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Modeling of Low Impact Development Nutrient Reduction Performance in the Lake Simcoe Watershed

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Stormwater quality management has evolved from traditional centralized downstream control devices (e.g. ponds and wetlands) to distributed low impact development practices (LID) at the source (e.g. bioretention, porous pavement, greenroof). In order to develop master LID plans for municipalities in the Lake Simcoe watershed (3576 km^2), a new modeling approach was developed. The challenge of modeling small scale LID practices over a watershed scale was resolved using unit response functions (URF) of different types of LID. The concept of URF is based on the linear assumption of LID performance on a watershed level where routing is not important. Detailed URF of runoff and nutrient reduction were developed on a lot level using US EPA SWMM models and linked with lot level characteristics such as imperviousness percentage. The process of modeling include: (1) screening of appropriate LID across the watershed based on identification of unsuitable areas (e.g. wellhead protection area, NaCl concentration, industrial land use) and prioritization suitable lots which maximize environmental benefits and demonstration potential; (2) development of hydrological unit response functions of each type of LID (i.e. average annual runoff and nutrient loading reduction) using US EPA SWMM models; (3) aggregation of the cumulative runoff and nutrient reduction of all appropriate LID at each municipalities; (4) cost-effective analysis of different combinations of LID (i.e. Pareto front); (5) recommendation of the preferred LID combinations for each municipal within the watershed . Results of the modeling indicate that (1) the average annual runoff volume reduction of implementing LID for the uncontrolled urban areas in Lake Simcoe watershed is estimated to be between 20% and 33%; and (2) the average annual phosphorus reduction of implementing LID for the uncontrolled urban areas in Lake Simcoe watershed is estimated to be between 2.0 to 2.7 tonnes per year. This study has demonstrated a new modeling approach of small scale LID over watershed scales.