Chapter 1
Introduction

1.1 Problem Statement

Land development activities in the country continue to expand to meet the demand of a growing population. It is reported in a recent study by the United States Conservation Service that the developed portion of Virginia, for example, has grown by 43% since 1982 (Roanoke Times Jan 14, 2001). Natural landscapes are disturbed to create impervious and grassed residential tracts through construction. These changes affect hydrologic response of the watershed, leading to the alteration of stream flow patterns. The stream flow variability affects the ecological health of the stream.

Land development or urbanization typically leads to an increase in flow variability due to the changes in the land surfaces. During land development, naturally pervious landscapes are replaced with impervious rooftops, driveways, sidewalks and roads, and less pervious lawns and fields (Finkenbine et al. 2000). This increase in impervious land reduces infiltration of stormwater to the groundwater causing reductions in baseflows, while increasing the amount of runoff during a storm event. The increased runoff during a storm event causes increased hydrograph peaks with shorter response periods. The resultant increased waterpower can induce both overland and channel erosion. The erosion causes increased sediment load, decreased interstitial spaces for habitat, and stream widening. Shading then decreases as the riparian foliage covers less of the wider channel (Hartley, et al. 2001). Large woody debris also decreases as the supply is decreased due to urbanization and the mobility is increased with a wider channel (Hartley, et al. 2001). The decrease in shading and decrease in baseflow can combine to increase the overall stream temperature. In addition, the increased frequency of flooding and decrease in woody debris can reduce the quality of channel pools (Hartley, et al. 2001).

Stream communities representing animal and plant life develop over the years around the characteristics of each stream. Native fish, plants, and insects that flourish in streams do so because the stream flow patterns, geomorphology, temperature, and other

physical attributes match or closely resemble the optimal ranges of the species. The native species reach equilibrium with the environment based upon these stream characteristics in a healthy, natural stream. For example, many lotic species have suitable habitat ranges such as depth and velocity that must be met for their continued existence. However, when these physical characteristics of the stream undergo changes, the stream moves away from this natural equilibrium and stream health degrades. These changes to habitat coupled with the direct stress effect that changing flowrates can have on fish and other species may lead to a change in lotic and fish species composition in response to a deviation from the natural stream equilibrium. The new habitat would favor colonizing and tolerant species, while many native fish and other lotic species are reduced or eliminated.

Flow and its variability has been recognized as the "master variable" of stream health because of its effects on all of the physical characteristics of a stream (Poff et al. 1997). This study will expand upon this observation to make links between flow variability and stream health.

1.2 Objectives

The major goal of this research is to identify linkages between hydrologic responses owing to residential tract development and the end effects on stream habitat quality. Several development scenarios with different residential tract densities will be used to characterize such linkages. In pursuit of this goal, the following are the objectives of this study:

i) long term simulation of stream flow

ii) identify the flow related variables that have been used to link to stream health

iii) establish a relationship between hydrologic and stream habitat variables to characterize the effect of residential development on stream habitat