THE EFFECTIVENESS OF CONTINUOUS DEFLECTIVE SEPARATION (CDS) POLLUTANT TRAPS IN REDUCING GEOCHEMICAL INPUT INTO URBAN WETLANDS: A COMPARATIVE STUDY OF TWO CONTRASTING STORMWATER CATCHMENTS, PERTH, WA

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Wetlands of the Swan Coastal Plain are important locales for groundwater recharge. Degradation of receiving waters, such as groundwater, is of major concern in the Perth Metropolitan Region, which relies upon groundwater for approximately 70% of its total water consumption, and almost 50% of domestic water supply. It is most important that measures are taken to prevent contamination of this vital resource. Impermeable surfaces in the urban area, such as roofs and roadways, catch and divert rainfall as stormwater runoff (Davidson 1995). The high permeability of the sands underlying Perth results in rapid transfer of stormwater from infiltration basins to the shallow aquifer. Thus, there is considerable interest in stormwater composition and the necessary measures to help reduce contamination of groundwater.

The present study investigated a type of gross pollutant trap (GPT) called a continuous deflective separation (CDS) unit. It focused on two separate CDS units installed in urban stormwater catchments of contrasting character and sought to determine their effectiveness in minimizing the flux of stormwater-derived pollutants (e.g., nutrients and metals) to adjacent urban wetlands.

The stormwater catchments were located at Blue Gum Lake Reserve and Quenda Wetland in the City of Melville. The catchment feeding the CDS unit at Blue Gum Lake Reserve has an area of 2.62 ha. Land-use within and adjacent to the Blue Gum Lake Reserve is primarily residential. In contrast, the catchment at the Quenda Wetland (3.0 ha) has adjacent land-use comprising arterial roadways to light industrial practices. Prior to, and following, the winter rains of 2002, anthropogenic litter and sediment trapped within each of the CDS units was removed. The organic-rich fractions were collected for nitric-perchloric digestion in preparation for metals analysis and the determination of total phosphorus (TP), total nitrogen (TN), and carbon and sulphur content.

In addition to sediment samples, approximately 60 samples of stormwater were collected entering and exiting the CDS units during the winter rains of 2002. Stormwater samples were analyzed for their electrochemical parameters, ionic concentrations, metal content, nutrient load (e.g., TP and TN) and total organic carbon (TOC).

In addressing fully the efficiency of CDS units in minimizing nutrients and metals flux to urban wetlands, comparison was made with alternative engineered structures. Within the Blue Gum Lake Reserve there is a man-made stormwater settling basin which functions as a type of GPT with larger storage capacity than a CDS unit. Within the Quenda Wetland stormwater catchment there is an engineered side-entry-pit (SEP). This structure is not a form of GPT but is designed to channel stormwater directly from the road surface into the receiving basin, the Quenda Wetland. Study of the performance of this structure provided an opportunity to investigate the composition and concentration of pollutants in stormwater delivered to the wetland without the interaction of a pollutant trap.

During the period of this study, the descending order of abundance of major cations found in stormwater from the Blue Gum Lake Reserve was $Na^+>Ca^{2+}>K^+>Mg^{2+}$, whilst that in stormwater from the Quenda Wetland CDS unit catchment was $Na^+>Ca^{2+}> Mg^{2+}>K^+$. The descending order of concentration of the major anions recorded in stormwater entering both the Blue Gum Lake Reserve and Quenda Wetland CDS units and the engineered wetland at Blue Gum Lake Reserve was $Cl^->SO_4^{2-}>NO_3^-$. Stormwater entering each of CDS units had an average pH of 6.7. However, periodic fluxes of increased acidity (pH 5.1 to 4.9) were recognized within each of the catchments, due, at least in part, to spikes in the nitrate concentrations. Nitrate concentrations in stormwater entering the CDS unit at Blue Gum Lake Reserve during typical rainfall events ranged from below detectable limit (<0.1 mg/l) to 145 mg/L, whilst nitrate levels in stormwater entering the CDS unit at Quenda Wetland during typical rainfall events ranged from below detectable limit to 7,100 mg/L.

Most transition metals in stormwater were within acceptable limits for urban recreational water usage as delineated by Australian (Contaminated Sites Monograph No. 4. 1995, Berkman 1989) and Canadian guidelines (Canadian Environmental Quality Guidelines 2002). However, trace metals which exceeded acceptable limits in some CDS unit sediment samples were V, Cr, Mn, Ni, Cu, As, Se, Ba, and Pb. Trace metals analysis of stormwater revealed that Cu, Pb and Al were consistently above guideline values.

Total phosphorus (TP) concentrations recorded in stormwater were 0.43 mg/L and 0.38 mg/L for Blue Gum Lake and Quenda Wetland, respectively. This falls within the TP range for stormwater within the Perth Metropolitan region as described by Tan (1992).

It was concluded that the efficiency of CDS units in minimizing nutrients and metals pollution from urban stormwater is highly variable. It was estimated that the Blue Gum Lake and Quenda Wetland CDS units removed 303 g and 285 g of particulate phosphorus, respectively, during the study period. The load of TP transported in stormwater within both catchments during the six months (April to September 2002) of this study was calculated, and indicated that the Blue Gum Lake and Quenda Wetland CDS units had removal efficiencies of 27% and 22%, respectively. These results for pollutant removal efficiencies are similar to those of previous studies by Walker *et al* (1999) and Bovell (2000). The small engineered settling basin at Blue Gum Lake Reserve has a higher storage capacity for stormwater and stormwater-derived debris. It was estimated that this structure trapped 4.1 kg of TP during the study priod with a removal efficiency of 29%.

The CDS units that were the subject of this research are effective in the removal of gross pollutants (> 5 mm diameter) from stormwater, and to a lesser degree, they provide capacity to trap particulate phosphorus and amounts of some heavy metals. However, based on the analytical results of the present study, there is evidence that CDS units can liberate and possibly assist in the mobilization of both nutrients and metals from entrapped sediment and litter. This was evident during extended dry periods where there was no input of stormwater and stagnation of that present in the unit sump. Mobilization of pollutants during the dry periods is promoted as atomic oxygen becomes bound in compounds such as nitrite (NO_2^-) and nitrate (NO_3^-) and the generation of weak acids assists in the decomposition of organic material, solubilizing both nutrients and pollutant metals. It has been well established that mobility of these stormwater-derived pollutants greatly increases in the presence of suspended and/or dissolved organic carbon. Organic carbon derives from the decomposition of organic materials in the CDS unit, and may be complemented by petroleum hydrocarbons transported in road runoff.

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