1. INTRODUCTION

Wisconsin is fortunate to have outstanding groundwater resources. Groundwater provides about half of the public water supply and virtually all of the water for irrigation and rural domestic. In addition, groundwater discharge into streams, lakes and wetlands is essential to the integrity of these surface-water resources.

But increasingly Wisconsin's groundwater resources are being stressed. The most obvious stresses involve contamination from a variety of sources, including septic systems, landfills, underground tanks, and agricultural chemicals. In addition, the amount of available groundwater is gradually being reduced. The greatest threat to groundwater quantity is urban expansion, which typically results in increased pumping and decreased recharge

In theory, it is possible to manage each of the various stresses to groundwater quality and quantity. Federal, state, and local laws enable a variety of programs which deal with issues such as pesticide regulation, stormwater management, wellhead protection, and landfill siting and management. However, the effectiveness of such programs depends to a large extent on our ability to understand and quantify groundwater flow systems, particularly with respect to the spatial distribution of groundwater recharge.

Groundwater recharge is the source of all groundwater. Effective management of groundwater quality and quantity requires the identification and quantification of critical recharge areas. Because most management strategies involve the regulation of certain activities, the success of these strategies is strongly dependent on the precision with which recharge areas are identified. The failure to include a critical recharge area in a management program limits the effectiveness of that program. Conversely, management restrictions on noncritical areas cause unnecessary economic losses, and undermine the credibility and political viability of management programs.

This report describes research conducted during the last two years of a four year project undertaken to improve our understanding of the spatial distribution of groundwater recharge in the Driftless Area of Wisconsin, which occupies the southwestern portion of the state. Results from the first two years of the project are reported in Amann (1993) and Potter *et al.* (1995). The Driftless Area was chosen for study because:

- It has significant water resources, which critically depend on groundwater recharge; these include productive deep aquifers, abundant springs, and baseflow-dominated streams which support prized trout fisheries.

- The region is predominantly agricultural, but is gradually changing to urban/suburban uses. The groundwater has been and continues to be degraded by agricultural activities, and is facing new threats from urban/suburban development.

- Over a sufficiently large spatial scale (of about 10 square miles) the region is reasonably homogeneous with respect to the factors affecting groundwater recharge.

2. DESCRIPTION OF STUDY AREA

The primary locus of this study was the Garfoot Creek watershed, a 5.4 square mile watershed west of Madison, WI. The study also included portions of the Black Earth Creek watershed, to which Garfoot Creek is tributary, and the Sugar River watershed, which is directly to the south. The Garfoot Creek watershed and the upper portion of the Sugar River watershed are entirely in the Driftless Area. Black Earth Creek heads in the Johnstown Terminal Moraine, which forms the eastern edge of the Driftless Area. Figure 1 illustrates the locations of the watersheds.

Like the Driftless Area in general, the topography of the study area consists of rolling uplands, steep hillslopes, and flat valley bottoms. The uplands and valley bottoms are typically farmed; the hillslopes are most often wooded. Bedrock consists of layers of Ordovician and Cambrian dolomites and sandstones (Figure 2). Upland soils, which are developed on loess, are shallow. Soils on the hillsides are developed on colluvium and are also shallow. The hillslopes are dissected by gulleys, which extend from the edge of the farmed uplands to the valley bottoms. There is clear evidence that these gulleys once extended into the uplands, and in fact were caused by agricultural activity. This is consistent with Sartz (1961a), which concludes that Driftless Area gullies are not natural landscape features.