QUALITY OF STORMWATER RUNOFF FROM AN URBANISED WATERSHED

CHUI PENG CHEONG

School of Civil and Structural Engineering, Nanyang Technological Institute, Republic of Singapore, Singapore 2263

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Abstract. A field monitoring network was set up within the Stamford canal watershed in 1989 to study both the quantitative and qualitative aspects of storm runoff from this urbanised catchment. The data acquisition equipment comprised a continuous recording rain gauge, a water level recorder and an automatic water sampler capable of sampling storm runoff at preset intervals during rainfall events. Water samples were collected after each storm and laboratory tests were carried out on the physical and chemical properties of the storm water. Preliminary findings on the temporal variations of stormwater quality during single storms and the effects of antecedent dry weather period on the quality are presented. The average ranges of some of the significant quality parameters found in the storm runoff were also established. The quality of storm runoff from the catchment under study was found to be of an acceptable level and could potentially be developed as a water catchment area.

Introduction

Singapore is a small country with a total land area of approximately 640 square kilometers. About 43 percent of the land area has been developed as residential, commercial and industrial areas, and 15 percent is agricultural land. The remaining areas are either natural reserves or other non-built-up areas. The average annual rainfall is 2400 mm (Meteorological Service Singapore, 1985), which is also the main source of water supply. As water is a scarce and limited resource in Singapore, almost half of the total land area has been developed as water catchment areas for the collection of rainwater into the fourteen impounding reservoirs. These catchment areas cover all the natural reserves and also include some of the heavily built-up residential, commercial and light industrial areas. The current daily water consumption is slightly less than 1 million cubic metres. But with continuing increases in economic and population growth and also with increase in social affluence, the demand for water is expected to continue to rise in the future. Thus, the search for additional sources of water supply like abstracting water from unprotected urban catchment areas or other unconventional sources must be explored. It is even more evident after the recent dry spell (February – April 1990), where rainfall over the whole island was much lower than the average values and with total reservoir stock falling below the 70 percent level.

In 1989, a field monitoring system was installed within the Stamford canal watershed, comprising a rain gauge, a water level recorder and a water sampler. The system was implemented to continuously collect data on rainfall, and both the quantitative and qualitative characteristics of stream flow within the basin. A considerable amount of field
data has since been collected and some preliminary studies on the temporal variation patterns of common water quality parameters have been carried out. The average ranges of these selected quality parameters were also established. Among other things, the results obtained could be used to assess the feasibility of abstracting storm runoff from unprotected urban catchment areas for water supply and could also be used as a baseline condition for future studies on the effects of urbanisation on storm runoff quality. This paper presents the main features of the field monitoring system and some preliminary results of the study.

Description of Study Area

The study area is a sub-basin of the main Stamford canal catchment, which embraces some of the most prestigious shopping, commercial and residential areas in Singapore. The drainage network of the Stamford canal system comprises four major upstream tributaries (Tributaries I, II, III and IV) and the main canal downstream, which discharges into the Marina bay (Figure 1).

The sub-basin is drained by Tributary I as shown Figure 2. It has a drainage area of about 110 hectares and is relatively undeveloped. Presently, about 20 percent of the basin (22 hectares) are impervious areas consisting mainly buildings, roads and vehicle parking areas. The remaining areas are turfed areas such as the Singapore Botanic Gardens, a nature park and a golf course. The basin has a steep terrain and the highest land altitude is about 40 m above the mean sea level. The mean slope is about 15 percent and the direction of slope is towards the main arterial road – Holland Road and Napier Road – which bisects the basin.

The basin is fully served by a separate sewerage system where excess rainfall is discharged directly into storm drains while sewage is discharged to a separate waste sewerage pipe. Tributary I, which is the main channel in the basin, runs along one side of the arterial road. It is constructed of reinforced concrete with a length of 1.7 km and a cross section of 3.7 m wide by 2.3 m deep at the monitoring site. The other minor drains consist of standard V-shaped and larger U-shape concrete sections.

Sampling and Monitoring System

The location of the water sampler, raingauge and water level recorder is shown in Figure 2. The sampling site has been selected at the downstream end of the Tributary I sub-basin so that representative samples of storm runoff from the whole catchment can be collected.

The water level in the channel is continuously monitored by means of a float-type stage recorder which is hooked on to an on-site data logger. Water levels are recorded at one minute intervals and the data are retrieved fortnightly using a lap-top computer. The measured stage hydrographs are subsequently converted into discharge hydrographs using a simple computer program based on the Manning’s equation. Rainfall in the catchment is measured by a tipping bucket raingauge located at the Botanic Gardens.

Stormwater is sampled using an ISCO automatic sampler which could retrieve up to a