Investigation into Stormwater Contamination from the Exide Technologies Reprocessing Plant, (51-57 Waione Street, Petone)

FINAL REPORT

Pollution Control Team Report (Resource Investigations Department)

Greater Wellington Regional Council (26 July 2005)

Investigation into Stormwater Contamination from the Exide Technologies Reprocessing Plant, 51-57 Waione Street, Petone

Howard Markland , Timothy Strange, Sarah Van Erp

Resource Investigations Department, Greater Wellington Regional Council

1.0 Introduction

1.1 Study Background

There is a lead-acid battery recycling plant at 51-57 Waione Street, Petone, which was established in 1965. It has been operated by Exide Technologies since November 2001, and processes 500,000 batteries per year[1]. The recycling process involves breaking-open used batteries, removing the lead alloy plates, and melting them to recover lead. By-products include an iron-rich slag that is stabilised on site pending disposal at the Wainuiomata landfill. Discharges to atmosphere occur via two stacks, and fugitive emissions via the building fabric.

Plant owners, Greater Wellington Regional Council and the Regional Public Health service have conducted extensive monitoring to characterise atmospheric fall-out of lead particulates onto the surrounding area over recent years. However, less is known about the mobility and fate of this contamination once in the environment, and in particular, its transportation via stormwater run-off and possible accumulation in receiving waters such as the Te Mome Stream.

The Te Mome Stream catchment occupies a large part of the area affected by atmospheric fall-out from the Exide Technologies site, and so stormwater run-off from the catchment is likely to transfer soluble and particulate contaminants to the stream. Once in the stream, it could either accumulate in sediments, or be carried into the Hutt River and Wellington Harbour.

Investigations by Greater Wellington's Pollution Control Team into environmental incidents on 4 November and 15 December 2004, identified the following means by which contaminants from the Exide Technologies site may enter the Te Mome stream via the municipal stormwater system:

- Fugitive emissions falling onto roof surfaces above the battery recycling plant, entering roadside drains (see Photo 1).
- Insufficient cleaning of outdoor surfaces on the East Street side of the site, enabling metallic debris to enter roadside drains (see Photo 2).
- Corrosive material spillage onto yard surfaces at Exide Technologies, entering the stormwater system in East Street, as evidenced by corroded concrete, surface staining and acidic stormwater in East Street (see Photos 3 & 4).
- Process water escape to East Street via doorways. For example, the incident on 15 December 2004 resulted in a significant discharge of contaminants from the slag reprocessing area floor into the Te Mome Stream via the stormwater system (see Photos 5 & 6).

Photo 1 Stormwater Drain from Roof of Exide Technologies (10/12/04)

[1] 'About Us', Exide Technologies web site 24 May 2005

Photo 2 Metallic Debris Accumulated in roadside in East Street (04/11/04)

Photo 3 Evidence of Yard-Sourced Contaminants Entering East Street (10/12/04)

Photo 4 Acidity of Stormwater in East Street Roadside Sump (04/11/04)

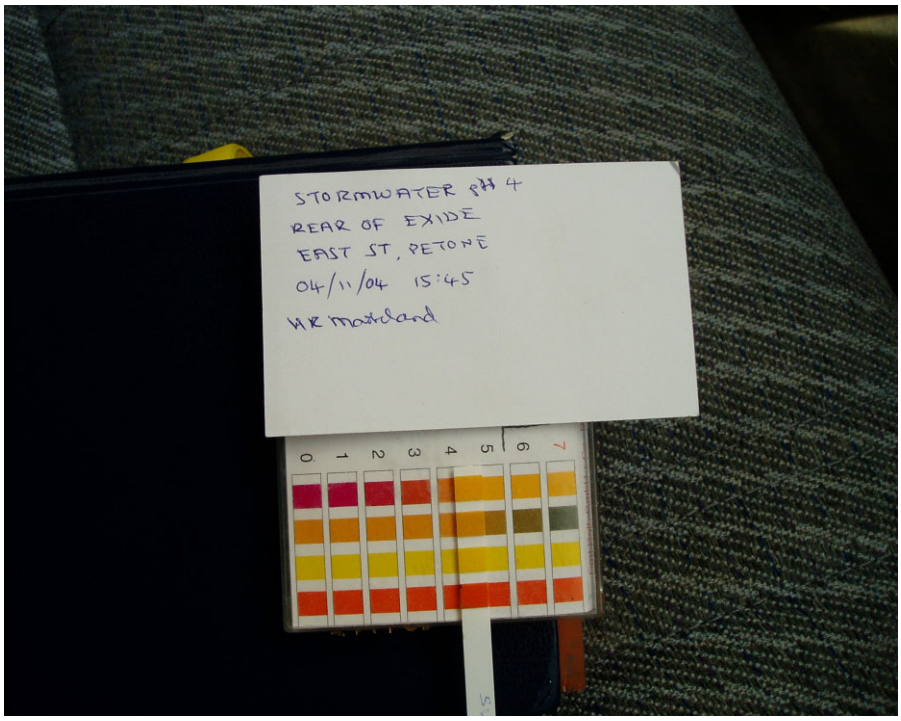


Photo 5 **Contaminant Discharge to East Street from Exide Technologies (15/12/05)**

Photo 6 **Impact on Te Mome Stream from Exide Technologies Incident (15/12/05)**

1.2 Te Mome Stream & Catchment Characteristics

The Te Mome Stream is a tidally influenced 'dead arm' of the Hutt River, which runs for 1.4km alongside the suburb of Ava near Lower Hutt (see Figure 1). The stream is up to 40 metres wide and 1.5 metres deep, with a tidal range of around 0.5 metres, that exposes fringing sediments at low tide. Stream sediments are highly organic, and in excess of 0.5 metres deep in places, ranging from silt to sandy mud. Stream biodiversity is limited, with the predominant biota being eels, algae and reeds.

The contributing catchment is approximately 110 hectares, and includes the suburbs of Ava, Petone and Alicetown (see Figure 2). There are eight distinct sub-catchments which discharge into the Te Mome Stream via identifiable stormwater outfalls. Catchment land use is largely residential although there is some industry present, the most significant industrial sites being Exide Technologies (lead-acid battery recycling), and Unilever Australasia (detergent manufacture).

2.0 Study Objective

Following the discharge of contaminants from Exide Technologies' Waione Street site into the Te Mome Stream on 15 December 2004, Greater Wellington conducted a preliminary investigation into water and sediments in the Te Mome Stream, to characterise the severity and extent of contamination arising from this incident and look for evidence of historic contaminant inputs.

3.0 Methodology

The following sections describe how a total of 22 samples (soil, sediment and water) were collected and analysed from the environment around the Exide Technologies site and the Te Mome Stream.

3.1 Stormwater Sampling

On 4 November 2004, Greater Wellington investigated alleged leakage from a skip in East Street, to the rear of the Exide Technologies site. Although there was no evidence of a leaking skip, a sample of accumulated water was taken from an adjacent stormwater drainage sump, situated between the yard access and battery reprocessing area at Exide Technologies. A single sample was collected by submerging a plastic bottle beneath the surface, and indicator paper used to determine pH (Photo 4).

3.2 Street Sediment Sampling

Following collection of the stormwater sample on 4 November 2004, an accumulation of rusty sediment was also noted in the East Street kerb and channel to the rear of the Exide Technologies slag reprocessing area (see Photo 2). A single sample was obtained by pushing a plastic sample container into the accumulated sediment.

3.3 Stream Sampling

Following the incident of 15 December 2004, grab samples of water (5) and sediment (15) were taken from the Te Mome Stream on 24 December 2004, at locations indicated in Figure 1. Samples were analysed for heavy metal contamination. Lead and antimony which are understood to be the 'signature' contaminants of the lead-acid battery recycling process used by Exide Technologies[2].

[2] Personal comment from Craig Stevens, Manager Recycling Division, Exide Technologies (10 December 2004)

Figure 1 Te Mome Stream & Surroundings

Figure 2 Contributing Subcatchments of the Te Mome Stream

Samples were collected at several points along the Te Mome Stream, but focused around three transects of the stream between Jackson Street and Waione Street, in the vicinity of the stormwater outfall serving East Street stormwater drains. Samples were also collected from 'background' sampling sites upstream and downstream, where it was considered there would be negligible influence from the Exide Technologies site. All sampling locations were referenced by GPS, and are illustrated in Figure 2. A small inflatable boat was used for sample collection, working from downstream to upstream direction, so as to minimise the effect of any stream bed disturbance.

All water samples were taken prior to the collection of sediment samples or any other disturbance of stream sediment, to ensure that sample representativeness was not compromised. Water pH was also recorded at multiple locations to determine the acidity/alkalinity of the water, and indicate whether metals in the sediment could be being mobilised. Water samples were collected from just beneath the surface using plastic containers containing a nitric acid preservative. All samples were labelled according to the sampling site and stored under refrigeration pending transfer to the laboratory for analysis.

Sediment samples were taken by inserting an open-topped plastic cylinder (50 mm diameter) into the sediment to a depth of up to 60 mm. The top of the cylinder was then sealed, so that when the container was withdrawn it retained a sample of the sediment profile at that point. Sediment samples were maintained vertical at all times, and left to settle for approximately two hours after sampling. After settling, water was poured-off and the sample partitioned using a plastic blade. For two of the samples (reference CS1 and CS2), each sample was divided into three aliquots at intervals of 20 mm depth (top, middle and bottom), with each aliquot placed in separate zip lock bags. For all other sediment samples, all but the top 20 mm of sample was discarded, and each sample placed in a zip-lock bag labelled according to the sampling site. All sample bags were stored under refrigeration pending transportation to the laboratory for analysis.

3.4 Sample Analysis

Water and sediment samples were taken to ELS (Environmental Laboratory Services) analytical laboratory in Seaview within 24 hours of sampling, where they were analysed for a range of heavy metals. Analytical methods used are specified in Appendix 2.

4.0 Results

Analytical results returned from the laboratory for all samples are presented in Tables 1-5 below, and as isopleths in Appendix 2. *Italics* indicates results that exceed environmental guideline values.

Table 1 East Street Stormwater Quality

		Concentration (g/m^3)					
Sample	**pH**	**Iron**	**Antimony**	**Arsenic**	**Cadmium**	**Lead**	**Copper**
SW1	3.8	*205.0*	*0.2*	*0.154*	*0.543*	*46.0*	*1.7*
Investigation Level[3]		0.3	0.009	0.024	0.0002	0.0034	0.0014

[3] ANZECC Water Quality Guidelines 2000 - low reliability trigger value

Table 2 East Street Sediment Quality

		Concentration (mg/kg)					
Sample	**pH**	**Iron**	**Antimony**	**Arsenic**	**Cadmium**	**Lead**	**Copper**
SOIL1		*79,400*	*419.0*	*269.0*	*11.0*	*27,400*	*563*
ISQG Low[4]		23,464.3[5]	2	20	1.5	50	65
ISQG High[4]		-	25	70	10	220	270

Table 3 Te Mome Stream Water Quality

		Concentration (g/m^3)					
Sample	**pH**	**Iron**	**Antimony**	**Arsenic**	**Cadmium**	**Lead**	**Copper**
A1	7	*0.33*	<0.002	*0.030*	<0.001	*0.005*	*0.004*
C1	7	*0.39*	0.002	*0.029*	<0.001	*0.025*	*0.005*
B1	8	*1.79*	*0.020*	0.010	<0.001	*0.364*	*0.014*
D1		*1.49*	*0.021*	0.011	<0.001	*0.235*	*0.008*
BK1		*0.79*	<0.002	0.008	<0.001	*0.005*	*0.015*
Investigation Level[6]		0.3	0.009	0.024	0.0002	0.0034	0.0014

Table 4 Sediment Samples – Lateral variation

		Concentration (mg/kg)				
Sample	**pH**	**Iron**	**Antimony**	**Arsenic**	**Cadmium**	**Lead**
A1	7.0	*29,900.0*	*21.0*	6.5	1.06	*1,320.0*
A2		21,800.0	*6.0*	5.4	0.53	*399.0*
A3		22,500.0	*3.0*	4.1	0.31	*211.0*
B1	8.0	22,600.0	*15.0*	7.3	0.99	*833.0*
B2		*25,900.0*	*18.0*	8.0	1.17	*1,580.0*
B3	7.0	21,200.0	*4.0*	4.9	0.43	*240.0*
C1		*24,500.0*	*9.0*	6.6	0.75	*690.0*
C2		21,900.0	*5.0*	5.3	0.55	*369.0*
C3	7.0	*24,400.0*	*3.0*	6.6	0.47	*208.0*
BK1		*24,500.0*	2.0	7.0	0.60	*171.0*
BK2		17,800.0	ND	2.8	0.17	*78.5*
BK3		19,500.0	ND	2.2	0.06	23.9
ISQG Low[4]		23,464.3[5]	2	20	1.5	50
ISQG High[4]		23464.3[5]	25	70	10	220

[4] Interim Sediment Quality Guidelines, National Water Quality Management Strategy (ANZECC, October 2000)
[5] Region 6 human health & residential screening level (USEPA)
[6] Freshwater Trigger Value to protect 95% of species, National Water Quality Management Strategy (ANZECC, October 2000)

Table 5 Sediment Samples – variation with depth

		Concentration (mg/kg)				
Sample	pH	Iron	Antimony	Arsenic	Cadmium	Lead
CS Top		*26,400.0*	*18.0*	9.2	1.32	*1,110.0*
CS Mid		*27,000.0*	*25.0*	11.1	*1.80*	*1,640.0*
CS Bottom	7	*28,700.0*	*28.0*	13.2	*1.92*	*1,780.0*
ISQG Low[4]		23,464.3[5]	2	20	1.5	50
ISQG High[4]		23,464.3[5]	25	70	10	220

It should be noted that ANZECC sediment guideline values were used for the assessment of street sediments from East Street, on the basis that they would be washed into the Te Mome Stream, where they would join the sediments. It is however acknowledged that Canadian Council of Ministers of the Environment guideline values would normally be used for soil sample comparison, as these take into consideration both environmental and human health risk considerations.

5.0 DATA INTERPRETATION

The following paragraphs summarise observations drawn from the analytical results of samples collected from East Street and the Te Mome Stream. Although all of the metals analysed exceeded guideline values in one or more samples, the scope of the following interpretation is limited to lead and antimony. The justification for this decision is that this investigation was initiated in response to contaminant discharges from the Exide battery reprocessing plant, and these metals are characteristic of the battery recycling process. Other contaminants will be addressed outside this report.

5.1 East Street Samples

The roadside sediment sample collected from the kerb and channel exhibited elevated concentrations for a range of heavy metals. In particular, lead in the sediment exceeded guideline values by 195 times, while both arsenic and antimony exceeded guideline values by a factor of approximately 20.

Stormwater collected from the roadside drain in East Street exhibited a strong acidity (pH 3.8). Lead concentrations exceeded guideline values by 13,500 times, while copper concentrations were 1,200 times greater than the guideline value. Both iron and cadmium exceeded guideline values by approximately 20 times.

5.2 Te Mome Stream Samples

Figures 3 and 4 provide an overview of the analytical results for water and soil samples taken in the Te Mome Stream. These schematic figures illustrate the metals that were detected at concentrations exceeding relevant environmental guideline values, with colour coding is used to indicate the magnitude of exceedance.

5.2.1 Lead

All stream sediments sampled within a 29 metre radius of the East Street outfall exceeded the ANZECC interim sediment quality guideline ‘high trigger’ level, with one sample close to the outfall (B2) exceeding this value by a factor of seven. Generally speaking, concentrations of lead in

Figure 3 Overview of Sediment Sample Results for the Te Mome Stream

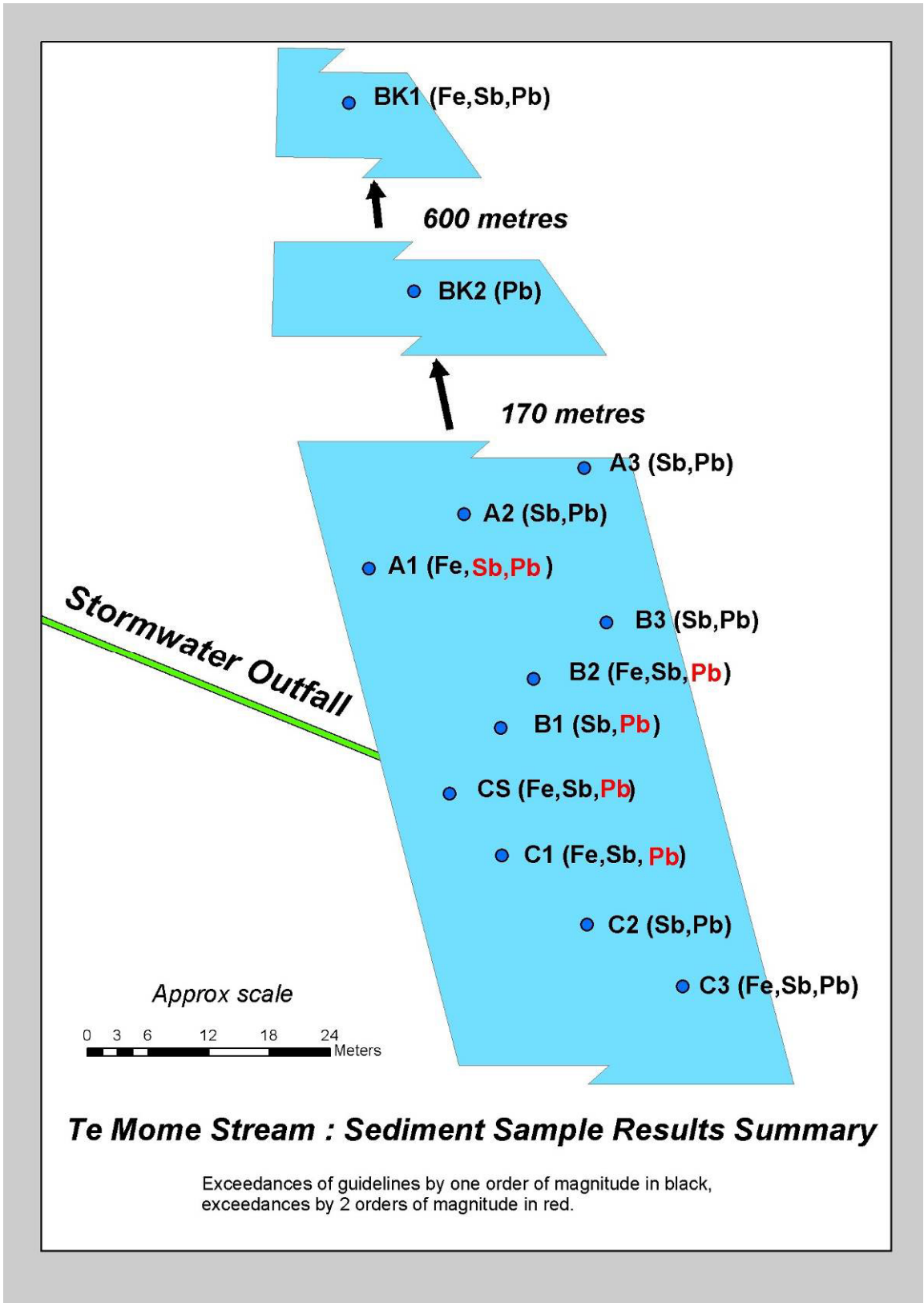
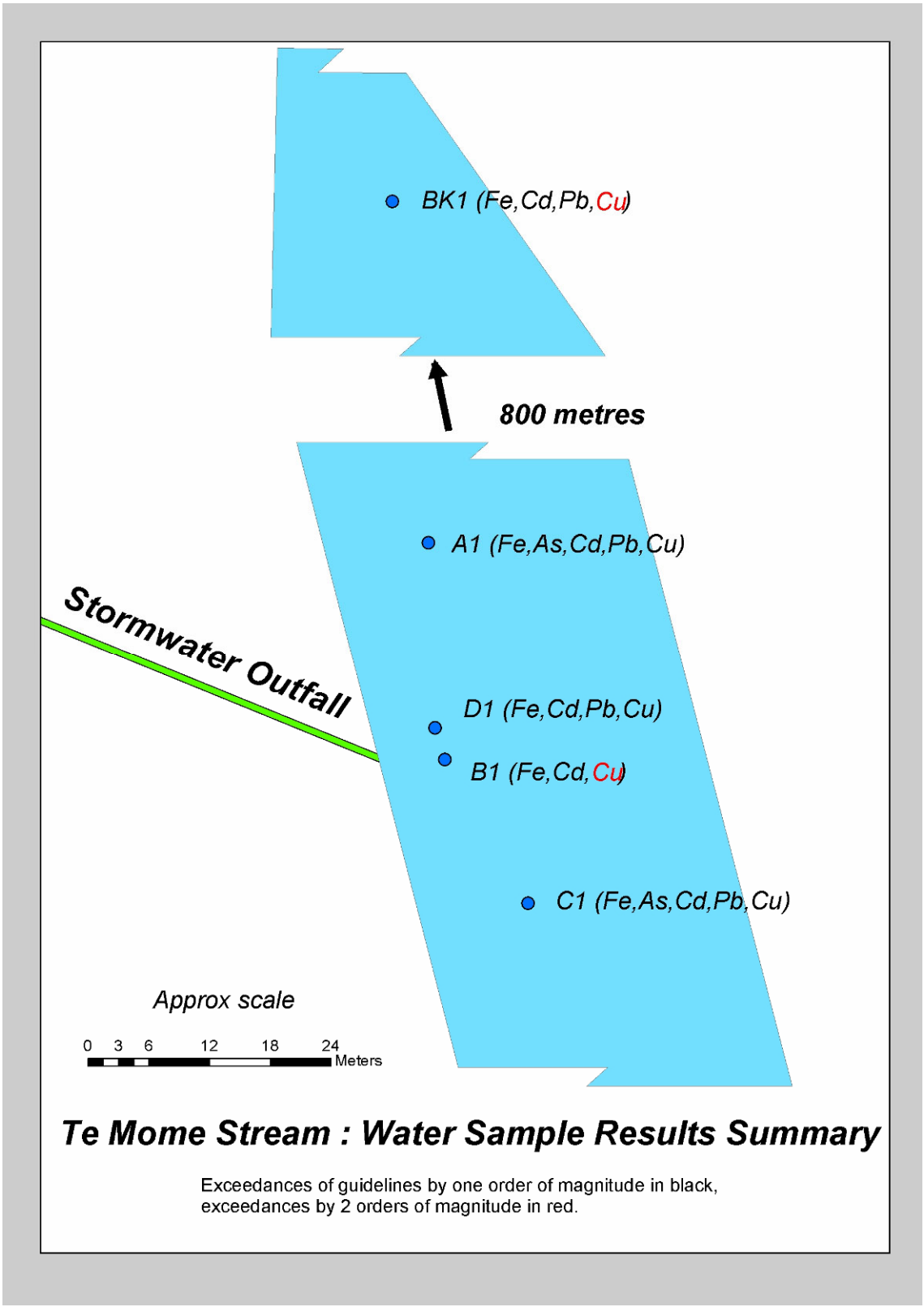


Figure 4 Overview of Water Sample Results for the Te Mome Stream



sediment decline with distance from the East Street stormwater outfall, but increase with depth in the sediment profile.

All stream water samples (including the background sample) exceeded the ANZECC trigger value for the protection of 95% of species, whilst water sampled in the vicinity of the East Street outfall was over one hundred times greater than the trigger value.

5.2.2 Antimony

Stream water samples from the vicinity of the East Street outfall exceeded the guideline for antimony. With the exception of background samples, all sediment samples exceeded the guideline for antimony, with the greatest exceedances being in the vicinity of the East Street outfall.

5.2.3 Other Metals

Other metals were also present in stream water and sediment at concentrations that exceeded relevant environmental standards. All water samples exceeded standards for iron and copper, whilst water samples from the vicinity of the East Street outfall also exceeded standards for arsenic. Sediment concentrations of iron exceeded the standard at several locations (including the upstream background site BK1), but showed no obvious influence of discharges from the East Street outfall.

5.2.4 Comparison with Background Levels

Table 6 compares typical background data sourced from the Wellington region, with results from samples taken from around the Exide Technologies site in the Te Mome stream catchment.

This comparison reveals that lead and antimony concentrations in stormwater, stream sediment and road surface sediments associated with the Exide Technologies site, significantly exceed background levels for the Wellington region, in some cases by several orders of magnitude.

5.2.5 Metal Ratios

The ratios of lead:antimony measured in samples taken is summarised in Table 7. This reveals a similarity between ratios for roadside sediments in East Street (65:1) and sediment samples taken from the Te Mome Stream nearest the East Street stormwater outfall (52:1). Investigations in industrial situations elsewhere[7] indicate that ratios of 50:1 can be expected.

Greater Wellington was unable to conduct a comprehensive review of lead: antimony ratios for stream and roadside sediments at other locations. However, a preliminary review of other stream sediment samples taken by Greater Wellington elsewhere in the region indicates a ration that varies between 1:1 to 11:1. It is therefore not possible to establish the significance of ratios found for East Street and Te Mome Stream sediments.

[7] Assessment of Urban Stormwater Quality in the Wellington Region (Kingett Mitchell Limited, June 2005)

Table 6 Stormwater Data Comparison

	Wellington Data	Te Mome Catchment
Stormwater		
Antimony	0.0007 g/m^3 (a)	0.2 g/m^3 (b)
Lead	0.0025 g/m^3 (a)	46.0 g/m^3 (b)
Surface Water		
Antimony	No data	0.021 g/m^3 (b)
Lead	No data	0.364 g/m^3 (b)
Stream Sediment		
Antimony	0.28 mg/kg (c)	21.0 mg/kg (b)
Lead	34.2 mg/kg (c)	1,580.0 mg/kg (b)
Roadside Sediment		
Antimony	9.0 mg/kg (d)	419 mg/kg (b)
Lead	1,989 mg/kg (d)	27,400 mg/kg (b)

(a) Assessment of Urban Stormwater Quality in the Greater Wellington Region (Greater Wellington Regional Council, June 2005)

(b) Greater Wellington Regional Council samples taken between November and December 2004

(c) Mean of water sample results for 33 streams in the Greater Wellington region

(d) Metals in Particulate Material on Road Surfaces (Kingett Mitchell Limited, 2003)

Table 7 Lead:Antimony Ratios in Sampled Media

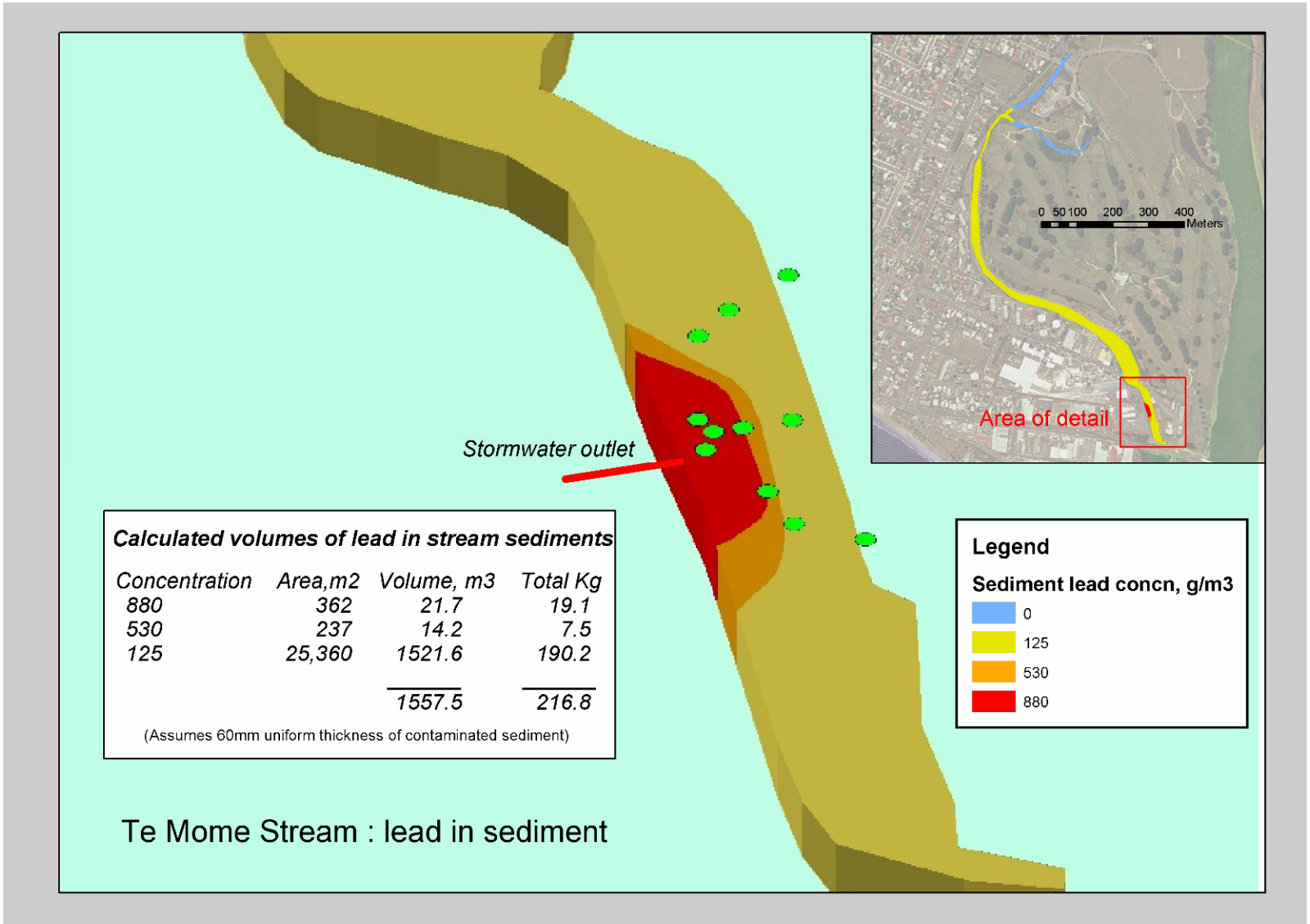
	No. of Samples	Stream at Outfall	East Street
Stream Water	2	15:1	-
Stream Sediments	3	**52:1**	-
Stormwater	1	-	230:1
Kerb & Channel Sediments	1	-	**65:1**

5.2.6 Load Estimation

Based upon the above concentration data, it is possible to estimate the quantity of sediments affected by excessive heavy metal concentration. Greater Wellington has done a preliminary estimate for lead-affected sediments, using the following assumptions:

- Lead contamination is assumed to affect a uniform 60 mm depth of sediment, as indicated by our sampling (although sediment depth is known to exceed 0.5 metres in places).
- Lead contamination is assumed to have three homogeneous bands, as illustrated in Figure 5 (derived by taking the arithmetic mean of samples collected within each band).

Figure 5 Load Estimation for Lead Contamination in the Te Mome Stream



- The bulk-density of stream sediments is assumed to be approximately[8] 1 tonne/m^3.
- The total lead load in sediment does not include that lead present at concentrations less than the ANZECC sediment quality guideline value of 50g/m^3.

The table inset in Figure 5 illustrates that there is an estimated 1,500 tonnes of lead contaminated stream sediment (lead concentrations in excess of ANZECC guideline levels), and that these sediments contain approximately 0.2 tonnes of lead.

6.0 CONCLUSIONS

Sampling of street sediments and stormwater in East Street, to the rear of the Exide Technologies site on 4 November 2004 confirmed that both street sediment and stormwater had lead concentrations significantly exceeding established environmental guideline levels. Other metals were also exceeded established guideline values to a lesser degree. It appears that the highly acidic nature of stormwater evident on this day encouraged metallic contaminants to enter solution.

Although battery recycling operations at Exide Technologies involve the use of acid and lead, these results do not confirm Exide Technologies as the source of the acidity and lead contamination found in street sediments and stormwater in East Street. Photographs 1, 2 and 5 (see section 1) indicate that the Exide Technologies site is contributing liquid and particulate contaminants to East Street. Photograph 3 indicates that acidic liquid may also have discharged into East Street from the Exide site, although there is nothing to confirm that such discharges caused the highly acidic conditions found in a nearby stormwater sump in East Street.

The incident of 14 December 2004 confirmed that contaminants entering stormwater drains in East Street to the rear of the Exide Technologies site can discharge into the Te Mome Stream via an outfall in the vicinity of Unilever Australasia Limited. It is therefore possible that contaminated street sediment and stormwater in East Street can also enter the Te Mome Stream. Following this incident, Greater Wellington Regional Council issued Exide Technologies with an abatement notice, restricting further release of acid or heavy metal contaminants to the stormwater system. Exide Technologies also committed to undertake an independent investigation into possible contaminant contributions from its site to the Te Mome Stream.

Sampling of water in the Te Mome Stream confirmed very high concentrations of lead and elevated concentrations of other heavy metals in the vicinity of the East Street stormwater outfall. In particular, lead concentrations in stream water were one hundred times greater than guideline levels. The concentration for lead and other heavy metals declined with distance from the outfall, and it is noted that tidal influence has enabled contaminants to affect both upstream and downstream of the East Street outfall.

It is presumed that contaminants in samples taken from the upper part of the water column indicate the presence of recent or ongoing contamination. The Exide Technologies battery reprocessing site represents the most significant source of lead presently in the stormwater catchment served by the East Street outfall.

Sampling of sediment in the Te Mome Stream confirmed high concentrations of lead, and elevated concentrations of other heavy metals in the vicinity of the East Street stormwater outfall. Heavy

[8] Soil Mechanics (fifth edition), R.F. Graig

metal concentration decline with distance from the outfall. Elevated heavy metal concentrations in sediments around the East Street outfall are attributed to historic contaminant inputs to the stream via this stormwater outfall. Information provided by Exide Technologies (John Hawkins), and the Hutt City Council (Gordon George) indicates that industrial contributions of metallic contaminants could have arisen from the following sources over the last 50 years:

- Battery recycling operations by GNB and Exide Technologies at 51-57 Waione Street (from 1965 to present).
- Battery manufacture by Rokfire at 45 Waione Street (1961-1971).
- Electroplating operations by Superior Springs at 45 Waione Street (from the 1980's to 2003).
- Battery manufacture by Forsyth Battery Rebuilders (in the 1960's to 1970's).
- Military firing range on the golf course site.
- Fraser Powder Coating in East Street.
- Robin Smith Spray Painting in East Street.

The concentration of all heavy metals appears to increase with depth, which suggests that historic contributions were more significant than those of more recent times, or that surficial sediments are transferring contaminants into the water column.

Lead and antimony concentrations in stormwater, stream sediment and road surface sediments associated with the Exide Technologies site significantly exceed their respective background levels (in the Wellington region), in some cases by several orders of magnitude.

It is estimated that 1,500 tonnes of stream sediment has lead concentrations in excess of ANZECC guideline levels, and that these sediments contain approximately 0.2 tonnes of lead. These estimates are considered to under represent the actual situation, due to the conservative nature of assumptions used in its calculation.

This investigation does not evaluate heavy metal fate and mobility in the receiving environment, or human and ecosystem exposures to heavy metals identified. As such, it is not possible to draw conclusions regarding the risk that the elevated heavy metal concentrations present to human health or the environment.

7.0 LIMITATIONS

The principal limitations for this investigation are the small number of samples taken, the lack of comparative data from other sites, and the lack of consideration of contaminant sources in the catchment other than Exide Technologies. The fact that stormwater and stream water were only sampled on one occasion also undermines the validity of these data sets, as their quality is likely to change due to processes such as flushing and sedimentation. However, it is considered that multiple sampling occasions would not significantly alter sediment-related findings.

APPENDIX 1 TEST METHODS

Surface Water & Stormwater Testing

Test	Methodology	Detection Limit
Iron by ICP Digest	APHA 20th Edition Method 3120 B modified, following in-house digest.	0.013 g/m3
Antimony by ICP-MS Digest	ICP-MS. Based on APHA Method 3030E	0.002 g/m3
Arsenic by ICP-MS Digest	ICP-MS. Based on AP HA Method 3030E	0.002 g/m3
Cadmium by ICP-MS Digest	ICP-MS. Based on APHA Method 3030E	0.001 g/m3
Copper by ICP-MS Digest	ICP-MS. Based on APHA Method 3030E	0.002 g/m3
Lead by ICP-MS Digest	ICP-MS. Based on APHA Method 3030E	0.001 g/m3

Stream Sediment & Soil Testing

Test	Methodology	Detection Limit
Iron by ICP	APHA 20th Edition Method 3120 B modified, following in-house digest.	0.5 mg/kg
Antimony by ICP-MS	Inductively Coupled Mass Spec. In house method	1 mg/kg
Arsenic by ICP-MS	Inductively Coupled Mass Spec. In house method	0.05 mg/kg
Cadmium by ICP-MS	Inductively Coupled Mass Spec. In house method	0.01 mg/kg
Lead by ICP-MS	Inductively Coupled Mass Spec. In house method	0.1 mg/kg

APPENDIX 2 SAMPLE RESULTS SUMMARY

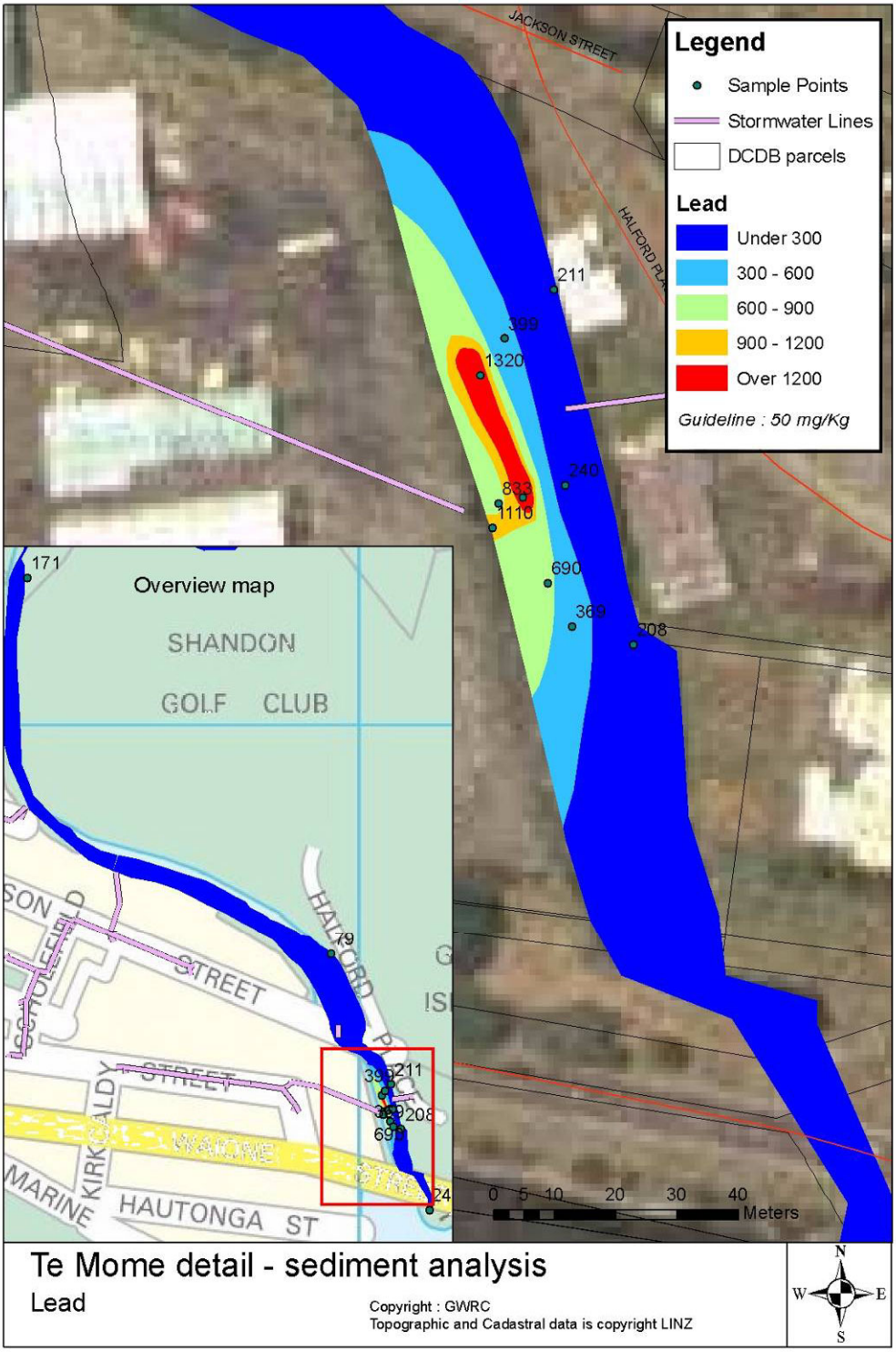
The following figures illustrate sample results for the following:

a) Lead concentrations in Te Mome Stream sediments

b) Lead concentrations in Te Mome Stream water

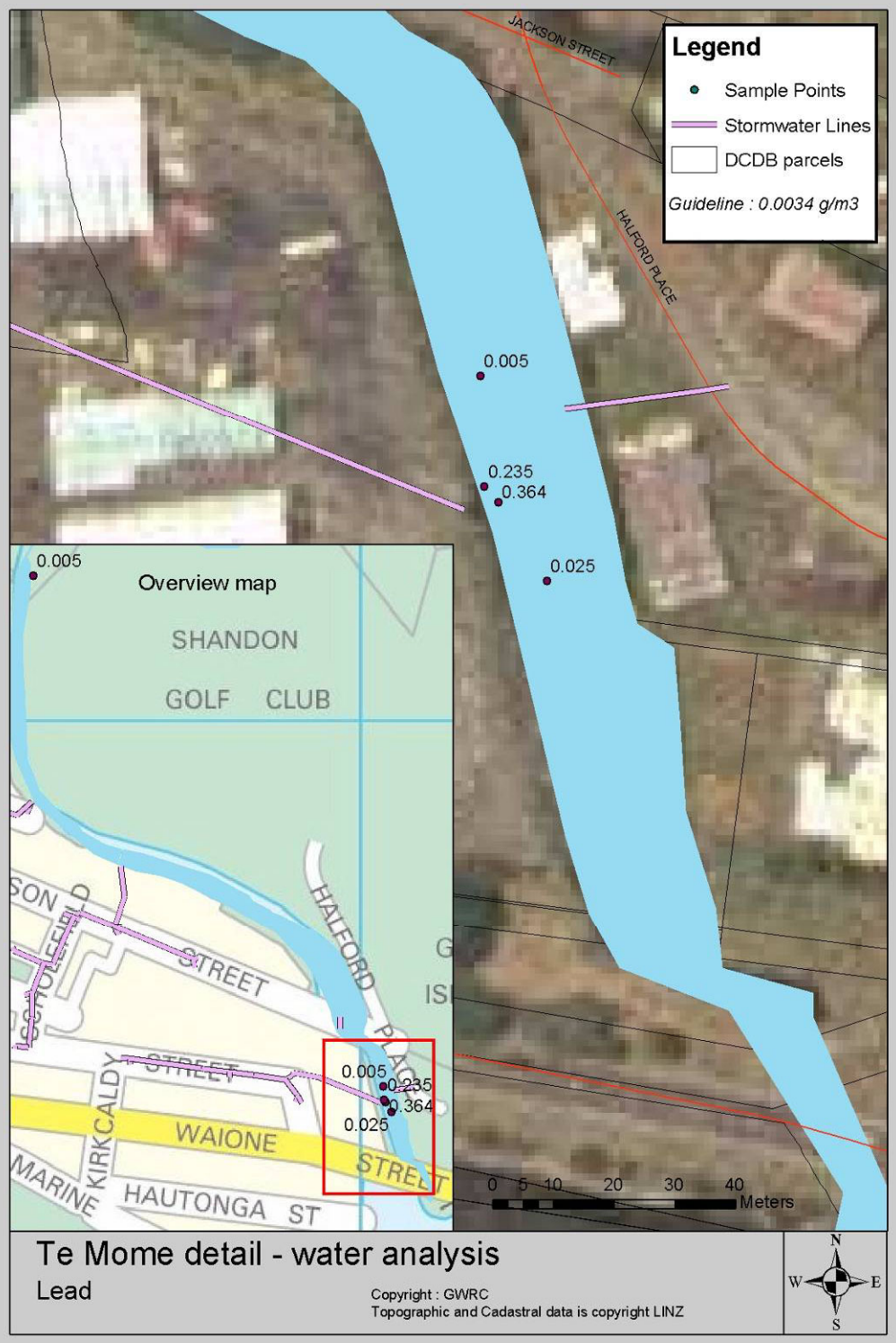
c) Antimony concentrations in Te Mome Stream sediments

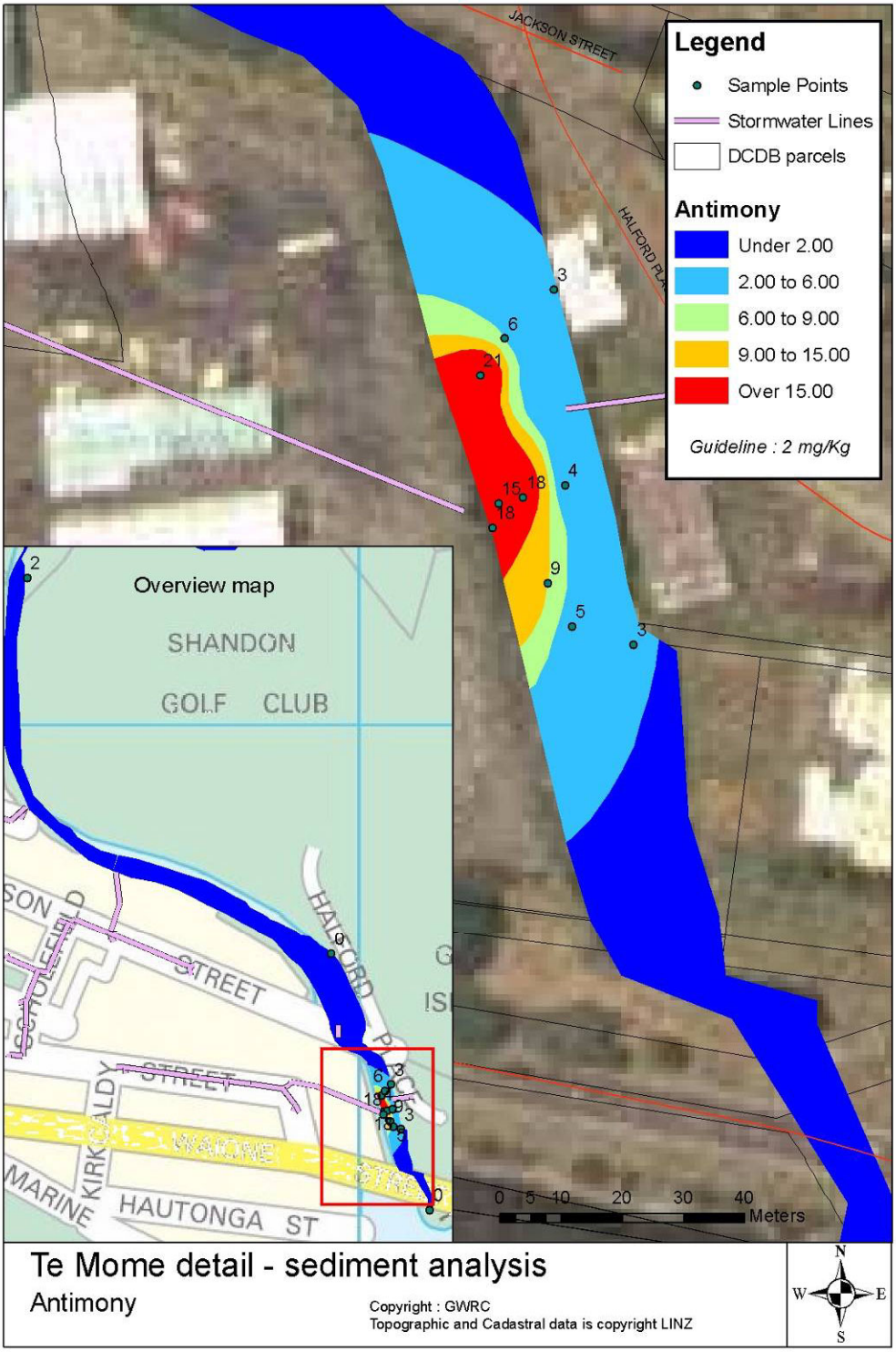
d) Antimony concentrations in Te Mome Stream water



Te Mome detail - sediment analysis

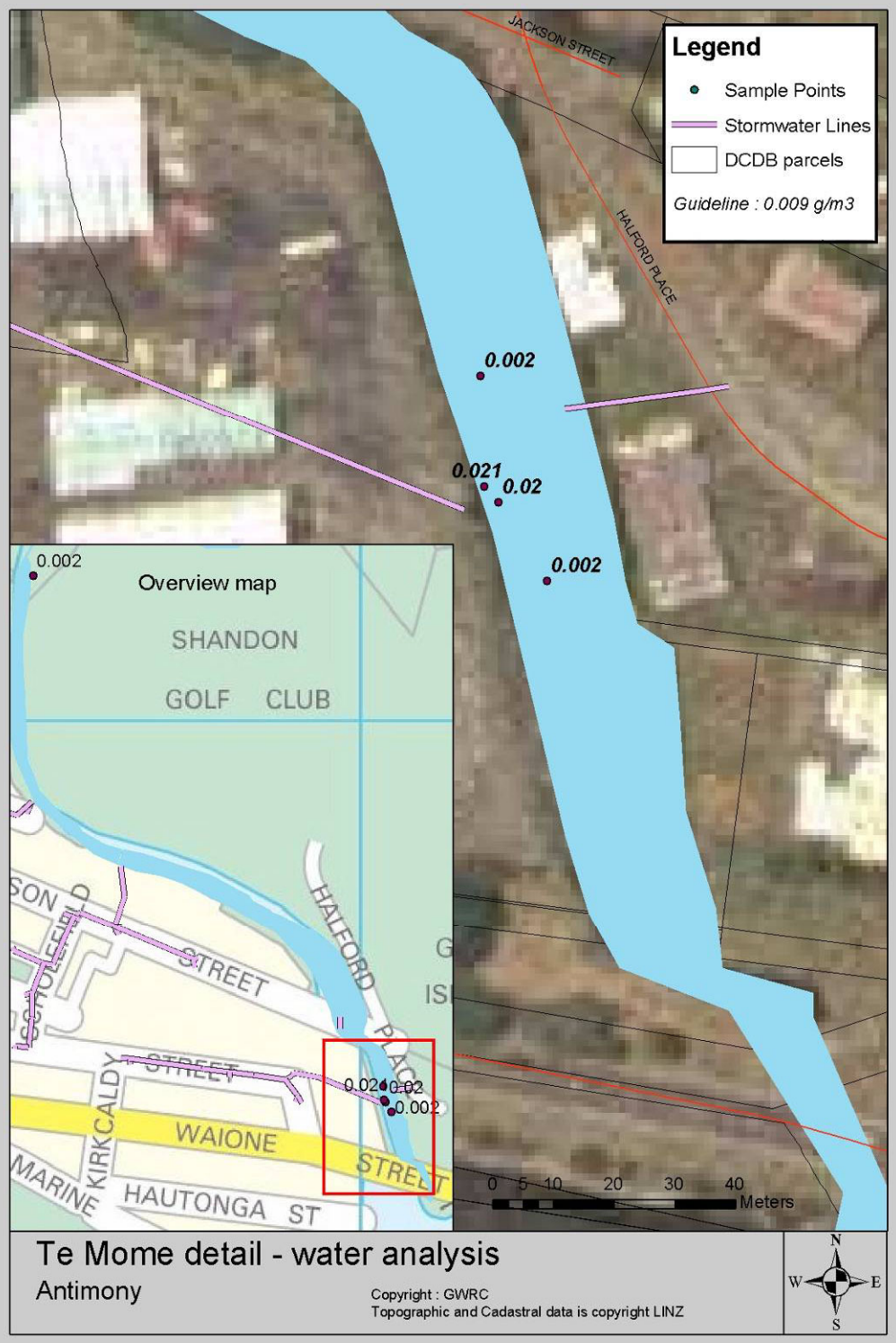
Lead


Legend
Sample Points
Stormwater Lines
DCDB parcels
Guideline : 0.0034 g/m3
JACKSON STREET
HALFORD PLACE
0.005
0.235
0.364
0.025
Overview map
SHANDON
GOLF CLUB
STREET
HALFORD PLACE
KIRKCALDY STREET
WAIONE STREET
MARINE
HAUTONGA ST
0 5 10 20 30 40
Meters
Te Mome detail - water analysis
Lead
Copyright : GWRC
Topographic and Cadastral data is copyright LINZ
N
W
E
S



Te Mome detail - sediment analysis

Antimony


Legend
Sample Points
Stormwater Lines
DCDB parcels
Guideline : 0.009 g/m3
JACKSON STREET
HALFORD PLACE
0.002
0.021
0.02
0.002
Overview map
SHANDON
GOLF CLUB
HALFORD PLACE
STREET
KIRKCALDY STREET
WAIONE STREET
MARINE
HAUTONGA ST
0.021
0.02
0.002
0 5 10 20 30 40
Meters
N
W
E
S
Te Mome detail - water analysis
Antimony
Copyright : GWRC
Topographic and Cadastral data is copyright LINZ