CHAPTER I

INTRODUCTION

1.1 Background and Motivation

Stormwater runoff carries a wide range of potentially harmful environmental contaminants such as sediment, nutrients, oxygen demanding substances, pathogens, oils, greases and hydrocarbons as well as heavy metals (Harper, 1998). Despite the fact that many heavy metals are necessary in small amounts for natural biological cycle, most of them become toxic to living things at high concentrations. Heavy metals in the environment cause serious health risks to human. Exposure to some heavy metals at excessive doses could cause kidney and liver damage, and anemia. In addition, they can be carcinogenic and teratogenic (Carson et al., 1986).

Heavy metals in stormwater runoff originate from the operation of motor vehicles, direct fallout, and the degradation of road materials. These metals are either dissolved in the storm water or are bound to particulates (Sansalone and Buchberger, 1997). The Nationwide Urban Runoff Program (NURP) (U.S. EPA, 1983) determined that copper (Cu), lead (Pb), and zinc (Zn), are the most common heavy metals found in stormwater runoff.

Dissolved heavy metals can be removed from the stormwater runoff primarily by physical and chemical processes such as chemical precipitation as hydroxides, carbonates and sulfides, adsorption onto negatively charged anionic sites in clay minerals, sorption and coprecipitation on hydrous oxides of iron and manganese, complexation with organics followed by coagulation and flocculation, and sorption onto carbonates and phosphates (Harper, 1998). Most of these methods have high capital or operational cost and disposal of resulting sludge is problematic. Low cost materials, such as agricultural by-products, industrial wastes, and biomass have been investigated as heavy metal sorbents. These materials, include soybean hulls (Nitirach, 2002 and Marshall et al., 1999), peanut shells (Watwoyo et al., 1999), rice husk (Lee et al., 1999), wheat straw (Kumar et al., 2000), apple residues (Lee et al.,

1998), sawdust (Ajmal et al., 1998), fungal biomass (Yin et al., 1999), and seaweed (Yu et al., 1999).

There is an innovative stormwater filtration system that uses a relative small volume of specially tailored compost made from leaves (USEPA, 1997). The leaf compost has high organic content and can absorb larger quantities of hydrocarbons. It is best used for sediment, particulate nutrients, organic carbon, hydrocarbons, and some heavy metal removal (Center for Watershed Protection, 1995/1996). The leaf compost filter removed 95% of total suspended solids (TSS), 67% of chemical oxygen demand (COD), 41% of total phosphorus, 56% of organic nitrogen, 87% of hydrocarbons, 88% of zinc, 61% of chromium and 67% of copper in storm water (Stewart, 1992). Furthermore, this stormwater treatment technology is inexpensive and promotes the use of wastes.

Since composting is a biological process, its efficiency and the quality of the final product are controlled by factors affecting microbial metabolism such as oxygen, pH, temperature, moisture, material mixing, organic matter and particle size. Moisture content (MC) and pH are two important factors that affect the characteristics of compost. Moisture content has been referred to as the critical design and operating factor to compost engineering systems (Jeris and Regan, 1973; Stentiford, 1996; McCartney and Tingley, 1998). Lei and VanderGheynst (2000) found that higher pH of compost material increased the thermophilic time of composting process and in turn the quality of compost.

The purpose of this research is to study the feasibility of using grass clipping compost as a sorbent to remove heavy metals, Cu, Pb, Zn, and cadmium (Cd), from runoff. Although Cd is not one of the most common metals in runoff, it is studied because of its high toxicity at low concentrations. The optimal composting moisture content and pH for maximum removal of heavy metals are investigated.

1.2 Objective

The main objective of this study is to investigate the use of grass clippings compost for heavy metal removal from runoff. The specific objectives are:

1. To investigate heavy metal removal performances of the compost that is produced at different moisture contents.
2. To investigate heavy metal removal performances of the compost that is obtained from different initial composting pHs.