to the system now used by TDOT, to a system that guarantees a range of minimum and maximum annual purchase

quantities. During the first year of the guaranteed contract (2012), Ohio guaranteed a minimum purchase of 50% and a maximum purchase of 150% of a specified quantity. The second year (2013), the purchase amounts were refined to 80%-120% of a specified quantity.

A comparison of rock salt prices in Ohio over the two-year period shows a reduction in the cost of rock salt by approximately $25.00 per ton, from $60.00 per ton in 2011 to $35.00 per ton in 2013. To ensure a secondary supply of rock salt, Ohio also requires their second lowest bidder to provide rock salt at the bid price if the purchase quantities in the primary contract are met or if the primary vendor cannot fulfill their contract obligations.

Opportunities for Tennessee

In comparison, TDOT's average cost per ton for rock salt, including transportation, was approximately $74.00 per ton in 2013. The average price per ton ranges from a low of $67.70 in Region 3 to a high of $80.00 in Region 1. Based on the average annual usage of 100,000 tons statewide, each $5.00 reduction in the price per ton could mean an annual cost saving of approximately $500,000 to TDOT. TDOT's current system offers the opportunity to explore potential changes in contract specifications that may result in cost reductions but that do not affect the effectiveness of snow response activities.

Recommendation

The potential exists that changes to contract terms and conditions may favorably impact salt prices in upcoming contract negotiations. We recommend that the CPO, at the request of and in conjunction with the TDOT Maintenance Division, conduct pre-bid inquiries with vendors to ascertain the sensitivity of salt prices to potential changes in TDOT's bid specifications. This information can be used to inform a discussion at TDOT regarding the feasibility, costs and benefits of any potential contract specifications or modifications.

Topics for discussion may include, but not be limited to:

- Guaranteed annual minimum purchases.
- Guaranteed annual maximum purchases.
- Centralized delivery locations.
- Changes in delivery terms.
- Changes in storage or bin capacity required by potential changes to minimum and maximum purchase quantities.
- Potential for high-capacity centralized storage location(s).

Contract Negotiation Timeline
Statewide Contract 507 - Road Salt

October	Central Procurement Office (CPO) opens discussions with TDOT about specifications for the new solicitation. CPO conducts vendor meetings.
November/December	CPO continues analysis / constructs solicitation structure.
February	TDOT provides salt usage figures for the previous calendar year to CPO.
March	CPO finalizes Invitation to Bid and sends to current and prospective vendors.
April	CPO deadline to receive bids from vendors.
April / May	CPO negotiates target prices and gets Best and Final Offer.
May	CPO announces Recommended Contract Awards and awards contracts.

APPENDIX B. MANAGEMENT RESPONSES

- Management's Responses Begin on Next Page –

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April 4, 2014

Mel Marcella
Director of Internal Audit
505 Deaderick Street, Suite 1600
Nashville, TN 37243

Subject: Acknowledgement of Salt Management Process Audit

Dear Mr. Marcella:

This letter is being sent to acknowledge my receipt and review of the draft Salt Management Process audit report. This report was provided to me by email on March 28, 2014.

The report includes one observation with an accompanying recommendation regarding the need for limiting the hours that employees work in a particular shift during ice/snow removal operations. I am in agreement with the recommendation and I will work with the TDOT Human Resources Office to develop a policy that addresses this issue.

Please feel free to contact me if you have any questions or comments regarding this matter.

Sincerely,

Jerry L. Hatcher, P.E.
Maintenance Division Director

cc: Mr. Greg Duncan
Ms. Delaine Linville
Mr. Estel Hagewood

Maintenance Division
Management Responses to Audit Recommendation – April 2014

Report Item and Description	Response to Recommendation / Action Plan	Assigned Responsibility	Estimated Completion
A. Implementation of a statewide standard for driving hours and rest times during snow response activities would provide controls that balance operational needs with the safety of TDOT drivers and provide a safe and reliable transportation system for the public during snow events.	*The Maintenance Division accepts this recommendation. The Maintenance Division and the Human Resources Division will work jointly on development of a policy that establishes limitations on hours per work shift.*	*Jerry Hatcher - Maintenance* *Delaine Linville – Human Resources*	*October 31, 2014*

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