

Road Salt Use on the Edgewood Campus

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Abstract:

Road salt (primarily sodium chloride) is widely used as a winter de-icer on paved surfaces in northern climates. High levels of sodium chloride can negatively affect the health and sustainability of life in the watershed. Road salt use in the Lake Wingra Watershed in Madison, Wisconsin is of concern because it contributes to high levels of sodium chloride in Lake Wingra. The purpose of this study was to determine if excessive levels of road salt were used on the Edgewood Campus. I took quadrat samples on Edgewood's parking lots and sidewalks to determine how much salt is left over after melting events. My hypothesis was that an excess amount of road salt would remain after road salt melts the ice and snow. Results supported this hypothesis. An average excess of 86 grams per square meter remained on the parking lots and an average excess of 107 grams per square meter remained on the sidewalks. Based on these calculations, and assuming 23 de-icing events each year (the average number of annual road salt applications by the city of Madison, 2000-2006), about 188 tons of road salt is applied annually to the paved impervious surfaces on the Edgewood Campus. Of this total application, an estimated 169 tons (7.3 tons per event) is excessive (that is, beyond what is needed to de-ice). I discuss possible implications of these results for watershed health and management, including alternatives to the use of road salt.

Introduction:

Road salt is used to melt ice and snow in parking lots, on roads, and on sidewalks. The chloride levels in Lake Wingra have risen since the 1959-60 season, the "start of recorded use of salt as road de-icer" (Salt Use Subcommittee). Before the 1950s, when Madison began road salting, chloride levels were below 10 mg/L. Since 1973, there has been an effort to reduce the amount of road salt in the Lake Wingra Watershed. Despite this, levels have risen as high as 302 mg/L during the spring snowmelt (WRM Workshop, 1999). Road salt affects the chloride levels in Lake Wingra, thus affecting the vegetation. By infiltrating groundwater, road salt can also affect chloride levels in drinking water. Some city wells in Madison have exceeded the EPA recommended maximum sodium levels (Salt Use Subcommittee, 2006).

"Excessive amounts of chloride can affect the survival, growth, and reproduction of freshwater aquatic life" (WRM Workshop, 1999). There are different ways road salt moves through the watershed. It may dry "to powder [and then be] transported by wind to other locations". Road salt is also passed through a watershed by infiltrating the soil and groundwater. Salt may run "downhill through the gutters and storm sewers into" bodies of water (Salt Use Subcommittee, 2006). Although there are negative affects to using road salt, it "has been proven an effective, economical, and readily available material" for cities, municipalities, and private contractors (WRM Workshop, 1999).

The Edgewood Campus sidewalks are salted by Edgewood College staff and the parking lots by a private contractor and there are not regulations or procedures for the amount of road salt applied. Runoff from road salt used on Edgewood Campus contributes to the chloride levels in Lake Wingra. I wanted to find out how much extra road salt remained on Edgewood College sidewalks and in the parking lots after the salt had melted ice and snow. Remaining road salt after a melting event indicates too much road salt was used. My hypothesis is that excess road salt will remain after a melting event. To test this hypothesis, I collected the salt that remained after melting of snow and ice. I collected samples from locations on Edgewood College sidewalks and parking lots. If there is excess, the Edgewood Campus and

private contractor could use less road salt for de-icing and potentially reduce runoff into Lake Wingra. If my hypothesis is wrong, then the Edgewood Campus and private contractor are using a reasonable amount of road salt.

Methods:

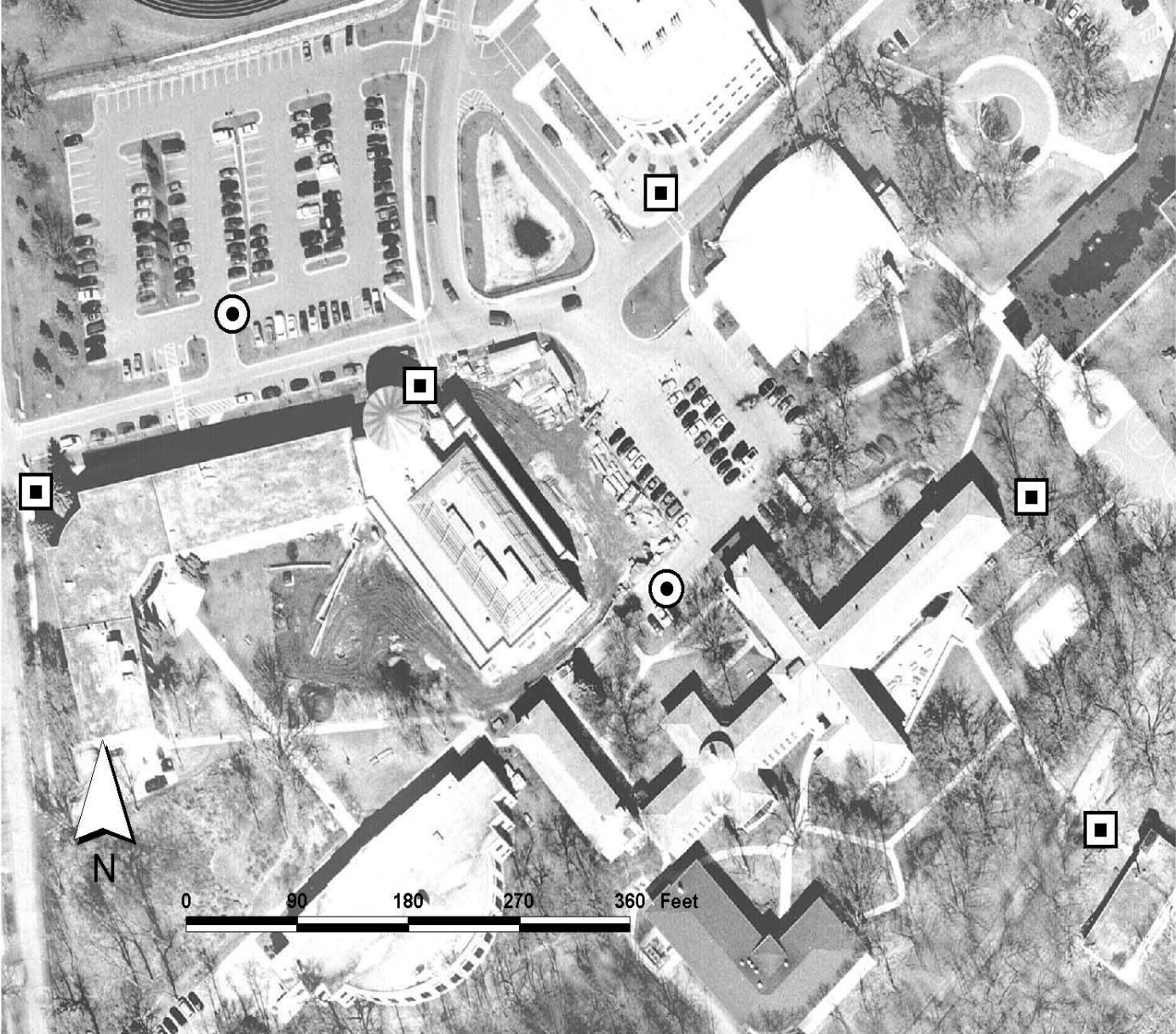
I took 0.25 meter² quadrat samples from the Edgewood parking lot and sidewalks. There were seven total samples taken after a salting event; five from the sidewalks and two from the parking lots. The areas of sidewalks where salt was gathered are around the main campus, and receive a fair amount of foot traffic. Only two samplings from the parking lots were collected because the spreader on the trucks produces more even distribution. Samplings were performed at approximately the same locations each time on 12/1/2008, 12/6/2008 and 2/27/2009 (sidewalks only) (Figure 1). I collected the salt samples from the parking lots in one ziplock bag and the salt samples from the sidewalks in a second ziplock bag, using a clean broom and dust pan for collection. When I performed collections, there was no or little visible ice or snow remaining on the sidewalks, indicating melting had occurred (that is, the salt I collected was excessive; it remained after the other salt had de-iced). The ziplock bags were labeled with date and sampling area and placed in a freezer until weighing.

I recorded the tare weight for empty, clean oven-proof trays then placed the salts in the trays. Each ziplock bag was put into one tray labeled with the date and location of the sample. I picked out larger debris with a forceps, but left debris that was stuck to salt. The trays were placed in the drying oven for at least 24 hours to remove water weight from snow and ice. After salts were dried, remaining visible debris was picked out. Trays were weighted with the dry salts and the weights were recorded. The dried salt was stored in labeled ziplock bags.

To interpret the results, I looked at guidelines given by the City of Madison and Green Venture, an organization that promotes environmental sustainability. The City of Madison uses 150 pounds of road salt/lane mile (Salt Use Subcommittee, 2006). A lane-mile is a one-mile distance that one lane occupies; on a two-lane street, one mile is equal to two lane miles. The average width of a lane is 10-12 feet (Parsons Transportation Group). To calculate the amount of salt that should be used on the Edgewood parking lots, I used this number as a guide. Per square meter, this is about 12 grams.

I used the data I gathered to estimate the amount of road salt used on the entire Edgewood Campus. Based on data from College records, there are 15.4 acres of paved impervious surfaces (Johnson, Johnson, & Roy, Inc., 1997). From 2000-2006, the city of Madison averaged 23 road salt applications annually (Salt Use Subcommittee, 2006). I used this number to calculate how many tons of road salt are used annually on the Edgewood Campus, and how much of this can be considered excessive.

Figure 1: Map with labeled sampling sites. ⊙ represents parking lots. □ represents sidewalks.



Results:

My results showed an average of 129 grams of excess salt/meter² was used on the sidewalks and an average of 86 grams of excess salt/meter² on the parking lots. Table 1 shows the amount collected at each sampling and the average amount used. Table 2 compares the average amount used on the parking lots and on the sidewalks. An average of 107 grams of salt remained at each sampling. Estimating 12 grams had already been used to melt snow and ice, an average of 119 grams of salt was used per square meter per salting event. When I calculated the campus total for annual road salt application on paved impervious surfaces, I found that 188 tons are used annually on the Edgewood Campus, 169 of which can be considered excessive (they are beyond what is needed for de-icing). The amount of excessive salt is about 90% of the amount applied. Table 3 compares the total estimated amount of road salt used on the Edgewood Campus, the amount needed to de-ice, and the estimated excess. Table 4 compares the amount of road salt Edgewood uses per acre to the amount the City of Madison uses per acre to maintain its comparable paved areas. I found that Edgewood applies road salt at 7.7 tons per acre, while the City of Madison applies road salt at a rate of 2.1 tons per acre.

Table 1: Result of Samples. The average salt/meter² indicates the amount of excess road salt.

Sample Date	Sidewalks g/m ²	Parking Lots g/m ²
12/1/2008	180.6 g	45.0 g
12/6/2008	102.8 g	127.8 g
2/27/2009	105.4 g	
Average g/m²	129.6 g	86 g

Table 2: Comparison of average excess road salt on sidewalks and parking lots.

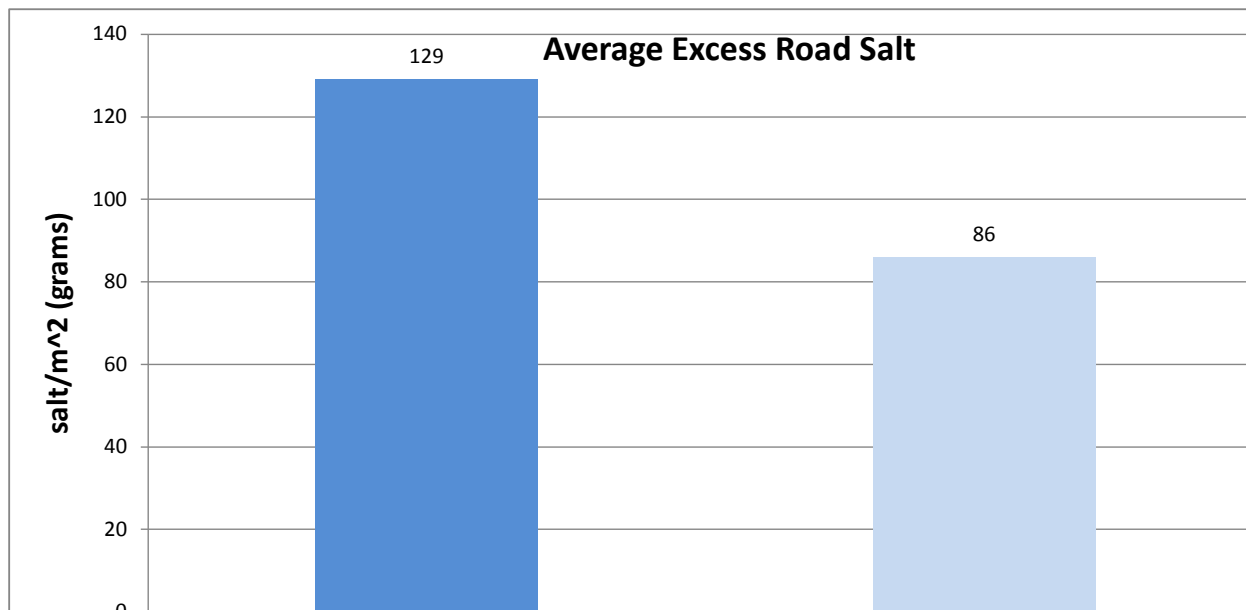


Table 3: Comparison of the estimated total annual salt use on Edgewood Campus, road salt used to de-ice, and excess amounts of road salt.

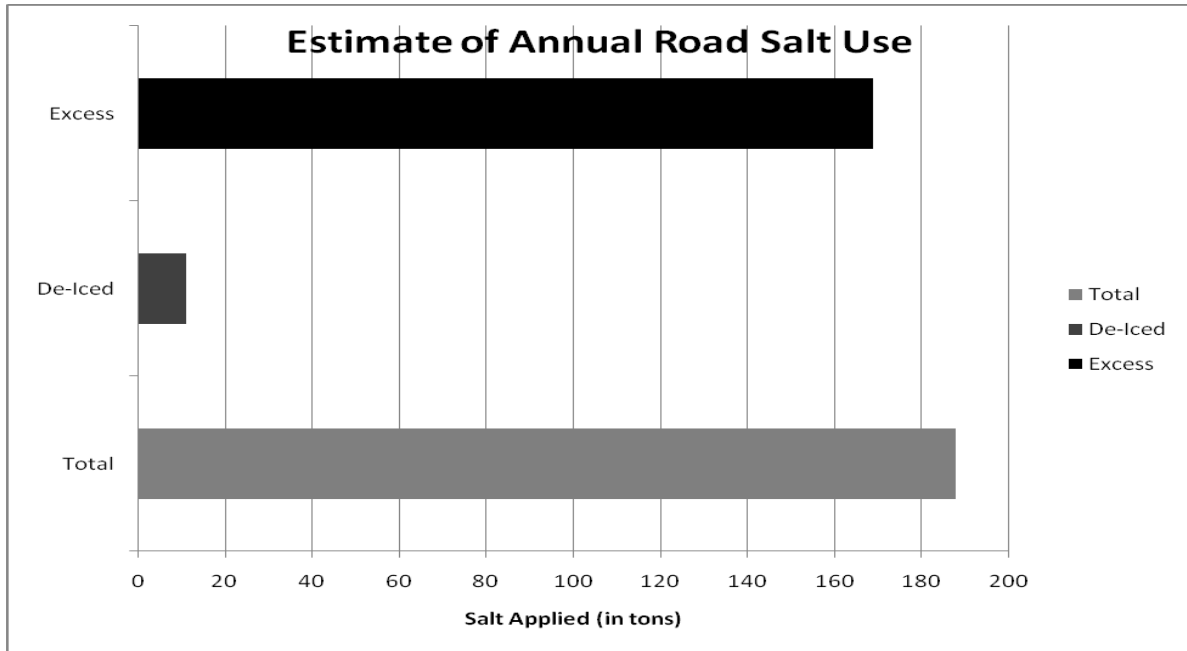
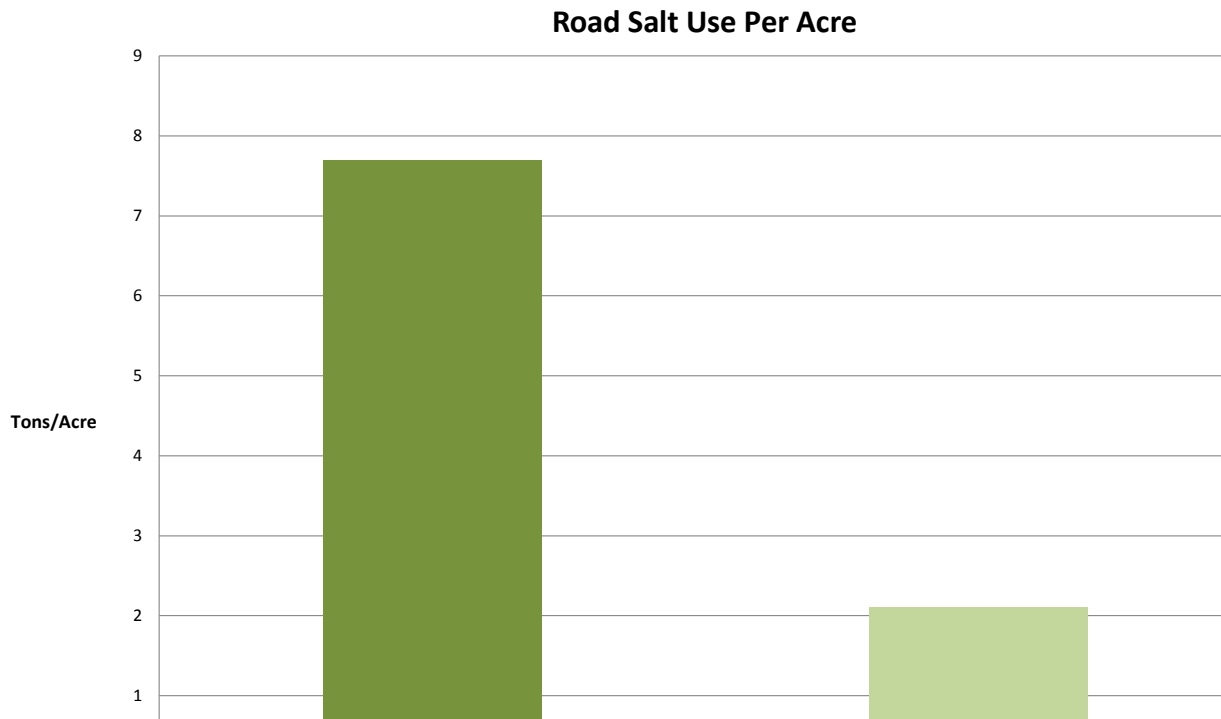


Table 4: Comparison of tons of road salt per acre that the City of Madison and Edgewood Campus use.

□



Discussion:

The results show that considerable excess road salt remains on Edgewood Campus sidewalks and in parking lots after ice and snow are melted. Frequent excess use of road salt contributes to high sodium chloride concentrations in Lake Wingra and the springs. My hypothesis was that excess road salt

remains after a melting event. The data I gathered supports this hypothesis. In every case, more than 12 g/m² necessary to de-ice was used, as evidenced by significant remaining road salt. Samples were collected when little or no snow or ice remained in the sampling areas, suggesting salt had already been used to remove ice.

Currently, the de-icing practices of Edgewood College result in an excess amount of road salt. Edgewood College should consider using practices that would limit the excess amount of road salt used. The campus has a significant effect on the Wingra Watershed as the excess road salt moves through the watershed and into the lake. The college may consider specific standards to determine when to ice sidewalks and when to have the contractor salt the parking lots. College staff members who apply road salt to the sidewalks should be aware of the concerns related to excess road salt in the watershed and be trained in management practices that minimize excess use.

The city of Madison has provided recommendations for reducing salt use. One of the recommendations, to provide training to employees, could be expanded to private contractors and those salting properties such as Edgewood College. Last year, the City of Madison provided training to individuals in the snow removal industry (Clean Lakes Report). Workshops such as these may help promote more responsible salt use. At this time, private contractors are not required to report the amount of salt used. There are estimates by the city of Madison that private contractors salt at twice the rate of the city. The City uses an application rate of 150 pounds per lane mile. Elective disclosure from private contractors on salting practices and application rates showed that between 280 and 600 pounds per lane mile are applied (Salt Use Subcommittee, 2006). Providing all employees with training would raise awareness regarding the proper amount of salt to be used and the ways in which excess salt affects the environment. Additionally, the commission suggests "ordinances for regulating private commercial application... [and] annual compliance reporting." This kind of proposal can be expected to be met with resistance by commercial operators. The city of Madison can also examine the amount of salt it uses to determine if less can be used (Salt Use Subcommittee, 2006).

Between 1990 and 2002, the City of Madison contributed an average of 795 tons of road salt annually to the Wingra Watershed (data from Madison-Dane County Public Health). Other residential and commercial sources also contribute to the road salt that enters the watershed each year. Together, Edgewood and Madison contribute an estimated 983 tons annually to the Wingra Watershed. The City of Madison uses 795 tons annually to maintain 380 paved impervious surfaces (data from Banneman, R.). Edgewood uses an estimated 118 tons annually to maintain 15.4 paved impervious acres. Per acre, Edgewood applies nearly four times as much road salt than the City of Madison to maintain its comparable area.

Sand is sometimes used on roads, parking lots and sidewalks to create friction, but sand is not a de-icer. Sand used for this purpose contains 5%-10% sodium chloride (Salt Use Subcommittee, 2006). Shoveling and plowing before applying salt or sand can help reduce the amount used. The use of a spreader can help calibrate the amount of salt applied on sidewalks. Trucks that salt parking lots may calibrate for less salt. Calcium magnesium acetate (CMA) is a viable de-icing alternative. It does not have the negative environmental impact of road salt. CMA is made from limestone and acetic acid and is biodegradable. The greatest drawback of using CMA is the cost. It can be up to 15-30 times as expensive as road salt. While CMA has a high initial cost, field tests have found this cost to be offset by less applications and less damage to streets and vehicles. Money is spent each year on repairing streets and publicly owned vehicles due to damage caused by road salt. Money is also spent to repair damaged plant life on the sides of roads (Viadero). The benefits of alternatives such as CMA should be considered

comprehensively. The drawbacks of costs should be weighed against the benefits that managing sodium chloride use has to the health of watersheds.

There were several limitations to the research. Determining when to collect the salt samples was one. I did not know precisely when Edgewood parking lots and sidewalks were salted and how much time passed between salting and some melting. Also unknown were the types of salts (and their sodium chloride content) used by Edgewood staff and the private contractor that salts the parking lots. During the collection, there was some salt left uncollected that was stuck in cracks or crevices, both in the parking lots and on the sidewalks. Removing all the debris from the samples was not possible. Some debris was factored into the final weighing. The amount of debris was small, and I assume it did not significantly affect the results. While emptying the salts into the trays to go into the oven, there were bits of salt that may not have been fully removed from the ziplock bags. The results may have been more accurate with more in-depth interpretations if there were more samples. Future studies may weigh locations individually in order to have an error bar to evaluate data against. More collections could be performed in order to better assess data. Future research may also widen the geographic range of sampling on campus and record weather conditions that required salting.

The results may be different with more sampling locations or with different sampling locations. The results may have also been different if the weather event leading to salting were recorded. The weather conditions, such as temperature and the amount of snow may affect how much excess road salt remains. Despite the limitations of the research, the data I collected demonstrates that an excess amount of road salt is used both on the Edgewood College sidewalks and in the parking lots. The data I collected shows that in each sampling, the amount of remaining salt was significant. Ice and snow had already been melted, suggesting much less road salt would be reasonable while still maintaining sidewalks that are free of ice and safe for pedestrians.

Bibliography

City of Madison. (2008 October 14). *Clean Lakes Report: 2008 Update*. Retrieved March 11, 2009, from http://www.cityofmadison.com/engineering/stormwater/documents/CleanLakesReport_2008.pdf

Friends of Lake Wingra. Data from Banneman, Roger.

Green Venture. (2007). *Wise Water Use*. Retrieved February 20, 2009, from Green Venture:

<http://water.greenventure.ca/road-salts-deicers>

Johnson, Johnson, & Roy, Inc. (1997). *Edgewood Campus Stormwater Master Plan*.

Madison-Dane County Public Health. Data on road salt contribution of City of Madison into Lake Wingra Watershed.

Road Salt and Water Quality. (2003 January 1). *Road Salt and Water Quality*. Friends of Lake Wingra.

Retrieved 11 March 2009, from <http://lakewingra.org/library/docs/1117595582-roadsalt.pdf>

Relationship between Lane Width and Speed: Review of Relevant Literature. (2003 September). *Parson*

Transportation Group for Colombia Pike Street Space Planning Task Force. Retrieved 11 March 2009, from
http://www.arlingtonva.us/Departments/CPHD/forums/columbia/pdf/lane_width.pdf

Salt Use Subcommittee to the Commission on the Environment (Salt Use Subcommittee). (2006). *Report of the Salt Use Subcommittee to the Commission on the Environment on Road Salt Use and Recommendations*. Madison: City of Madison.

Viadero, Roger C. (2005). *Environmental Issues: Roadway Deicing and the Environment*. Government Engineering January-February. Retrieved 11 March 2009 from
http://www.govengr.com/environment/env_0105.pdf

Watershed Resource Management Workshop (WRM Workshop). (1999, Spring/Summer/Fall). *Friends of Lake Wingra*. Retrieved October 23, 2008, from
<http://danenet.wicip.org/fowingra/wrm/wrmtoc.html>

Acknowledgements: I would like to thank Jim Lorman, Professor of Biology, Edgewood College Natural Science Department, for his assistance with this research project.