

**CHEMICAL RELATIONSHIPS IN WATERS AND
SEDIMENTS OF SOME URBAN STREAMS,
WITH PARTICULAR REFERENCE TO
HEAVY METALS AND PHOSPHORUS**

by

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CERTIFICATE

I certify that this thesis has not already been submitted for any degree and is not being submitted as part of candidature for any other degree.

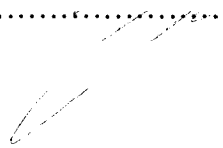
I also certify that the thesis has been written by me and that any help that I have received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

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Part 1

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List of Abbreviations

AAS	=	atomic absorption spectrophotometry
ANOVA	=	analysis of variance
ANZECC	=	Australian and New Zealand Environment and Conservation Council
AT	=	Appendix Table
bdl	=	below detectable limit
BOD	=	biochemical oxygen demand
CEC	=	cation exchange capacity
Ck.	=	creek
diss.	=	dissolved
DO	=	dissolved oxygen
EDTA	=	ethylenediamine tetraacetic acid
F	=	flow group
Fig.	=	Figure
G	=	geology category
GC	=	Gwawley Creek
HMO	=	hydrrous metal oxides *
IW	=	interstitial water
Kjeld-N	=	kjeldahl nitrogen
L	=	land use category
LC50	=	the lethal concentration for 50% of the test organisms
log	=	natural logarithmic transformed data
MDS	=	multidimensional scaling
mmolNa	=	millimoles of sodium
NSW	=	New South Wales
OMS	=	organic matter and sulfides *
o-	=	ortho-
ppm	=	parts per million
QC	=	quality control
R	=	residual *
RE	=	rapidly exchangeable *
redox	=	reduction / oxidation potential
SC	=	Savilles Creek
sedOP	=	sediment organic phosphorus
sedS2P	=	sediment sum secondary phase
sedTP	=	sediment total phosphorus
SFA	=	segmented flow analyser
SPCC	=	State Pollution Control Commission #
sq	=	square root transformed data
SRP	=	soluble reactive phosphorus
SS	=	sample station
SW	=	surface water
TC	=	Temptation Creek
TOC	=	total organic carbon
trib.	=	tributary
TWINSpan	=	two-way indicator species analysis
UDP	=	Urban Development Program
v/v	=	volume per volume
w/v	=	weight per volume

* categories of sediment heavy metal speciation analysis

now the NSW Environment Protection Authority (EPA)

Part 2

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Abstract

This thesis describes two studies of the chemistry of freshwater streams in the Sydney basin.

The first was a survey of 86 waterways, sampled under low flow conditions. Samples were generally low in salinity, soft, of poor buffering capacity and dominated by sodium and chloride. Co-dominance by calcium, magnesium and (bi-)carbonate occurred in a number of particular cases. Multivariate analyses indicated three groups, separated primarily by levels of dissolved nutrients, trace metals, turbidity and colour. Groupings were associated strongly with the type of catchment development. Streams in areas relatively unaffected by human influence had notable uniformity in chemistry, while those from developed catchments were varied. Heavy metal contamination was relatively low, although a few of the samples displayed inordinately large levels of one or more metals. In such cases the more extreme measurements of phosphorus and nitrogen were also seen. These findings were consistent with occasional or localised elevation of contaminant levels.

The second study involved monitoring of three Hawkesbury Sandstone streams. Sampling of surface waters, interstitial waters and sediments was performed at irregular intervals over a two year period at three stations within each site. The streams predominantly existed under low flow conditions and showed similar major ion chemistries to the majority of the survey samples. Levels of calcium and total carbonate, plus heavy metals and nutrients were generally higher in the urbanised creeks, compared to the reference stream. During a heavy storm, high levels of nutrients, suspended solids and colour were detected in all surface waters at peak-flow, as well as alkaline pH, oxidising redox, and reduced conductivity, alkalinity and hardness.

The sandy sediments were characterised by very low levels of organic matter and cation exchange capacity. Sequential extractions identified that the sums of secondary phase lead, zinc and copper were over nine, four and two times that of the corresponding residual, respectively. Greatest proportions of zinc and lead were associated with coatings of iron and manganese oxides, or coarse waste particles. Copper was preferentially associated with organic matter. Concentration gradients between interstitial and surface waters were rare and release of sedimentary constituents should occur rapidly from the upper-most particulates.

Poor water and sediment qualities were often observed in the urban sites. Poor water quality was also seen on occasion in the reference stream. However, since poor sediment quality was not detected at those times and interstitial waters for all sites displayed high within-site variability, surface waters were considered the most reliable short-term indicator of condition for Hawkesbury Sandstone streams. Multidimensional scaling showed that all streams had distinct water and sediment chemistries. High levels of temporal and spatial variability were apparent within the urbanised sites - particularly in interstitial waters - mostly due to concentrations of heavy metals, phosphorus and suspended solids. Seasonal differences were detected, but only in terms of the level of variability between summer and winter samples.