Chapter 11
Traffic and Climate Change Impacts on Water Quality:
Measuring Build-Up and Wash-Off of Heavy Metals and Petroleum Hydrocarbons

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ABSTRACT

Understanding the impacts of traffic and climate change on water quality helps decision makers to develop better policy and plans for dealing with unsustainable urban and transport development. This chapter presents detailed methodologies developed for sample collection and testing for heavy metals and total petroleum hydrocarbons, as part of a research study to investigate the impacts of climate change and changes to urban traffic characteristics on pollutant build-up and wash-off from urban road surfaces. Cadmium, chromium, nickel, copper, lead, iron, aluminium, manganese and zinc were the target heavy metals, and selected gasoline and diesel range organics were the target total petroleum hydrocarbons for this study. The study sites were selected to encompass the urban traffic characteristics of the Gold Coast region, Australia. An improved sample collection method referred to as 'the wet and dry vacuum system' for the pollutant build-up, and an effective wash-off plan to incorporate predicted changes to rainfall characteristics due to climate change, were implemented. The novel approach to sample collection for pollutant build-up helped to maintain the integrity of collection efficiency. The wash-off plan helped to incorporate the predicted impacts of climate change in the Gold Coast region. The robust

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experimental methods developed will help in field sample collection and chemical testing of different stormwater pollutants in build-up and wash-off.

INTRODUCTION

The volume and characteristics of Australian urban traffic are expected to undergo extensive changes due to the continuously increasing urbanisation of the continent's major cities. Climate change is also expected to result in longer periods of dry weather with fewer, but more intense, storms (CSIRO 2003, 2007). The dynamic scenarios of changes to rainfall characteristics due to climate change and changes to the urban traffic due to increased urbanisation can readily affect pollutant build-up and wash-off into the local water bodies. This, in turn, can have significant impacts on urban water quality.

Suspended solid is the most important stormwater runoff pollutant and has additional significance because other pollutants, such as heavy metals and hydrocarbons, are primarily attached to them (Sartor et al., 1974; Harrison & Wilson 1985). The main anthropogenic activities that generate heavy metals and hydrocarbons are vehicular traffic, combustion of fossil fuels and lubricants, and industrial activities. Toxic pollutants such as Total Petroleum Hydrocarbons (TPH) and heavy metals are transported into water bodies by urban stormwater runoff (Hunter et al., 1979; Hoffman et al., 1982, 1984; Herngren, 2005). Brown et al. (1985) found that vehicular crankcase oil is the most significant anthropogenic source of TPH contamination in urban stormwater runoff.

This chapter describes the experimental methodology developed to measure selected heavy metals and TPH contaminants in pollutant build-up and wash-off samples from road surfaces. Firstly, a general discussion on the impacts of urban traffic and climate change on water quality is provided. Then the selected study sites and their selection criteria are presented, followed by a novel method that combines vacuuming and spraying to collect pollutant build-up samples and presentation of an approach to collect wash-off samples. This is then followed by a discussion on sample collection, preservation, extraction and testing techniques.

Impacts of Urban Traffic on Water Quality

The ever-increasing urbanisation of major cities around the world is affecting the characteristics of urban traffic in terms of volume and vehicle mix. In Australia, the Bureau of Infrastructure, Transport, and Regional Economics (BITRE) has provided a comprehensive summary of transport activities in Australia (BITRE, 2008). According to this report, total travel in the urban areas of Australia has grown almost nine-fold over the last 50 years. Almost all of that growth came from cars and light commercial vehicles used for private purposes. The total vehicle kilometres travelled (kilometres travelled by a vehicle in a year) by passenger cars in Australia in 2005, was ninety four times higher than that of buses. It was also reported that there were 13.9 million motor vehicles which travelled a total of 206 billion kilometres in Australia in 2005. This trend of dominance in numbers by passenger cars is still continuing, as the sales of passenger cars were three times higher than other vehicles in the 2006/07 financial year. The stock of light commercial vehicles also increased by four times in 2006 compared to 1971. The total road traffic for cars, light commercial vehicles and buses in 2004 increased by 2, 1.68 and 1.75 times respectively compared to 1977, in all Australian metropolitan areas. In the Gold Coast region in Southeast Queensland, the percentage increases in the Vehicle Kilometre Travelled (VKT) are expected to be 39% for 2011, and 74% in 2021 compared to 2000, if current conditions remain unchanged (Brown et al., 2004).