Marine Sediment Contaminant Monitoring: 2012 and 2013 Organic Contaminants Data Report

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Marine Sediment Contaminant Monitoring:
2012 and 2013 Organic Contaminants Data Report

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Executive summary

Marine sediments sampled in November 2012 and November 2013 as part of Auckland Council's Regional Sediment Contaminant Monitoring Programme (RSCMP) were analysed for persistent toxic organic contaminants.

The analyses were undertaken to update data obtained in the former State of the Environment (SoE) programme in 2003, 2005, and 2007.

The organic contaminants analysed were polycyclic aromatic hydrocarbons (PAH), organochlorine pesticides (OCPs), and polychlorinated biphenyls (PCBs).

A total of 26 sediment samples, from 13 sites in each of 2012 and 2013, were analysed by AsureQuality (Wellington), using isotope dilution high resolution gas chromatography mass spectrometry (HRGC-MS). Sites selected for analysis were generally high risk sites, where organics were considered to be most likely to pose a risk to benthic aquatic fauna.

This report provides a summary of the organic contaminant data, including an assessment of contaminant status (i.e. concentrations in relation to Auckland Council sediment quality guidelines; Auckland Regional Council technical publication TP168, ARC 2004) and comparison with previous monitoring results to assess trends over time.

Status

Organic contaminants exceeded the ARC Environmental Response Criteria (ERC; ARC 2004) amber or red threshold levels at 10 of the 26 sites. PAH exceeded the ERC-amber threshold at six sites and the red threshold at two sites. OCPs exceeded the ERC red threshold at 5 sites (note there is no amber threshold for OCPs or PCBs). ERC amber or red thresholds for both PAH and OCPs were exceeded at 3 sites. PCBs were in the ERC-green range (i.e. below the ERC-red threshold) at all sites.

PAH concentrations were generally low, below the ERC amber or red range at 18 of the 26 sites. At the 8 sites with elevated PAH levels (ERC-amber or, at two sites possibly ERC red), metals' concentrations were also elevated. PAHs were the status determining contaminant only at Chelsea, where moderately elevated PAH concentration and relatively low TOC level combined to give a result in the ERC-Red range (at 1% TOC).

PCBs were below the ERC-red threshold at all sites. However, elevated concentrations were found at Meola Inner and to lesser degree at Whau Wairau and Henderson Upper. While not exceeding the ERC-red threshold, the PCB levels at these sites were markedly higher than those found at other sites. Based on the 2013 results, elevated PCBs may indeed occur at the most contaminated sites (e.g. Meola Inner), but it seems unlikely that exceedance of the ERC-Red threshold will occur.

OCPs were in the ERC-red range at Henderson Upper, Meola Inner, Whau Upper, Whau Wairau, and possibly also at Oakley. DDE, DDD, or Total DDTs were the only OCPs that exceeded the ERC-Red thresholds. OCPs were the status determining factor at Henderson Upper, and possibly also at Oakley – at these sites OCPs exceeded the ERC-Red threshold while metals concentrations in 2013 were in the ERC-amber range. At the

other sites with ERC-Red OCP levels, one or more metals concentrations also exceeded the ERC-Red threshold.

Hexachlorobenzene (HCB) was elevated at Awaruku Stream, an intertidal bottom of catchment urban stream site at Long Bay. There are no sediment quality guidelines (ERC values) for HCB, so the environmental significance of this elevated value is unknown.

Concentrations of the other OCPs were either below detection limits, or very close to the laboratory blank levels. As found in previous surveys, it appears that DDTs (DDE, DDD, and DDT), and at lower levels dieldrin, remain the most significant OCPs remaining in receiving water sediments.

Trends

Trend assessment for organochlorines was limited by variable data quality and availability from previous surveys. There were no useful data for assessing trends in PCBs. Based on very limited data, OCP concentrations appear to be stable or decreasing over the past decade. A slow decline in environmental concentrations is consistent with the combined effects of discontinued use (slow depletion of source material stored in estuary catchments) and the persistence of these chemicals in receiving sediments.

Recommendations for future surveys

Another OCP survey should be undertaken 10 years from now to assess longer term trends. The focus should be on high risk sites, where OCPs are currently in the ERC-red range: Henderson Upper, Meola Inner, Whau Upper, Whau Wairau, and possibly also at Oakley.

Based on comparison of sediment concentrations with ERC, PCBs are of lower environmental risk to benthic fauna than OCPs, and on this basis could therefore be dropped from future monitoring. However, sufficiently elevated levels to be of some concern were found at Meola Inner (and to a lesser degree at Whau Wairau and Henderson Upper). To provide assurance that, as anticipated, levels are dropping over time, it is recommended that PCBs also be analysed at the same 5 sites identified above for OCP analysis.

Based on their ERC grades, PAHs have been found to be of generally lower environmental risk than metals (or at some sites, OCPs). Unlike the OCPs and PCBs, PAHs may possibly increase at some sites over time in response to on-going urban stormwater inputs. In addition, it is possible that they may contribute to cumulative contaminant multi-stressor effects. For these reasons, PAH analysis at selected higher risk sites should continue to be undertaken. These sites are the 5 sites recommended for OCP/PCB analysis, and also those identified as ERC-amber in Table 4-1 (Middlemore, Shoal Hillcrest, Chelsea, Panmure, and Coxs Bay).

To ensure consistency of data quality, analysis of OCPs, PAHs, and PCBs should be undertaken using the same high sensitivity methods used in the 2012/13 survey. If this is not possible, quality assurance assessments must be undertaken to verify that the new methods produce results that can be directly compared with historical (i.e. 2007 and 2012/13) data.

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1.0 Introduction

1.1 Purpose

This document provides a concise summary of organic contaminant data obtained from estuarine sediments sampled as part of the Auckland Council's sediment contaminant monitoring programme in 2012 and 2013.

The organic contaminants analysed were polycyclic aromatic hydrocarbons (PAH), organochlorine pesticides (OCPs) and polychlorinated biphenyls (PCBs). The analyses were undertaken primarily to update OCP and PCB data obtained in the former State of the Environment (SoE) programme in 2003 and 2007. These earlier data were reviewed by Mills (2013a)

The report provides**:**

- a summary of the data obtained;
- a status assessment based on comparison of contaminant concentrations with Auckland Council Environmental Response Criteria (ERC; ARC 2004), in order to assess potential effects of the organic contaminants on benthic aquatic ecosystem health, and
- an assessment of trends, based on comparison with results obtained from the previous monitoring conducted in 2003 and 2007. As outlined later in the report (section 4.3) the available data limited the trend assessment to indicative trends in OCPs. A detailed assessment of status and trends in PAHs has been reported elsewhere (Mills et al. 2012), and therefore trends in PAHs have not been included in this summary report.

1.2 Organic contaminants analysed in 2012 and 2013

The organic contaminants analysed were polycyclic aromatic hydrocarbons (PAH), and organochlorines – organochlorine pesticides (OCPs) and polychlorinated biphenyls (PCBs). These chemicals are generally environmentally persistent, toxic to aquatic life, and can be bioaccumulative. They are therefore of concern with respect to their potential effects on aquatic ecosystem health.

Organochlorines (OCPs and PCBs) are legacy persistent organic pollutants (POPs), which are no longer legally used in New Zealand but remain in the environment as a result of their slow rates of degradation. OCPs were historically used in horticulture and agriculture, and PCBs in a wide range of industrial applications and domestic products, including electrical insulators, flame retardants, and some plasticisers.

These contaminants enter Auckland's marine receiving waters largely as a result of runoff from horticultural (or ex-horticultural) land and from urban stormwater runoff. Landfills are another potential source of these chemicals. High localised concentrations are also found in port and wharf areas (e.g. Devonport Naval Base and Ports of Auckland) due to historical activities associated with operations in these areas.

The organochlorines are considered to be contaminants of secondary importance for potential effects of Auckland’s urban stormwater discharges on marine receiving environments (ARC 2004). This is because their use in NZ has been discontinued, and therefore inputs into the marine environment should be decreasing over time. The most prevalent OCP compounds found in marine receiving water sediments in Auckland are DDTs (usually dominated by the degradation compounds DDE and DDD rather than the parent DDT compound), and dieldrin. The key sources and properties of the organochlorine contaminants were described in more detail in Mills (2013a) – readers are referred to that report for further information.

Polycyclic aromatic hydrocarbons (PAHs) are a key group of organic contaminants associated with urban activities. Urban sources of PAHs include combustion of fossil fuels (e.g. vehicular exhaust), oil spills/leaks, and historical use of coal tar in roading. PAHs are also produced in forest fires. Because they continue to be produced and discharged into the environment, PAHs (along with metals such as zinc (Zn), copper (Cu), and lead (Pb)) are considered to be primary contaminants of concern for stormwater impacts (ARC 2004). A comprehensive assessment of the concentrations and trends in PAHs from 1998–2010 from all former SoE, RDP, and UWH programme sites was reported by Mills et al. (2012).

2.0 Sampling and analysis

2.1 Sites

A list of sites sampled is given in Table 2-1 and shown in Figure 2-1. Sediments were sampled from:

- 22 RSCMP sites sampled in the November 2012 (12 sites) and November 2013 (10 sites) monitoring rounds. Note that the sample from the Middlemore RSCMP site was the Bulk Reference Sediment (BRS) used for quality assurance assessments in the RSCMP (Mills 2014a). This sample was taken from adjacent to the Middlemore SoE monitoring site in July 2011. The material analysed for organics in 2013 was stored in freeze dried form in the Auckland Council archive since then.
- one site from the Upper Waitemata Harbour benthic ecology programme (UWH), sampled in November 2013;
- two bottom of the catchment tidally-influenced stream sites at Long Bay, sampled in November 2013, and
- one site from the Central Waitemata Harbour benthic ecology programme (CWH Eco) sampled in November 2012.

Details of the monitoring data from these samplings are given in Mills 2013b, Mills 2014a & b).

The number of sites analysed were limited by budget constraints, due to the high cost of the analysis. Sites were chosen based on:

- Level of contamination – previous organics data were reviewed and sites that rated as above the ERC-Red threshold were given priority for reassessment;
- A need for background data from undeveloped reference locations – Te Matuku Bay, a rural reference site on Waiheke Island, was chosen;
- A need for baseline data from developing areas – the Long Bay stream sites and Rangitopuni (UWH) were included for this reason; and
- Broadening the spatial coverage of organochlorine data – previous data from 2003 and 2007 were collected only from former State of the Environment (SoE) programme sites. The 2012 samples were from a range of former Regional Discharges Project (RDP) sites that have not previously been sampled. The upper estuary site from the UWH, and the two stream sites from Long Bay also broadened the spatial coverage.
- A need for temporal trend data, both to evaluate changes over time at sites previously analysed, and to establish a baseline for future trend assessment. The 2013 samples were mostly from former SoE sites (some of which were analysed previously in 2003 and 2007) and included contaminated sites that were likely to require future monitoring to assess trends.

The samples were all from estuarine locations, except for the two Long Bay stream sites – Awaruku and Vaughan Streams – which are tidally-influenced bottom of catchment freshwater stream sites (see Mills 2014b for details of these sites).

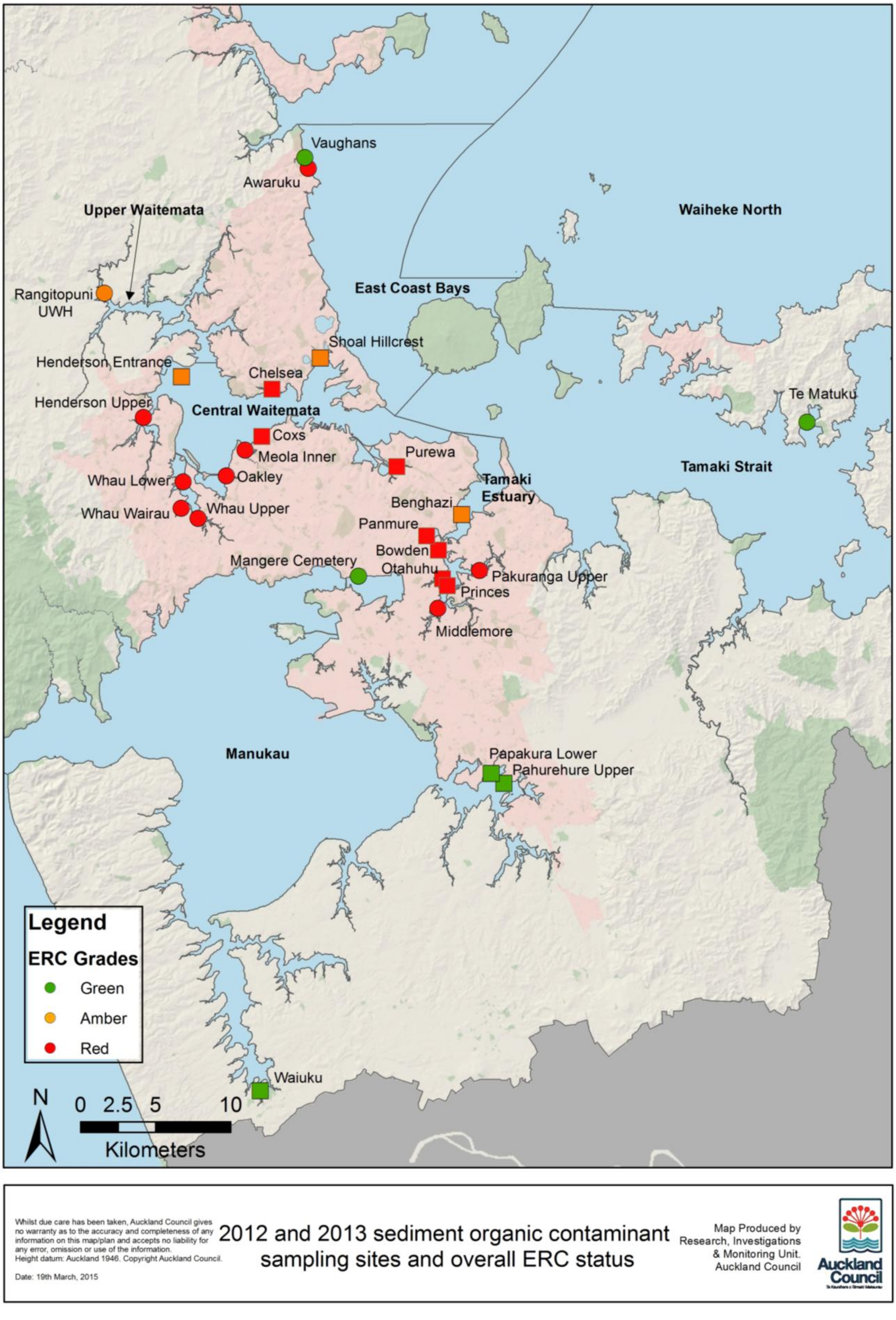


Figure 2-1 Locations of sites selected for analysis of organic contaminants in 2012 (square symbols) and 2013 (round symbols). Colour coding indicates overall ERC grades based on Table 4-1.

2.2 Sample collection and processing

Samples were collected using the sampling protocols prescribed for the RSCMP, UWH, CWH Ecology, and Long Bay monitoring programmes. Samples were homogenised and freeze dried (NIWA, Hamilton), then 0.5 mm (500 µm) sieved to remove coarse debris (e.g. shell hash, organic litter).

A single replicate sample (replicate 1) from each site was used for analysis, except for Rangitopuni (UWH). Samples used for organic analysis were the freeze dried and sieved fractions remaining after analysis of the primary contaminants (heavy metals) and particle size distribution. There was insufficient sample remaining from Rangitopuni for analysis of an individual replicate. Therefore, a composite sample made up from equal amounts of each of the 3 replicates was used for organic contaminant analysis from this site.

The Middlemore sample analysed for organic contaminants was the Bulk Reference Sediment (BRS), used for quality assurance purposes in the RSCMP. There were currently approximately 90 separate aliquots of freeze dried BRS, all of which made up from the same homogenised stock, archived for tracking data quality over time in the RSCMP. One of these BRS samples was randomly selected for analysis. It was analysed in duplicate, by submitting two samples from the same jar to the lab with different sample codes (i.e. as blind duplicates).

For all sites, freeze-dried samples of approximately 50 g were transferred into sample jars provided by AsureQuality and sent to Wellington for organic contaminant analysis (on 17th July 2013 for the 2012 samples, and on 10th February 2014 for the 2013 samples).

At the same time, a second set of samples, of the same freeze dried and sieved material, were sent to R.J. Hill laboratories (Hamilton) for analysis of Total Organic Carbon (TOC). Samples from the sites sampled in 2012 were analysed in July 2013, and those from the 2013 sites were analysed with the 2013 RSCMP samples (in February 2014).

Table 2-1 Sites used for organic contaminant analysis

Site	Batch	Programme	MRA	Sampling Date	Sampled by
Princes	2012	RSCMP	Tamaki Estuary	08/11/12	DSL
Waiuku	2012	RSCMP	Manukau Hbr	20/11/12	DSL
Otahuhu	2012	RSCMP	Tamaki Estuary	08/11/12	DSL
Benghazi	2012	RSCMP	Tamaki Estuary	21/11/12	DSL
Papakura Lower	2012	RSCMP	Manukau Hbr	05/11/12	DSL
Shoal Hillcrest	2012	RSCMP	Central Waitemata Hbr	14/11/12	DSL
Chelsea	2012	RSCMP	Central Waitemata Hbr	14/11/12	DSL
Purewa	2012	RSCMP	Central Waitemata Hbr	16/11/12	DSL
Bowden	2012	RSCMP	Tamaki Estuary	12/11/12	DSL
Pahurehure Upper	2012	RSCMP	Manukau Hbr	06/11/12	DSL
Panmure	2012	RSCMP	Tamaki Estuary	12/11/12	DSL
Henderson Entrance	2012	CWH Eco	Central Waitemata Hbr	12/12/12	AC
Coxs	2012	RSCMP	Central Waitemata Hbr	09/11/12	DSL
Awaruku Stream	2013	Long Bay	East Coast Bays	15/11/13	DSL
Vaughan's Stream	2013	Long Bay	East Coast Bays	15/11/13	DSL
Henderson Upper	2013	RSCMP	Central Waitemata Hbr	01/11/13	DSL
Mangere Cemetery	2013	RSCMP	Manukau Hbr	04/11/13	DSL
Meola Inner	2013	RSCMP	Central Waitemata Hbr	07/11/13	DSL
Middlemore (BRS)	2013	RSCMP	Tamaki Estuary	21/07/11	DSL
Oakley	2013	RSCMP	Central Waitemata Hbr	13/11/13	DSL
Pakuranga Upper	2013	RSCMP	Tamaki Estuary	12/11/13	DSL
Te Matuku	2013	RSCMP	Tamaki Strait	03/11/13	DSL
Whau Lower	2013	RSCMP	Central Waitemata Hbr	13/11/13	DSL
Whau Upper	2013	RSCMP	Central Waitemata Hbr	14/11/13	DSL
Whau Wairau	2013	RSCMP	Central Waitemata Hbr	14/11/13	DSL
Rangitopuni Creek (Rng TOP)	2013	UWH	Upper Waitemata Hbr	07/11/13	NIWA

2.3 Analysis

Organic contaminants were analysed at AsureQuality laboratory (Wellington). The analytical methods used by AsureQuality are based on solvent extraction, clean up by solid phase chromatography, and analysis of clean extracts by isotope dilution high resolution gas chromatography mass spectrometry (HRGC-MS). This provides the high sensitivity and specificity required for reliable identification and quantification of these trace level organics in marine sediments. The method for OCPs is based on USEPA Method 1699, for PCBs USEPA Method 1668A, and an in-house method is used for PAHs. The AsureQuality lab holds International Accreditation New Zealand (IANZ) accreditation for these methods. Further technical details of the methods can be obtained from AsureQuality.

Sixteen PAH compounds, 28 OCPs (2 compounds of the listed 30 compounds, endrin aldehyde and ketone, were not quantified), and 52 PCB congeners (plus co-eluting compounds) were included in the AsureQuality analyses (appendix A, Table 7-1 to Table 7-6 tabulates the data). This represents a comprehensive suite of the most commonly monitored PAH, OCP, and PCB compounds, including those analysed in earlier ARC monitoring (Reed & Gadd 2009, Mills 2013a).

Samples for organic compounds and TOC were analysed in two batches – one in July/August 2013 (for the November 2012 samples) and one in February/March 2014 (for the November 2013 samples).

TOC was analysed at R.J. Hill labs (Hamilton) by Elementar Combustion Analyser after acid pre-treatment to remove carbonates.

Copies of the laboratory reports are available from the Research, Investigations, and Monitoring Unit (RIMU) at Auckland Council.

2.4 Quality assurance

A laboratory blank was analysed with each sample batch, and results were included in the laboratory analysis reports. The blank data have been included in the data tabulations and plots presented later in this report to allow comparison of analytical-sourced artefacts with concentrations present in low concentration samples.

One blind duplicate sample was included in each batch – Cox's Bay for the 2012 batch and Middlemore (BRS) for the 2013 batch. The results for the blind duplicates have been included in the tabulated data and are summarised in Table 2-2. Note that blind duplicate results for OCPs and PAHs from the 2012 sample batch initially analysed at AsureQuality showed poor agreement. Relative percentage differences (RPDs) between duplicates were approximately 96% for Total PAH, and 110% for Total DDTs. In contrast, agreement between duplicates for Total PCBs was good (RPD of 10%). AsureQuality conducted an investigation of the cause, and concluded that inadequate sample size for the PAH and OCP analyses was the likely issue. All the 2012 samples were reanalysed for PAHs and OCPs using larger sample amounts. The 2012 results presented in this report (including the QA data summarised in Table 2-2) are from the reanalysed sample batch.

The QA data showed only very low levels of blank contamination and RPDs between blind duplicates across all contaminants measured of 0.2–10%; Table 2-2). These RPDs are small for low level organic contaminant analysis, and indicate good analytical repeatability. While the contaminant concentrations in the lab blanks were very low, for some OCPs (e.g. lindane, chlordanes, dieldrin) the concentrations were comparable with those found in the cleaner site samples.

Within-batch laboratory data variability for TOC analysis was assessed by analysis of blind duplicate analysis of two samples – Middlemore BRS and an UWH programme sample (Brighams UWH replicate 2) – included in the larger RSCMP sample batch. Data are summarised in

Table 2-3, and showed good agreement between blind duplicates (RPDs <4%). TOC variability was also assessed from analysis of three replicates of Middlemore BRS. Repeatability was good, with a coefficient of variation (CV, %; N=3) of 4.1%.

Table 2-2 Within-batch (WB) blind duplicate analysis results. Differences between duplicates are expressed in absolute terms (ng/g, parts per billion) and as relative percentage differences (RPD)

Site	Year	Rep	Total PAH	HWPAH	Dieldrin	Chlordane	Total DDT	Total PCB
Coxs	2012	1	889	518	0.0590	0.0268	0.2312	0.531
		WB	955	565	0.0601	0.0293	0.2286	0.588
difference between reps (ng/g)			65.6	46.9	0.0011	0.0025	-0.0026	0.057
RPD (%)			7.1	8.7	1.8	9.0	1.1	10.3
Middlemore BRS	2013	1	1231	729	0.455	0.1031	1.31	5.73
		WB	1139	672	0.426	0.1073	1.30	5.50
difference between reps (ng/g)			-92.3	-57.6	-0.029	0.0042	-0.0031	-0.226
RPD (%)			7.8	8.2	6.6	4.0	0.2	4.0

Table 2-3 Within-batch (WB) variation for total organic carbon (TOC, %) in an UWH site sample (Brighams Rep 2) and Middlemore Bulk Reference Sediment (BRS) submitted to the laboratory as blind duplicates.

Sample	Result 1	WB Rep	RPD (%)
Middlemore Freeze dried BRS	1.87	1.81	-3.3
Brighams UWH Rep 2	2.50	2.50	0.0

3.0 Data treatment

3.1 Less than detection limit values

The generally low concentrations of OCPs and PCBs in Auckland's marine sediments require sensitive analytical methods to obtain reliable data above detection limits (DLs). Because PAHs are present at higher concentrations, this is generally not a significant issue for PAH data.

Many of the organochlorine data collected in the past for the Auckland sediments have been below DLs (<DL), partly because the concentrations at many sites are low, and partly because the analytical methods used in some previous surveys had DLs that were high relative to ambient concentrations (e.g. 2003 and 2007 surveys, reviewed in Mills 2013a).

For the 2012/13 sample data summarised in this report, the analytical DLs were low, well below environmental guideline values; e.g. for lindane, the OCP with the lowest ERC value (0.3 ng/g), the DLs for the 2012 and 2013 sample batches were at least a factor of 10x lower, at 0.014–0.029 ng/g (sample dependent).

Results for individual compounds with less than DL values have been treated in two ways when presenting the data, and for calculating and plotting contaminant class totals (total DDTs, chlordane, PCBs, PAH):

- including the <DL values as being equal to the DL. This provides an upper limit to the group total concentrations. This method was used when plotting the 2012/13 data, to show the contribution that the <DL values made to low level samples. Data treated in this way provides a slightly more conservative picture of contaminant levels; and
- treating the <DL values as equal to zero. This provides an indication of the lower bound of concentrations. This method was applied to the 2003 survey data (which had high DLs) for comparing with the 2007 and 2012/13 data (low DLs) to assess indicative trends in section 4.3.

Because the 2012/13 sample analyses had low DLs, the treatment of <DL values is a minor issue, and any small variations arising from DLs are of no real practical significance.

3.2 Estimated maximum possible concentrations (EMPC)

Some of the laboratory results are flagged as estimated maximum possible concentrations (EMPC). These represent the maximum amount of the analyte that could be present in the sample. An EMPC flag indicates that the method quantification criteria have been met, but the analyte signal only meets a lower level of identification quality, probably due to matrix interference. The EMPC is defined in the USEPA isotope dilution HRGC-MS protocols, and detail can be obtained from AsureQuality.

For this summary, values flagged as EMPC have been included at the concentrations given.

3.3 Laboratory blanks

At cleaner sites, contaminant concentrations can be comparable with laboratory blanks. Including the blank data in the summary data tables and plots provides a useful reality check for assessing whether these very low levels are real (present in the environment) or largely due to the influence of the laboratory analysis process.

At the cleaner sites, the low concentration OCPs (e.g. lindane, dieldrin, chlordane, HCB) were the compounds that were closest to blank levels. For total PCBs, PAH, and DDTs, most site concentrations were well above blank levels, except for the rural reference site Te Matuku, where concentrations of all contaminants were close to blank levels.

3.4 Environmental Response Criteria (ERC)

To assess potential adverse ecological effects, contaminant concentrations have been compared with the ARC Environmental Response Criteria (ERC; ARC 2004). ERC are summarised in Table 3-1.

Table 3-1 Environmental Response Criteria (ERC; ARC 2004). Values are concentrations, expressed in ng/g (µg/kg or parts per billion, ppb) at 1% total organic carbon (TOC) content.

Contaminants	ERC Green	ERC Amber	ERC Red
p,p'-DDE	< 2.1	no amber ERC for Ocs	>2.1
p,p'-DDD	< 1.2		>1.2
p,p-DDT	< 3.2		>3.2
Total DDTs	< 3.9		>3.9
chlordane	< 2.3		>2.3
dieldrin	< 0.72		>0.72
lindane	< 0.3		>0.3
Total PCBs	< 22		>22
HWPAH	< 660	660 - 1700	1700

Notes:
1. Total DDTs is the sum of o,p'- and p,p'- isomers of DDE, DDD, and DDT
2. chlordane is the sum of cis- and trans-chlordane
3. HWPAH are high molecular weight PAH, the sum of the concentrations of benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene and pyrene (as defined in ANZECC 2000).
4. TOC-normalisation to 1% total organic carbon (TOC), is recommended in the ANZECC (2000) guidelines, and involves dividing the measured concentrations by sediment TOC concentration (%).

ERC-Green conditions reflect a low level of impact. Further investigations are not required unless significant changes in upstream catchment land use occur. The status is reassessed every 5 years.

ERC-Amber concentrations indicate contaminant levels are elevated and the biology of the site is possibly impacted. As discussed in ARC (2004), unlike for metals and PAHs, there are no ERC-amber values for organochlorines because of uncertainties about the sources of these contaminants and trends in their concentrations. Exceedance of the ERC-Green concentrations triggers investigation of the sources and likely trends.

ERC-Red sites are higher impact sites where significant degradation has already occurred, and remedial opportunities are often more limited. Restoration of the site may not be feasible in the short term, but actions should be taken to slow the rate of contaminant accumulation and limit the spread of contaminants.

TOC-normalisation to 1% total organic carbon (TOC), is recommended in the ANZECC (2000) guidelines, and involves dividing the measured concentrations by sediment TOC concentration (%). This TOC-normalisation is used to account for changes in contaminant bioavailability (and hence potential toxicity) with changing TOC level in the sediment – organic contaminants are primarily bound to sediment organic carbon, which may reduce their bioavailability (and toxicity) to aquatic organisms. Contaminants may therefore be less toxic in sediments with higher TOC levels (and conversely, contaminant may be more toxic in low TOC sediments). Note that the appropriateness of the 1% TOC normalisation adopted in the ERC (and by ANZECC guidelines) for organic contaminants is unclear, because the original toxicity data base upon which the guidelines were based did not use TOC-normalised concentrations (this was discussed in Mills (2013a). Because of these uncertainties, contaminant data and ERC-Status have been considered in both dry weight terms (e.g. ng/g d.w.) and in TOC-normalised concentrations (ng/g at 1% TOC).

4.0 Results

4.1 Status assessment

The analytical data are tabulated in Appendix A (Table 7-1 to Table 7-6). A status summary of the concentrations of key contaminants and their ERC grades is given in Table 4-1. The ERC grades for metals have been included for comparison. A full tabulation of all the organic contaminant results contributing to this assessment is given in Appendix B. Graphical comparison of individual site concentrations for the key contaminants dieldrin, p,p'-DDE, p,p'-DDD, p,p'-DDT, Total DDTs, HWPAH, PCBs, lindane and hexachlorobenzene (HCB) are shown in Figure 4-1 to Figure 4-10.

The status assessment indicates that, for either dry weight (dw) or TOC-normalised (unless stated) data, organic contaminants exceeded the ERC-Green levels at 10 of the 26 sites:

- PAH (as HWPAH) at 8 sites – Meola Inner, Oakley, Whau Wairau, Middlemore, Shoal Hillcrest, Chelsea, Panmure, and Coxs Bay. The highest PAH levels were found at Meola Inner, with an ERC-Red (for non- TOC normalised concentrations) or ERC-amber (concentrations normalised to 1% TOC) grade. HWPAH were also in the ERC-Red (TOC-normalised) or amber (non-normalised concentration) range at Chelsea, the ERC-Red grade resulting (in part) from the low TOC content at this sandy site. HWPAH was the status determining factor (i.e. the highest rating ERC grade) only at Chelsea, although it was shared with Pb at Shoal Hillcrest. At other sites where PAHs were elevated above ERC-Green levels, there was at least one metal that was either ERC-amber or ERC-red.
- OCPs at 5 sites – Henderson Upper, Meola Inner, Whau Upper, Whau Wairau, and possibly also Oakley. DDE, DDD, or Total DDTs were the only OCPs that exceeded the ERC-Red thresholds. OCPs were the status determining factor at Henderson Upper, and possibly also at Oakley – at these sites OCPs were ERC-Red (or at Oakley, near the red threshold) while metals concentrations in 2013 were in the ERC-amber range. At the other sites with ERC-Red OCP levels, one or more metals concentrations were also in the ERC-Red range.

Other notable features of the results were:

- Elevated PCBs at Meola Inner (18 ng/g) and to lesser degree at Whau Wairau (15 ng/g) and Henderson Upper (12 ng/g). These levels did not exceed the ERC-Red threshold (22 ng/g), but were markedly higher than those found at other sites (0.04–8.8 ng/g). The previous organochlorine data review (Mills 2013a) suggested that, from limited historical data, it was possible that PCBs could approach or exceed ERC-Red thresholds at the most contaminated sites. Based on the 2013 results, elevated PCBs can indeed occur at the most contaminated sites (e.g. Meola Inner), but it seems likely that ERC-Red exceedance will be rare.
- An unusually elevated hexachlorobenzene (HCB) concentration of 1.43 ng/g (dw) was found at Awaruku Stream (Figure 4-10). There are no sediment quality

guidelines (ERC values) for HCB, so the environmental significance of this elevated value is unknown. Henderson Upper had the second highest HCB concentration (0.55 ng/g), followed by Whau Wairau (0.33 ng/g). In comparison, the HCB concentration at Te Matuku (reference site) was 0.0257 ng/g.

- Lindane was near lab blank levels at most sites. Pakuranga Upper was the most notable exception, with an EMPC of 0.135 ng/g (Figure 4-3).

Concentrations of the other OCPs were either below DLs, or very close to the lab blank levels. As found in previous surveys, it appears that DDTs (DDE, DDD, and DDT), and at much lower levels dieldrin, remain the most significant OCPs remaining in receiving water sediments.

Table 4-1 Summary of contaminant concentrations and ERC status from 2012/13 sampling. Colour coding indicates ERC grades (red, amber, green). Analytes exceeding ERC grades are noted. 'None' indicates no exceedance of ERC-green levels.

	Sample	Status			
Site	Year	Metals	HWPAH	OCPs	PCBs
Awaruku Stream	2013	Zn	None	None	None
Vaughan's Stream	2013	None	None	None	None
Henderson Upper	2013	Cu Pb Zn	None	DDE, (DDD), Total DDT	None
Mangere Cemetery	2013	None	None	None	None
Meola Inner	2013	Pb Zn	(HWPAH)	DDD, Total DDT	None
Oakley	2013	Cu Pb Zn	(HWPAH)	(DDD), (Total DDT)	None
Pakuranga Upper	2013	Zn	None	None	None
Te Matuku	2013	None	None	None	None
Whau Lower	2013	Zn	None	None	None
Whau Upper	2013	Pb Zn	None	(Total DDT)	None
Whau Wairau	2013	Cu Pb Zn	(HWPAH)	(DDD), (Total DDT)	None
Rangitopuni	2013	Cu	None	None	None
Middlemore (BRS)	2013	Zn	(HWPAH)	None	None
Princes	2012	Zn	None	None	None
Waiuku	2012	None	None	None	None
Otahuhu	2012	Zn	None	None	None
Benghazi	2012	Cu Zn	None	None	None
Papakura Lower	2012	None	None	None	None
Shoal Hillcrest	2012	Pb	(HWPAH)	None	None
Chelsea	2012	Cu Pb	(HWPAH)	None	None
Purewa	2012	Zn	None	None	None
Bowden	2012	Zn	None	None	None
Pahurehure Upper	2012	None	None	None	None
Panmure	2012	Zn	(HWPAH)	None	None
Henderson Entrance	2012	Cu Zn	None	None	None
Coxs	2012	Pb Zn	(HWPAH)	None	None

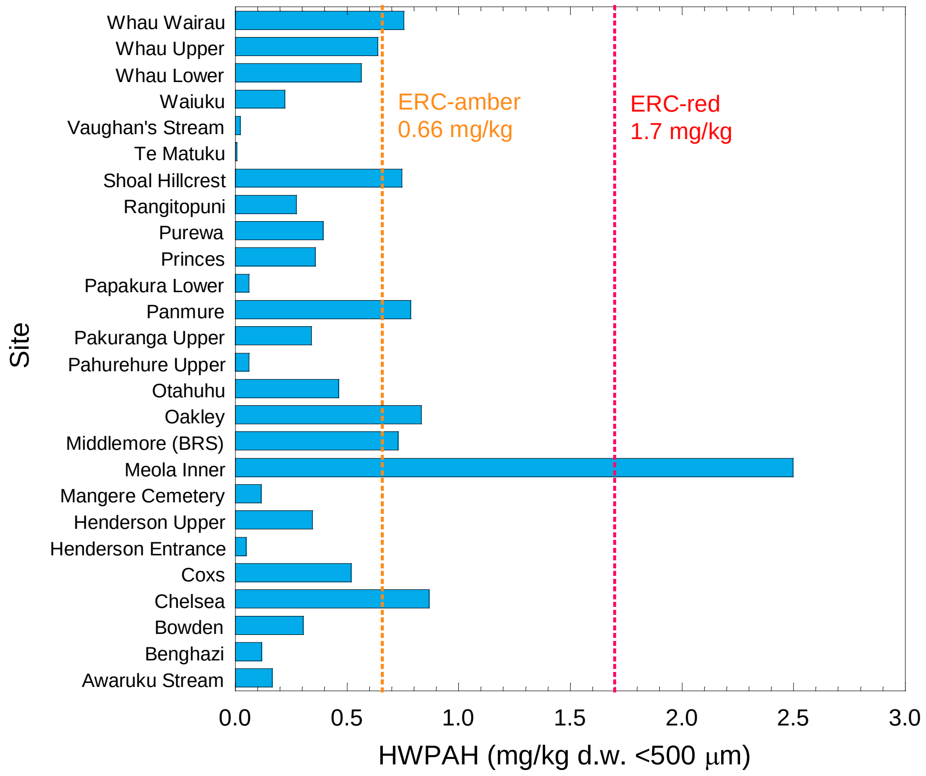
Notes:
1. Darker red shading indicates exceedance of ERC-Red in both ng/g (dw) and TOC-normalised concentrations. Pale red shading indicates concentrations within 10% of ERC-Red. Bracketing for HWPAH or OCPs indicates exceedance of ERC in only one of the concentration units, including within 10% of ERC.
2. Middlemore BRS – metals' status assessed from 2013 sampling results, organics from BRS sampled in 2011.

4.2 Contaminant concentrations at individual sites

The following plots (Figure 4-1 to Figure 4-10) show the concentrations of key organic contaminants (those found above detection limits in most samples) at each sampling site. Data are shown for concentrations in ng/g (<500 µm fraction) and also in ng/g at 1% TOC (TOC-normalised). The ERC are shown for comparison.

Laboratory blank levels are indicated on the plots where they can be seen above the baseline. Less than DL values have been plotted at the DL, and EMPC values were plotted at EMPC.

Figure 4-11 shows the proportions of the major DDT components (p,p'-isomers of DDE, DDD, and DDT) making up the Total DDT. While not the dominant component at any site, the parent p,p'-DDT component contributes a significant proportion of the total DDT at some sites, in particular at Whau Upper and Lower, and at Meola Inner. This suggests that on-going inputs of fresh DDT to these sites may still be occurring.



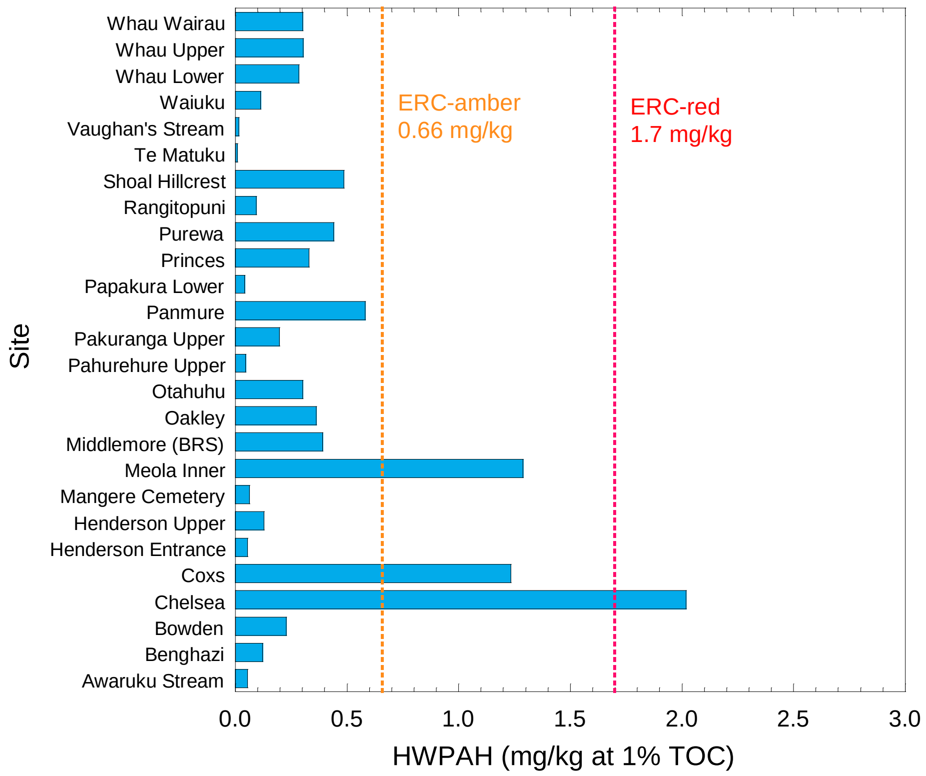


Figure 4-1 HWPAH concentrations in 2012 and 2013 samples

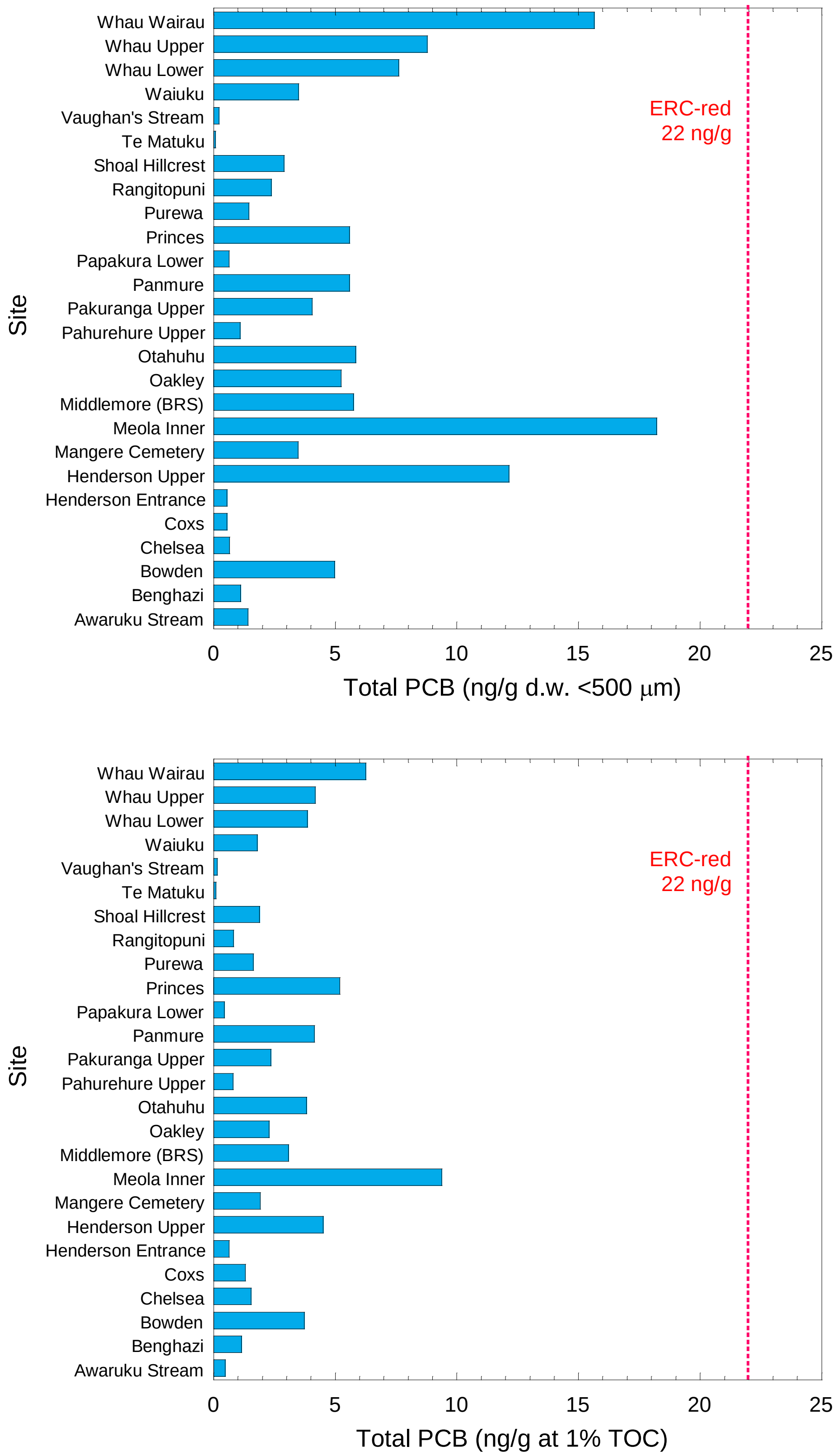


Figure 4-2 Total PCB concentrations in 2012 and 2013 samples

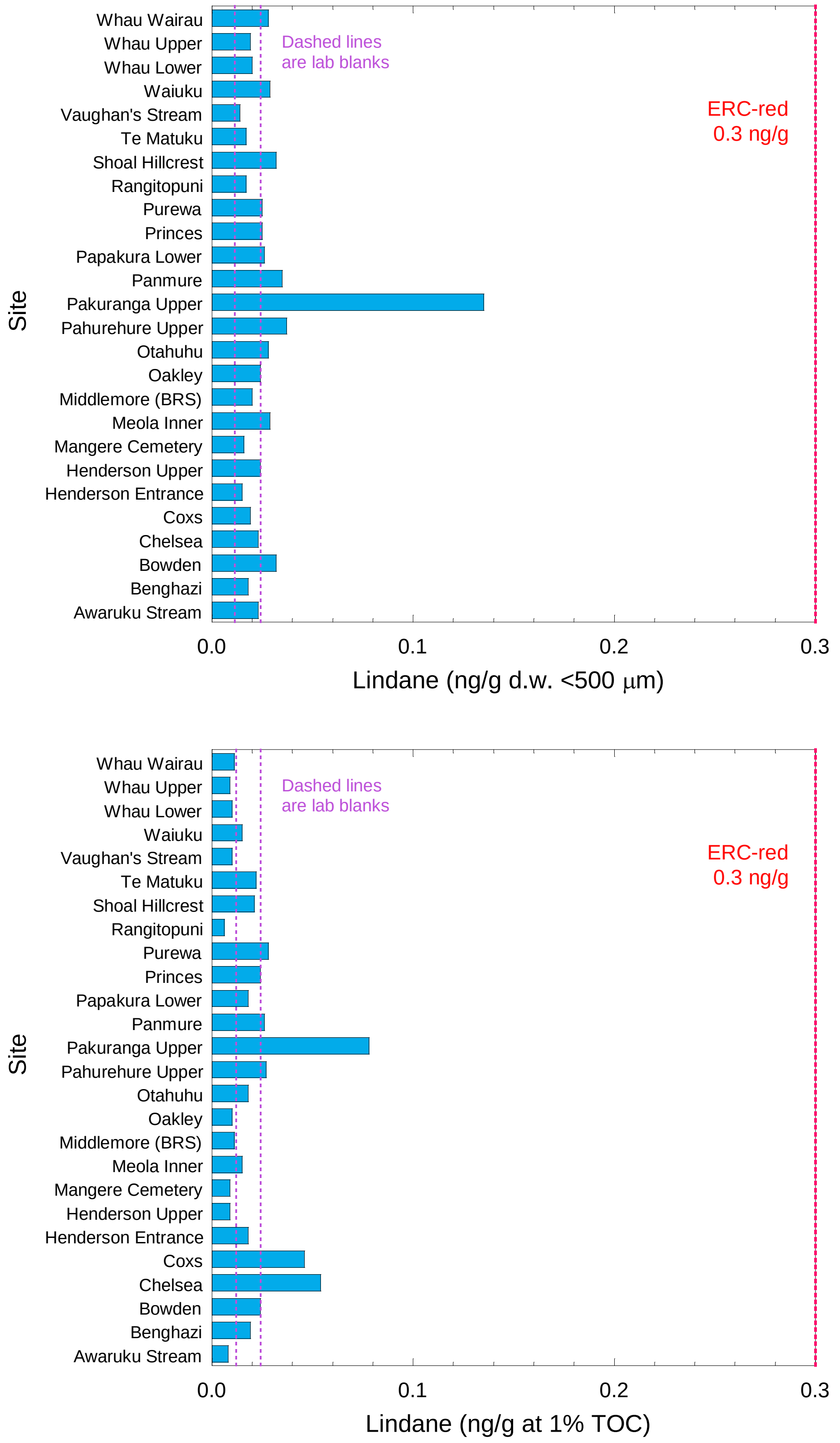


Figure 4-3 Lindane concentrations in 2012 and 2013 samples

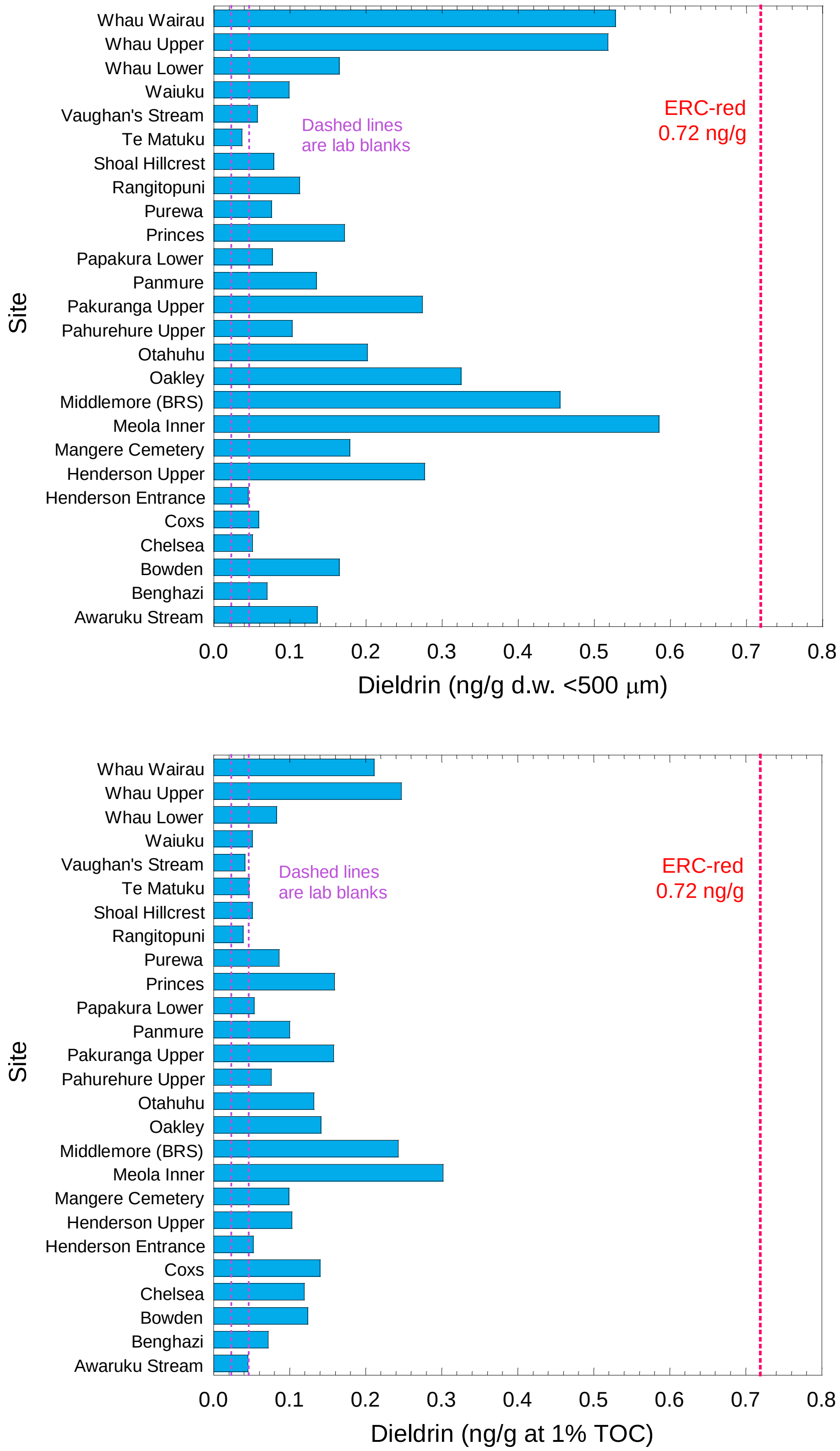
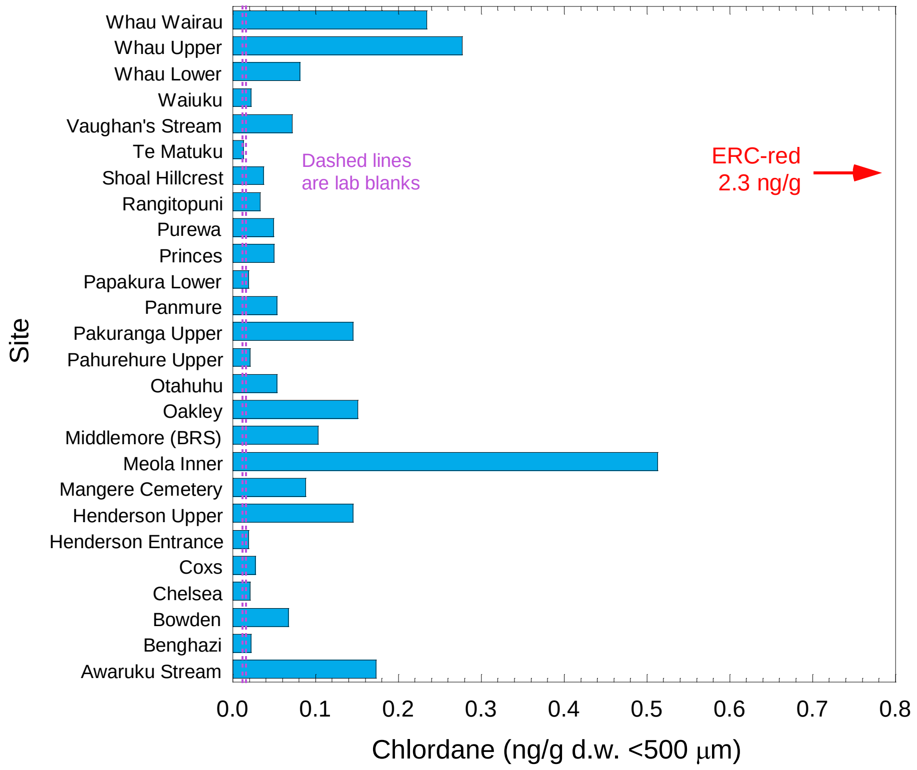


Figure 4-4 Dieldrin concentrations in 2012 and 2013 samples



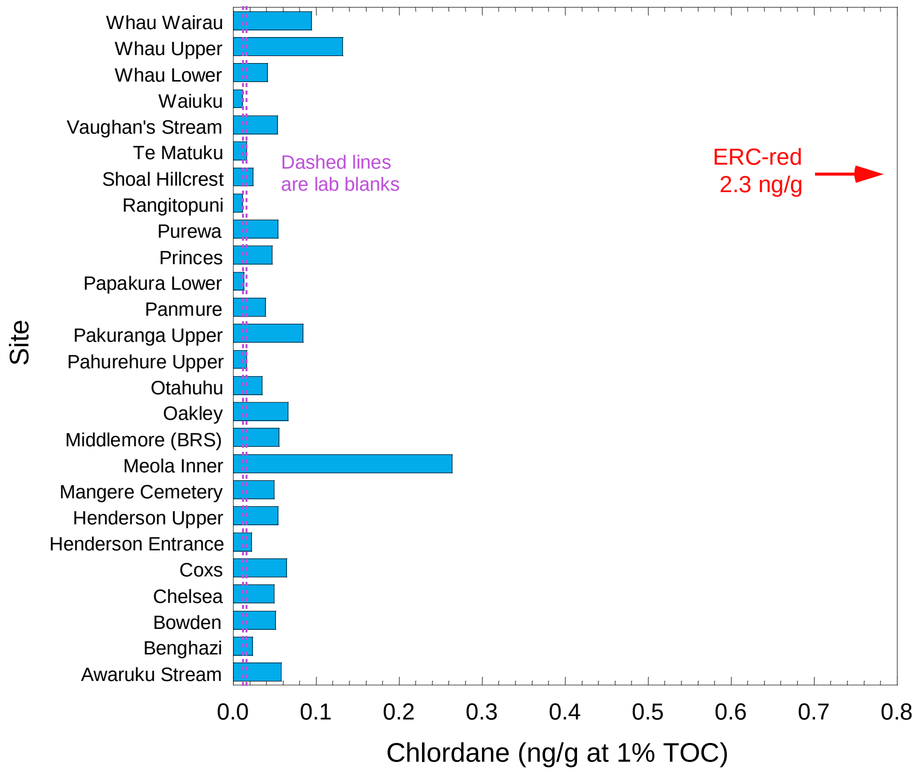


Figure 4-5 Chlordane (sum of alpha- and gamma-chlordane) concentrations in 2012 and 2013 samples

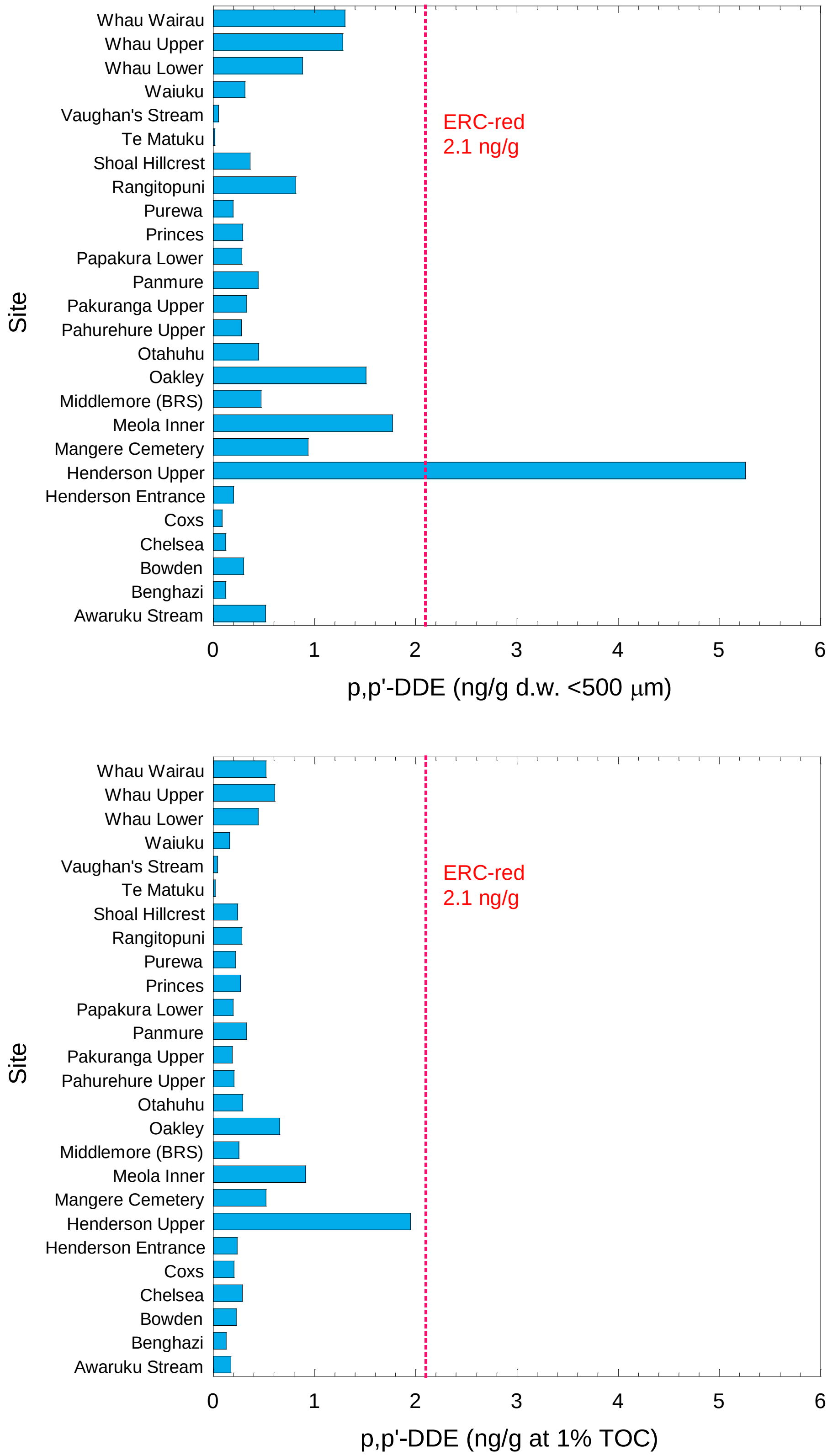


Figure 4-6 p,p'-DDE concentrations in 2012 and 2013 samples

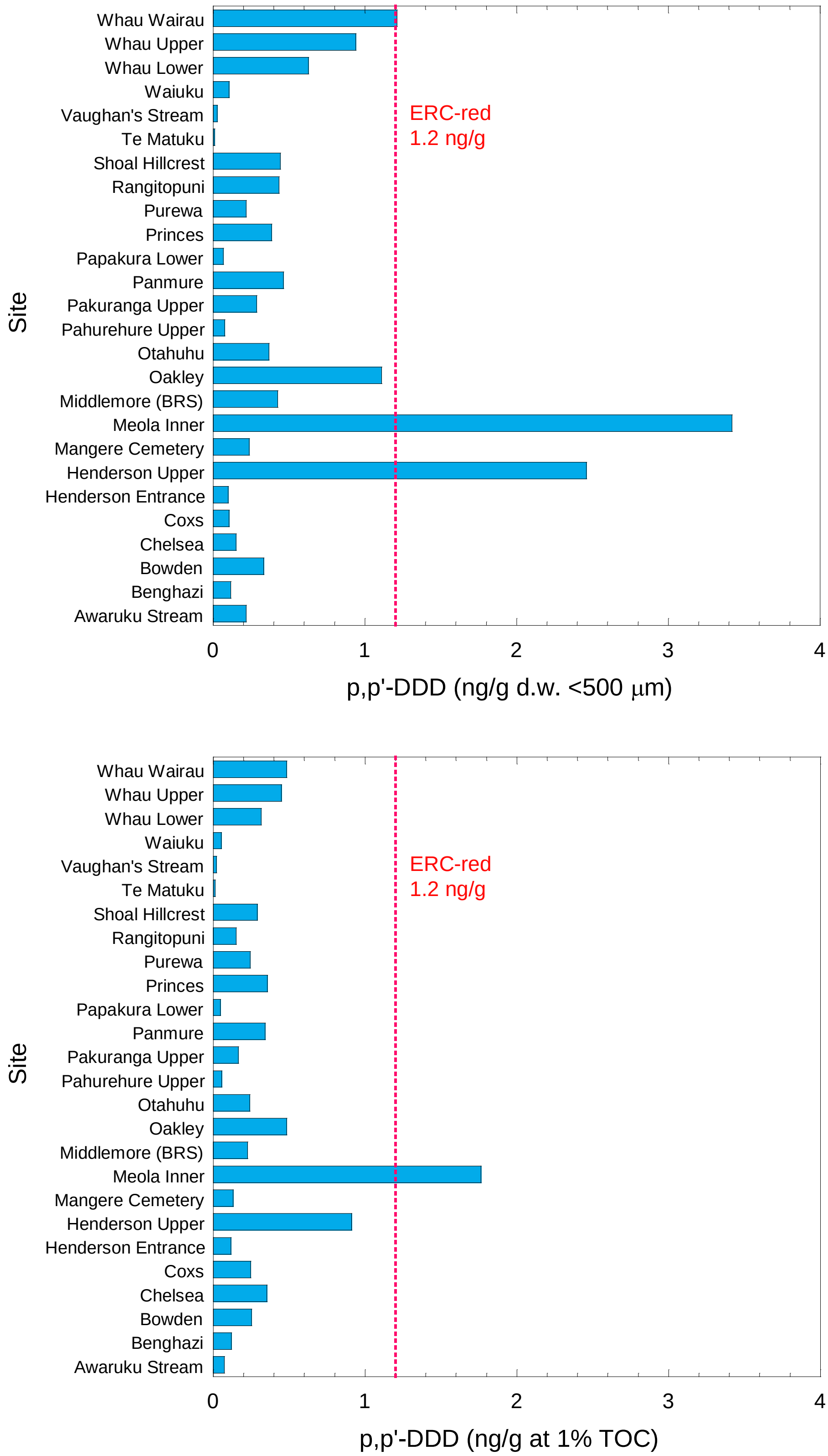


Figure 4-7 p,p'-DDD concentrations in 2012 and 2013 samples

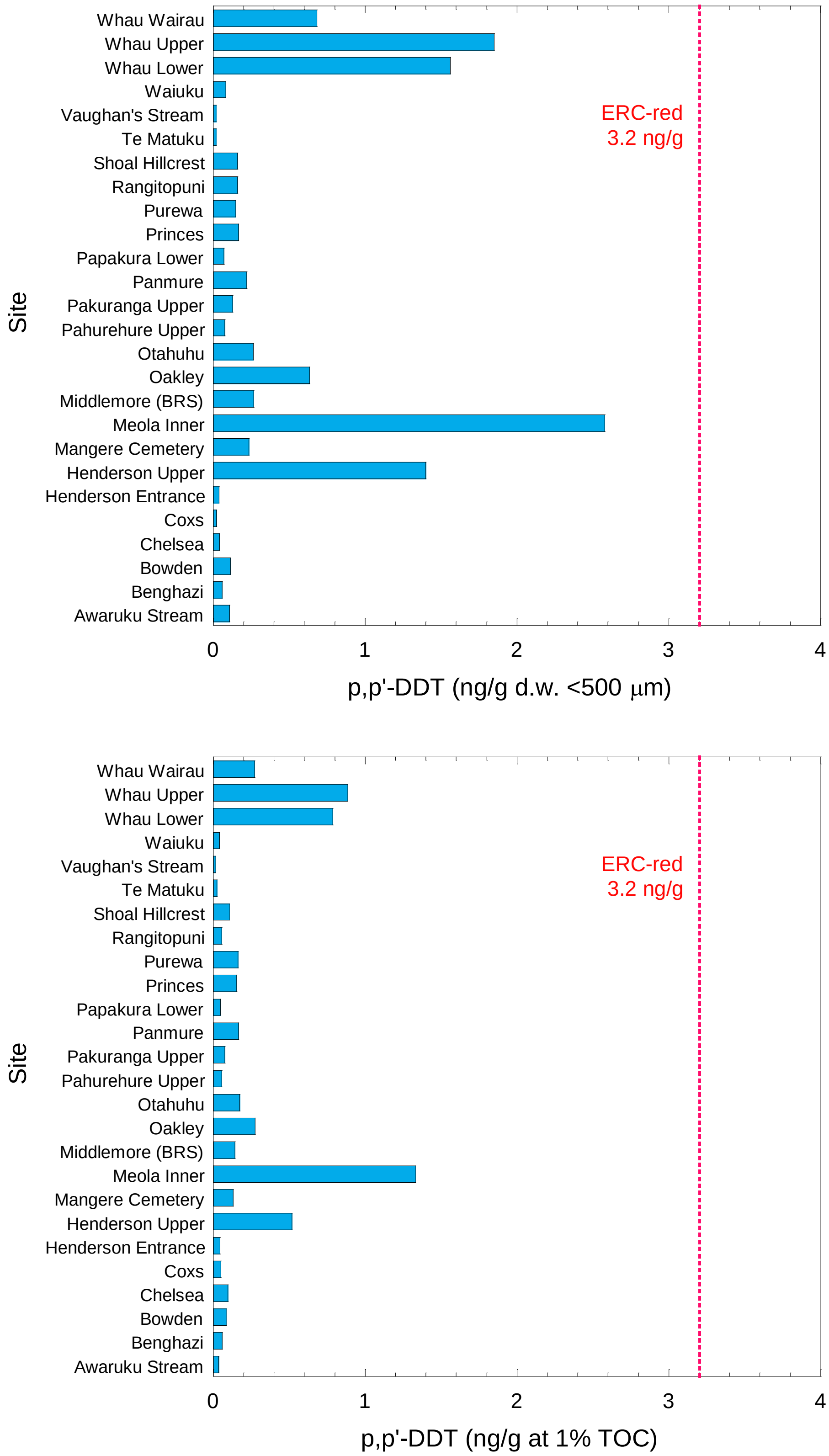


Figure 4-8 p,p’-DDT concentrations in 2012 and 2013 samples

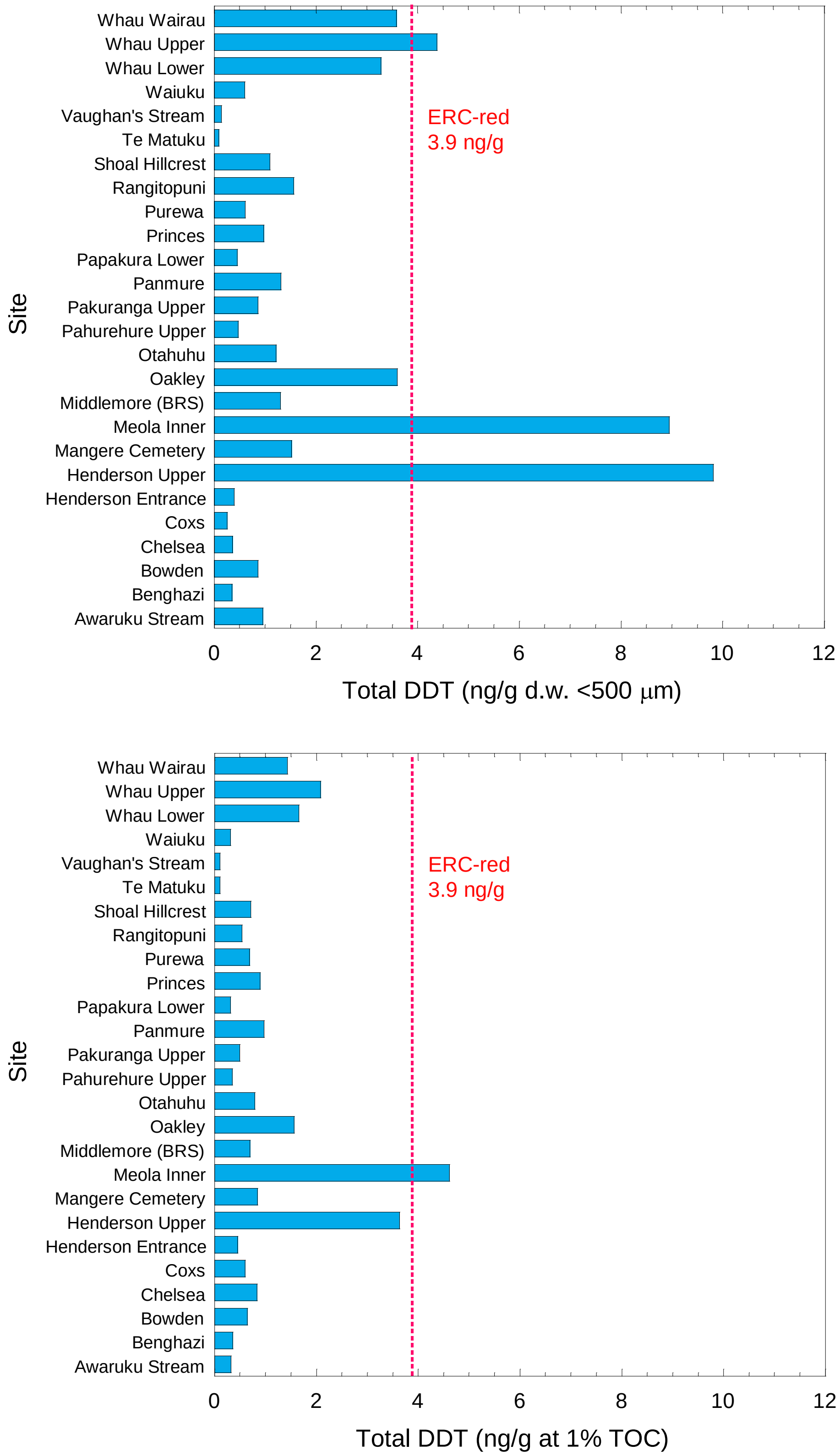


Figure 4-9 Total DDT concentrations in 2012 and 2013 samples.

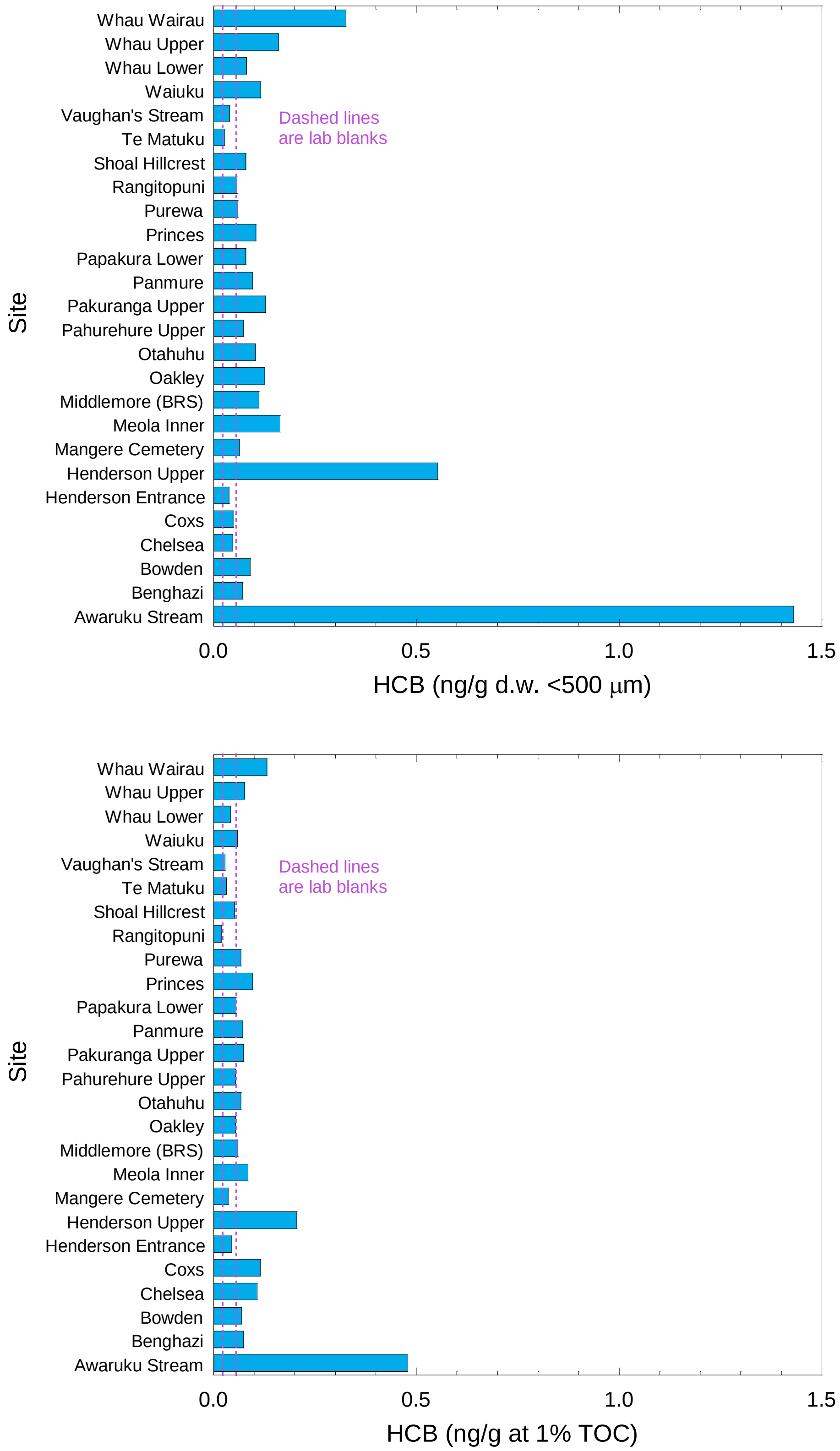


Figure 4-10 Hexachlorobenzene concentrations in 2012 and 2013 samples

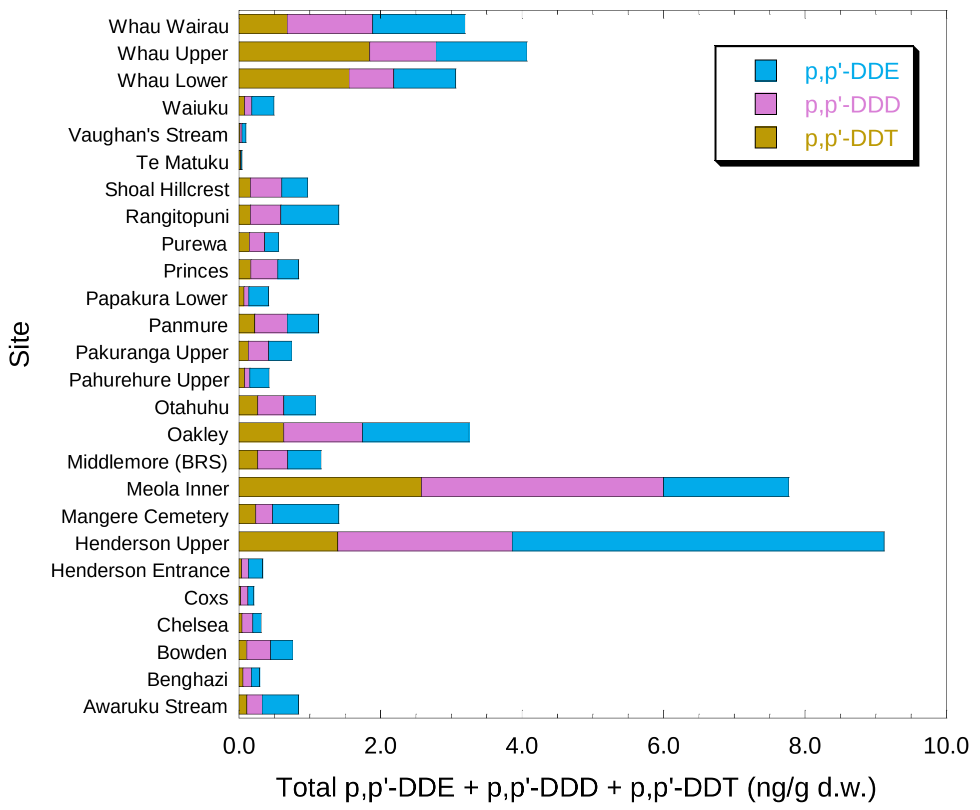


Figure 4-11 DDT composition showing the proportions of p,p'-isomers of DDE, DDD, and DDT

4.3 Indicative trends for organochlorine pesticides

Three surveys of organochlorines have been undertaken – one in 2003, one in 2007, and the present one in 2012/13. However, for the reasons outlined below, the data have limitations for providing reliable quantitative trend information:

- Fewer sites were analysed in 2007 and 2012/13 than in 2003. Ten of the sites sampled in 2003 were also analysed in 2012/13, but only 4 sites were common to all the 2003, 2007 and 2013 surveys. None of the sites sampled in 2012 were monitored in 2003 or 2007.
- Analytical methods varied considerably in the surveys. The 2003 OCP analyses had higher detection limits, and less quantitative rigour, than those used in 2007 or 2012/13 (Mills 2013a). While the 2007 and 2012/13 data were generated by consistent analytical methods (and are therefore directly comparable), comparing the 2003 data with the 2007/12/13 data requires consideration of the very different analysis methods (and their different DLs).
- PCBs were not measured in 2003, and the analytical method used in the initial screening survey undertaken in 2007 had DLs that were too high to yield useful results (Mills 2013a). Therefore, there are no useful PCB data for quantitative comparison with the 2012/13 results, and therefore trends for PCBs cannot be assessed.

Despite these limitations, an indicative assessment of trends for OCPs has been made to see whether OCP concentrations are likely to be changing much over time.

The trend information has been shown in three ways:

- From status assessment information obtained from the 2003, 2007, and 2012/13 monitoring. These status trends are summarised in Table 4-2;

From the OCP concentration data from each of the sites monitored in 2003, 2007, and 2013. These results are shown graphically for all sites in Figure 4-12 to Figure 4-16, and data are summarised in

- Table 4-3. Note that chlordane and lindane were not included because their concentrations were very low, with many <DL values; and
- To show the trend data for only the 4 sites analysed in all three surveys, the data have been plotted in Figure 4-17 and Figure 4-18.

Table 4-2 indicates that OCP status in 2013 was the same as in 2003 at 6 of the 10 sites, improved slightly at one site (Oakley), and changed from ERC-red to green at 3 sites (Mangere Cemetery, Whau Lower, and Middlemore).

The OCP data plotted in Figure 4-12 to Figure 4-18 suggest that OCP concentrations in 2007 were lower than those reported in 2003, and that 2013 levels were generally similar to those recorded in 2007. The only increases in concentrations recorded were for p,p'-DDT at Whau Upper and Whau Lower, which were slightly higher in 2013 than in 2007.

The DDT composition data shown in Figure 4-11 suggest there may still be on-going inputs of fresh DDT to some estuaries. However, these inputs do not seem to be sufficient to dominate the DDT residues present at any sites analysed in 2012/13, nor to increase sediment concentrations (apart perhaps for the two Whau estuary sites).

Overall, therefore, based on very limited data, the picture appears to be one of stable-to-decreasing concentrations of OCPs over the past decade. A slow decline in environmental concentrations is consistent with the combined effects of discontinued use (slow depletion of source material stored in estuary catchments) and the persistence of these chemicals in receiving sediments.

Table 4-2 Indicative trends in organochlorine pesticides' status from 2003 to 2013.

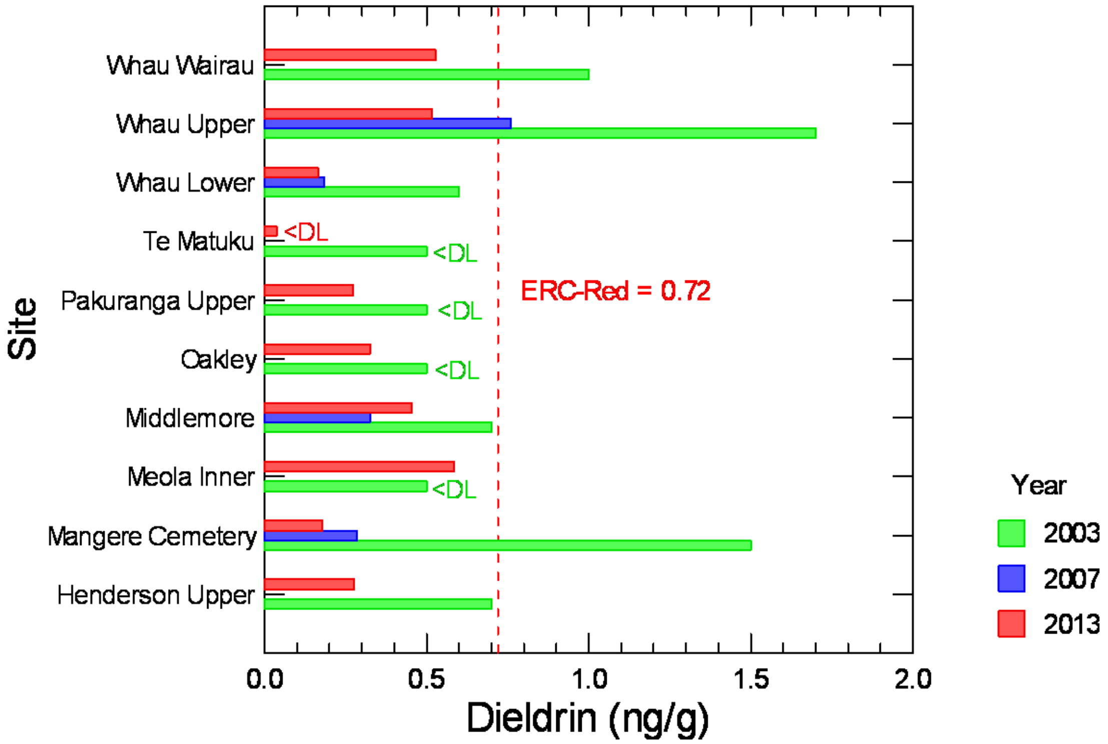
Site	Organochlorine Status & compounds exceeding ERC		
	2003	2007	2013
Henderson Upper	(Dieldrin), DDE, (DDD), (DDT), Total DDT	n/a	DDE, (DDD), Total DDT
Mangere Cemetery	Dieldrin, (DDE), (DDD), (Total DDT)	(Total DDT)	None
Meola Inner	DDD, DDT, Total DDT	n/a	DDD, Total DDT
Oakley	(DDD), (Total DDT)	n/a	(DDD), (Total DDT)
Pakuranga Upper	None	n/a	None
Te Matuku	None	n/a	None
Whau Lower	(Total DDT)	None	None
Whau Upper	(Dieldrin), (DDD), (Total DDT)	(Dieldrin), (DDD), (Total DDT)	(Total DDT)
Whau Wairau	(Dieldrin), (DDD)	n/a	(DDD), (Total DDT)
Middlemore	(Dieldrin)	None	None

Notes:
Darker red shading indicates exceedance of ERC-Red for OCPs in both ng/g and TOC-normalised concentrations. Pale red shading indicates OCPs within 10% of ERC-Red. Bracketing indicates exceedance of ERC in only one of the concentration units, including within 10% of ERC. n/a indicates not analysed in 2007. 'None' indicates no exceedance of ERC-green levels (i.e. concentrations below ERC-red threshold)

Table 4-3 OCP data for sites monitored in 2003, 2007, and 2013.

Site	Year	TOC %	Dieldrin		p,p'-DDE		p,p'-DDD		p,p'-DDT		Total DDT	
			ng/g	at 1% TOC	ng/g	at 1% TOC	ng/g	at 1% TOC	ng/g	at 1% TOC	ng/g	at 1% TOC
Henderson Upper	2003	2.77	0.70	0.25	6.80	2.45	3.10	1.12	5.70	2.03	16.10	5.94
Henderson Upper	2013	2.70	0.277	0.103	5.260	1.948	2.460	0.911	1.400	0.519	9.817	3.636
Mangere Cemetery	2003	1.59	1.50	0.98	3.60	2.35	1.20	0.78	<0.5	<0.3	5.70	3.56
Mangere Cemetery	2007	1.30	0.286	0.220	1.590	1.223	0.509	0.392	0.482	0.371	3.519	2.707
Mangere Cemetery	2013	1.81	0.179	0.099	0.939	0.519	0.237	0.131	0.236	0.130	1.519	0.839
Meola Inner	2003	1.72	<0.5	<0.3	1.80	1.08	4.30	2.50	7.10	4.13	13.10	7.62
Meola Inner	2013	1.94	0.585	0.302	1.770	0.912	3.420	1.763	2.580	1.330	8.949	4.613
Middlemore	2003	1.35	0.70	0.52	<0.5	<0.4	<0.5	<0.4	<0.5	<0.4	<3	<2.2
Middlemore	2007	1.60	0.325	0.203	0.537	0.336	0.542	0.339	0.143	0.089	1.387	0.867
Middlemore	2013	1.87	0.455	0.243	E 0.472	E 0.252	0.425	0.227	0.266	0.142	1.305	0.698
Oakley	2003	2.23	<0.5	<0.2	1.70	0.81	1.80	0.81	<0.5	<0.2	3.70	1.72
Oakley	2013	2.30	0.325	0.141	1.510	0.657	1.110	0.483	0.632	0.275	3.595	1.563
Pakuranga Upper	2003	1.74	<0.5	<0.3	<0.5	<0.3	<0.5	<0.3	<0.5	<0.3	<3	<1.6
Pakuranga Upper	2013	1.73	0.274	0.158	E 0.324	E 0.187	0.286	0.165	0.129	0.075	0.856	0.495
Te Matuku	2003	0.39	<0.5	<1.3	<0.5	<1.3	<0.5	<1.3	<0.5	<1.3	<3	<7.7
Te Matuku	2013	0.80	<0.037	<0.047	<0.014	<0.017	<0.0095	<0.012	<0.018	<0.023	<0.087	<0.109
Whau Lower	2003	2.02	0.60	0.30	0.80	0.40	1.10	0.53	2.20	1.09	4.10	2.07
Whau Lower	2007	1.80	0.185	0.103	0.917	0.509	0.847	0.471	0.216	0.120	2.226	1.237
Whau Lower	2013	1.98	0.165	0.083	0.880	0.444	0.627	0.317	1.560	0.788	3.279	1.656
Whau Upper	2003	2.66	1.70	0.64	2.00	0.75	1.40	0.53	<0.5	<0.2	3.80	1.48
Whau Upper	2007	2.30	0.759	0.330	1.650	0.717	1.330	0.578	0.517	0.225	3.915	1.702
Whau Upper	2013	2.10	0.518	0.247	1.280	0.610	0.939	0.447	1.850	0.881	4.377	2.084
Whau Wairau	2003	1.74	1.00	0.56	2.00	1.15	1.60	0.89	<0.5	<0.3	3.60	2.01
Whau Wairau	2013	2.50	0.528	0.211	E 1.30	E 0.52	1.210	0.484	0.683	0.273	3.581	1.433

Notes:
Darker red shading indicates exceedance of ERC-Red for OCPs in both ng/g and TOC-normalised concentrations. Pale red shading indicates OCPs within 10% of ERC-Red. Prefix of E – estimated maximum possible concentration.



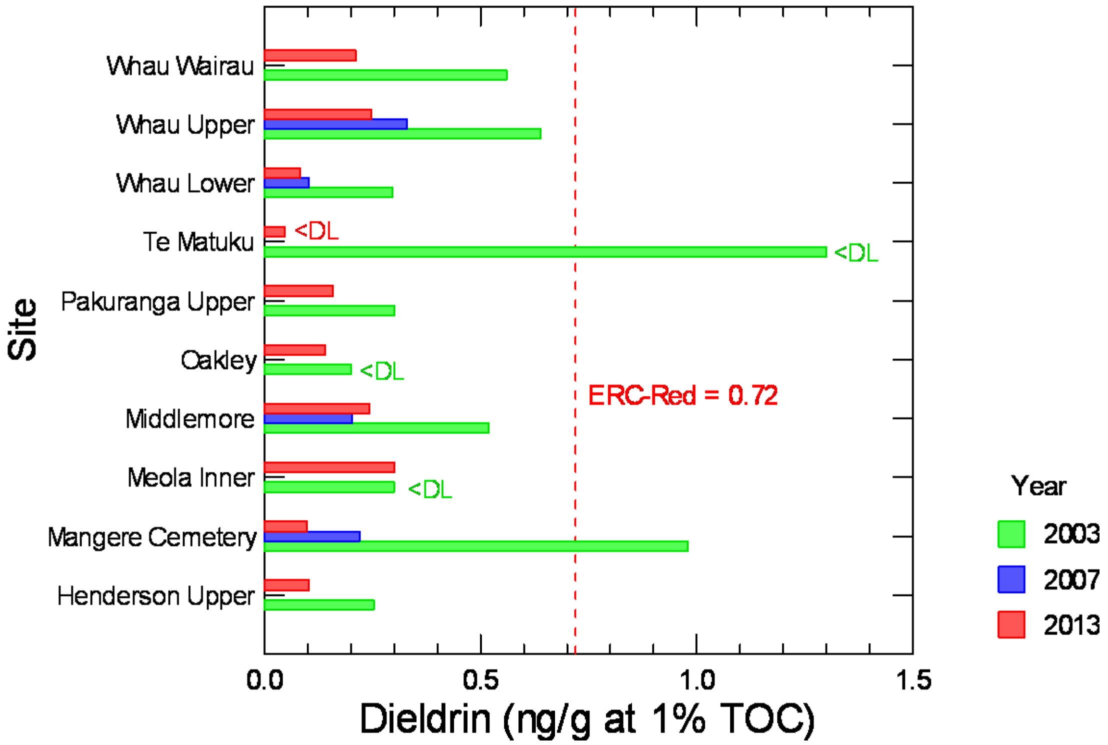


Figure 4-12 Comparison of dieldrin concentrations obtained in 2003, 2007, and 2013

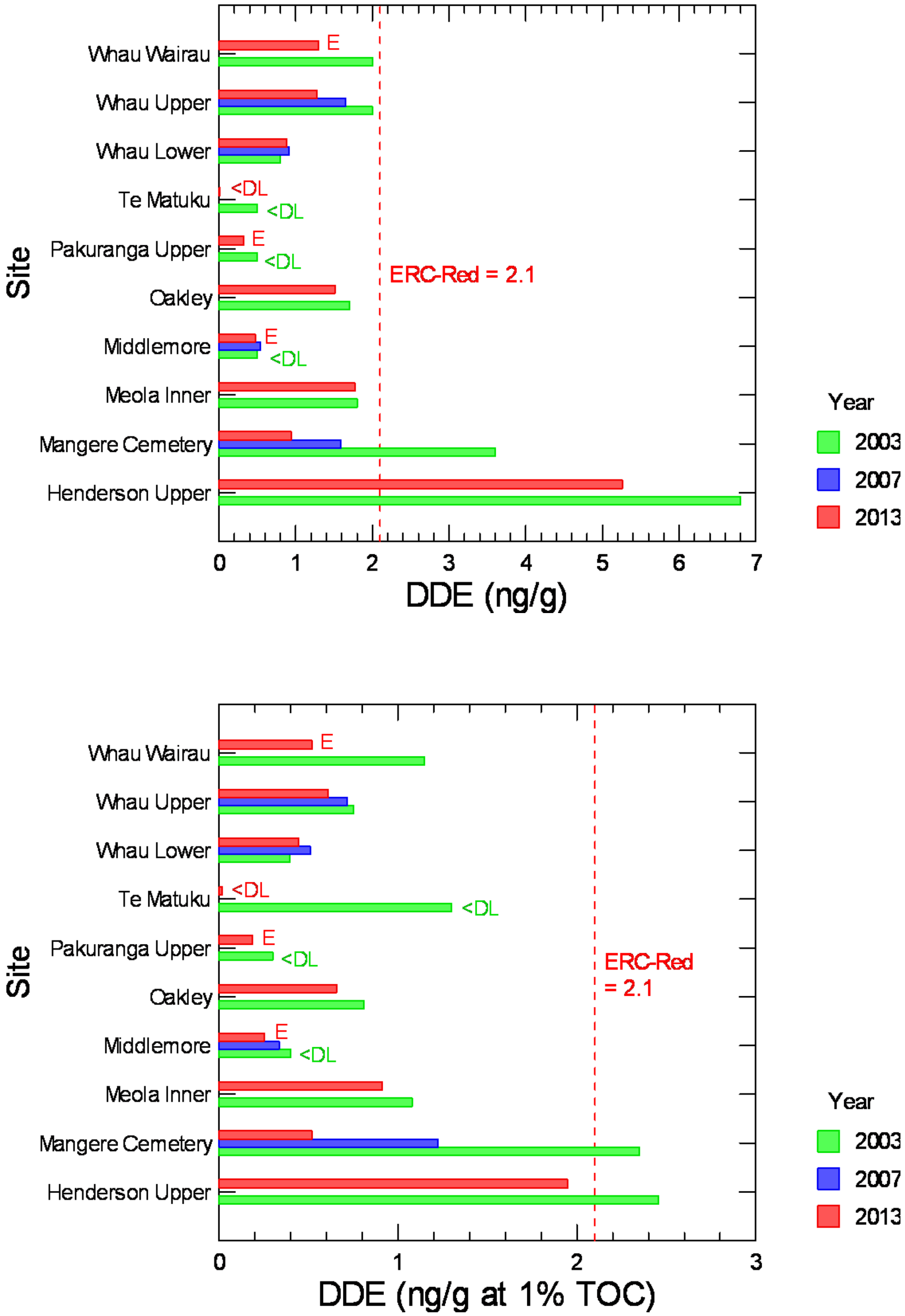
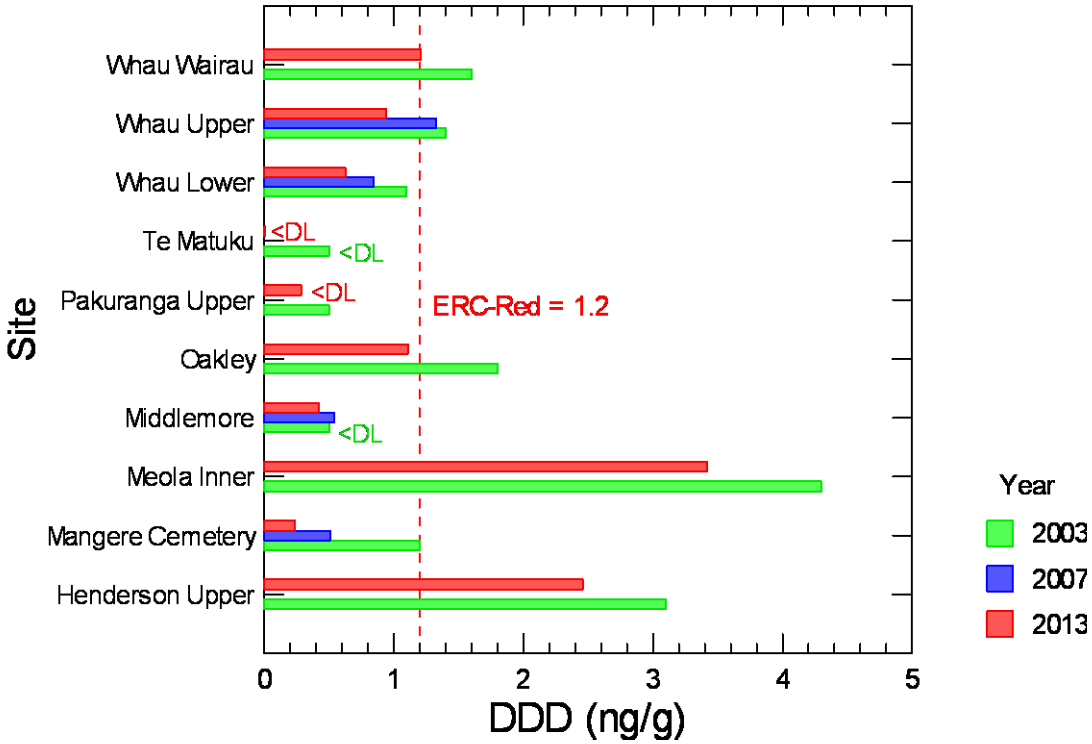


Figure 4-13 Comparison of p,p'-DDE concentrations obtained in 2003, 2007, and 2013



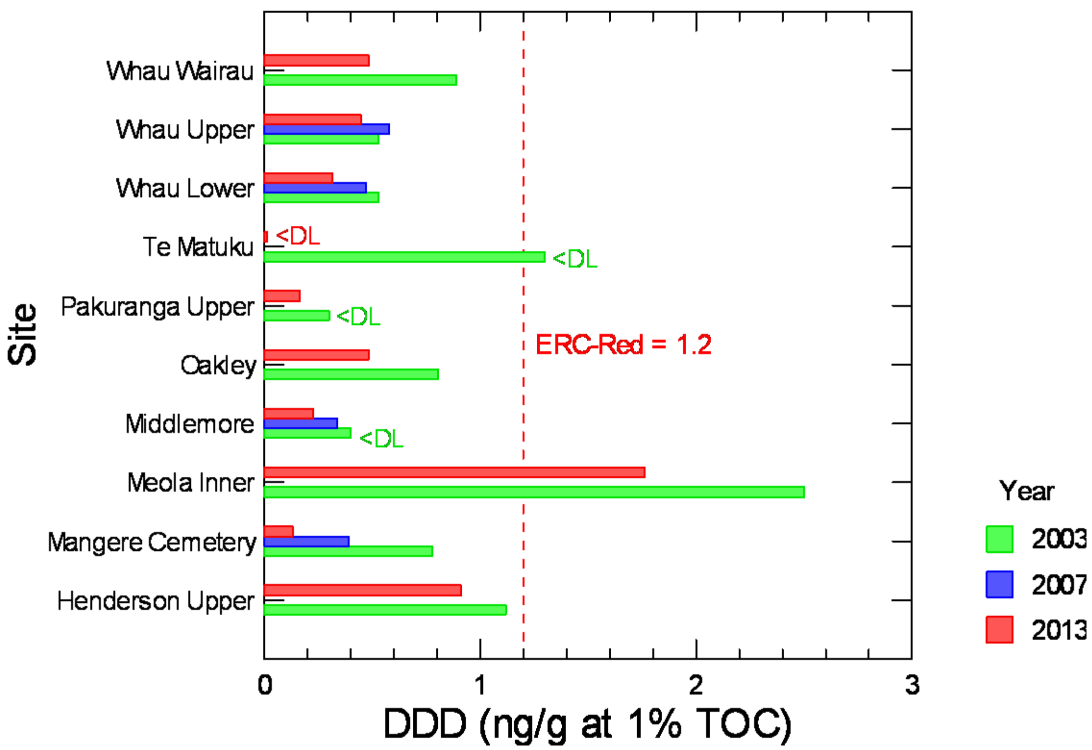


Figure 4-14 Comparison of p,p'-DDD concentrations obtained in 2003, 2007, and 2013

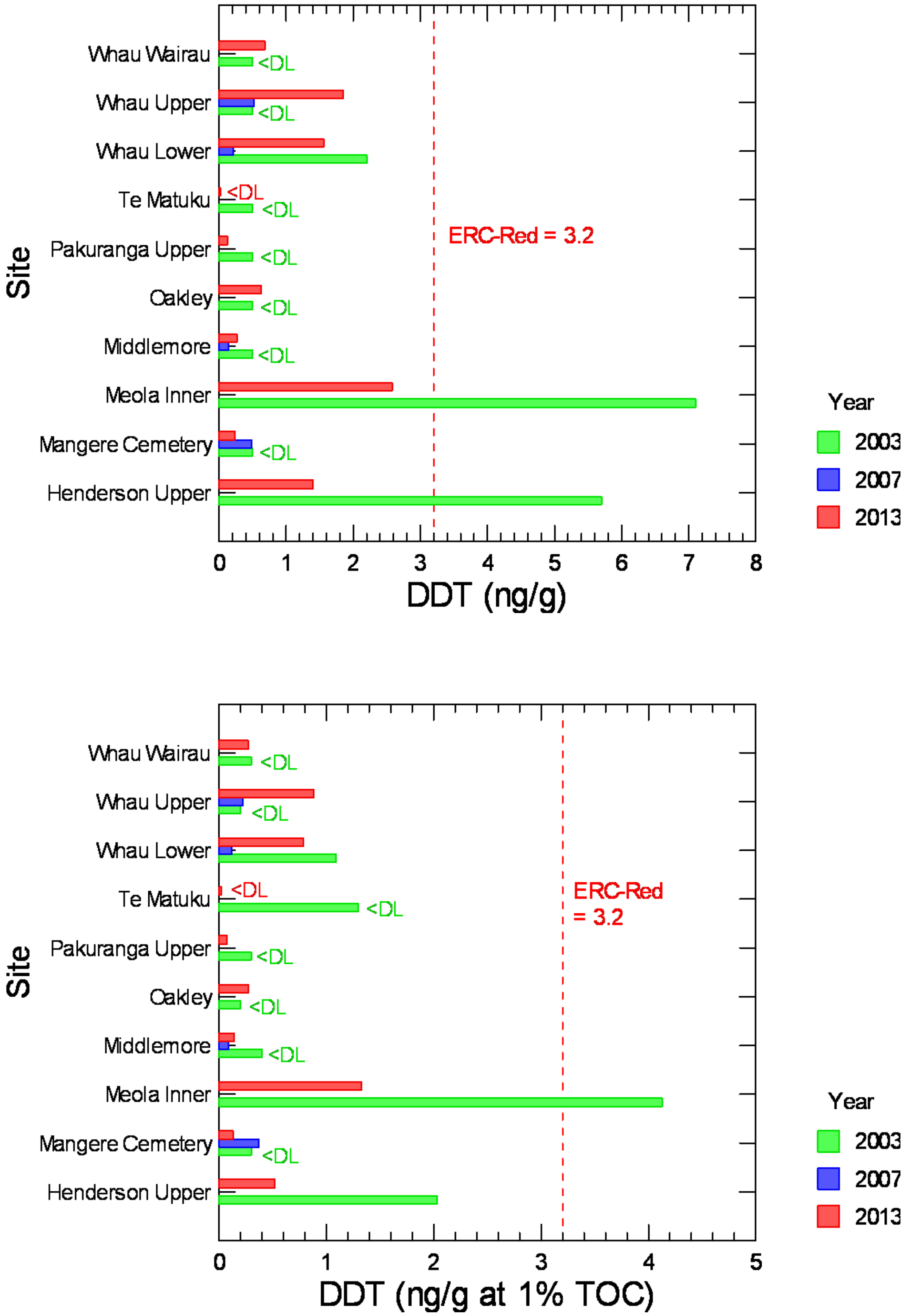
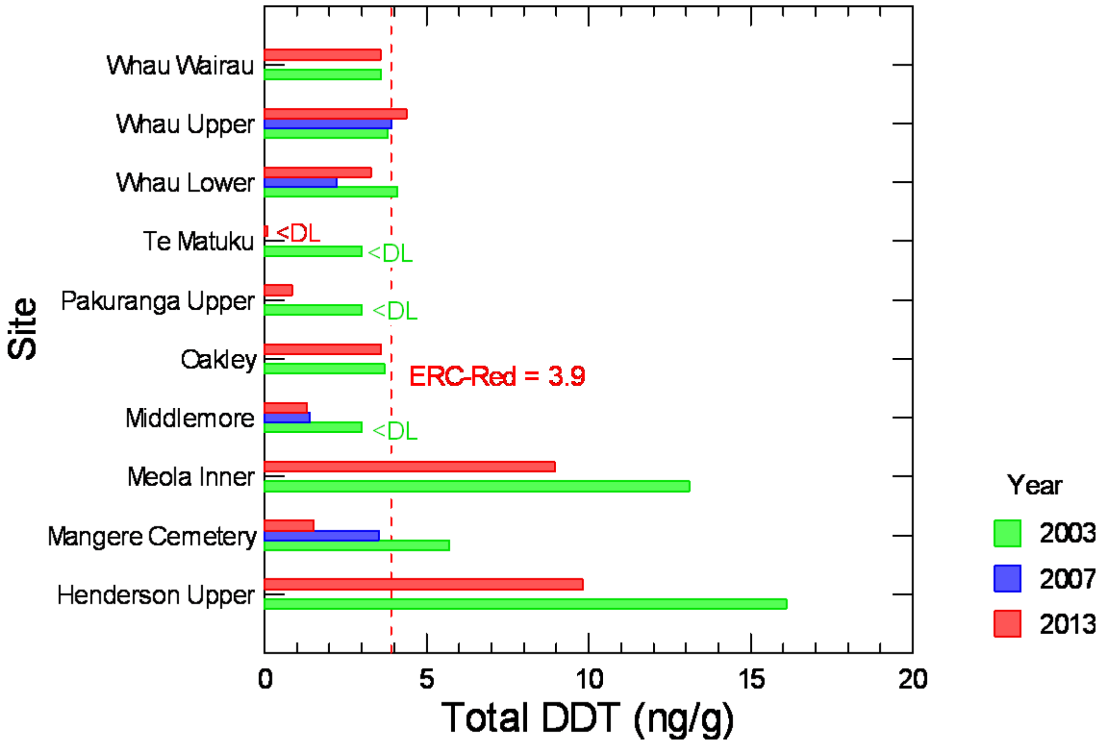


Figure 4-15 Comparison of p,p'-DDT concentrations obtained in 2003, 2007, and 2013



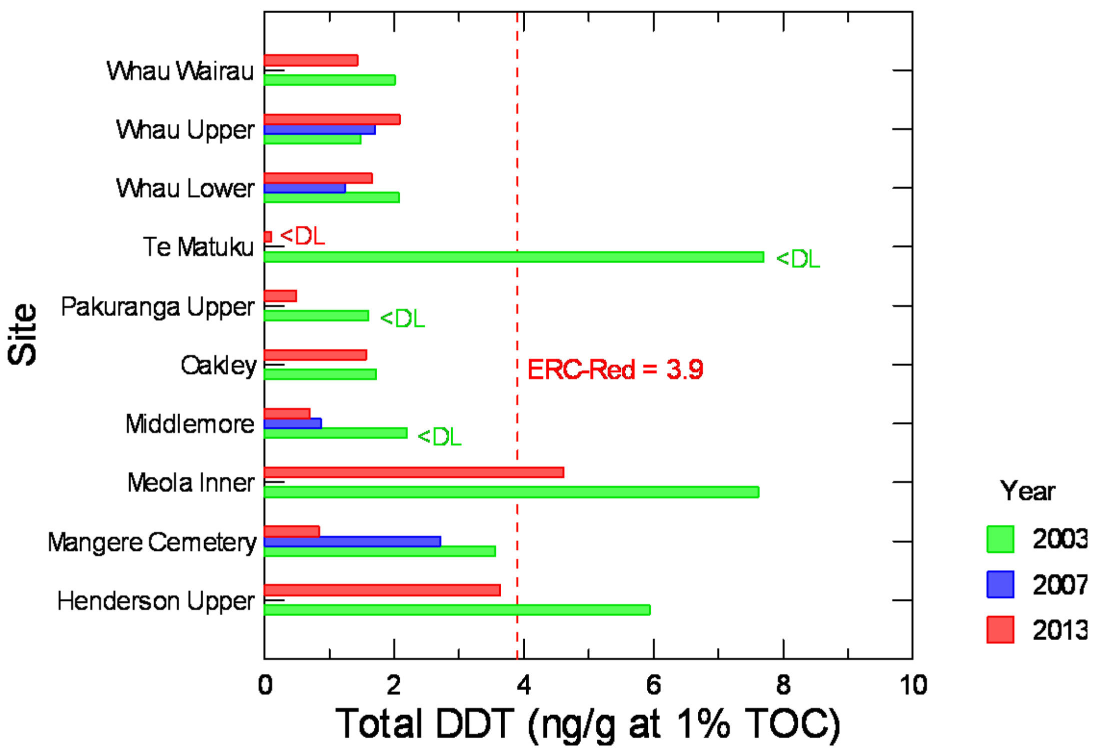


Figure 4-16 Comparison of total DDT concentrations obtained in 2003, 2007, and 2013

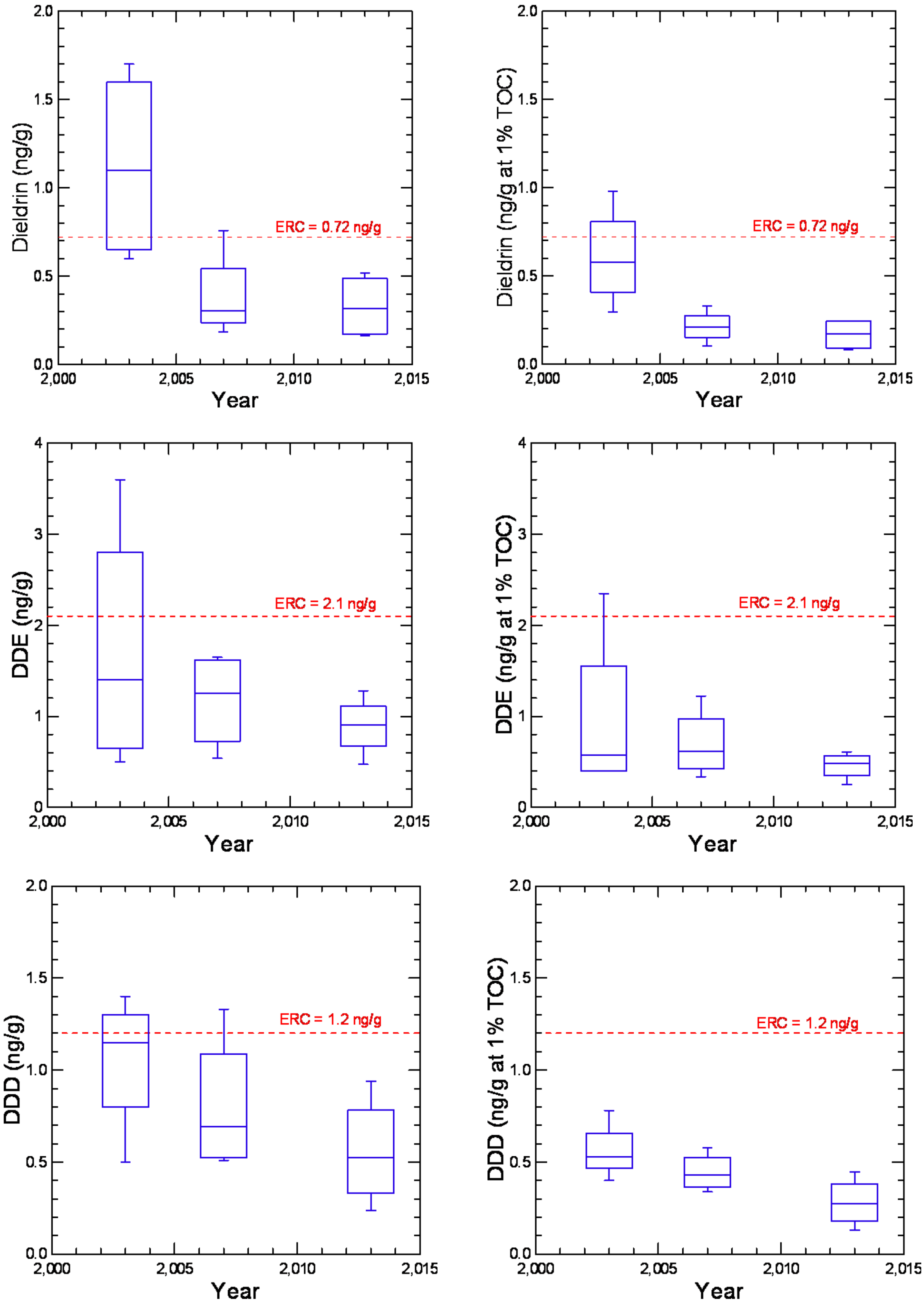


Figure 4-17 Concentrations of dieldrin, p,p'-DDE, and p,p'-DDD at four sites (Mangere Cemetery, Middlemore, Whau Lower, and Whau Upper) analysed in each of 2003, 2007, and 2013.
The 2003 data are medians (N = 3 per site), while the 2007 and 2013 data are from single samples per site.

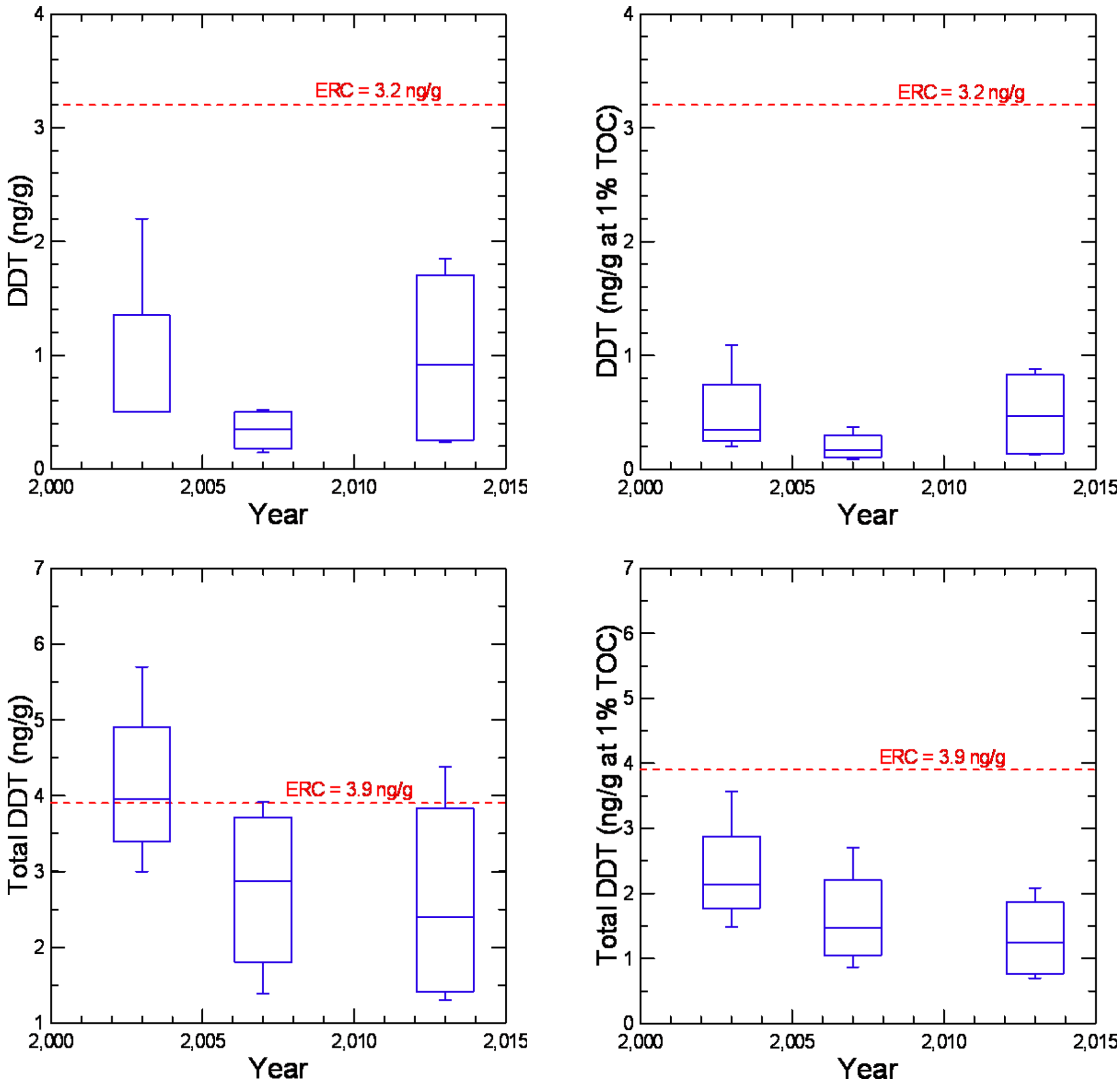


Figure 4-18 Concentrations of p,p'-DDT and Total DDT at four sites (Mangere Cemetery, Middlemore, Whau Lower, and Whau Upper) analysed in each of 2003, 2007, and 2013.
The 2003 data are medians (N = 3 per site), while the 2007 and 2013 data are from single samples per site.

5.0 Summary

Organic contaminants – PAH, OCPs, and PCBs – were analysed in marine sediments sampled in November 2012 and November 2013 as part of the Auckland Council's RSCMP, UWH, CWH-Ecology and Long Bay monitoring programmes.

A total of 26 sediment samples, from 13 sites in each of 2012 and 2013, were analysed by AsureQuality (Wellington), using isotope dilution high resolution gas chromatography mass spectrometry (HRGC-MS). Total organic carbon was also measured on all samples by R.J. Hill laboratories (Hamilton).

5.1 Status

Organic contaminants exceeded the ARC Environmental Response Criteria (ERC) ERC-amber or red threshold levels at 10 of the 26 sites. PAH exceeded the ERC-amber threshold at six sites and the red threshold at two sites. OCPs exceeded the ERC red threshold at 5 sites (note there is no amber threshold for OCPs or PCBs). ERC amber or red thresholds for both PAH and OCPs were exceeded at 3 sites. PCBs were in the ERC-green range (i.e. below the ERC-red threshold) at all sites.

PAH concentrations were generally low, below the ERC amber or red range at 18 of the 26 sites. At the 8 sites with elevated PAH levels (ERC-amber or, at two sites possibly ERC-red), metals' concentrations were also elevated. PAHs were the status determining contaminant only at Chelsea, where moderately elevated PAH concentration and relatively low TOC level combined to give HWPAH in the ERC-Red range (at 1% TOC).

PCBs were below the ERC-red threshold at all sites. However, elevated concentrations were found at Meola Inner and to lesser degree at Whau Wairau and Henderson Upper. While not exceeding the ERC-red threshold, the PCB levels at these sites were markedly higher than those found at other sites. Based on the 2013 results, elevated PCBs may indeed occur at the most contaminated sites (e.g. Meola Inner), but it seems unlikely that exceedance of the ERC-Red threshold will occur.

OCPs were in the ERC-red range at Henderson Upper, Meola Inner, Whau Upper, Whau Wairau, and possibly also at Oakley. DDE, DDD, or Total DDTs were the only OCPs that exceeded the ERC-Red thresholds. OCPs were the status determining factor at Henderson Upper, and possibly also at Oakley – at these sites OCPs exceeded the ERC-Red threshold while metals concentrations in 2013 were in the ERC-amber range. At the other sites with ERC-Red OCP levels, one or more metals concentrations also exceeded the ERC-Red threshold.

Hexachlorobenzene (HCB) was elevated at Awaruku Stream, an intertidal bottom of catchment urban stream site at Long Bay. There are no sediment quality guidelines (ERC values) for HCB, so the environmental significance of this elevated value is unknown.

Concentrations of the other OCPs were either below detection limits, or very close to the laboratory blank levels. As found in previous surveys, it appears that DDTs (DDE, DDD, and DDT), and at lower levels dieldrin, remain the most significant OCPs remaining in receiving water sediments.

5.2 Trends

Trend assessment for organochlorines was limited by variable data quality and availability from previous surveys. There were no useful data for assessing trends in PCBs. Based on very limited data, OCP concentrations appear to be stable or decreasing over the past decade. A slow decline in environmental concentrations is consistent with the combined effects of discontinued use (slow depletion of source material stored in estuary catchments) and the persistence of these chemicals in receiving sediments.

5.3 Recommendations for future surveys

Another OCP survey should be undertaken in 10 years' time to assess longer term trends. The focus should be on high risk sites, where OCPs are currently in the ERC-red range: Henderson Upper, Meola Inner, Whau Upper, Whau Wairau, and possibly also at Oakley.

Based on comparison with ERC, PCBs are of lower environmental risk to benthic fauna than OCPs, and on this basis could therefore be dropped from future monitoring. However, sufficiently elevated levels to be of some concern were found at Meola Inner (and to a lesser degree at Whau Wairau and Henderson Upper). To provide assurance that, as anticipated, levels are dropping over time, it is recommended that PCBs also be analysed at the same 5 sites identified above for OCP analysis.

The 2012/13 survey data, and earlier monitoring results from 1998 to 2010 (Mills et al. 2012) indicate that elevated PAH concentrations, above the ERC-amber or red thresholds, occur less frequently than metals. On this basis, PAHs (on their own) probably pose a lower environmental risk to the health of benthic fauna than metals or, at some sites, OCPs. Unlike the OCPs and PCBs, PAHs may possibly increase at some sites over time in response to on-going urban stormwater inputs. In addition, it is possible that they may contribute to cumulative contaminant multi-stressor effects. For these reasons, PAH analysis at selected higher risk sites should continue to be undertaken. These sites are the 5 sites recommended for OCP/PCB analysis, and also those identified as ERC-amber (or possibly red) in Table 4-1 (Middlemore, Shoal Hillcrest, Chelsea, Panmure, and Coxs Bay).

To ensure consistency of data quality, analysis of OCPs, PAHs, and PCBs should be undertaken using the same high sensitivity methods used in the 2012/13 survey. If this is not possible, quality assurance assessments must be undertaken to verify that the new methods produce results that can be directly compared with historical (i.e. 2007 and 2012/13) data.

6.0 Acknowledgements

The author wishes to thank Marcus Cameron and Mike Hudson of Auckland Council for their input into preparation of the report and reviews of drafts.

7.0 References

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Appendix A Data tables

Table 7-1 PAH concentrations (ng/g; parts per billion) in sediments sampled in 2012. High molecular weight PAH (HWPAH) shaded.

Site	Lab Blank	Princes	Waiuku	Otahuhu	Benghazi	Papakura Lower	Shoal Hillcrest	Chelsea	Purewa	Bowden	Pahurehure Upper	Panmure	Henderson Entrance	Coxs	Coxs WB Rep
Lab Number	136172 BLANK	136172-1	136172-2	136172-3	136172-4	136172-5	136172-6	136172-7	136172-8	136172-9	136172-10	136172-11	136172-13	136172-12	136172-14
Sample Code	Lab Blank	Princes 12R1	Waiuku 12R1	Otahuhu 12R1	Benghazi 12R1	Papakura Lower 12R1	Shoal Hillcrest 12R1	Chelsea 12R1	Purewa 12R1	Bowden 12R1	Pahurehure Upper 12R1	Panmure 12R1	HC Eco 12R1	Coxs 12R1	QA 12R1
naphthalene	3.20	18.7	29.4	18.2	10.5	11.5	39.4	31.9	17.9	18.7	14.8	34.8	6.9	11.4	8.9
acenaphthylene	0.182	5.3	4.3	6.9	2.2	1.3	13.3	17.5	6.3	5.8	1.8	12.9	1.3	9.6	7.8
acenaphthene	0.222	1.8	1.2	3.0	0.9	0.6	4.8	4.6	2.1	2.2	0.6	3.4	0.3	2.5	3.3
fluorene	0.444	3.0	3.3	3.5	1.5	1.5	5.5	10.5	2.6	3.4	2.1	4.3	0.5	4.2	3.5
phenanthrene	1.06	36.1	38.0	44.9	13.8	10.9	90.2	147.0	37.6	31.0	11.9	70.9	5.0	61.1	63.8
anthracene	0.324	9.3	9.0	10.3	3.7	2.5	24.4	44.1	10.2	9.0	3.8	22.5	1.3	12.9	12.9
fluoranthene	0.471	88.4	66.3	116.6	30.8	17.3	178.9	226.2	96.4	74.3	17.0	190.5	11.7	133.3	142.5
pyrene	0.446	97.4	64.6	123.8	30.7	16.9	191.0	225.7	105.1	78.3	17.0	192.1	12.6	145.3	152.4
benz[a]anthracene	< 0.095	39.7	22.3	52.1	13.0	6.0	88.0	118.5	44.3	34.6	6.3	99.7	4.4	54.1	60.3
chrysene	0.108	52.8	26.6	64.8	16.8	8.6	113.8	124.2	54.2	44.3	8.4	116.9	7.1	70.9	76.8
benzo[b]fluoranthene	0.204	49.2	22.3	56.0	18.7	8.9	108.4	96.9	55.4	49.1	8.9	111.2	8.6	66.1	71.4
benzo[k]fluoranthene	< 0.115	47.0	31.4	74.9	17.5	8.7	108.9	103.0	55.3	46.8	8.6	116.1	8.0	68.8	72.7
benzo[a]pyrene	< 0.199	66.6	35.5	86.4	21.3	10.1	146.8	148.8	76.4	57.7	10.5	154.8	9.7	97.0	113.9
indeno[123,-c,d]pyrene	< 0.373	51.2	33.9	76.1	20.0	9.9	114.6	91.5	62.7	55.0	10.3	110.2	9.3	71.0	76.2
dibenz[a,h]anthracene	< 0.468	12.8	6.6	19.0	4.8	1.9	27.0	24.3	15.4	13.7	2.1	30.5	2.1	17.3	18.7
benzo[g,h,i]perylene	< 0.233	49.5	33.9	68.1	18.1	10.4	99.3	79.3	55.6	50.8	11.7	116.6	8.6	63.9	69.5
Total PAH (<DL=0)	6.66	629	429	824	224	127	1354	1494	697	575	136	1387	97.5	889	955
Total PAH (<DL=DL)	8.14	629	429	824	224	127	1354	1494	697	575	136	1387	97.5	889	955
HWPAH (<DL=0)	1.03	358	222	463	117	60.9	745	868	392	303	61.2	785	47.6	518	565
HWPAH (<DL=DL)	1.79	358	222	463	117	60.9	745	868	392	303	61.2	785	47.6	518	565

Table 7-2 PAH concentrations (ng/g; parts per billion) in sediments sampled in 2013. High molecular weight PAH (HWPAH) shaded.

Site	Lab Blank	Awaruku Stream	Vaughan's Stream	Henderson Upper	Mangere Cemetery	Meola Inner	Oakley	Pakuranga Upper	Te Matuku	Whau Lower	Whau Upper	Whau Wairau	Rangitopuni UWH	Middlemore BRS	Middlemore BRS WB Rep
Lab Number	152076 BLANK	152076-1	152076-2	152076-3	152076-4	152076-5	152076-6	152076-7	152076-8	152076-9	152076-10	152076-11	152076-13	152076-12	152076-14
Sample Code	Lab Blank	OA172/11	OA172/120	OA172/29	OA172/49	OA172/54	OA172/74	OA172/90	OA172/110	OA172/133	OA172/138	OA172/143	OA172/196 - 198	OA172/MID BRS	OA172/QA21
naphthalene	2.77	14.5	4.8	18.3	15.1	67.4	28.1	14.8	3.7	28.3	30.3	28.3	21.6	29.3	22.1
acenaphthylene	< 0.144	5.2	0.5	6.7	2.2	30.6	10.3	5.1	0.2	8.8	8.9	14.6	5.9	7.9	6.0
acenaphthene	< 0.237	0.8	0.3	1.9	0.8	22.0	4.7	1.6	< 0.283	3.4	3.8	3.7	1.4	4.9	4.3
fluorene	0.417	1.9	0.5	2.1	1.2	16.0	4.4	1.4	0.2	4.0	3.9	4.1	2.2	5.3	4.1
phenanthrene	1.28	19.2	3.4	33.6	14.1	267.0	80.9	28.7	1.7	60.5	57.6	66.1	27.3	75.9	68.0
anthracene	0.250	5.2	1.0	8.2	3.9	63.8	20.1	7.6	0.4	14.6	15.9	16.3	6.7	15.5	13.7
fluoranthene	0.302	40.4	5.5	88.0	31.1	587.0	222.0	86.3	1.9	150.0	164.0	185.0	68.8	204.0	185.0
pyrene	0.442	52.3	5.8	91.0	34.4	648.0	212.0	90.6	1.9	149.0	167.0	212.0	73.3	190.0	180.0
benz[a]anthracene	< 0.159	17.6	2.8	43.9	14.3	393.0	117.0	50.7	0.7	75.9	87.1	101.0	34.9	104.0	94.4
chrysene	< 0.164	29.6	4.2	60.9	17.1	431.0	144.0	62.2	1.0	95.4	109.0	128.0	47.5	119.0	112.0
benzo[b]fluoranthene	< 0.096	18.2	3.2	49.6	16.0	257.0	97.1	55.2	0.9	70.9	85.4	110.0	40.6	91.1	81.8
benzo[k]fluoranthene	< 0.103	14.2	2.5	43.2	14.8	345.0	97.4	35.6	0.5	66.2	77.9	89.5	33.2	81.3	81.0
benzo[a]pyrene	< 0.129	19.2	2.9	50.7	15.1	366.0	116.0	42.9	0.7	77.6	91.5	110.0	41.2	94.1	83.6
indeno[123,-c,d]pyrene	< 0.235	20.7	3.1	55.6	17.8	332.0	107.0	52.6	1.1	77.6	90.8	120.0	42.8	87.3	84.9
dibenz[a,h]anthracene	< 0.239	4.5	0.6	10.4	3.2	72.8	20.6	9.7	< 0.317	15.2	18.0	17.7	7.9	18.2	16.7
benzo[g,h,i]perylene	< 0.208	53.8	3.8	68.2	23.9	406.0	134.0	65.1	1.1	93.4	118.0	147.0	51.5	103.0	101.0
Total PAH (<DL=0)	5.46	317	44.8	632	225	4305	1416	610	16.2	991	1129	1353	507	1231	1139
Total PAH (<DL=DL)	7.18	317	44.8	632	225	4305	1416	610	16.8	991	1129	1353	507	1231	1139
HWPAH (<DL=0)	0.74	164	21.8	345	115	2498	832	342	6.13	563	637	754	274	729	672
HWPAH (<DL=DL)	1.44	164	21.8	345	115	2498	832	342	6.44	563	637	754	274	729	672

Table 7-3 Organochlorine pesticide concentrations (ng/g; parts per billion) in sediments sampled in 2012

Site	Lab Blank	Princes	Waiuku	Otahuhu	Benghazi	Papakura Lower	Shoal Hillcrest	Chelsea	Purewa	Bowden	Pahurehure Upper	Panmure	Henderson Entrance	Coxs	Coxs WB Rep
Lab Number	136172 BLANK	136172-1	136172-2	136172-3	136172-4	136172-5	136172-6	136172-7	136172-8	136172-9	136172-10	136172-11	136172-13	136172-12	136172-14
Sample Code	Lab Blank	Princes 12R1	Waiuku 12R1	Otahuhu 12R1	Benghazi 12R1	Papakura Lower 12R1	Shoal Hillcrest 12R1	Chelsea 12R1	Purewa 12R1	Bowden 12R1	Pahurehure Upper 12R1	Panmure 12R1	HC Eco 12R1	Coxs 12R1	QA 12R1
Pentachlorobenzene	0.0398	0.118	0.0947	0.14	0.06	0.0675	0.0693	0.0334	0.0551	0.113	0.0683	0.0931	0.0261	0.0303	0.0309
HCB (hexachlorobenzene)	0.0604	0.1040	0.1160	0.1030	0.0722	0.0792	0.0785	0.0460	0.0597	0.0903	0.0735	0.0952	0.0379	0.0483	0.0520
Alpha-BHC	< 0.0169	0.0066	< 0.0203	< 0.00735	< 0.00626	0.0053	< 0.0149	< 0.00303	< 0.00398	< 0.0152	< 0.0159	< 0.0223	< 0.0137	< 0.0147	< 0.0151
Beta-BHC	< 0.0097	0.0049	< 0.00838	< 0.00644	0.0051	0.0040	< 0.0137	0.0032	0.0042	< 0.0137	< 0.0107	< 0.0195	< 0.0131	< 0.0119	< 0.0134
Gamma-BHC (lindane)	E 0.0239	0.0254	0.0289	0.0275	0.0180	E 0.0255	0.0324	E 0.0231	0.0249	0.0322	0.0371	0.0354	< 0.0151	E 0.0194	< 0.0162
Delta-BHC	< 0.00707	< 0.00367	< 0.00868	< 0.00695	< 0.00499	< 0.0041	< 0.0148	< 0.00303	< 0.00378	< 0.0157	< 0.00564	< 0.0218	< 0.0149	< 0.0125	< 0.0147
Heptachlor	< 0.00535	< 0.00357	< 0.00664	< 0.00878	< 0.00469	0.0039	< 0.00352	< 0.00192	< 0.00306	< 0.00268	< 0.00615	< 0.00423	< 0.00353	0.0043	0.0038
Aldrin	< 0.00566	0.0145	< 0.0133	0.0316	< 0.011	< 0.0108	< 0.0129	< 0.0091	< 0.0159	0.0213	< 0.0106	< 0.0189	< 0.0237	< 0.0165	< 0.0147
Heptachlor exo-epoxide	< 0.00273	0.0028	< 0.00419	< 0.00296	< 0.00401	< 0.0031	< 0.00301	< 0.00202	< 0.00245	< 0.00278	< 0.00636	< 0.00413	< 0.00474	< 0.00249	< 0.00355
Oxychlordane	< 0.0113	< 0.00643	< 0.0195	< 0.0149	< 0.0128	< 0.0107	< 0.0133	< 0.00718	< 0.00991	< 0.0109	< 0.0232	< 0.0123	< 0.0191	< 0.00998	< 0.017
Gamma-chlordane	E 0.00707	0.0259	0.0111	0.0285	0.0124	0.0110	0.0221	0.0125	0.0263	0.0383	0.0139	0.0287	0.0112	0.0168	0.0190
Endosulfan-A	< 0.0129	< 0.0153	< 0.022	< 0.0138	< 0.0156	< 0.0187	< 0.0215	< 0.0148	< 0.0152	< 0.0185	< 0.0151	< 0.014	< 0.0141	< 0.0122	< 0.017
Alpha-chlordane	0.0049	0.0244	0.0106	0.0246	0.0100	0.0077	0.0147	0.0086	0.0222	0.0289	0.0073	0.0239	0.0079	0.0100	0.0103
Trans-nonachlor	< 0.0311	< 0.0201	< 0.0188	< 0.0126	< 0.0156	< 0.0132	< 0.02	< 0.0171	E 0.027	0.0293	< 0.017	< 0.0218	< 0.0234	0.0382	0.0544
op-DDE	< 0.00717	0.0096	< 0.013	0.0125	< 0.00616	< 0.00629	0.0128	0.0045	0.0080	0.0106	< 0.00882	0.0171	< 0.0199	< 0.013	< 0.0135
pp-DDE	0.0281	0.2890	0.3150	0.4470	0.1230	0.2810	0.3660	0.1230	0.1940	0.3020	0.2770	0.4420	0.2010	0.0855	0.0791
Dieldrin	0.0461	0.1720	0.0989	0.2020	0.0699	0.0765	0.0787	0.0510	0.0763	0.1650	0.1030	0.1350	0.0446	0.0590	0.0601
Endrin	< 0.0136	< 0.0112	< 0.0201	< 0.0128	< 0.0113	< 0.0128	< 0.0139	< 0.00647	< 0.0111	< 0.00853	< 0.0134	< 0.015	< 0.0224	< 0.00928	< 0.0152
Endosulfan-B	< 0.0821	< 0.0449	< 0.0874	< 0.0539	< 0.0572	< 0.0415	< 0.0593	< 0.0225	< 0.0633	< 0.0471	< 0.056	< 0.0568	< 0.0398	< 0.0261	< 0.035
Cis-nonachlor	< 0.0221	< 0.0167	< 0.0143	< 0.0197	< 0.0168	< 0.0187	< 0.021	< 0.0093	0.0240	E 0.0146	< 0.0197	0.0277	< 0.0354	< 0.0149	< 0.0129
Endrin-aldehyde	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ
Kepone	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ
Endosulfan sulfate	< 0.00717	E 0.0193	0.0092	0.0231	< 0.00577	0.0127	0.0067	< 0.00222	< 0.00593	0.0128	0.0246	0.0176	0.0066	0.0034	E 0.0072
op-DDD	< 0.00859	0.0841	0.0387	0.0796	0.0297	0.0123	0.0834	0.0314	0.0351	0.0756	0.0136	0.1080	0.0222	E 0.0218	0.0209
pp-DDD	< 0.00697	0.3850	0.1030	0.3670	0.1150	0.0681	0.4420	0.1520	0.2160	0.3340	0.0763	0.4620	0.0991	0.1030	0.1010
op-DDT	< 0.0134	0.0366	0.0558	0.0447	0.0131	0.0125	0.0270	0.0066	0.0085	0.0224	0.0159	0.0599	< 0.00988	< 0.00768	< 0.0107
pp-DDT	< 0.0131	0.1650	0.0788	0.2640	0.0573	0.0701	0.1600	0.0407	0.1450	0.1130	0.0763	0.2210	0.0368	E 0.0209	0.0276
Endrin-ketone	< 0.0526	< 0.0331	< 0.0724	< 0.0567	< 0.0538	< 0.0377	< 0.0593	< 0.0327	< 0.0311	< 0.0409	< 0.0496	< 0.0633	< 0.0408	< 0.0334	< 0.0379
Methoxychlor	< 0.022	< 0.0229	< 0.0223	< 0.0147	< 0.0212	< 0.017	< 0.0146	< 0.0118	< 0.0154	< 0.0124	< 0.0216	< 0.0198	< 0.011	< 0.00938	< 0.00861
Mirex	< 0.00647	0.0098	0.0067	0.0113	0.0034	0.0185	0.0072	0.0016	0.0085	0.0562	0.0436	0.0115	0.0022	0.0016	0.0017

Table 7-4 Organochlorine pesticide concentrations (ng/g; parts per billion) in sediments sampled in 2013

Site	Lab Blank	Awaruku Stream	Vaughan's Stream	Henderson Upper	Mangere Cemetery	Meola Inner	Oakley	Pakuranga Upper	Te Matuku	Whau Lower	Whau Upper	Whau Wairau	Rangitopuni UWH	Middlemore BRS	Middlemore BRS WB Rep
Lab Number	152076 BLANK	152076-1	152076-2	152076-3	152076-4	152076-5	152076-6	152076-7	152076-8	152076-9	152076-10	152076-11	152076-13	152076-12	152076-14
Sample Code	Lab Blank	OA172/11	OA172/120	OA172/29	OA172/49	OA172/54	OA172/74	OA172/90	OA172/110	OA172/133	OA172/138	OA172/143	OA172/196 - 198	OA172/MID BRS	OA172/QA21
Pentachlorobenzene	0.0241	0.2860	0.0328	0.1350	0.0546	0.2030	0.1310	0.1630	0.0236	0.0992	0.1540	0.1840	0.0544	0.1510	0.1270
HCB (hexachlorobenzene)	0.0259	1.4300	0.0386	0.5530	0.0643	0.1640	0.1250	0.1280	0.0257	0.0807	0.1590	0.3270	0.0579	0.1120	0.0967
Alpha-BHC	< 0.00554	< 0.0176	< 0.0107	< 0.0193	< 0.0132	< 0.0232	< 0.019	< 0.015	< 0.0128	< 0.0158	< 0.0107	< 0.0226	< 0.0129	< 0.0122	< 0.0107
Beta-BHC	< 0.0109	< 0.022	< 0.0125	< 0.0212	< 0.0197	< 0.0308	< 0.0284	< 0.0208	< 0.0199	< 0.0233	< 0.0145	< 0.0309	< 0.0174	< 0.0155	< 0.017
Gamma-BHC (lindane)	E 0.0127	< 0.023	< 0.0143	< 0.0237	< 0.0162	< 0.0291	< 0.0239	E 0.1350	< 0.0174	< 0.0204	0.0192	< 0.0278	< 0.0166	0.0200	< 0.0133
Delta-BHC	< 0.00949	< 0.0245	< 0.0149	< 0.0251	< 0.020	< 0.0342	< 0.0296	< 0.0214	< 0.0206	< 0.0238	< 0.0151	< 0.0336	< 0.0185	< 0.0163	< 0.0175
Heptachlor	< 0.00376	< 0.00369	< 0.0029	< 0.00456	< 0.00937	< 0.0145	< 0.0124	< 0.0105	< 0.00917	< 0.013	< 0.00743	< 0.0123	< 0.00813	< 0.00788	< 0.0103
Aldrin	< 0.00603	NQ	NQ	< 0.0297	0.0500	0.0560	< 0.025	0.0468	< 0.027	< 0.0366	0.0693	0.0566	< 0.0958	0.0553	0.0398
Heptachlor exo-epoxide	< 0.00455	< 0.00719	< 0.0052	< 0.00644	< 0.0125	< 0.0195	< 0.0131	< 0.0111	< 0.00908	< 0.0138	< 0.00906	< 0.013	< 0.0125	< 0.00646	< 0.0118
Oxychlordane	< 0.0302	< 0.0302	< 0.0208	< 0.0264	< 0.0382	< 0.0597	< 0.0565	< 0.028	< 0.0271	< 0.0481	< 0.0242	< 0.0497	< 0.0368	< 0.0238	< 0.0369
Gamma-chlordane	< 0.00761	0.0881	0.0396	0.0717	0.0419	0.2670	0.0719	0.0773	< 0.00608	0.0406	0.1400	0.1220	0.0180	0.0533	0.0547
Endosulfan-A	< 0.0416	< 0.155	< 0.043	< 0.0828	< 0.191	< 0.265	< 0.18	< 0.203	< 0.154	< 0.318	< 0.18	< 0.285	< 0.177	< 0.185	< 0.246
Alpha-chlordane	< 0.0086	0.0848	0.0325	0.0729	0.0459	0.2460	0.0790	0.0674	< 0.00683	0.0401	0.1370	0.1120	E 0.0152	0.0498	0.0526
Trans-nonachlor	< 0.0317	0.1290	< 0.0567	0.1020	< 0.0979	0.3120	0.1500	< 0.104	< 0.0888	< 0.0956	0.1680	< 0.165	< 0.0591	0.0660	< 0.113
op-DDE	< 0.016	< 0.038	< 0.0233	0.0563	0.0315	0.0484	0.0266	< 0.0209	< 0.02	< 0.0281	E 0.0254	E 0.0356	< 0.0227	E 0.015	< 0.02
pp-DDE	< 0.0121	E 0.518	E 0.0528	5.2600	0.9390	1.7700	1.5100	E 0.324	< 0.0137	0.8800	E 1.28	E 1.3	E 0.817	E 0.472	E 0.42
Dieldrin	E 0.0229	0.1360	0.0567	0.2770	0.1790	0.5850	0.3250	0.2740	< 0.0373	0.1650	0.5180	0.5280	0.1130	0.4550	0.4260
Endrin	< 0.0163	< 0.036	< 0.0185	< 0.0338	< 0.044	< 0.0694	< 0.0403	< 0.0296	< 0.0293	< 0.0501	< 0.0295	< 0.0485	< 0.0356	< 0.0271	< 0.0392
Endosulfan-B	< 0.0924	< 0.116	< 0.0962	< 0.118	< 0.186	< 0.151	< 0.165	< 0.169	< 0.185	< 0.217	< 0.108	< 0.225	< 0.153	0.3090	0.2310
Cis-nonachlor	< 0.0246	< 0.0724	< 0.0357	< 0.0613	< 0.0663	0.1350	0.0710	0.0488	< 0.0472	< 0.0775	0.0958	0.0944	< 0.0596	< 0.0437	< 0.0655
Endrin-aldehyde	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ
Kepone	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ
Endosulfan sulfate	< 0.0139	< 0.0255	E 0.042	E 0.0471	< 0.0456	E 0.0727	< 0.0467	E 0.0615	< 0.0443	< 0.0562	E 0.0815	E 0.081	E 0.63	E 0.812	E 0.901
op-DDD	< 0.015	0.0475	< 0.00921	0.4810	E 0.0523	0.8250	0.2220	E 0.069	< 0.012	0.1310	0.2170	0.2830	0.0947	0.0914	0.0913
pp-DDD	< 0.0144	E 0.216	E 0.0281	2.4600	0.2370	3.4200	1.1100	0.2860	< 0.00945	0.6270	0.9390	1.2100	0.4350	0.4250	0.4370
op-DDT	< 0.0161	< 0.0276	< 0.0143	0.1600	< 0.0236	0.3060	0.0946	E 0.027	< 0.0141	E 0.0527	E 0.066	E 0.0698	E 0.0355	0.0356	0.0616
pp-DDT	< 0.0171	E 0.109	< 0.0165	1.4000	0.2360	2.5800	0.6320	0.1290	< 0.0182	1.5600	1.8500	0.6830	0.1580	0.2660	0.2920
Endrin-ketone	< 0.0647	< 0.151	< 0.0783	< 0.129	< 0.177	< 0.268	< 0.218	< 0.219	< 0.147	< 0.242	< 0.154	< 0.261	< 0.157	< 0.124	< 0.204
Methoxychlor	< 0.0487	< 0.075	< 0.0461	< 0.0697	< 0.0599	< 0.0967	< 0.0817	< 0.0846	< 0.0451	< 0.088	< 0.0568	< 0.108	< 0.0863	< 0.0544	< 0.0774
Mirex	< 0.00257	E 0.0188	< 0.0037	E 0.0209	0.0124	0.0381	E 0.0128	0.0211	< 0.00365	0.0121	0.0896	E 0.0236	0.0075	0.0586	0.0566

Table 7-5 PCB concentrations (ng/g; parts per billion) in sediments sampled in 2012

Site	Lab Blank	Princes	Waiuku	Otahuhu	Benghazi	Papakura Lower	Shoal Hillcrest	Chelsea	Purewa	Bowden	Pahurehure Upper	Panmure	Henderson Entrance	Coxs	Coxs WB Rep
Lab Number	136172 BLANK	136172-1	136172-2	136172-3	136172-4	136172-5	136172-6	136172-7	136172-8	136172-9	136172-10	136172-11	136172-13	136172-12	136172-14
Sample Code	Lab Blank	Princes 12R1	Waiuku 12R1	Otahuhu 12R1	Benghazi 12R1	Papakura Lower 12R1	Shoal Hillcrest 12R1	Chelsea 12R1	Purewa 12R1	Bowden 12R1	Pahurehure Upper 12R1	Panmure 12R1	HC Eco 12R1	Coxs 12R1	QA 12R1
PCB#77	< 0.000966	0.00987	0.00846	0.0161	0.00385	0.00308	E 0.00932	E 0.00225	E 0.00355	0.0111	E 0.00222	0.0152	0.00169	E 0.00129	0.00199
PCB#81	< 0.000984	< 0.00233	< 0.00179	< 0.00134	< 0.00183	< 0.00173	< 0.0022	< 0.00127	< 0.00102	< 0.0025	< 0.00205	0.0158	< 0.00163	< 0.000925	< 0.00114
PCB#126	< 0.000691	0.00368	0.00491	0.00372	< 0.00173	< 0.00235	< 0.0028	< 0.00256	< 0.00178	0.00349	< 0.00241	E 0.00265	< 0.00228	< 0.000926	< 0.000676
PCB#169	< 0.00098	< 0.00245	< 0.00184	< 0.00251	< 0.00175	< 0.00193	< 0.0027	< 0.00183	< 0.00184	< 0.00195	< 0.00242	0.00216	< 0.00166	< 0.00138	< 0.00181
PCB#105	< 0.000555	0.145	0.0316	0.106	0.0206	0.0129	0.0594	0.0124	0.0314	0.0735	0.0127	0.0991	0.0105	0.0106	0.0113
PCB#114	< 0.000546	0.00768	< 0.00245	0.00406	< 0.00164	< 0.00209	< 0.00249	< 0.00235	< 0.00169	0.00318	< 0.0021	0.00543	< 0.00195	< 0.000858	< 0.000609
PCB#118	< 0.000496	0.343	0.111	0.289	0.0582	0.0309	0.157	0.0338	0.0861	0.191	0.035	0.266	0.0261	0.0296	0.032
PCB#123	< 0.000501	0.00487	< 0.00226	0.00396	< 0.0029	< 0.00188	E 0.00235	< 0.00206	0.00164	< 0.00282	< 0.00192	E 0.00309	< 0.00181	< 0.000775	< 0.00053
PCB#156	< 0.000741	0.121	0.0524	0.0842	E 0.0123	0.00714	0.0365	0.0084	0.0203	0.0656	E 0.00731	0.0764	0.00614	0.00636	0.00679
PCB#157	< 0.000716	0.0253	0.0061	0.0149	0.00346	< 0.00156	0.00832	< 0.0031	0.0046	0.0116	< 0.00204	E 0.0127	< 0.00138	0.00163	< 0.00146
PCB#167	< 0.000658	0.0483	0.0278	0.0439	0.00887	0.00391	0.0196	E 0.00396	0.00984	0.0329	0.00342	0.04	0.00326	0.00415	0.00357
PCB#189	< 0.00122	0.0112	0.0089	0.0161	< 0.00351	< 0.00301	0.00546	< 0.00134	E 0.00229	0.0143	< 0.00274	0.013	< 0.00261	< 0.00111	< 0.00092
PCB#4/10	< 0.00159	0.00444	< 0.00176	0.00762	< 0.00472	0.00243	E 0.00895	0.00252	0.00614	0.00756	< 0.00161	0.00851	E 0.00189	0.00201	0.00242
PCB#8/5	E 0.00221	0.022	0.0159	0.0392	0.0123	0.0125	0.0371	E 0.00783	E 0.0184	0.0413	0.015	0.0616	0.00689	E 0.008	E 0.00797
PCB#15	< 0.00135	0.0208	0.0113	0.0406	0.00912	0.00963	0.0188	E 0.00397	0.00851	0.0252	0.0097	0.0496	0.00269	0.00259	E 0.00347
PCB#19	< 0.000792	0.00193	E 0.00102	0.00374	< 0.00304	0.000977	0.00296	0.000919	0.00253	0.00306	< 0.000951	0.00611	< 0.00077	0.000936	E 0.00117
PCB#18	0.00287	0.0182	0.00945	0.0296	0.00727	0.0119	0.0152	0.0076	0.00821	0.0185	0.0117	0.0333	0.00415	0.00869	0.00585
PCB#28	0.00232	0.038	0.0198	0.0707	0.00985	0.021	0.0247	0.0169	0.0196	0.0522	0.0207	0.117	0.00677	0.00871	0.0231
PCB#37	< 0.00172	0.0334	0.0186	0.0534	E 0.0106	0.0148	0.027	0.0106	0.014	0.0406	0.0201	0.0787	E 0.00425	0.00476	E 0.00735
PCB#54	< 0.000756	< 0.000914	< 0.000792	< 0.000799	< 0.00254	< 0.000866	< 0.000848	< 0.000602	< 0.000499	< 0.00132	< 0.00105	0.000629	< 0.000707	< 0.000584	0.000566
PCB#52	< 0.00137	0.108	0.0572	0.105	0.0213	0.0223	0.0573	0.0221	0.0218	0.0724	0.0197	0.146	0.0111	0.0156	0.0153
PCB#49	< 0.00122	0.0495	0.0211	0.0758	0.0157	0.0188	0.0391	0.0176	0.0233	0.0666	< 0.00149	0.0962	0.0169	0.01200	0.0121
PCB#44	< 0.00155	0.0507	0.0149	0.0619	0.0128	E 0.012	0.029	0.0116	0.0118	0.0374	E 0.0115	0.0725	0.00451	0.00732	0.00626
PCB#74	< 0.000655	0.019	0.00683	0.0239	0.00588	0.00669	0.0141	0.00597	E 0.00627	0.018	0.00598	< 0.00163	E 0.00222	0.00341	0.00383
PCB#70	< 0.000699	0.0635	0.0238	0.0679	0.0151	0.0154	0.0392	0.0146	0.0189	0.0508	0.0152	0.00213	0.00611	0.00882	0.00968
PCB#66	< 0.00113	0.0463	0.0196	0.0731	0.0174	E 0.0173	0.0468	E 0.0111	0.0299	0.0667	0.0254	0.0958	0.0115	E 0.0103	0.0139
PCB#104	< 0.000319	< 0.000608	< 0.000665	< 0.000431	< 0.00124	< 0.000486	< 0.000472	< 0.000398	< 0.000288	< 0.00107	< 0.000458	< 0.000372	< 0.000394	< 0.000464	< 0.000375
PCB#121	< 0.00105	< 0.00205	< 0.00249	< 0.00356	< 0.000938	< 0.00317	< 0.00217	< 0.00184	< 0.0022	< 0.0011	< 0.00206	< 0.00196	< 0.00305	< 0.00197	< 0.00259
PCB#101	< 0.00069	0.524	0.374	0.432	0.0804	0.0424	0.18	0.0555	0.0967	0.322	0.0472	0.429	0.0312	0.0431	0.04
PCB#99	< 0.000684	0.206	0.0566	0.24	0.0472	0.0238	0.13	0.0323	0.0748	0.171	0.0272	0.231	E 0.0211	0.02980	0.0278
PCB#86	< 0.00155	< 0.00305	< 0.0037	< 0.00265	< 0.00139	< 0.00236	< 0.00193	< 0.00273	< 0.00197	< 0.00164	< 0.00306	< 0.00291	< 0.00227	< 0.00292	< 0.00385
PCB#110	< 0.000496	0.458	0.177	0.298	0.0561	0.0309	0.129	0.0335	0.0636	0.208	0.0347	0.276	0.0198	0.0274	0.0255
PCB#155	< 0.000317	< 0.000296	< 0.000413	< 0.000299	< 0.000901	< 0.000404	< 0.000313	< 0.000335	< 0.000278	< 0.000914	< 0.000291	< 0.000408	< 0.000365	< 0.000278	< 0.000165
PCB#151	< 0.000638	0.0549	0.0903	0.0815	0.0194	0.00791	0.102	0.0201	0.0363	0.0939	0.165	0.106	0.0115	0.00822	0.00938
PCB#153	< 0.000659	0.76	0.553	0.814	0.156	0.0729	0.367	0.082	0.204	0.684	0.0763	0.777	0.0783	0.0743	0.0863
PCB#141	< 0.000626	0.0421	0.0854	0.0665	0.0165	0.0056	0.0836	0.0104	0.0251	0.0849	0.149	0.0902	0.00546	0.00596	0.00688
PCB#138/163/164	< 0.00076	1.07	0.641	0.957	0.185	0.0804	0.417	0.0936	0.227	0.827	0.082	0.9	0.0764	0.0797	0.098
PCB#128	< 0.000716	0.0671	0.0492	0.101	0.0246	0.0128	0.0787	0.012	E 0.0464	0.115	0.0749	0.133	0.0118	0.01050	0.0129
PCB#188	< 0.000594	< 0.00117	< 0.00147	< 0.000994	< 0.00439	< 0.00195	< 0.00133	< 0.000837	< 0.000447	< 0.00163	< 0.00162	< 0.00105	< 0.00153	< 0.000593	< 0.000525
PCB#187	< 0.000984	0.196	0.167	0.288	0.0469	0.0248	0.128	0.0215	0.0599	0.274	0.0278	0.241	0.0326	0.0231	0.0246
PCB#183	< 0.00101	0.0936	0.0861	0.12	0.0167	0.00701	0.0429	0.00763	0.0217	0.129	0.00906	0.102	0.00908	0.00755	0.00933
PCB#180	< 0.0011	0.406	0.332	0.546	0.0707	0.0332	0.191	0.0342	0.0951	0.512	0.0369	0.455	E 0.0327	0.0296	0.0342
PCB#170	< 0.00158	0.247	0.193	0.31	0.0476	0.021	0.115	0.0203	0.06	0.304	0.0219	0.245	0.0204	0.0186	0.0209
PCB#202	< 0.000463	0.0111	0.00725	0.0151	0.00246	0.00147	0.0118	E 0.00116	0.00424	0.0152	0.0014	0.0135	0.00356	0.00137	E 0.00134
PCB#199	< 0.00124	0.0544	0.0594	0.0731	0.0197	0.00674	0.0754	0.00554	0.0164	0.0559	0.0508	0.0582	0.0135	0.00633	0.00495
PCB#196/203	< 0.00073	0.0884	0.0609	0.12	0.0152	0.00802	0.0649	0.00687	0.0202	0.115	E 0.00694	0.0877	0.0147	0.00752	0.00714
PCB#195	< 0.0011	0.0141	0.0187	0.0165	0.00486	< 0.0027	0.015	0.00225	0.00851	0.0242	0.0249	0.0234	0.00435	0.00226	< 0.00195
PCB#194	< 0.00085	0.0647	0.0348	0.0836	0.0101	0.00545	0.039	E 0.00313	0.015	0.0779	0.00568	0.0684	E 0.008	0.00516	0.00644
PCB#205	< 0.000954	0.00435	0.00201	0.00493	< 0.00274	< 0.00132	< 0.0022	< 0.00148	0.0015	0.00474	< 0.00248	0.00426	< 0.00197	< 0.000887	< 0.000706
PCB#208	< 0.000504	0.00355	E 0.00109	0.00467	E 0.000844	0.00095	0.0071	< 0.000618	0.00197	0.00363	< 0.00102	0.00405	0.00103	E 0.000631	0.000612
PCB#206	< 0.000825	0.0166	E 0.00469	0.021	0.00312	E 0.0019	0.0255	< 0.000843	E 0.00442	0.014	0.00241	0.0158	E 0.0029	E 0.00178	0.00186
PCB#209	< 0.000313	0.0039	E 0.00119	0.00624	0.00178	0.00126	0.00961	0.000891	0.00335	E 0.00381	E 0.00106	0.00656	0.00122	E 0.000904	0.00114
Total PCB Lower Bound (<DL=0)	0.007	5.58	3.47	5.83	1.07	0.612	2.87	0.637	1.44	4.95	1.06	5.59	0.526	0.531	0.588
Total PCB Mid-Range	0.029	5.59	3.48	5.84	1.09	0.626	2.88	0.649	1.44	4.95	1.08	5.59	0.538	0.537	0.597
Total PCB Upper Bound (<DL=DL)	0.050	5.59	3.48	5.85	1.11	0.640	2.89	0.661	1.45	4.96	1.09	5.60	0.551	0.544	0.605

Table 7-6 PCB concentrations (ng/g; parts per billion) in sediments sampled in 2013

Site	Lab Blank	Awaruku Stream	Vaughan's Stream	Henderson Upper	Mangere Cemetery	Meola Inner	Oakley	Pakuranga Upper	Te Matuku	Whau Lower	Whau Upper	Whau Wairau	Rangitopuni UWH	Middlemore BRS	Middlemore BRS WB Rep
Lab Number	152076 BLANK	152076-1	152076-2	152076-3	152076-4	152076-5	152076-6	152076-7	152076-8	152076-9	152076-10	152076-11	152076-13	152076-12	152076-14
Sample Code	Lab Blank	OA172/11	OA172/120	OA172/29	OA172/49	OA172/54	OA172/74	OA172/90	OA172/110	OA172/133	OA172/138	OA172/143	OA172/196 - 198	OA172/MID BRS	OA172/QA21
PCB#77	< 0.00235	0.00709	< 0.00157	0.0232	0.0213	0.0402	0.0256	0.0198	< 0.00119	0.027	0.0372	0.0472	0.012	0.0307	0.0243
PCB#81	< 0.00213	< 0.00192	< 0.00153	< 0.00136	< 0.00114	< 0.00231	< 0.00135	< 0.0014	< 0.00113	< 0.00189	< 0.00128	< 0.00236	< 0.00187	< 0.00127	< 0.00099
PCB#126	< 0.00113	< 0.00223	< 0.000882	0.00448	0.00265	0.0109	0.00623	0.004	< 0.00071	0.00845	0.00666	0.0125	0.00269	E 0.00394	0.00434
PCB#169	< 0.00141	< 0.00206	< 0.00172	< 0.00155	< 0.00229	< 0.00153	< 0.00208	< 0.00126	< 0.0014	< 0.00153	< 0.00165	< 0.00193	< 0.0011	< 0.00241	< 0.00152
PCB#105	< 0.00103	0.0368	0.00411	0.163	0.0852	0.458	0.124	0.0952	0.000785	0.239	0.207	0.333	0.0604	0.137	0.123
PCB#114	< 0.00104	< 0.00221	< 0.000862	0.00784	0.00421	0.0261	0.00634	0.00431	< 0.000613	0.0152	0.00991	0.0163	0.00215	0.00644	0.00544
PCB#118	0.00107	0.0771	0.0112	0.377	0.208	1.11	0.294	0.237	0.00251	0.606	0.483	0.873	0.159	0.334	0.312
PCB#123	< 0.00103	< 0.00212	< 0.00088	0.00389	0.00203	0.0113	0.0032	0.00283	< 0.000648	0.00626	< 0.00285	< 0.00233	< 0.00178	< 0.002	< 0.00227
PCB#156	< 0.00123	0.0213	0.00171	0.0947	0.0416	0.274	0.0706	0.0588	< 0.00116	0.143	0.114	0.236	0.0332	0.0701	0.0742
PCB#157	< 0.00116	0.00476	< 0.00163	0.0159	0.00982	0.0544	0.0169	0.0133	< 0.0012	0.0322	0.024	0.0475	0.00861	0.0162	0.0165
PCB#167	< 0.00103	0.00986	< 0.00169	0.0393	0.0202	0.113	0.0379	0.0317	< 0.00117	0.0646	0.06	0.115	0.0183	0.039	0.0375
PCB#189	< 0.00209	< 0.00261	< 0.00136	0.0183	0.00544	0.039	0.00972	0.00818	< 0.00119	0.0124	0.0165	0.0362	0.00419	0.0113	0.0119
PCB#4/10	< 0.00399	0.00219	< 0.00161	0.0192	0.013	0.042	0.0142	0.00671	< 0.00189	0.0105	0.0183	0.019	0.00724	0.00866	0.00895
PCB#8/5	< 0.00304	0.00674	0.00366	0.0939	0.0459	0.183	0.0771	0.0408	0.0034	0.0527	0.086	0.0794	0.0319	0.0691	0.0643
PCB#15	< 0.00371	0.00622	0.00299	0.0732	0.0541	0.129	0.0489	0.0377	< 0.00163	0.0349	0.0699	0.0613	0.0171	0.0625	0.0548
PCB#19	< 0.00268	< 0.00244	< 0.00235	0.00999	0.00504	0.0169	0.00496	0.00339	< 0.00214	0.00465	0.0129	0.0123	0.00328	0.00473	0.00508
PCB#18	< 0.0026	0.00629	E 0.00309	0.127	0.0437	0.12	0.0814	0.0263	0.00273	0.0262	0.0994	0.0604	0.0166	0.0417	0.0438
PCB#28/31	0.00653	0.0315	0.016	0.819	0.231	0.526	0.415	0.128	0.00799	0.122	0.369	0.258	0.062	0.215	0.212
PCB#37	< 0.00227	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	0.108	NQ
PCB#54	< 0.00207	< 0.000823	< 0.00137	< 0.00441	< 0.000539	0.00169	< 0.000979	< 0.00078	< 0.0013	< 0.00179	< 0.00116	< 0.00104	< 0.000704	< 0.0018	< 0.00111
PCB#52	0.00334	0.0253	0.00746	0.171	0.13	0.593	0.106	0.074	0.00393	0.13	0.224	0.33	0.0411	0.118	0.11
PCB#49	< 0.00289	0.0118	0.00399	0.129	0.0773	0.257	0.0866	0.0569	< 0.00182	0.0835	0.159	0.208	0.0371	0.108	0.084
PCB#44	< 0.00307	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	0.0691	NQ
PCB#74	< 0.002	0.00897	0.00256	0.0626	0.0601	0.169	0.0662	0.038	0.00156	0.0513	0.0893	0.0926	0.0192	0.0614	0.058
PCB#70	< 0.00176	0.0262	0.00561	0.176	0.125	0.47	0.135	0.0803	0.00214	0.14	0.213	0.253	0.0455	0.139	0.129
PCB#66	< 0.00187	0.0221	0.00537	0.149	0.123	0.281	0.133	0.0801	0.00163	0.109	0.188	0.207	0.0486	0.139	0.131
PCB#104	< 0.00105	< 0.001	< 0.000782	< 0.00132	< 0.00077	< 0.00107	< 0.000497	< 0.00085	< 0.000658	< 0.00124	< 0.000486	< 0.000722	< 0.00185	< 0.000819	< 0.000741
PCB#121	< 0.0014	< 0.00102	< 0.00178	< 0.00219	< 0.00465	< 0.00467	< 0.00113	< 0.00421	< 0.00136	< 0.00141	< 0.00181	< 0.00357	< 0.00189	< 0.00236	< 0.00149
PCB#101/90	0.0026	0.0673	0.0102	0.465	0.216	1.27	0.251	0.251	0.00287	0.617	0.551	1.13	0.124	0.346	0.318
PCB#99	< 0.00137	0.034	0.0056	0.177	0.113	0.521	0.142	0.132	0.00141	0.296	0.259	0.467	0.0894	0.201	0.185
PCB#86	< 0.00194	< 0.00142	< 0.00248	< 0.00304	< 0.00323	< 0.00324	< 0.00157	< 0.00292	< 0.00188	< 0.00196	< 0.00252	< 0.00497	< 0.00262	< 0.00328	< 0.00207
PCB#110	0.0013	0.0822	0.00928	0.397	0.208	1.25	0.252	0.214	0.0022	0.555	0.538	1.02	0.109	0.302	0.279
PCB#155	< 0.000515	< 0.000466	< 0.00037	< 0.000915	0.000424	0.00079	< 0.000343	< 0.000698	< 0.000424	< 0.00068	< 0.000367	< 0.000632	< 0.000386	< 0.000645	< 0.000906
PCB#151	< 0.00157	0.0389	0.00338	0.447	0.0698	0.472	0.109	0.0957	< 0.00161	0.178	0.207	0.466	0.0491	0.121	0.124
PCB#153	< 0.00112	0.189	0.0225	1.38	0.403	2.08	0.668	0.579	0.00383	1.09	1.15	2.24	0.352	0.771	0.805
PCB#141	< 0.00135	0.0302	0.00284	0.258	0.0464	0.425	0.0848	0.0692	< 0.00138	0.164	0.176	0.369	0.0321	0.0794	0.0901
PCB#138	< 0.00136	0.245	0.0277	1.3	0.45	2.64	0.804	0.685	0.00399	1.35	1.38	2.7	0.392	0.888	0.878
PCB#128	< 0.00151	0.0382	0.0035	0.16	0.0709	0.45	0.139	0.114	< 0.00155	0.257	0.228	0.421	0.0664	0.152	0.145
PCB#188	< 0.00124	< 0.00178	< 0.00111	< 0.00488	< 0.00102	< 0.0044	< 0.00218	< 0.00185	< 0.000871	< 0.0013	< 0.00288	< 0.00282	< 0.000935	< 0.00168	< 0.00192
PCB#187	< 0.00176	0.0625	0.00626	0.938	0.11	0.65	0.195	0.168	0.00119	0.214	0.316	0.603	0.0996	0.209	0.219
PCB#183	< 0.00178	0.0261	0.00204	0.34	0.0387	0.303	0.0682	0.059	< 0.0011	0.0873	0.125	0.274	0.0306	0.0745	0.0806
PCB#180	< 0.00185	0.109	0.0107	1.46	0.158	1.37	0.291	0.259	< 0.00123	0.347	0.556	1.14	0.138	0.308	0.347
PCB#170	< 0.00264	0.0635	0.00513	0.507	0.102	0.707	0.178	0.16	< 0.00135	0.225	0.326	0.695	0.0828	0.206	0.234
PCB#202	< 0.00125	0.00436	< 0.000688	0.106	0.00689	0.0492	0.0141	0.0104	< 0.000505	0.0157	0.0222	0.0345	0.00857	E 0.0124	0.0143
PCB#199	< 0.0017	0.0236	0.00195	0.414	0.0335	0.262	0.0686	0.0521	< 0.000706	0.0732	0.113	0.193	0.0383	0.0637	0.069
PCB#196/203	< 0.00138	0.0219	0.00183	0.385	0.0309	0.223	0.0585	0.0476	< 0.000573	0.0589	0.0991	0.18	0.0323	0.0559	0.0614
PCB#195	< 0.00182	0.0119	< 0.00142	0.19	0.0167	0.126	0.028	0.0189	< 0.00124	0.0302	0.045	0.0872	0.0141	0.0282	0.0282
PCB#194	< 0.00161	0.0266	0.00217	0.456	0.0434	0.32	0.0724	0.0566	< 0.00109	0.0763	0.118	0.217	0.042	0.0794	0.0763
PCB#205	< 0.00125	< 0.0022	< 0.000874	0.0209	0.00199	0.0145	0.00361	0.00305	< 0.00087	0.00371	0.00577	0.0104	< 0.0024	0.00345	0.00429
PCB#208	< 0.000838	0.0024	< 0.000658	0.0245	0.00337	0.0201	0.00683	E 0.0032	< 0.00049	0.00816	0.0105	0.0144	0.00452	0.00551	0.00588
PCB#206	< 0.00107	0.00775	< 0.000836	0.103	0.0127	0.0808	0.025	0.0124	< 0.000623	0.0268	0.0387	0.0495	0.0141	0.0186	0.0181
PCB#209	< 0.000651	E 0.00335	< 0.000411	0.0109	0.00453	0.0263	0.0123	E 0.00627	< 0.000293	0.0119	0.0151	0.0188	0.00876	0.00858	E 0.00868
Total PCB Lower Bound (DL=0)	0.015	1.39	0.183	12.1	3.45	18.2	5.23	4.04	0.042	7.60	8.77	15.6	2.36	5.73	5.50
Total PCB Mid-Range	0.056	1.40	0.197	12.1	3.46	18.2	5.24	4.05	0.062	7.61	8.77	15.6	2.37	5.73	5.51
Total PCB Upper Bound (DL=DL)	0.096	1.42	0.212	12.1	3.46	18.2	5.24	4.06	0.081	7.62	8.78	15.6	2.37	5.74	5.51

Appendix B Status table

Table 7-7 Status assessment for 2012 and 2013 samples: PAH and PCBs. Organochlorine concentrations are in parts per billion (ng/g) freeze dried weight (<500 µm fraction), PAH are in parts per million (mg/kg).

							HWPAH (<DL = 0)		HWPAH (<DL = DL)		Total PCB (<DL = 0)		Total PCB (<DL = DL)	
	Sample	Status					ERC Green < 0.66, Amber 0.66 - 1.7, Red > 1.7				ERC Red > 22		ERC Red > 22	
Site	Year	Metals	HWPAH	OCPs	PCBs	TOC (%)	mg/kg	at 1% TOC	mg/kg	at 1% TOC	ng/g	at 1% TOC	ng/g	at 1% TOC
Awaruku Stream	2013	Zn	None	None	None	3.00	0.164	0.055	0.164	0.055	1.392	0.464	1.416	0.472
Vaughan's Stream	2013	None	None	None	None	1.37	0.022	0.016	0.022	0.016	0.183	0.133	0.212	0.155
Henderson Upper	2013	Cu Pb Zn	None	DDE, (DDD), Total DDT	None	2.70	0.345	0.128	0.345	0.128	12.117	4.488	12.136	4.495
Mangere Cemetery	2013	None	None	None	None	1.81	0.115	0.064	0.115	0.064	3.449	1.905	3.462	1.913
Meola Inner	2013	Pb Zn	(HWPAH)	DDD, Total DDT	None	1.94	2.498	1.288	2.498	1.288	18.186	9.374	18.203	9.383
Oakley	2013	Cu Pb Zn	(HWPAH)	(DDD), (Total DDT)	None	2.30	0.832	0.362	0.832	0.362	5.234	2.276	5.244	2.280
Pakuranga Upper	2013	Zn	None	None	None	1.73	0.342	0.198	0.342	0.198	4.044	2.337	4.058	2.345
Te Matuku	2013	None	None	None	None	0.80	0.006	0.008	0.006	0.008	0.042	0.053	0.081	0.101
Whau Lower	2013	Zn	None	None	None	1.98	0.563	0.284	0.563	0.284	7.604	3.840	7.616	3.846
Whau Upper	2013	Pb Zn	None	(Total DDT)	None	2.10	0.637	0.303	0.637	0.303	8.766	4.174	8.781	4.182
Whau Wairau	2013	Cu Pb Zn	(HWPAH)	(DDD), (Total DDT)	None	2.50	0.754	0.301	0.754	0.301	15.628	6.251	15.648	6.259
Rangitopuni	2013	Cu	None	None	None	2.90	0.274	0.094	0.274	0.094	2.358	0.813	2.373	0.818
Middlemore (BRS)	2013	Zn	(HWPAH)	None	None	1.87	0.729	0.390	0.729	0.390	5.727	3.062	5.743	3.071
Princes	2012	Zn	None	None	None	1.08	0.358	0.331	0.358	0.331	5.581	5.168	5.594	5.180
Waiuku	2012	None	None	None	None	1.95	0.222	0.114	0.222	0.114	3.465	1.777	3.485	1.787
Otahuhu	2012	Zn	None	None	None	1.53	0.463	0.302	0.463	0.302	5.834	3.813	5.846	3.821
Benghazi	2012	Cu Zn	None	None	None	0.97	0.117	0.121	0.117	0.121	1.070	1.103	1.105	1.139
Papakura Lower	2012	None	None	None	None	1.45	0.061	0.042	0.061	0.042	0.612	0.422	0.640	0.441
Shoal Hillcrest	2012	Pb	(HWPAH)	None	None	1.53	0.745	0.487	0.745	0.487	2.871	1.876	2.890	1.889
Chelsea	2012	Cu Pb	(HWPAH)	None	None	0.43	0.868	2.018	0.868	2.018	0.637	1.481	0.661	1.538
Purewa	2012	Zn	None	None	None	0.89	0.392	0.440	0.392	0.440	1.435	1.613	1.447	1.626
Bowden	2012	Zn	None	None	None	1.33	0.303	0.228	0.303	0.228	4.946	3.719	4.961	3.730
Pahurehure Upper	2012	None	None	None	None	1.36	0.061	0.045	0.061	0.045	1.061	0.780	1.093	0.803
Panmure	2012	Zn	(HWPAH)	None	None	1.35	0.785	0.581	0.785	0.581	5.587	4.138	5.595	4.144
Henderson Entrance	2012	Cu Zn	None	None	None	0.86	0.048	0.055	0.048	0.055	0.526	0.612	0.551	0.640
Coxs	2012	Pb Zn	(HWPAH)	None	None	0.42	0.518	1.233	0.518	1.233	0.531	1.263	0.544	1.296

Notes:

1. Darker red shading indicates ERC-Red exceeded in both ng/g and TOC-normalised concentrations. Pale red shading indicates concentrations within 10% of ERC-Red. Bracketed for HWPAH or OCPs indicates exceedance of ERC in only one of the concentration units, including within 10% of ERC. 'None' indicates no exceedance of ERC-green levels.
2. Middlemore BRS – metals' status from 2013 sampling, organics from BRS sampled 2011.

Table 7-7 continued. Status assessment for 2012 and 2013 samples: OCPs. Organochlorine concentrations are in parts per billion (ng/g) freeze dried weight (<500 µm fraction).

							Lindane		Dieldrin		Chlordane (<DL = 0)		Chlordane (<DL = DL)		4,4'-DDE		4,4'-DDD		4,4'-DDT		Total DDT (<DL = 0)		Total DDT (<DL = DL)	
	Sample	Status					ERC Red > 0.3		ERC Red > 0.72		ERC Red > 2.3		ERC Red > 2.3		ERC Red > 2.1		ERC Red > 1.2		ERC Red > 3.2		ERC Red > 3.9		ERC Red > 3.9	
Site	Year	Metals	HWPAH	OCPs	PCBs	TOC (%)	ng/g	at 1% TOC	ng/g	at 1% TOC	ng/g	at 1% TOC	ng/g	at 1% TOC	ng/g	at 1% TOC	ng/g	at 1% TOC	ng/g	at 1% TOC	ng/g	at 1% TOC	ng/g	at 1% TOC
Awaruku Stream	2013	Zn	None	None	None	3.00	< 0.023	< 0.008	0.136	0.045	0.173	0.058	0.173	0.058	E 0.518	E 0.173	E 0.216	E 0.072	E 0.109	E 0.036	0.891	0.297	0.956	0.319
Vaughan's Stream	2013	None	None	None	None	1.37	< 0.0143	< 0.010	0.057	0.041	0.072	0.053	0.072	0.053	E 0.0528	E 0.039	E 0.0281	E 0.021	< 0.0165	< 0.012	0.081	0.059	0.144	0.105
Henderson Upper	2013	Cu Pb Zn	None	DDE, (DDD), Total DDT	None	2.70	< 0.0237	< 0.009	0.277	0.103	0.145	0.054	0.145	0.054	5.260	1.948	2.460	0.911	1.400	0.519	9.817	3.636	9.817	3.636
Mangere Cemetery	2013	None	None	None	None	1.81	< 0.0162	< 0.009	0.179	0.099	0.088	0.049	0.088	0.049	0.939	0.519	0.237	0.131	0.236	0.130	1.496	0.826	1.519	0.839
Meola Inner	2013	Pb Zn	(HWPAH)	DDD, Total DDT	None	1.94	< 0.0291	< 0.015	0.585	0.302	0.513	0.264	0.513	0.264	1.770	0.912	3.420	1.763	2.580	1.330	8.949	4.613	8.949	4.613
Oakley	2013	Cu Pb Zn	(HWPAH)	(DDD), (Total DDT)	None	2.30	< 0.0239	< 0.010	0.325	0.141	0.151	0.066	0.151	0.066	1.510	0.657	1.110	0.483	0.632	0.275	3.595	1.563	3.595	1.563
Pakuranga Upper	2013	Zn	None	None	None	1.73	E 0.135	E 0.078	0.274	0.158	0.145	0.084	0.145	0.084	E 0.324	E 0.187	0.286	0.165	0.129	0.075	0.835	0.483	0.856	0.495
Te Matuku	2013	None	None	None	None	0.80	< 0.0174	< 0.022	< 0.0373	< 0.047	0.000	0.000	0.013	0.016	< 0.0137	< 0.017	< 0.0095	< 0.012	< 0.0182	< 0.023	0.000	0.000	0.087	0.109
Whau Lower	2013	Zn	None	None	None	1.98	< 0.0204	< 0.010	0.165	0.083	0.081	0.041	0.081	0.041	0.880	0.444	0.627	0.317	1.560	0.788	3.251	1.642	3.279	1.656
Whau Upper	2013	Pb Zn	None	(Total DDT)	None	2.10	0.019	0.009	0.518	0.247	0.277	0.132	0.277	0.132	1.280	0.610	0.939	0.447	1.850	0.881	4.377	2.084	4.377	2.084
Whau Wairau	2013	Cu Pb Zn	(HWPAH)	(DDD), (Total DDT)	None	2.50	< 0.0278	< 0.011	0.528	0.211	0.234	0.094	0.234	0.094	E 1.30	E 0.52	1.210	0.484	0.683	0.273	3.581	1.433	3.581	1.433
Rangitopuni	2013	Cu	None	None	None	2.90	< 0.0166	< 0.006	0.113	0.039	0.033	0.011	0.033	0.011	E 0.817	E 0.282	0.435	0.150	0.158	0.054	1.540	0.531	1.563	0.539
Middlemore (BRS)	2013	Zn	(HWPAH)	None	None	1.87	0.020	0.011	0.455	0.243	0.103	0.055	0.103	0.055	E 0.472	E 0.252	0.425	0.227	0.266	0.142	1.305	0.698	1.305	0.698
Princes	2012	Zn	None	None	None	1.08	0.025	0.024	0.172	0.159	0.050	0.047	0.050	0.047	0.289	0.268	0.385	0.356	0.165	0.153	0.969	0.897	0.969	0.897
Waiuku	2012	None	None	None	None	1.95	0.029	0.015	0.099	0.051	0.022	0.011	0.022	0.011	0.315	0.162	0.103	0.053	0.079	0.040	0.591	0.303	0.604	0.310
Otahuhu	2012	Zn	None	None	None	1.53	0.028	0.018	0.202	0.132	0.053	0.035	0.053	0.035	0.447	0.292	0.367	0.240	0.264	0.173	1.215	0.794	1.215	0.794
Benghazi	2012	Cu Zn	None	None	None	0.97	0.018	0.019	0.070	0.072	0.022	0.023	0.022	0.023	0.123	0.127	0.115	0.119	0.057	0.059	0.338	0.349	0.344	0.355
Papakura Lower	2012	None	None	None	None	1.45	E 0.0255	E 0.018	0.077	0.053	0.019	0.013	0.019	0.013	0.281	0.194	0.068	0.047	0.070	0.048	0.444	0.306	0.450	0.311
Shoal Hillcrest	2012	Pb	(HWPAH)	None	None	1.53	0.032	0.021	0.079	0.051	0.037	0.024	0.037	0.024	0.366	0.239	0.442	0.289	0.160	0.105	1.091	0.713	1.091	0.713
Chelsea	2012	Cu Pb	(HWPAH)	None	None	0.43	E 0.0231	E 0.054	0.051	0.119	0.021	0.049	0.021	0.049	0.123	0.286	0.152	0.353	0.041	0.095	0.358	0.833	0.358	0.833
Purewa	2012	Zn	None	None	None	0.89	0.025	0.028	0.076	0.086	0.049	0.054	0.049	0.054	0.194	0.218	0.216	0.243	0.145	0.163	0.607	0.682	0.607	0.682
Bowden	2012	Zn	None	None	None	1.33	0.032	0.024	0.165	0.124	0.067	0.051	0.067	0.051	0.302	0.227	0.334	0.251	0.113	0.085	0.858	0.645	0.858	0.645
Pahurehure Upper	2012	None	None	None	None	1.36	0.037	0.027	0.103	0.076	0.021	0.016	0.021	0.016	0.277	0.204	0.076	0.056	0.076	0.056	0.459	0.338	0.468	0.344
Panmure	2012	Zn	(HWPAH)	None	None	1.35	0.035	0.026	0.135	0.100	0.053	0.039	0.053	0.039	0.442	0.327	0.462	0.342	0.221	0.164	1.310	0.970	1.310	0.970
Henderson Entrance	2012	Cu Zn	None	None	None	0.86	< 0.0151	< 0.018	0.045	0.052	0.019	0.022	0.019	0.022	0.201	0.234	0.099	0.115	0.037	0.043	0.359	0.418	0.389	0.452
Coxs	2012	Pb Zn	(HWPAH)	None	None	0.42	E 0.0194	E 0.046	0.059	0.140	0.027	0.064	0.027	0.064	0.086	0.204	0.103	0.245	E 0.0209	E 0.050	0.231	0.550	0.252	0.600

Notes:

1. Darker red shading indicates ERC-Red exceeded in both ng/g and TOC-normalised concentrations. Pale red shading indicates concentrations within 10% of ERC-Red. Bracketed for HWPAH or OCPs indicates exceedance of ERC in only one of the concentration units, including within 10% of ERC. 'None' indicates no exceedance of ERC-green levels.
2. Middlemore BRS – metals' status from 2013 sampling, organics from BRS sampled 2011.