Assessing the Impacts of Planning Regulations on Residential Impervious Coverage in Amherstview, Ontario

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Executive Summary

Stormwater Management has become a popular topic as severe flooding troubled multiple Canadian cities in 2013. Stormwater that is unable to naturally percolate into the ground through infiltration is forced overland and often channeled or harnessed using municipal infrastructure. Asphalt and concrete are both necessities of modern cities and alter the natural flows of water (Hodge & Gordon, 2013). Residential site design and layout can significantly change the amount of impervious coverage that results from asphalt, buildings and concrete which comprise the built environment. This transformation from natural landscape to an urban environment has a significant impact on trees, soil, streams and the overall hydrological cycle.

The purpose of this research is to understand which municipal planning policies and regulations have the most impact on residential imperviousness. Analyzing 1,668 residential properties, this report aims to determine which factors contribute in producing the greatest level of impervious coverage in Amherstview Ontario, located within Loyalist Township.

The report summarizes the significance of impervious coverage and its impact on watershed health. Along with identifying this link, stormwater management alternatives are presented as options for combating the effects of stormwater runoff. Chapter two outlines the methodology utilized to examine which planning policies and regulations affect residential impervious. This methodology has been used previously, developed by Dr. Brian Stone and his research in Madison Wisconsin. Pisani, 2006 and MacIsaac, 2010 also utilized this methodology for SURP reports in their analysis of Kingston and Peterborough.

The report discusses the geospatial analysis completed within GIS, along with the descriptive and explanatory analysis completed using SPSS statistical software. The descriptive statistics analysis section summarized multiple components and independent variables that contribute to imperviousness. The table below summarizes these values.

Variable	Mean	Min	Max	Std. Deviation
All housing types (n=1,668)				
Lot Size (m^2)	814.17	257.93	4403.77	493.62
Parcel Size (m^2)	1028.82	407.70	4733.71	525.77
Number of Bedrooms	3.11	2.0	6.0	0.55
Year of Construction	1977	1830	2011	18.01
Frontage (m)	19.80	9.14	65.53	5.78
Front Yard Setback (m)	7.99	2.02	23.68	3.29
Total Impervious Cover – Parcel (m^2)	279.18	174.68	597.81	58.62

Explanatory statistics via multiple regression analysis was used to interpret the extent to which a given variable influences the total imperviousness of an individual parcel. The multiple regression in this study analysed the following dependent and independent variables:

Y: Total Impervious Coverage (Parcel)

X_1: Parcel Size

X_2: Lot Frontage

X_3: Front Yard Setback

X_4: Number of Bedrooms

The results of the regression analysis indicate that there is a moderate relationship between total impervious coverage and the parcel design components tested. The adjusted R-squared value of 0.474 means that the model can explain 47% of the variation in total impervious coverage:

Total Imperviousness = 122.079 + 0.003 (Parcel Size) + 4.664 (Frontage) + 6.868 (Setback) + 2.294 (# of bedrooms)

From this regression analysis and the four variables tested against total impervious coverage, lot frontage and front yard setback were the only two that yielded significant results at the 90 percent level. When holding the other variables constant at their mean values, a 1 metre increase in the front yard setback distance would increase the total area of impervious coverage by 6.87 m^2, while a 1 metre increase in the properties frontage would force the total area of impervious coverage to increase by 4.66 m^2. These results are similar to what Stone found, in that frontage and front yard setback were most impactful while lot size had the least weight on total impervious coverage.

Chapter four consists of a several key recommendations in reducing impervious coverage at the residential site level. Within this final chapter, four recommendations were provided to aid Loyalist Township and other municipalities in reducing the impacts of residential development on the natural environment. Two recommendations pertain explicitly to Loyalist Township's Official Plan and Zoning By-Law policies, while the other two could be applied to Loyalist Township or transferred to other similar sized municipalities. The following is a list of the recommendations:

Recommendation 1: Include Imperviousness in Official Plan

Recommendation 2: Include Imperviousness in Zoning By-Laws, Subdivision Agreements

Recommendation 3: Introduce a Stormwater Utility Fee

Recommendation 4: Introduce LID alternatives

The analysis for Amherstview confirms that residential parcel design which is mainly controlled by zoning ordinances, particularly frontage and front yard setback, influence the amount of total impervious coverage each property contains. This research presents planners the ability to reduce the environmental impacts of suburban development through modified zoning regulations and site specific changes. Although it's slightly out of the scope of this report, LID alternatives are an area of future research that ties closely to reducing stormwater runoff at the site level. Adopting LID alternatives in tandem with Zoning By-law alterations can reduce the downstream impacts of impervious coverage. This research provides a direct connection between the science of watershed degradation and the most impactful land use policies that can be used to lessen anthropogenic effects into the future.