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The Distribution and Fate of Contaminants in Estuarine Sediments

Recommendations for environmental monitoring and assessment

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The Distribution and Fate of Contaminants in Estuarine Sediments

Recommendations for environmental monitoring and assessment

**R.B. Williamson
R.J. Wilcock**

**prepared for
Environment and Planning
Auckland Regional Council**

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**NIWA
PO Box 11-115
Hamilton, New Zealand
Telephone +64-7-856 7026
Facsimile +64-7-856 0151**

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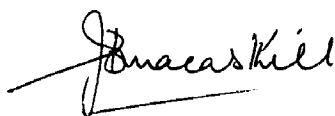

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Reviewed by

J.B. Macaskill and D.J. Morrisey

Approved for release by



R.D. Pridmore

1 INTRODUCTION

This report summarises progress made in understanding the fate of contaminants in estuarine sediments, with particular reference to studies carried out in the Manukau Harbour from 1989-1993. This work was funded by the Auckland Regional Council and the Foundation for Science Research and Technology.

The report summarises information on:

- Distribution of contaminants
- The processes controlling their concentration and effects in sediments
- The processes controlling recovery (self-cleansing) of sediments

The report makes recommendations on:

- Which contaminants should be routinely analysed in the Auckland region
- Other contaminants that need further investigation of their occurrence
- Other parameters that must be measured when studying contaminants
- Procedures for conducting studies on estuarine contaminants, including:
 - Design
 - Sampling
 - Laboratory analysis

The report is divided into two sections:

- A summary of the Sediment Recovery Programme, along with recommended procedures for future work.
- Specific guidelines for sediment analysis, which can be used without reference to the summary report.

2 MANUKAU HARBOUR AND ITS DEVELOPMENT

2.1 Physical setting

Manukau Harbour (37°02'S, 174°41'E) is a large, shallow estuarine lagoon located on the west coast of the North Island of New Zealand, covering an area of 344 km² (Fig. 2.1). Of that area, a large proportion (145 km²) is exposed at spring tide as low-gradient, intertidal flats. The intertidal sediments are consolidated sands in the main body of the harbour, and soft muds in the tidal creeks. Four main channels drain the harbour. The water circulation is mainly tidal with a mean residence time for water of 22 days (Heath et al. 1977). Tidal range in the harbour lies between 1.9m (neap tides) and 3.8m (spring tides). The volume of water that flows out of the harbour between high and low tides is 450 million m³ (neap) and 690 million m³ (spring). Tidal flows dominate over freshwater inflows. Sediment disturbance is mainly caused by wave action. The total catchment area of the harbour is 1100 km² and only small streams flow into the harbour.

Mangere Inlet lies at the northeastern end of Manukau Harbour. It has an area of 6.6 km² and a catchment of 34.5 km² (Hume 1979). The inlet is relatively shallow with a maximum depth of 8.3 m below mean sea level. It is a site of sediment deposition because it is sheltered from the effects of strong tidal currents and high-energy wave action (Tonkin and Taylor 1986).

2.2 Inputs of pollutants

Manukau Harbour receives waste, including heavy metals, organochlorines and PAHs, from Auckland city via sewage, urban and industrial stormwater and farm runoff. The most important in the past were inputs from industrial point sources to Mangere Inlet (Glasby et al. 1988). Since 1962, these were treated at the Manukau Sewage Purification Works (MSPW). The MSPW now treats much of the waters from domestic, commercial, and industrial sources together with some storm water from the Auckland region and discharges about 250 000 m³ of treated water per day into the harbour. MSPW effluent is known to contain PAH, chlordane, Pb, Zn, Cu, Ni and Cr. Despite routing of effluents to the MSPW, Mangere

Inlet probably remains the most polluted estuary in New Zealand. A number of other minor treatment plants also discharge treated sewage effluent to the Manukau Harbour and dredge spoil is dumped in Purakau Channel. In addition, Glenbrook Steel Mill discharges Fe, Zn, minor quantities of Pb and Cr, and possibly PAH to the Waiuku Estuary. The current level of pollution in the sediments has been described in various reports (e.g. Fox et al. 1988; Glasby et al. 1988; Roper et al. 1988; ARWB 1990, Williamson et al 1992) which have identified a number of zones where toxic substances are concentrated. A summary of some of the principal sources of pollutants in the harbour is summarised in Table 2.1, which was taken from Williamson et al 1992).

In addition to discharges from point sources, there is runoff from urban and rural areas. The urban runoff carries PAH, Pb, Cu and Zn to the harbour. Rural runoff includes diffuse source pollutants from pasture (e.g., DDT Hume et al 1989) and a number of treated effluents from piggeries and cowsheds. There is a significant amount of horticulture in the catchment and this, together with the pasture, carries an unknown quantity of pesticides.

2.3 Catchment development

Prior to the arrival of Europeans in the 1850s, Manukau Harbour was rich in fish, bird and forest food and had been occupied by the Maori for a thousand years. Since that time, the Auckland region has experienced a steadily increasing population, and the area around Mangere Inlet has become one of the most industrialised areas in New Zealand (Linge 1959,). This development has obvious implications for the level of pollution in Mangere Inlet and the rest of Manukau Harbour. Developments in the region through time are given in Table 2.1, and these may serve as time markers for pollution events in the harbour. While this table may not be comprehensive, it does give an idea of the time frame of development. The history and nature of the sewerage systems in the region is summarised in Table 2.2, also taken from Williamson et al 1992.

Table 2.1. Development of the Manukau Harbour catchment by decade since European settlement (Williamson et al 1992).

1850s	First arrival of settlers; burning of bush; flour mill at Onehunga; Manukau Harbour becomes important for shipping.
1860s	Shipbuilding and sawmill plus substantial wharf built at Onehunga; gum digging at Papakura; flax mill at Waiuku.
1870s	Manukau becomes a rich dairying area; general engineering works at Onehunga.
1880s	Pit sawing in Huia; tannery, woollen mills and cardboard box factory in Onehunga; NZ. Iron and Steel Company set up and closed down in Onehunga (1883-1886).
1890s	Fellmongery in Onehunga
1900s	First trials with artificial fertiliser at Papakura.
1910s	NZ. Fertilizer Co. in Onehunga (1916); first Mangere Bridge; soap production at Penrose; damming of streams in Huia.
1920s	Introduction of chrome tanning of leather at Otahuhu; damming of streams at Huia; bay at Huia left littered with debris from bush clearance with great many scars on the landscape; railway workshops opened in Otahuhu; by the 1920s, the following factories were operating in the upper part of the Manukau (woollen mills, three gigantic fertiliser works, freezing works, abattoirs, tanneries and fellmongeries, glue works, glass works, timber mills, ironworks, soap and candle works, reinforced concrete pipe works and wool scouring establishments); over 300 vessels with a gross tonnage of 180,000 tonnes operating in Manukau Harbour.
1930s	Development of Penrose industrial area including Reidrubber, asbestos-cement factory, furniture manufacturing, die casting, steel industry and dairy equipment; manufacture of truck, tractor and marine engines at Papakura; quarrying begins for millions of m ³ of aggregate on Huia hills.
1940s	Further development of Penrose industrial area including paint, plastics, furniture, dairy equipment, electrical and tobacco factories and timber processing; expansion of Papakura military camp; perpetual drainage problems in Papakura especially from additional sewage outfalls.
1950s	Engineering and sheetmetal works and Colonial Oil and Chemical Co. in Penrose; boom in shipping at Onehunga Wharf.
1960s	Manukau Sewage Purification Works commissioned (1962); New Zealand Steel Ltd begins manufacturing steel at Glenbrook.

Table 2.2. Summary of sewerage systems in areas adjacent to Manukau Harbour (Williamson et al 1992). Information supplied by K.R. Davis (pers. comm.).

Mount Roskill Borough Drainage System

First portion of borough sewered in 1925. Discharged to harbour after passing through a "septic tank" beyond end of Queenstown Road. Sewered area confined to eastern side of borough. Other areas (from northern side of Mt Albert Rd to north (Auckland City) and southern side to Queenstown Rd and Manukau Harbour) sewered from about 1940.

New Lynn Borough Council

"Treatment tanks" and sewers constructed 1929. Discharge to harbour at Green Bay. The tanks had no means for providing sludge removal other than by discharge to the harbour. Tanks designed for 3,600 persons. In 1954, 7,850 persons were connected.

One Tree Hill Borough Council

Sewerage from area No.3 is discharged into the Onehunga Borough Council System. The other sections are pumped to the Auckland system (Waitemata Harbour). Sewered in 1940 or thereabouts.

Otahuhu Borough Council

First sewers built in 1910 or thereabouts. These were gradually extended until, by 1954, about 80% of the borough had been sewered. Only a portion of borough sewage went to Manukau Harbour. Three of four septic tanks discharged into Tamaki Estuary. Sewage from psychiatric hospital treated by Imhoff tank and discharged into Manukau Harbour. Sludge sluiced into harbour from all tanks.

Onehunga Borough Council

First sewers constructed in 1910. By 1954, borough completely sewered. Storage tanks with outfall were located at the end of Whurangi Street. Volcanic rocks provided good soakage for stormwater.

Overall

In 1954, about 45,000 persons were connected to sewers which ultimately discharged into Manukau Harbour. From Otahuhu to Onehunga, there were 18 trade waste outfalls (described in Glasby et al 1988). In 1955, it was estimated that $20 \times 10^6 \text{ m}^3$ of untreated trade waste plus $0.7 \times 10^6 \text{ m}^3$ of domestic sewage (from industrial premises) were being discharged into Manukau Harbour per year. The 5 day BOD load was estimated to be 27,000 kg per year (equivalent to a population of 400,000 people).
