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A Comparative Study of Stream-Gaging Methods Employed in Non-point Source Pollution Studies in Small Streams

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Abstract

The demand for accurate stream flow measurement has increased with the rising concern about nonpoint source (NPS) pollution. NPS pollution studies, such as Total Maximum Daly Load (TMDL) development, often involve quantification of flow in small first and second order streams. The comparative analysis of the current technologies which is used to measure flow in small streams with respect to its accuracy is made. This involved field and laboratory experimental investigation to compare the accuracy of various methods for estimating stream discharge in small first and second order streams and also to compare the accuracy of various methods for estimating stream discharge in a controlled laboratory environment. Ten stream-gagging methods were evaluated for field and laboratory performance. The analysis of the field investigation data indicated that Marsh McBirney current meter and One-Orange method were the most accurate among the methods studied. The results of the laboratory experiments imply that the Starflow acoustic Doppler and Valeport BFM001 current meter performed best among the ten methods. The overall best performance for both field and laboratory situations among the methods evaluated were exhibited in Marsh McBirney and Valeport BFM001 current meters.

Keywords: Stream – Gaging, Pollution, Streams, Nonpoint Source, Measurement

1.0 Introduction

Considering the rising concern about non-point source (NPS) pollution, there is an increasing demand for accurate measurement of water quality [1]. In any study involving estimates of sediment, nutrient, or bacteria loadings in surface water, accurate measurement of flow in the stream of interest is critical. Flow rates, along with concentrations of various pollutants in water samples are used to determine the pollutant loadings in streams. Today, there are 161 gaging stations and 219 measuring sites in operation in Virginia alone [2]. Gaging stations are installations that facilitate systematic collection of discharge data, whereas measuring sites are used to collect flow data as required outside the systematic data-collection system [2]. Flow in streams is of special interest because it is the only hydrologic cycle component that can be measured with any significant degree of accuracy [3].

An example of a study where flow measurement directly impacts the estimation of pollutant load is the development of total maximum daily loads (TMDLs). In the development of TMDLs, accurate stream flow measurement is critical to estimating the contaminant loads in the impaired stream reaches. Often, these stream reaches are low-order streams with low discharges and flow velocities. These conditions present a challenge to traditional methods of stream-gaging, which are typically applied to larger streams with higher discharge rates. The flow velocities encountered in smaller streams are often below the recommended minimum velocities for most methods [4]. The aim of this study was to conduct a comparative analysis of the current technologies used in NPS pollution stream-gaging applications with respect to their accuracy.

2.0 Field Study Sites

Field investigations were performed at one of the outlets of the Crab Creek of small agricultural watersheds which is used as a gaging site. This watershed is located in Ekpan fish pond zone, Warri, Delta state Nigeria. The drainage area of the watershed is 786 acres. The average slope of the watershed is 12.14% [5]. The land use, and data for the Crab Creek

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