Te Awarua-o-Porirua Whaitua Committee

greater WELLINGTON REGIONAL COUNCIL Te Pane Matua Taiao

Title: Contaminants in Te Awarua-o-Porirua Whaitua

Purpose: To provide information on contaminants entering Porirua Harbour from the surrounding catchment: sources and transport of, main contaminants, and where they end up.

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1. Executive Summary

A contaminant is "something that makes a place or a substance (such as water, air or food) no longer suitable for use", further "in sufficient concentrations, [contaminants] can adversely affect living organisms". A contaminant may be biological, physical or chemical with many occurring naturally in the environment. Contaminants typically become problematic when levels get too high (such as sediment rates and *Escherichia coli* counts), or when they are visible (e.g. litter). They may also be long lasting (bioaccumulative), such as the pesticide dichlorodiphenyltrichloroethane (DDT) which remains in the soil for decades.

There is no doubt that there are issues with contaminants in Te Awarua-o-Porirua whaitua. The area has been mistreated and neglected since settlement and the beginning of the urban sprawl when forests were converted to pasture, road and rail were built and untreated sewage was pumped into Porirua Stream.

The whaitua has been the subject of many studies focussing on contaminants over the last several decades; where they come from, the impact they are having on the harbour, waterbodies and streams in the surrounding catchment and potential mitigation solutions. Long-term monitoring suggests that there has been an improvement in the health of the harbour, although this appears related to specific sites such as areas in Pauatahanui Inlet.

The main contaminants in the whaitua are sediment, chemical contaminants such as heavy metals, and biological contaminants such as pathogens, nutrients, and litter. Historically, sedimentation rates in the harbour have been high but recent studies suggest accumulation has lessened. Pathogens (organisms such as bacteria that can cause illness) are at levels considered to be at risk to human health in areas of the harbour where freshwater enters. The pesticide, DDT, is a widespread legacy contaminant found throughout the entire harbour at levels above recommended guidelines. Zinc, also a persistent chemical residue that accumulates, is found at the southern end of Onepoto Arm and near Porirua Stream and stormwater outfalls.

The main pathways that contaminants enter the waterbodies and streams in the whaitua is via land run-off and stormwater runoff carrying contaminants through the whaitua and into its streams, lagoons and wetland, all of which drain into the harbour.

2. Current status of Te Awarua-o-Porirua whaitua

Historically, misuse and modification of Te Awarua-o-Porirua whaitua from several sources, combined with more recent major urban development, saw increased degradation and deterioration of waterbodies, particularly the harbour, throughout the whaitua.

Recently however, steps have been taken to correct this historical damage through a number of processes. The Te Awarua-o-Porirua Harbour and Catchment Strategy and Action Plan was developed with the vision of "a healthy catchment, waterways and harbour…". Greater Wellington Regional Council (GWRC) with assistance from Porirua City Council (PCC) has undertaken substantial monitoring and research over the last two decades. GWRC monitor estuary sediment quality and ecological health on a regular basis to understand the natural environmental variation and impacts of human activities on the whaitua. Water quality is also measured to track sources of sediment and other contaminants, particularly after heavy rain. Much of this monitoring forms GWRC's State of the Environment (SoE) and recreational water quality programmes, which also includes water quality monitoring and ecological health assessments in three of the larger streams (Porirua, Kenepuru and Mitchell Streams) in the whaitua.

Community and school groups, such as Porirua Harbour Trust (PHT), Guardians of Pauatahanui Inlet (GOPI) and Whitireia Park Restoration Group, have been restoring/replanting areas along streams as well as undertaking various monitoring programmes/surveys. One of the longest running volunteer surveys is that of the cockle population in Pauatahanui Inlet. Results from the 2013 survey show a steady improvement in the health of the cockle population (Michael & Wells, 2014).

Investigations of contaminants throughout the whaitua show sediment is the most significant contaminant particularly from an ecological health perspective; catchment modelling indicates approximately 35,000 tonnes of sediment enters the harbour annually (Green *et al*. 2014). This figure will increase by approximately 2,500 tonnes per year during construction of Transmission Gully (McGimpsey *et al*. 2011). A recently updated report on sedimentation rates in Te Awarua-o-Porirua harbour over the 5 year period between 2009 and 2014 (DML, 2015) suggests the rate of sediment accumulation is approximately 2 mm per year throughout the harbour on average, considerably less than rates proposed by Gibb and Cox (2009) over a 35-year period but higher than the rate of accumulation for a healthy estuary (less than 1 mm per year).

Parts of the southern end of the harbour contain elevated sediment levels of copper, lead, zinc and DDT; many at levels above known guidelines. Elevated levels of copper and zinc are also present in Porirua Stream. Polycyclic aromatic hydrocarbons (PAHs) are present in high concentrations particularly in the immediate vicinity of the Semple Street outfall. PAHs originate from a number of sources such as wear and tear of asphalt, oils, diesel and tyre rubber (Oliver & Conwell 2014, Sorenson & Milne 2009).

Faecal contamination from animal and human waste is monitored routinely; weekly during summer and monthly over winter. Three sites in the whaitua are consistently graded 'poor' in terms of recreational use meaning the site is susceptible to faecal pollution and swimming should be avoided for two days after rainfall (Keenan et al. 2015).

The first environmental 'scorecard' for Porirua harbour was released early 2014 by PHT which assessed the implementation of the Porirua Harbour Strategy. The 2014 scorecard concluded that sedimentation rates, water quality for swimming and shellfish gathering, and the amount of litter remain a concern.

3. Sources and pathways of contaminants

There are two primary sources that contaminants originate from: non-point and point sources. Non-point sources, also called diffuse discharge, are where contaminants come from widespread or dispersed sources. Non-point sources typically occur after rainfall when contaminants are picked up and carried along until they are end up in waterbodies such as streams, lagoons or wetlands. Non-point sources include:

- Land run-off
  - fertilisers, herbicides, insecticides, pesticides from use on agricultural land
  - sediment from improperly managed construction sites, agricultural land, forestry activities and eroding streambanks
  - bacteria and nutrients from livestock, animal wastes
  - leaching soil disturbance and grazing from farmland

- Urban stormwater run-off
  - runoff from sports grounds, parks and residential areas
  - oil, grease and toxic chemicals from urban runoff (e.g. roads and train tracks)

- Wastewater network discharges
  - faulty sewer pipes, illegal connections and wastewater overflow from septic tanks

Point sources are easy to identify and are contained/confined. They include the following which may discharge into a waterbody by way of pipes, ditches and channels:

- Wastewater treatment plants (WWTP) – Porirua Wastewater Treatment facility, located off Moki Street Titahi Bay, was commissioned in 1990. It treats all sewage, waste from all sinks, toilets, laundries, kitchens and bathrooms from Wellington's northern suburbs. This waste flows through the sewerage network. Porirua's treated wastewater discharges into the sea at Titahi Bay while sludge is disposed of at Spicer's landfill on Broken Hill Road
- Vessels, or other floating craft

Significant contamination of urban streams throughout the whaitua with heavy metals, PAHs and DDT is primarily a result of stormwater runoff (Milne & Watts 2008). Pathogens and nutrients are significant contaminants in stormwater and in the Porirua and Kenepuru Streams, with elevated copper and zinc levels also present. Additionally, stormwater runoff picks up and carries sediment and soil into various waterbodies. Sediment often has other contaminants such as heavy metals and nutrients attached/bound to it.



4. Contaminants in Te Awarua-o-Porirua Whaitua

Many areas of the whaitua contain contaminants derived from the surrounding catchment with high levels often found in sediments sampled from the harbour. There are also 'legacy' contaminants present such as the pesticide DDT that is still leaching out of soils of the surrounding catchment today.

4.1. Sediment

Sediment is a naturally occurring material, such as rock, soil, plant and animal remains, resulting from the effects of weathering or erosion. The weathering/erosion process can be accelerated through events such as flooding, and soil disturbing activities, such as construction, earthworks and forestry operations. The bulk of the sediment now entering the harbour is terrestrial based (e.g. streambank and land erosion, and earthworks) rather than a mix of terrestrial and marine sediment, and flows in via streams throughout the whaitua.

In estuaries a sedimentation rate less than 1 mm per year is considered natural. Successive studies since 1849 have shown accumulation of sediment in Te Awarua-o-Porirua Harbour were large, averaging 6 mm per year in the Onepoto Arm and 9 mm per year in the Pauatahanui Inlet over a 35-year period ending in 2009 (Gibb & Cox 2009). Current catchment modelling estimates sediment is now accumulating at approximately 2 mm per year (Green et al, 2014). This is supported by a recently completed bathymetric survey (Fig 1; DML 2015) and yearly GWRC sedimentation plate measurements (Oliver 2014).

Sediment has a number of impacts on both the ecological health and water quality of a waterbody. These impacts may include:

- smothering habitat such as seagrass and salt marsh
- clogging the gills and feeding apparatus of aquatic life (fish, shellfish and invertebrates)
- altering water flow
- reducing light needed by aquatic plants for growth
- increasing the 'muddy' bottom and infilling
- increasing contaminants from surrounding land
- 'murky' waters that make an area unsafe or dangerous for recreational users.

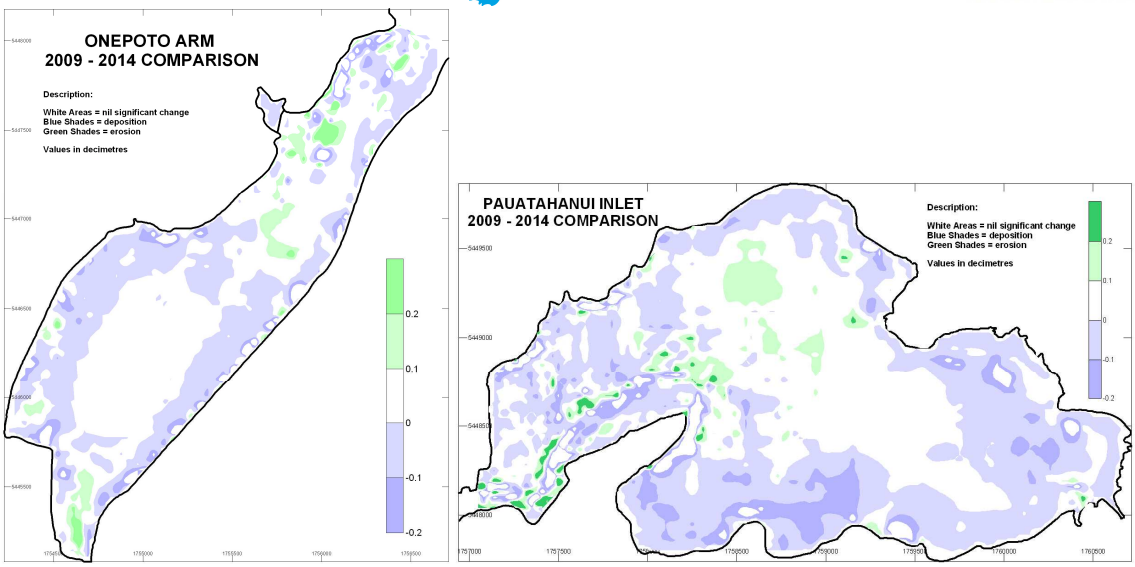

Figure 1: A comparison of 2009 and 2014 bathymetry of the two arms of Porirua Harbour, Onepoto Arm (left) and Pauatahanui Inlet (right). White areas indicate no change in depth, purple areas indicate sediment accumulation and green areas indicate erosion or deepening. (Diagrams are from DML 2015 report commissioned by PCC. Re-printed with permission from K. Calder, PCC).

4.2. Chemical contaminants

There are a range of chemical contaminants accumulating within the harbour and several of the streams that enter the harbour. These contaminants, and some likely present day origins, include:

- Heavy metals
  - Copper (Cu) primarily from vehicle brake pads
  - Lead (Pb) from leaching from roadside soils from use in petrol
  - Zinc (Zn) mainly from unpainted galvanished-iron roofing and vehicle tyre wear
- Pesticides
  - DDT is residue from historical use in agriculture and horticulture. It is found in sediments throughout the entire harbour as well as some of the streams in the surrounding catchment.
  - Dieldrin, an alternative to DDT and just as persistent, is also a residue of historical use
- Polycyclic aromatic hydrocarbons (PAHs), which occur through incomplete combustion (when there is not enough oxygen for a fire to burn properly) and come from vehicle exhausts, household fires and industrial use (e.g. tar/bitumen). Only found at specific sites in the harbor, predominately near stormwater and stream outfalls.

Most of these chemical contaminants, as well as illegal discharge from business and industrial areas, are collected in the stormwater system or from land runoff, particularly after heavy rainfall, and discharge into the streams and harbour (particularly Kenepuru, Mitchell and Porirua Streams). Chemical contaminants can be toxic to aquatic life while some may accumulate in the food chain.

DDT in New Zealand

DDT was used to control grass grub and porina moth in the 1950s and 60s. It was banned in 1989. DDT is known as legacy contaminant, remaining in the soil for decades, depending on conditions. It is also bioaccumulative, meaning that an organism absorbs the chemical at a faster rate than it is lost. DDT residues are still found in livestock and marine mammals today.

Grass grub larvae hatch Dec-Mar. Eat plant roots.

Brown adult grass grub beetle feed on fruit trees and seedling crops.

Photographs Peter E. Smith
www.TeAra.govt.nz/en/photograph/17954/grass-grub

4.3. Biological contaminants

Water contaminated with human or animal faeces can contain pathogens (bacteria, protozoans and viruses) that can make people sick with illnesses such as campylobacter, giardia and norovirus. The variety and low concentration of pathogens in streams and coastal areas makes them difficult to test for individually. Instead faecal indicator bacteria (*E. coli* in rivers and streams and enterococci in coastal waters) are used to monitor contamination in waterways. Sources of faecal contamination in the whaitua are sewer leaks and overflows from septic tanks in urban areas, runoff from farms and stock access to streams in rural areas. Wildfowl such as ducks can also be a source of faecal contamination.

Porirua also has a wastewater treatment plant (WWTP) located off Moki Street in Titahi Bay where human waste is treated. Treated wastewater is discharged into the sea at Rukutane Point and surplus sludge disposed at Spicer landfill. While recent upgrades have been completed at the WWTP and additional upgrades are planned for the city's stormwater system network, in wet weather conditions WWTP overflows occur exceeding consent limits.

4.4. Nutrients

Nutrients are essential to sustain life; humans and animals get nutrients from what we eat, plants get nutrients from the soil and algae absorb nutrients from the water. The two main nutrients, nitrogen (N) and phosphorus (P) are naturally occurring but create issues at excess concentrations.

N is found in the air, land and water with major sources in the Porirua harbour coming from sewer cross-connections, fertilisers and animal urine. Excess N in waterways often produces a 'bloom' of algae (e.g. sea lettuce or *Ulva*) in the harbour and periphyton (slime) in streams, particularly during summer. These blooms can decrease oxygen in the water, smother other aquatic life, look unsightly and smell terrible.

P is an essential plant nutrient and also occurs naturally and is commonly found in fertilisers, manure, and organic wastes in sewage and industrial effluent. In urban streams, sewer faults are often a significant source of P. Soil erosion is also a major contributor of P to streams. Bank erosion occurring during floods can transport a lot of phosphorous from the river banks and adjacent land into a waterbody. When there is too much of it in water, the effect is much the same as seen with excess N; increased growth of nuisance algae.

4.5. Litter

Litter was considered the biggest threat in the whaitua by community in a recent community environmental perception survey commissioned by PCC (Key Research 2014). Litter ranges from takeaway containers and plastic bottles to road cones and vehicle tyres (see below). It is the most visible of the contaminants and can impact/affect the animals, recreational use and ecology of the area.

4.6. Emerging contaminants

Emerging contaminants are those that are likely to occur in waterbodies, are extremely diverse, have been identified as being a potential environmental or public health risk but are not currently monitored. Many of these contaminants may have been present in the environment for a long time but have only now become detectable due to advances in analytical chemistry (Gaw 2013). These include naturally occurring and man-made substances such as detergents, fragrances, prescription and non-prescription drugs and steroid hormones excreted by humans and animals. Sources include wastewater discharge, stormwater and sewer overflows, leachate from landfills, re-use of wastewater for irrigation, runoff from farmland, disposal of animal waste, and septic tank effluents. Emerging contaminants have not been monitored in the whaitua to date.

4.7. Contaminants in shellfish and fish

Contaminants may remain suspended in the water particularly during periods of high winds, rather than settling to the bottom, meaning that fish and shellfish are likely to consume and accumulate them in their flesh. Periodic sampling of shellfish flesh for contaminants started in 1997. Cockle samples from Porirua Harbour had some faecal contamination and a range of heavy metals present in their tissue, though tissue concentrations did not exceed the national food standards (Milne, 2006). Rather than continue to monitor shellfish flesh, GWRC has recently undertaken faecal plume modelling to identify the most at risk sites. If these fish and shellfish are caught and eaten by humans, it could cause serious illness from the accumulated pathogens/faecal material. Hence, many areas within the harbour have ‘no take’ health warning signs.

5. Fate of contaminants

Where do contaminants end up? Contaminants end up in a variety of places – stuck to sediment, washed into streams and other waterbodies after rainfall, washed down drains and into the stormwater system, soaking into the soil where some contaminants can remain for decades, transported via groundwater (through cracks and spaces in between rocks and soil) and perhaps even entering the food chain.

Depending on the water flow within a stream, lagoon or lake and environmental conditions, contaminants may either remain in the surface water or settle to the streambed and accumulate. Forested areas are more effective at trapping contaminants than pasture or bare land.

Many of the contaminants are known to have a variety of adverse impacts on biology and ecology apart from the obvious effects on aesthetics. Impacts already seen in the whaitua, particularly in the harbour include declining seagrass cover from smothering by sediment, an absence of saltmarsh from Onepoto Arm, nuisance algae during summer caused by increasing N and P levels, and the presence of pathogens and heavy metals in shellfish flesh.

Further, these contaminants accumulating within waterbodies and sediment can be taken up by plants and ingested by a number of animals from insects and marine/terrestrial organisms to birds, fish and even humans (Fig. 2). Some of the contaminants mentioned in this paper, such as pathogens, can be a risk to human health, which is why limits on the amount of these contaminants entering waterbodies is required.

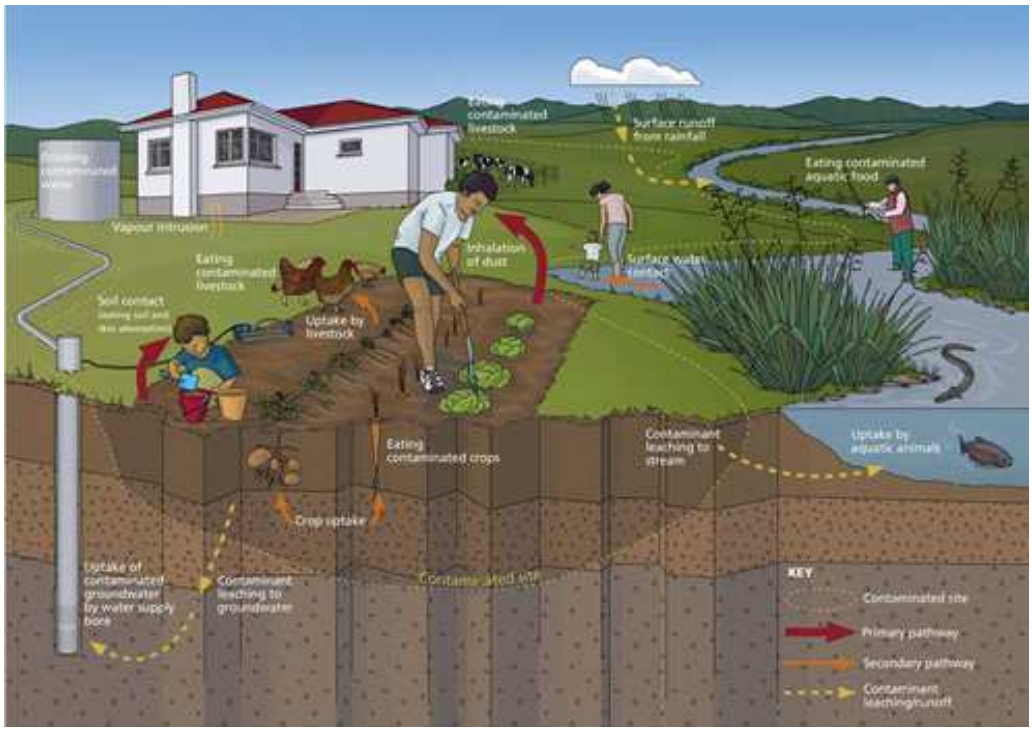

Figure 2: Diagram showing the main pathways by which contaminants in soil can affect human health (diagram sourced from the Ministry for the Environment http://www.mfe.govt.nz/land/risks-contaminated-land/about-contaminated-land-new-zealand/what-contaminated-land).

6. References

ANZECC 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, The Guidelines.* Australian and New Zealand Environment and Conservation Council. Agriculture and Resource Management Councils of Australia and New Zealand, Canberra.

Discovery Marine Ltd (DML) 2015. *Te Awarua-o-Porirua Harbour: Report of survey and verification of sedimentation rates*. Commissioned by Porirua City Council. Project # SP00041. 17 p

Gaw, S. 2013. Emerging organic contaminants: A threat to New Zealand freshwaters? Waiology http://sciblogs.co.nz/waiology/2013/11/29/emerging-organic-contaminants-a-threat-to-new-zealand-freshwaters/

Gibb, J.G. and Cox, G.J. 2009. *Patterns and rates of sedimentation within Porirua Harbour*. Consultancy Report CR2009/1. Coastal Management Ltd, Kerikeri, New Zealand. 65p

Green, M., Stevens, L. and Oliver, M.D. 2014. *Te Awarua-o-Porirua Harbour and catchment sediment modelling: Development and application of the CLUES and Source-to-Sink models.* Greater Wellington Regional Council, Publication No. GW/ESCI-T-14/132, Wellington.

Keenan, L., Morar, S.R. and Greenfield, S. 2015. *Is it safe to swim? Recreational water quality monitoring results for the 2014/15 summer.* Greater Wellington Regional Council, Publication No. GW/ESCI-T-15/35, Wellington.

Key Research 2014. *Porirua Harbour and Catchment: Environmental Perceptions Study 2014*. Prepared for Porirua City Council 104p

McGimpsey, P., Crack, C., Rickard, A & Hall, M. 2011. *Transmission Gully Project: Assessment of Environmental Effects report*. Prepared by Beca Carter Hollings & Ferner Ltd for the NZ Transport Authority and Porirua City Council. http://www.nzta.govt.nz/assets/projects/transmission-gully-application/docs/aee-full-report.pdf

Michael, K. & Wells, J. 2014. *Community survey of cockles (*Austrovenus stutchburyi*) in Pauatahanui Inlet, Wellington, December 2013*. NIWA Client report WLG2014-13

Milne, J. 2006. *Contaminants in shellfish flesh: an investigation into microbiological and trace metal contaminants in shellfish from selected locations in the Wellington region*. GWRC report No. GW/EMI-G-06/285, Wellington.

Milne, J.R. & Watts, L. 2008. *Stormwater contaminants in urban streams in the Wellington region.* Greater Wellington Regional Council, Publication No. GW/EMI-T-08/82, Wellington.

Oliver, M.D. & Conwell, C. 2014 *Porirua Harbour subtidal sediment quality monitoring: Results from the 2010 survey.* Greater Wellington Regional Council, Publication No. GW/ESCI-T-14/110,Wellington.

Oliver, M.D. 2014. *Coastal State of the Environment monitoring programme: Annual data report 2013/14.* Greater Wellington Regional Council, Publication No.GW/EMI-T-14/122,Wellington.

Sorensen, P.G. & Milne, J.R. 2009. *Porirua Harbour targeted intertidal sediment quality assessment.* Greater Wellington Regional Council, Publication No. GW/EMI-T-09-136, Wellington.

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