AHB Alliance

# Auckland Harbour Bridge Maintenance Discharge

## Assessment of Environmental Effects

NZ TRANSPORT AGENCY
WAKA KOTAHI

Auckland Harbour Bridge
Part of Auckland Motorways

# Quality Assurance

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Appendix F – Records of Iwi Consultation

## List of Acronyms

| | |
|---|---|
| ACDP:NS | Auckland Council District Plan: Operative North Shore Section |
| ACDP:I | Auckland Council District Plan: Operative Isthmus Section |
| AHB | Auckland Harbour Bridge |
| AHBA | Auckland Harbour Bridge Alliance |
| AMF | Adaptive Management Framework |
| ANZECC | Australia and New Zealand Guidelines for Fresh and Marine Water Quality 2000 |
| ARP:ALW | Auckland Regional Plan: Air, Land, and Water |
| ARP:C | Auckland Regional Plan: Coastal |
| CWH | Central Waitemata Harbour |
| CPA | Coastal Protection Areas |
| DoC | Department of Conservation |
| EMP | Environmental Management Plan |
| HGMPA | Hauraki Gulf Marine Park Act 2000 |
| LTMA | Land Transport Management Act (2003) |
| NES:AQ | National Environmental Standard: Air Quality (2004) |
| NZCPS | New Zealand Coastal Policy Statement (2010) |
| PAUP | Proposed Auckland Unitary Plan (2013) |
| RMA | Resource Management Act 1991 |
| RPS | Auckland Regional Policy Statement (1999) |
| SEA:M | Significant Ecological Areas – Marine |

# 1 Introduction

## 1.1 Purpose of the Application

The current consents regulating Auckland Harbour Bridge (AHB) maintenance discharges are prescriptive and inflexible. These consents require a containment structure to capture discharges from maintenance activities and the consents also limit the type of paints that can be used. They require 85% capture of the dry discharge resulting from maintenance activities (or 15% of discharges to occur), recognising that 100% capture of discharges is not possible or practicable. 100% containment of washwater discharges however is required.

This proposal seeks to maintain the current consented discharge levels and environmental outcomes, while improving flexibility of maintenance activities and enabling the potential reduction of discharge levels over the sought 25 year consent duration. The discharge amounts currently authorised form the basis of calculating thresholds for each key contaminant that is likely to cause adverse environmental effects. These are proposed as key contaminant thresholds that cannot be exceeded in an annual period (or the relevant averaging period for air quality thresholds).

This application proposes an Adaptive Management Framework (AMF) that provides flexibility to the maintenance operations, methodologies and the types of products that can be used for the maintenance of the AHB, on the basis that the annual discharge thresholds are not exceeded. This approach will enable maintenance behaviour to reduce the annual discharges further below the thresholds.

## 1.2 Project Context

The AHB is the most strategically important bridge in New Zealand, providing the primary transportation link between Northland and the Auckland Isthmus. The bridge also serves as a conduit for regional water supply, electricity transmission, natural gas, and telecommunications networks. As such, the bridge forms a vital link that enables the sustainability of the Regional and National economy.

As the AHB is part of the State Highway network, the New Zealand Transport Agency (NZ Transport Agency) has a statutory responsibility under the Land Transport Management Act 2003 (LTMA) to manage and operate the AHB so that it is maintained to operate in a safe and structurally sound condition. To undertake this responsibility, the Auckland Harbour Bridge Alliance (AHBA) was formed, comprising NZ Transport Agency staff and various contractors, to plan and undertake maintenance works.

The AHB is a predominately steel structure in an exposed location spanning the Waitemata Harbour, and is vulnerable to continuous exposure to environmental elements. Its approximately 125,000m$^2$ of surface area is exposed to wind, UV radiation, and corrosion from rainwater and coastal salt spray. Constant maintenance of the bridge is required to maintain its safe and efficient operation, its structural integrity, and its aesthetic value as an iconic structure and New Zealand landmark.

Maintenance has typically been undertaken at a rate of approximately 10% of its surface area annually.

Daily maintenance activities on the bridge typically involve surface preparation and repairs, including water blasting, wet/dry abrasive blasting, application of coatings (primers, rust inhibitors, and paints), and minor strengthening works. Bridge maintenance activities have historically resulted in discharges of contaminants to air, land, and coastal water; such activities were consented in accordance with the Resource Management Act 1991 (RMA) first in 2001 and again in 2011.

## 1.3 Existing Consents

The current resource consents 38519, 38835, and 38836 granted in 2011 authorise three types of discharges:

- 38519: Discharge of contaminants into air;
- 38835: Discharge (other) of washwater, wastewater, and dry wastes to land; and
- 38836: Discharge of contaminants to the Coastal Marine Area.

These activities are regulated by consent conditions stipulating the progressive phasing of containment to 85% of dry discharges, and 100% of wastewater discharges to air, water and land by 2021. This applied to the majority (approximately 96%) of the bridge surface areas but excluded the lower overarch which was excluded from containment due to restricted access. The basis for full containment as a method was driven largely by international best practice.

Since the granting of these resource consents, the NZ Transport Agency has further investigated the possibilities of compliance with ‘full containment’ and has subsequently determined that this is not the Best Practicable Option. This is discussed further in 2.0 below.

The consented mass or concentrations for each key containment discharge authorised by the 15% threshold is quantified in the supporting technical reports, and set out in Section 3.5.1 of the AEE in the key contaminants table (Table 3.1). This discharge threshold and the level of effect generated by these discharges constitute part of the existing environment that is authorised by these existing consents 38519, 38835, and 38836.

Additional adverse effects of the proposal are therefore limited to effects that may arise as a result of undertaking this consented level of discharge without a containment structure in place.

## 1.4 Summary of Resource Consents Required

This AEE supports an application for resource consents to authorise the same or improved level of discharge effects resulting from bridge maintenance as authorised under the prescriptive ‘containment’ consents. However, it seeks to remove the prescriptive requirement to achieve this outcome via a physical containment structure. This same level of effect can be achieved by remaining within set discharge thresholds for key contaminants.

The application proposes that these thresholds can be measured and achieved via the proposed AMF (Appendix A), Environmental Management Plan (EMP) and draft conditions (section 9 below).

Resource consents are being sought for the following activities under section 15 of the Resource Management Act 1991:

- Discharge of contaminants to the Coastal Marine Area; and
- Discharge of contaminants into Air;

## 1.5 Outline of this Report

This AEE has been prepared in accordance with the RMA, particularly the matters set out in the Fourth Schedule. The AEE sets out:

- A consideration of alternatives to the proposal;
- A description of the existing receiving environment;
- Reasons for this consent application;
- The proposed adaptive management framework (AMF);
- An assessment of the actual and potential effects of the proposal;
- The statutory framework within which this application has been prepared;
- An assessment of the proposal against the relevant matters of the RMA;
- Proposed conditions; and
- Discussion on consultation undertaken to date.

## 1.6 Structure of Technical Reports

The technical reports appended to this AEE have been prepared to provide an understanding of the level of effects from each of the three types of discharges that result from bridge maintenance activities (marine, land, and air). These reports have been structured to set out the existing environment which includes the level of discharge permitted under the existing consent and to assess the level of effects generated by those discharges. These levels are set as annual thresholds for key contaminant discharges.

The reports describe the AMF and how this framework enables annual discharges to remain within or below the key contaminant discharge thresholds and / or identifies further mitigation necessary to meet the thresholds. The technical reports include a case study regarding a trialled product called 'Termarust'. The case studies were undertaken iteratively in conjunction with the development of the AMF. The purpose of the case studies is to show how the adaptive processes within the AMF will work in practice.

Outputs of the case studies include the technical sheets that are attached to the AMF (Appendix A). These sheets set out the methodology and processes that will be followed to understand and determine whether the level of effects of a new product or method will be within the effects envelope of the granted consent, and whether discharges as a result of the new method/product can be maintained within the proposed key contaminant discharge thresholds.

# 2 Consideration of Alternatives

Current consents 38519, 38835, and 38836 granted in 2011 require containment as the prescribed method to achieve environmental outcomes associated with maintenance discharges from the AHB. International best practice examples, such as maintenance on the Sydney Harbour Bridge, heavily informed the original decision to implement containment on the AHB.

Since the granting of the above consents, the Transport Agency has undertaken feasibility investigations and recently completed a Containment Feasibility Summary Report (August 2014) to investigate the actions necessary to move containment from a concept for resource consenting purposes to a physical structure for maintenance and operational purposes. These investigations conclude a number of difficulties with the practical implementation of containment on a structure of the scale and form of the AHB and in particular in the exposed location. The feasibility report concludes that a capital cost of $66 million would be required to establish a containment structure.

Full containment is often implemented in order to avoid the discharge of lead into coastal environments from large-scale works. In these instances, the risks and likelihood of lead contaminants discharging are relatively high due to discharge masses and receiving environments. The potential discharge of lead from the AHB is especially limited in mass due to its presence only on Span 7 (refer Figure 3.1 below).

Additionally, new painting methods and products are available which reduce the need for abrasive blasting, effectively avoiding discharge of lead without any further mitigation. Targeted repainting and spot repairs have also become a more standard method of maintenance, reducing both the potential discharge mass and the efficiency of a full containment system.

The project team for this consenting process has considered reasonable alternatives to containment to inform the consent application and satisfy RMA requirements to consider alternatives for discharges that contravene section 15 of the RMA. Section 105 of the RMA states that:

> 1) *If an application is for a discharge permit or coastal permit to do something that would contravene section 15 or section 15B, the consent authority must, in addition to the matters in section 104(1), have regard to—*
>
> *(c) any possible alternative methods of discharge, including discharge into any other receiving environment.*

Section 107 of the RMA provides further guidance on maintenance discharge applications:

> 2) *A consent authority may grant a discharge permit or a coastal permit to do something that would otherwise contravene section 15 or section 15A that may allow any of the effects described in subsection (1) if it is satisfied—*
>
> *(c) that the discharge is associated with necessary maintenance work—*

*and that it is consistent with the purpose of this Act to do so.*

The project team have considered three broad alternatives in preparing this consent application for discharges under section 15 of the RMA:

- Option 1 – Relax the discharge restrictions;
- Option 2 – Containment; and
- Option 3 – Adaptive Management Framework.

These options are discussed below:

**Option 1 (Relax discharge restrictions):**

This option involves a relaxation of the consents to enable continued discharges at historic rates or at a lesser degree of restriction allowing greater discharges of contaminants. This option was discounted at the outset, as the Transport Agency is committed to environmental best practice and improving environmental outcomes.

**Option 2 (Containment):**

This option involves pursuing a containment structure and any associated consents.

The feasibility report identified a range of constraints in implementing a discharge containment system, providing strong indications that physical containment is not the best practicable option for numerous activities and areas on the AHB.

The main constraint is the insufficient structural capacity of the truss bridge, in some areas, to support the gravity and wind loads of a containment system. The issue of sufficient clearance under the bridge for water traffic would need to be addressed. Furthermore, while not considered in detail, occupation consents would be required for the containment structure and the visual effects of such a structure would likely be contentious and potentially difficult to consent.

The feasibility report also determined indicative costs of implementing the containment system. The AHB was originally designed for a 4-lane road deck, and has been subsequently upgraded to include two additional lanes on each side and cables for telecommunications and power – the former requiring strengthening of the bridge structure.

The installation and infrastructure required to undertake containment was estimated at $66 million over ten years including strengthening. This compares to a current annual coatings budget of less than $1 Million.

**Option 3 (AMF):**

This option involves formalising the level of discharge authorised by the containment consents into thresholds and then managing the maintenance activities so those thresholds are not exceeded.

This approach considers the use of contaminant thresholds and an AMF to enable the application of Best Practicable Options for mitigating contaminant discharges. This envisages an adaptive process that can annually operate within existing consented discharge levels and incorporate emerging methods and products, potentially with lesser environmental risks and improved operational efficiency.

This provides flexibility, which the existing consent does not provide for due to its prescriptive nature, and recognises that there are a range of maintenance methods and products which generate different effects and will be more appropriate in certain locations and situations than in others. These methods and products are discussed further in Section 5: The Adaptive Management Framework (AMF) and Section 6: Assessment of Environmental Effects (AEE) of this report. The principle of this approach is that the outcomes will be no worse, potentially better, and more practicable. This drives improvement in practice rather than just enforcing controls on methods.

## 2.1 Summary of Considerations

In summary, the NZ Transport Agency considered Option 2 and Option 3 as potential methods for environmental management for bridge maintenance. Option 1, which would seek to relax the discharge consent restrictions, was considered to be contrary to the environmental principles of the Transport Agency. As such, it was discounted without further analysis.

The concept of Option 2 (Containment) was considered to be the preferred option during the development of the existing consent applications. Through the analysis in the feasibility studies, it was shown that while this option was not infeasible, it was highly impracticable due to the physical design, operation, and maintenance that the containment structures would require. It would be very complex, costly, and would require significant structural strengthening. Potentially it could create adverse visual effects.

Option 3 (AMF) was selected as the preferred option and is being pursued as the best practicable option (BPO) for the reasons set out above, particularly when compared to option 2 and the cost implication of this option. Option 3 enables the Transport Agency to achieve the same environmental outcomes as option 2 using a range of mitigation and control methods in a far more cost effective way. This option also drives improvements in operational behaviour rather than relying on a prescriptive method (containment).

# 3 Existing Environment

## 3.1 Bridge Description

The AHB spans the Waitemata Harbour between Stokes Point (northern abutment) and Point Erin (southern abutment). The bridge carries an annual average of approximately 160,000 vehicles per day, and is the primary transport link between Auckland and Northland, providing a vital route for both commuter traffic and freight. In addition to its economic significance, it is an iconic structure in the Auckland skyline.

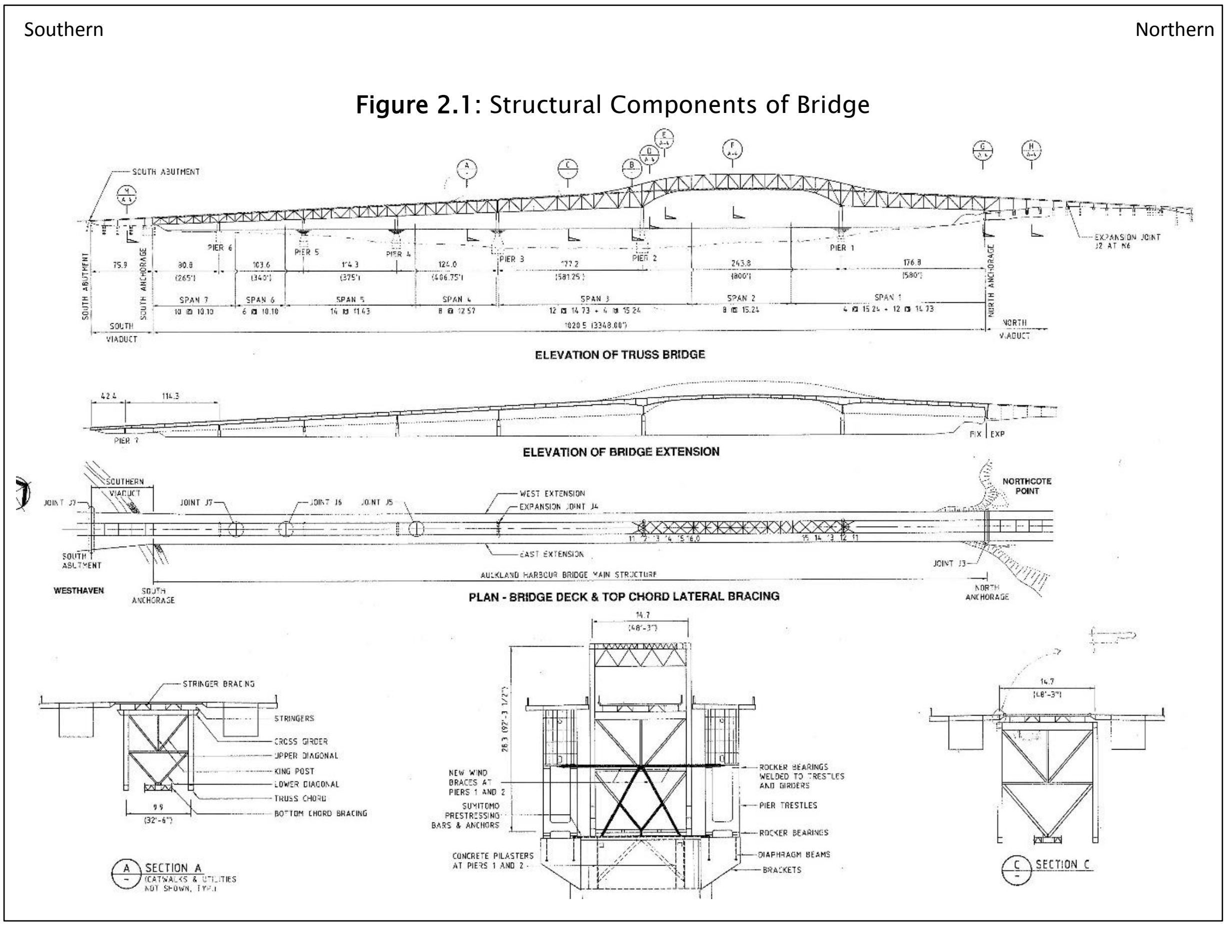



**Figure 3.1. Outline of the Auckland Harbour Bridge, showing the abutments and piers.**

## 3.2 Receiving Coastal Marine Environments

The AHB spans approximately 1km of the Waitemata Harbour, which is the primary receiving water environment for discharges from the AHB. As described in the Marine Ecology Assessment (MEA) in Appendix B, the Waitemata Harbour is located on the east coast of the Auckland Isthmus in the Hauraki Gulf and is described as a drowned river valley, extending from Riverhead in the north-west to the Tamaki River in the east. It is the largest estuary on the east coast of the Auckland Region at $80km^2$.

The AHB and its surrounding environment are located within the Central Waitemata Harbour (CWH), which extends from the harbour mouth to Catalina Bay, Hobsonville. The waters beneath the bridge are subject to marine traffic from a range of users, including anglers, recreational craft, event participants, and ferry services.

In addition to the waters directly beneath the bridge, the CWH contains a number of smaller embayments and landforms. Little Shoal Bay, Shoal Bay/Ngataringa Bay, Te Tokaroa/Meola Reef, and Westhaven Marina are subject to tidal influence from waters within the harbour.

### 3.2.1 Planning Maps

The Coastal Marine Area is regulated through the Auckland Regional Plan: Coastal (ARP:C) and the Proposed Auckland Unitary Plan (PAUP). Figures 3.2 and 3.3 show the zone/overlay areas under the PAUP and the ARP:C. A description of each is provided below.

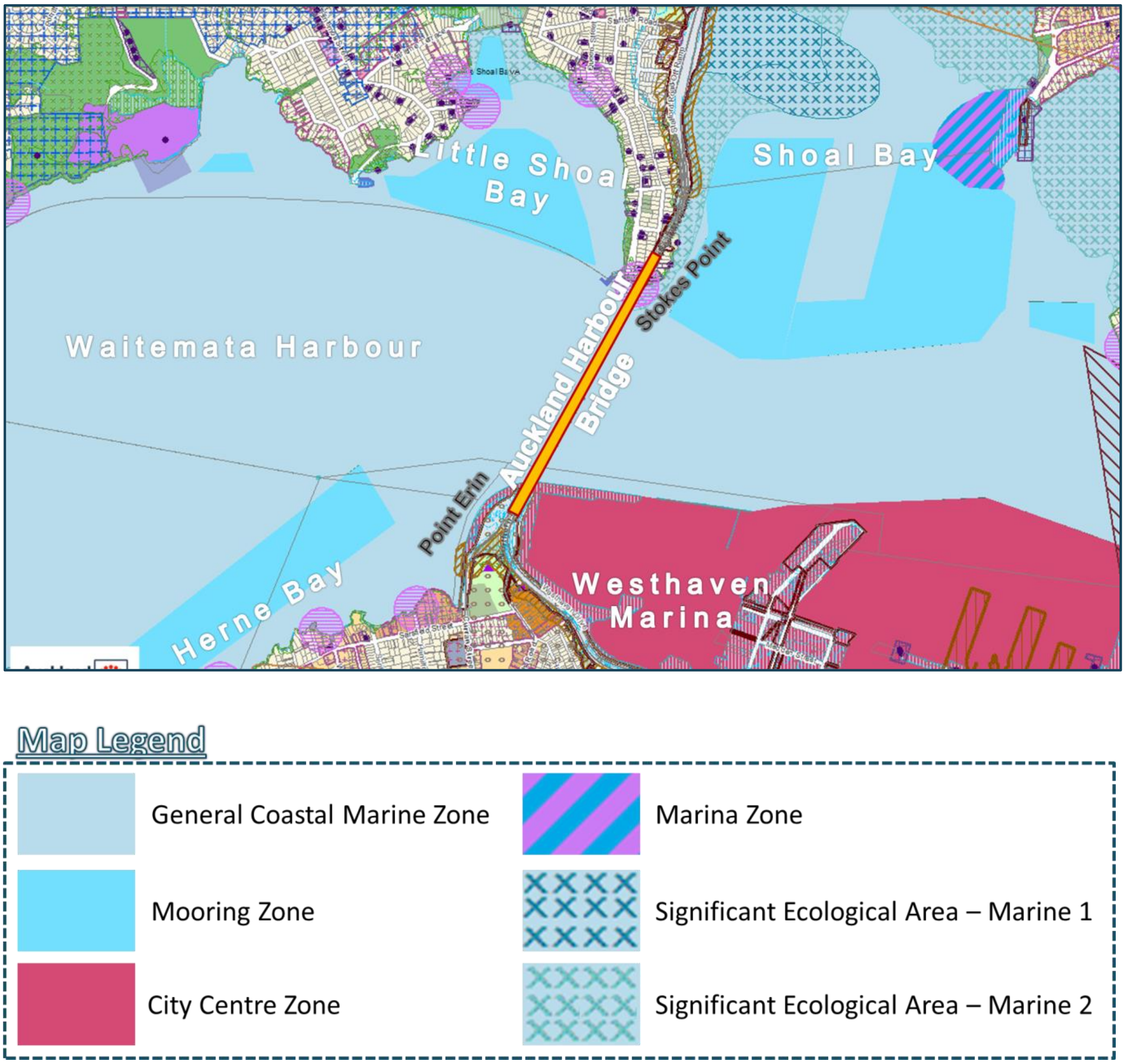



**Figure 3.2. Excerpt from Auckland Unitary Plan GIS Viewer of the Auckland Harbour Bridge and surrounding environment.**

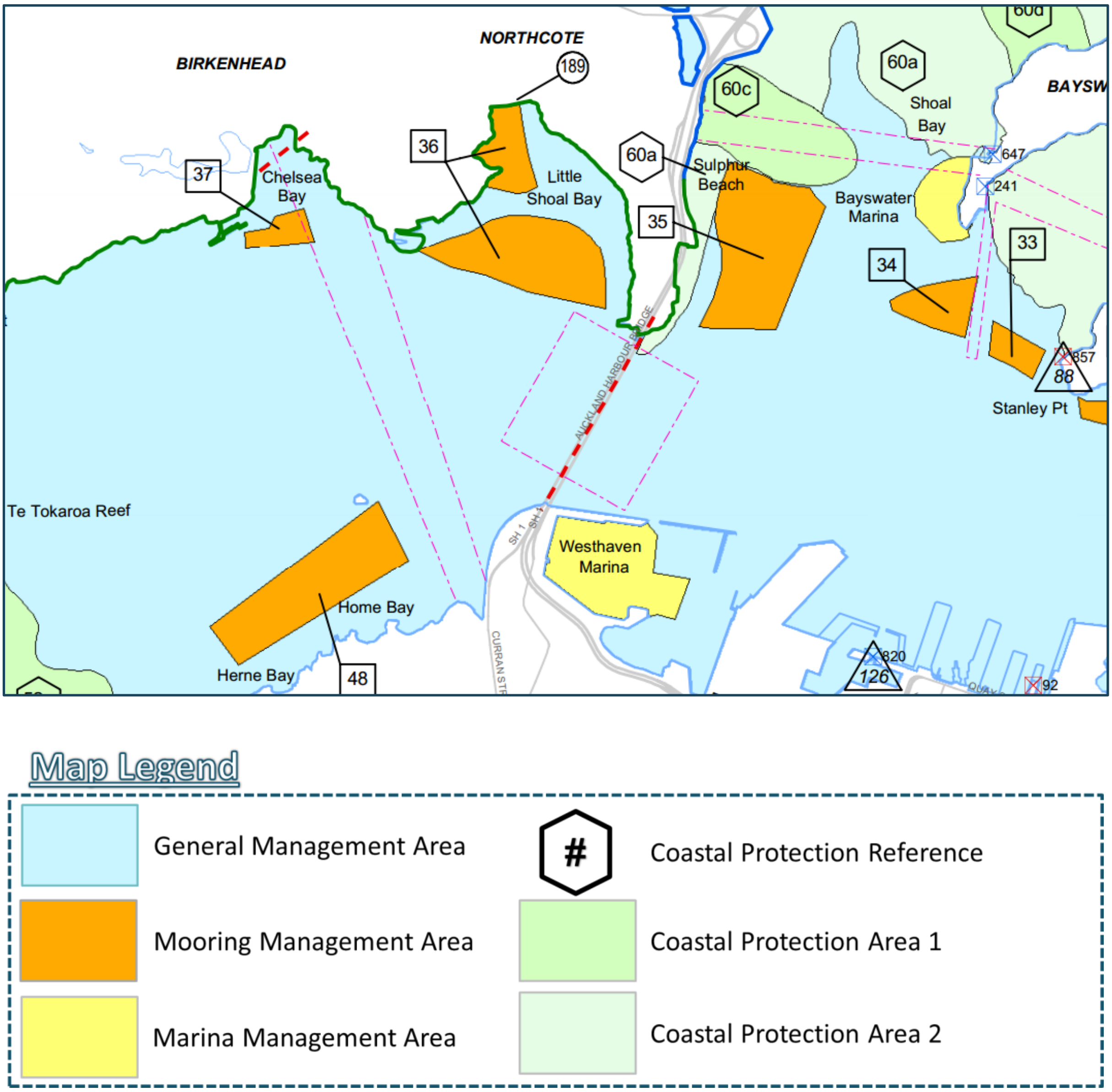



**Figure 3.3. Excerpt from ARP:C Map 29, Series 1.**

### 3.2.2 Primary Coastal Marine Receiving Environments

The MEA has identified the two primary coastal marine receiving environments as the benthic environments in the CWH directly beneath the AHB and that of Shoal Bay/Ngataringa Bay.

#### *3.2.2.1 Central Waitemata Harbour*

The harbour in the vicinity of the bridge is constricted due to the two natural headlands of Point Erin and Stokes Point. The harbour in this location has a channel that is (at its deepest) approximately 26m in depth. The MEA notes that its benthic habitat is likely to comprise relatively coarse grained sediment, low to moderate species diversity, and likely contains both sensitive and tolerant exotic and indigenous species.

Stormwater catchments that empty to the CWH are laden with sediment, polycyclic aromatic hydrocarbons, and heavy metals from land uses and the transport network. The MEA notes that the total annual discharge of zinc to the CWH was estimated to be 18,600 kg.

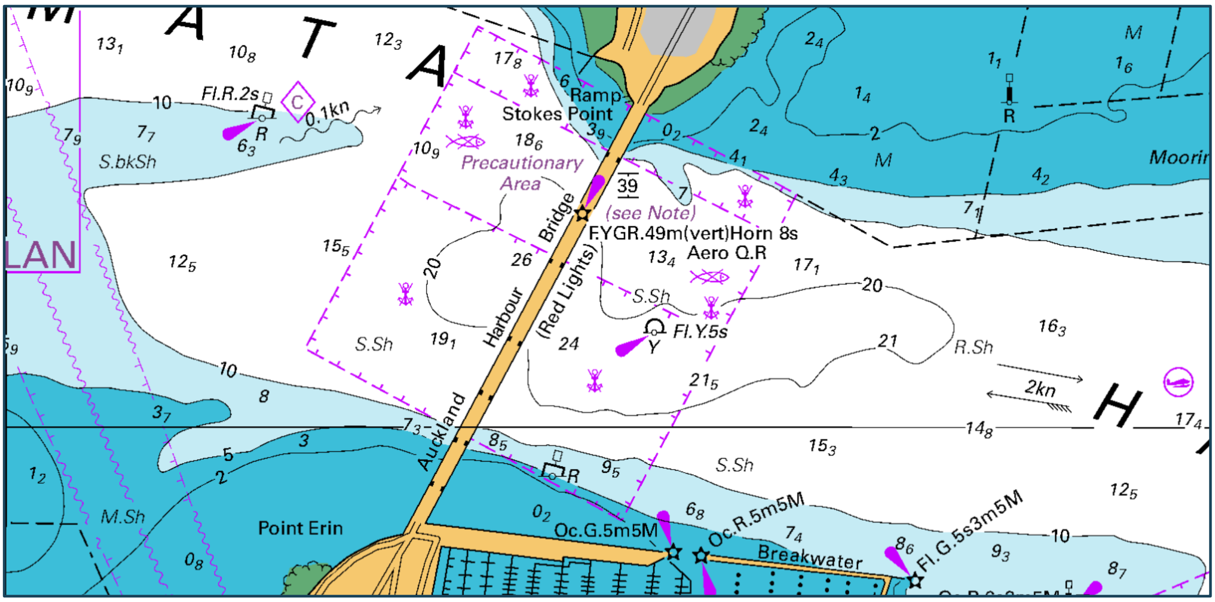



Figure 3.4. Excerpt of the Nautical chart of the Central Waitemata Harbour, showing bed depths.

### *3.2.2.2 Shoal Bay and Ngataringa Bay*

Shoal Bay and Ngataringa Bay are located on the eastern shore of Stokes Point (see Figure 3.5 overleaf). The combined area is approximately 6,465,000 $m^2$ and is mainly surrounded by residential and transportation land uses. The Northern Motorway stretches from the northern abutment of the AHB for approximately 3km along Shoal Bay, and Esmonde Road for another 1km.

The majority of the embayment area is scheduled as Coastal Protection Areas (CPA) under the ARP:C and Significant Ecological Areas – Marine (SEA:M) under the PAUP (refer Figures 3.2 and 3.3 above for the locations and status). These areas are considered under these plans to be significant areas for wading birds. The PAUP also identifies areas within the northern portion of the bay as Outstanding Natural Features.

The MEA notes that the bays are largely intertidal and comprise estuarine muds, sandflats, and sand/shell banks. The CPAs/SEAs are concentrated around the extensive areas of mangrove and saltmarsh vegetation, which provide habitat and feeding areas for coastal birds.

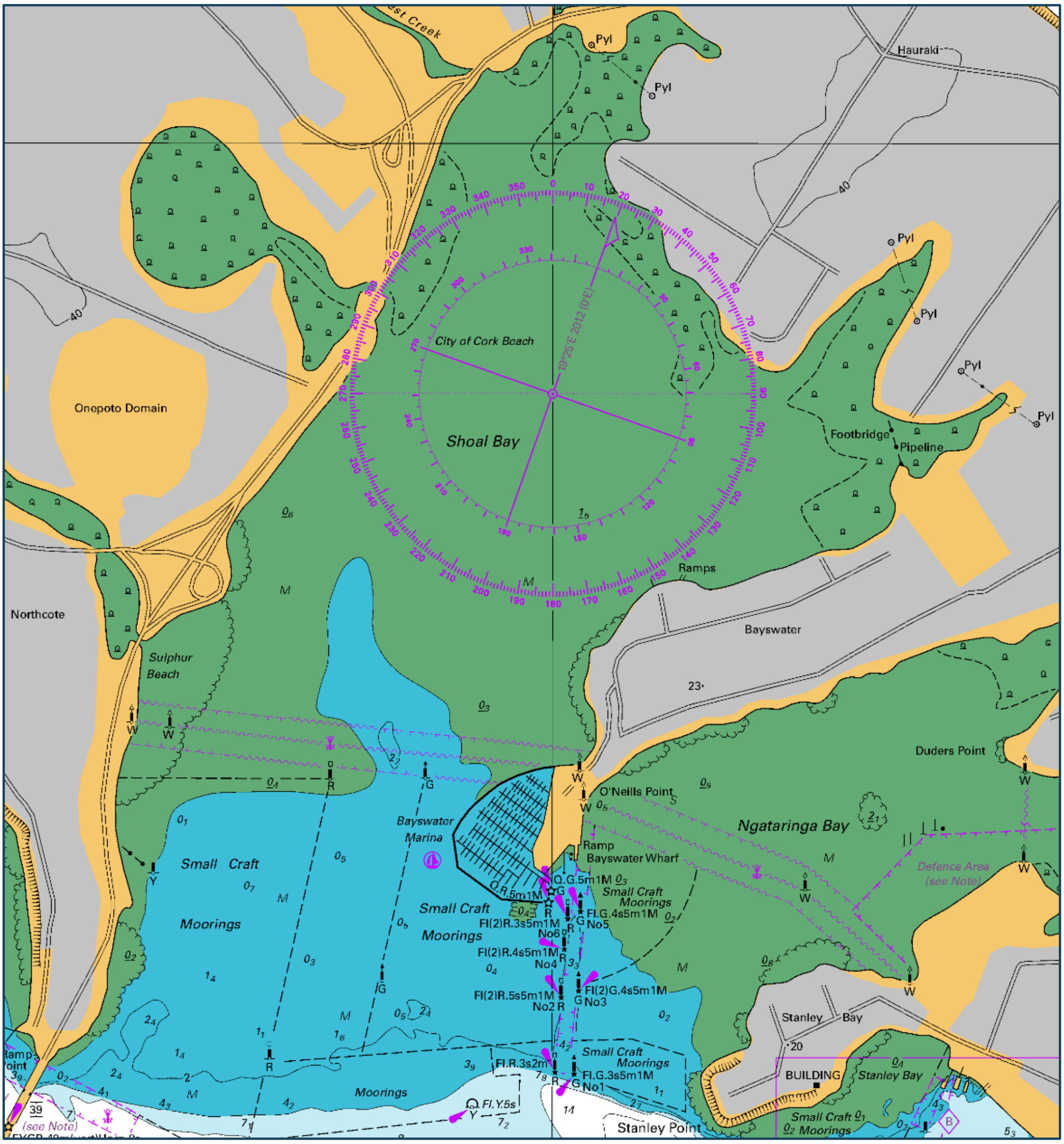



Figure 3.5. Excerpt of the nautical chart for Shoal Bay and Ngataringa Bay, showing bed depths.

### 3.2.3 Secondary Coastal Marine Receiving Environments

The coastal marine environments of Little Shoal Bay and Westhaven Marina are adjacent to the AHB, but are not considered to be primary receivers of environmental effects resulting from the works. Sediment and contaminant accumulation primarily occurs within the CWH and Shoal Bay/Ngataringa Bay, with the Hauraki Gulf as the ultimate receiving environment.

## 3.3 Receiving Land Environments

### 3.3.1 Stokes Point

The northern abutment of the AHB is located at Stokes Point, a peninsula between Little Shoal Bay and Shoal Bay primarily used for residential purposes. The steel structure of the AHB extends over Princes Street, directly adjacent to a number of residences. The southernmost extent of Stokes Point is a reserve with cultural and landscape values, as discussed below.

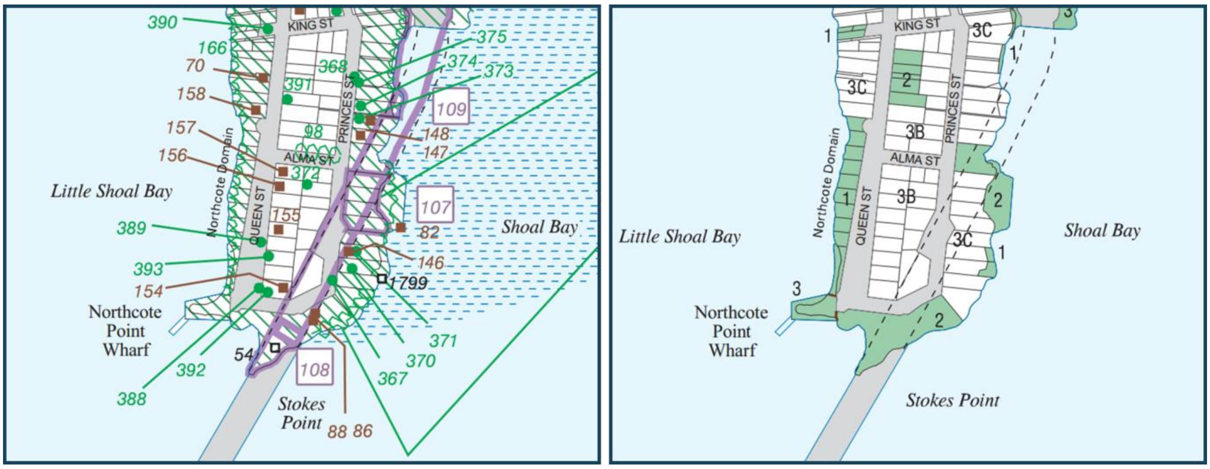



**Figure 3.6. Excerpts from ACDP:NS Maps 30.**

#### *3.3.1.1 Social Uses*

The land use zones in the vicinity of the bridge include the Stokes Point/Northcote Reserve, which is a ‘Recreation 2’ Zone under the Auckland Council District Plan: Operative North Shore Section (ACDP:NS) and a ‘Public Open Space – Informal Recreation Zone’ under the PAUP. A small beach area is located on the western shore of the reserve.

There are a number of residences on Queen, Alma and Princes Streets that are directly adjacent to or in close proximity to the AHB at the northern abutment. ‘The Wharf’ function and conference facility is located approximately 70m to the west of the northern abutment.

#### *3.3.1.2 Culture and Heritage*

Stokes Point is identified as a pa site, and there is known archaeological evidence within Stokes Point/Northcote Reserve. This is identified in the ACDP:NS (Archaeological Site #54) and in the PAUP as a Site/Place of Value to Mana Whenua (ID 1515).

In addition to the cultural values in Stokes Point, this area was developed pre-1940 for residential use. Many of the houses on the peninsula remain in their original form, and some are scheduled historical buildings under the ACDP:NS and PAUP.

#### *3.3.1.3 Landscape and Vegetation*

The coastline along Stokes Point is a ‘Regionally Significant Coastal Landscape’ under the ARP:C, with native tree and shrub vegetation that is classified as a ‘Significant Ecological Area’ under the PAUP. Ten scheduled groups of notable trees are also within the immediate vicinity of the AHB.

### 3.3.2 Point Erin

The southern abutment of the AHB is located at Point Erin, a peninsula between the Westhaven Marina and the Waitemata Harbour. The steel structure of the AHB extends over a small portion of the Point Erin reclamation, adjacent to the Ponsonby Cruising Club. Curran Street runs beneath the bridge at this point.

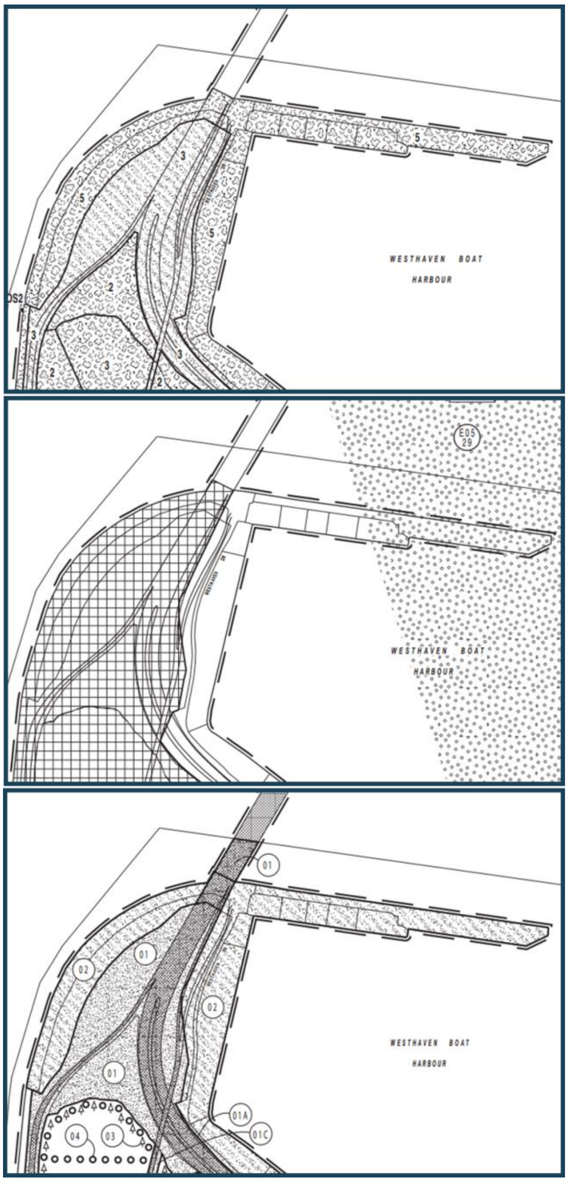



**Figure 3.7. Excerpts from ACDP:I Maps A07.**

#### *3.3.2.1 Social Uses*

Land uses within the vicinity of the southern abutment include Open Space (OS) 2, 3, and 5 Zones under the ACDP:I and City Centre and Public Open Space Zones under the PAUP. Immediately to the east of the southern abutment are activities associated with the Westhaven Marina, including boat clubs, a café, and offices utilised by marine industry businesses. The Point Erin Pools are located some 300m to the south. The seawall along the road is a popular spot for recreational anglers. The site office and access to the 'Auckland Bridge Climb and AJ Hackett Bungy' is also located here. The Auckland Bridge Bungy operates from beneath the road deck and the Bridge Climb traverses the entire structure.

#### *3.3.2.2 Culture and Heritage*

Point Erin has been significantly modified as part of the historical reclamations that occurred in part to construct the AHB and Westhaven Marina. There are no identified cultural or historic heritage items identified within the immediate vicinity of the AHB's southern abutment.

#### *3.3.2.3 Landscape and Vegetation*

Point Erin's coastline is heavily modified, with Curran Street and Westhaven Drive running its length, bordered by a rock and concrete seawall. The only vegetation located within the vicinity of the southern abutment consists of screening vegetation directly adjacent to the AHB. There are no scheduled notable trees.

## 3.4 Receiving Air Environment

The receiving air environment is a mixture of urban and coastal air quality management areas, as defined under the Auckland Regional Plan: Air, Land and Water (ARP:ALW) and the PAUP. These areas are primarily impacted by vehicle emissions and the surrounding urban activities. Potential receivers also include land users, as described in Section 3.3 above.

The AHB is subject to prevailing south-westerly winds.

## 3.5 Existing Consented Activities

The existing environment includes the discharges from maintenance activities on the AHB (in accordance with an Environmental Management Plan) authorised by consents 38519, 38835, and 38836. The consents require progressive staging (over three stages) toward full containment as the prescribed method for managing maintenance discharge effects on the receiving environment. These stages are defined in the consents as:

a) *Pre-Containment Phase: Year 0 to 3, 30 August 2011 to 30 August 2014. 'Pre-Containment' means the maintenance works that will be carried out prior to the deployment of the proposed containment systems (including any structures);*

b) *Partial Containment Phase: Year 3 to Year 10, Partial Containment to be in place by 30 August 2014. 'Partial Containment' shall be considered to be a method which controls and collects:*

- *85% of the mass of all dry discharges and spray paint generated during maintenance works; and*
- *100% of the mass of washwater used for treatment before discharge other than in Zone B, the 'Lower Overarch' (as specified on 'Figure 1 – Proposed Zones for Encapsulation') which has 100% discharge of all contaminants;*

*and shall be deployed in the areas north of Pier 1 and south of Pier 5;*

c) *Full Containment Phase: Year 10+, Full Containment to be in place by 30 August 2021. 'Full Containment' shall be considered to be a method which controls and collects:*

- *85% of the mass of all dry discharges and spray paint generated during maintenance works; and*
- *100% of the mass of washwater used for treatment before discharge other than in Zone B, the 'Lower Overarch' (as specified on 'Figure 1 – Proposed Zones for Encapsulation') which has 100% discharge of all contaminants;*

*and shall be deployed in the area defined as 'partial containment' and the area between Pier 1 and Pier 5 (over the CMA).*

### 3.5.1 Key Contaminants

The key contaminants discharged from AHB maintenance activities arise from overspray of applied surface coatings, abrasive agents, historical coatings, and washwater. Under the existing consents, during pre-containment, the mass of contaminants discharged annually to the environment as a result of the maintenance activities totals approximately 95.5 tonnes[1]. This is mostly comprised of abrasive agent garnet sand (approximately 92 tonnes), but also includes zinc and other 'paint' contaminants (approximately 3.5 tonnes).

Under 'full-containment', 85% of particulate mass discharges are required to be contained (except for the lower overarch), and up to 15% of the 'pre-containment' mass is authorised to discharge to the air, land, and CMA under permits 38519, 38835, and 38836.

Therefore the existing consents allow a certain threshold of contaminant discharges and associated effects on the receiving environment. The level of discharge provided for by these existing consents has been calculated based on the assumed total uncontained discharges from maintenance activities which informed the applications for the existing consents. These levels are the recommended thresholds for discharges identified in Table 3.1 below. Additional air thresholds have been determined using international and New Zealand guidelines and standards.

The application, assessments and the officer's recommendation that informed the decision to grant the existing consents concluded that across all stages of the consent (pre, partial and full containment) there were less than minor adverse effects on the receiving environment and that there were no adversely affected parties. This same outcome can be achieved through this proposal by setting and not exceeding the thresholds in Table 3.1 below.

**Table 3.1. Key contaminants discharged as a result of AHB maintenance activities.**

| Contaminant | Source | Reasons for Inclusion | Recommended Thresholds / Guidelines |
|---|---|---|---|
| $PM_{10}$ / Total Suspended Particulates | Released during dry abrasive blasting. | PM10 is a contaminant of concern for Auckland Council and regulated through the NES:AQ. | PM10 total: 31 kg/annum (2011 consent baseline for abrasive blasting)<br>PM10 (acute - 24hr): 50µg/m$^3$ (MfE)<br>TSP (acute - 24hr): 80µg/m$^3$ (MfE) |
| Garnet Sand / Dust | Released during dry abrasive blasting. | Non-toxic, but used in large volumes during AHB surface preparation. | Coastal: 14,679 kg/annum (2011 consent baseline) |
| Zinc | Present in bridge coatings. Released as particulate during dry abrasive blasting or as spray paint overspray (primer and mid-coat). | Contaminant of concern for Auckland Council and the Waitemata Harbour. | Air (acute 1hr): 20µg/m$^3$ (TCEQ ESL)<br>Coastal: 223 kg/annum (2011 consent baseline) |
| Lead | Historic coating layers (Span 7). Released as | Only present in small quantities but known to | Air (acute 0.5hr): 1.5µg/m$^3$ (Ontario Ministry for the Environment) |

[1] Based on calculations used for the existing consents to determine the historic discharge volumes based on repainting 10% of the bridge per year.

| Contaminant | Source | Reasons for Inclusion | Recommended Thresholds / Guidelines |
|---|---|---|---|
| | particulate during dry abrasive blasting. | be toxic to humans. Air quality sampling has indicated lead is present during dry abrasive blasting. | |
| Chromium | Historic coating layers across bridge. Released as particulate during dry abrasive blasting. | Only present in small quantities but known to be toxic to humans. Air quality sampling has indicated chromium is present during dry abrasive blasting. | Air (acute 1hr): 3.6µg/m$^3$ (TCEQ ESL) |
| Iron | Present in bridge coatings. Released as particulate during dry abrasive blasting or as spray paint overspray (top coat). | Air quality sampling has indicated iron is present during dry abrasive blasting. Included due to potential human health effects. | Air (acute 1hr): 50µg/m$^3$ (TCEQ ESL) |
| Volatile Organic Compounds (VOCs) | Released during spray painting. | VOCs are a contaminant of concern to Auckland Council. | Xylene: Air (odour 1hr): 350µg/m$^3$ (TCEQ ESL)<br>Toluene: Air (odour 1hr): 640µg/m$^3$ (TCEQ ESL)<br>Naptha: Air (odour 1hr): 3500µg/m$^3$ (TCEQ ESL)<br>Ethylbenzene; Air (odour 1hr): 740µg/m$^3$ (TCEQ ESL)<br>Methyl Isobutyl Ketone; Air (odour 1hr): 820µg/m$^3$ (TCEQ ESL) |
| Diisocyanates | Released during spray painting. | Contaminant of concern to Auckland Council. | Air (acute 1hr): 50µg/m$^3$ (TCEQ ESL) |
| Paint | Released as overspray during spray painting and as paint flakes during abrasive blasting. | Not a key contaminant, but used as a 'catch-all' for any constituents not considered as separate 'key contaminants'. | Coastal: 646kg/annum (2011 consent baseline) |

It is worth noting that air discharges are not calculated by a mass. This is because it is the concentration of air discharges that can result in an adverse effect on human health and nuisance (dust and odour). For this reason there are no concentrations referenced in the material supporting the existing consents from which to calculate a 15% discharge threshold in the same way that there is a mass discharge for particulates and paint.

The application and decision for the existing consents did however conclude that as a result of the containment method and consent conditions effect on the receiving environment would be less than minor and there would be no adversely affected parties. The above thresholds relevant to air discharges have been proposed to achieve the same or better outcomes.

## 3.6 Existing Environmental Effects

In assessing the effects of the proposal, it is necessary to establish the level of effects on the receiving environment that result from the discharges authorised by the existing consents. The assessment can then use the existing environment and current level of effects to understand the change in effects as a result of the proposal. This then informs methods to avoid, remedy and/or mitigate additional effects. Discharges to the coastal, land and air receiving environments under the existing consents have been assessed in the supporting technical reports (Appendix B, C, D and E) to enable an understanding of the effects of the maintenance discharges that are authorised by the current consents.

This section summarises the effects potentially or actually authorised to occur based on the assessments from the supporting technical reports.

### 3.6.1 Coastal Marine Ecology

The MEA undertaken by Boffa Miskell describes the primary potential effects of maintenance discharges from the AHB on the marine ecological values of the Waitemata Harbour as being the smothering of the benthic environment caused by the discharge of garnet sand, and toxicity of zinc to, and any bioaccumulation within, benthic organisms.

As part of the MEA, an ‘effects matrix’ was used to determine the magnitude of an effect based on the ecological or conservation values of the receiving environment, as well as the characteristics of the existing discharge. The two predominant receiving environments are the CWH and Shoal Bay/Ngataringa Bay. The CWH has been assessed as having moderate ecological and conservation value and Shoal Bay/Ngataringa Bay has been assessed has having moderate to high ecological and conservation value.

#### *3.6.1.1 Particulate*

Garnet sand is typically used as an abrasive agent used in dry abrasive blasting. Based on previous studies undertaken for the existing resource consent applications, the uncontained annual deposition of 62,500 kg of garnet sand to the CMA covered an area directly beneath the AHB of about 12,000m$^2$ at an average estimated depth of 2.5mm, and an additional adjacent area of 480,000m$^2$ at a depth of 0.2mm.

As the characteristics of the abrasive agent currently used has not changed, the MEA has estimated that allowable garnet sand discharges of 14,679kg during full containment will cover the 12,000m$^2$ area beneath the AHB at a depth of 0.6mm, and the 480,000m$^2$ area adjacent to the AHB at a depth of 0.09mm. Over time some sand will be redistributed within the benthic environment, resulting in the spreading of sand in thinner layers over a wider area.

The MEA notes that benthic marine invertebrate communities can be adversely affected by deposition to a depth of 3.0mm or greater. Given that the estimated depth of garnet deposition in the benthic habitats is predicted to be up to 0.6mm, and largely at depths closer to 0.09mm, it is concluded that the magnitude of the effect of the current consented discharge is negligible and the significance of effect of the current levels of discharge is very low.

#### *3.6.1.2 Zinc*

Auckland Council has identified zinc as a contaminant of concern for the Waitemata Harbour and its embayments.

Currently, an estimated total of 18,623 kg of zinc enters the CWH annually from all sources, based on Council’s stormwater discharge contaminant modelling. Maintenance of the AHB results in the discharge of zinc to the coastal marine environment, and the current consents (containment) authorise a residual discharge to the CWH of 224 kg per annum, or 1.2% of the modelled total annual zinc load to the CWH.

The MEA has assumed that the zinc currently discharged to the harbour from AHB maintenance is discharged equally to the northern and southern sections of the AHB.For discharges from the southern half of the bridge, modelling indicates that 95% of sediment and contaminants discharge to the wider Hauraki Gulf, and 1% discharges to Shoal Bay. For discharges from the northern half of the bridge, modelling indicates that 67% of sediment and contaminants discharge to the wider Hauraki Gulf, and 24% are retained within Shoal Bay. In total, this roughly equates to annual zinc discharges of 181.4 kg to the CWH/Hauraki Gulf and 27.9kg to Shoal Bay.

Contaminant accumulation occurs within surface sediment layers, which are often referred to as the top 2-3 cm. Based on the area of Shoal Bay/Ngataringa Bay, an estimated density of surface sediment (2,000-2,500 kg/m$^3$), and the annual discharge mass of zinc, the concentration of zinc within Shoal Bay can be estimated as 0.09 – 1.0mg/kg. The MEA assesses the accumulation of zinc at 1mg/kg of sediment per year resulting in low to very low effects on marine ecological values.

#### 3.6.1.3 Washwater

The existing coastal permit requires that 100% of washwater discharges be contained (except for the lower overarch). Washwater contains a range of the key contaminants that are discharged from water blasting and also other contaminants, including copper and lead that may be discharged as a result of dislodging contaminants that have settled on the bridge structure from vehicles on the bridge (although this is difficult to confirm contaminant origin).

Under the current consents, adverse environmental effects as a result of discharges from washwater are significantly minimised due to the requirement to contain 100% of the washwater (except for the lower overarch, which represents approximately 4% of the total surface area of the bridge).

### 3.6.2 Soils

Total Bridge Services (Opus) has prepared an assessment of discharges to land (Appendix C). AHB maintenance works over land at Stokes Point and Point Erin involves some potential discharge to land immediately adjacent to the bridge. The current consent authorises the discharge to land of up to 15% of abrasive blasting and paint overspray to occur during the containment phase. The EMP that is currently in operation and has been approved by Auckland Council requires that discharges to land be avoided as far as practicable (during the pre-containment phase). The discharge of contaminants to land also potentially arises from washwater and wet abrasive blasting discharges. These discharges are currently contained and disposed of offsite in compliance with the existing consents requiring 100% of washwater to be contained.

In the containment phase (partial and full), 15% of contaminants (excluding those from washwater/wet abrasive blasting) are permitted to be discharged to land under the existing consents. This was concluded in the officer’s report to result in less than minor effects.

### 3.6.3 Air Quality

The Air Discharge Assessment (ADA) of discharges to air prepared by Air Matters (Appendix D) includes the identification and description of the effects arising from discharges to air in order to determine the existing consented effects and determine the appropriate effect thresholds for air discharges where a threshold did not already exist under the existing consents. The report identifies three potential air quality effects that could arise as a result of the level of contaminants discharged from maintenance works: human toxicity, odour and nuisance effects.

The report describes in detail the constituents of the air discharges that will occur as a result of maintenance activities. These include particulate matter (TSP, $PM_{10}$ and $PM_{2.5}$), metals (Cr, Fe, Pb, and Zn), Volatile Organic Compounds (VOCs), and diisocyanates.

While the $PM_{10}$ annual mass thresholds have been calculated based on the existing consents for the containment phase, calculating the mass discharge thresholds permitted for the remaining key contaminants in the pre-containment and containment phases is more complex. For the pre-containment phase, specific conditions (30 – 34) were imposed under the air discharge permit 38519.

These conditions regulate nuisance and odour effect on sensitive receivers and restrict the maintenance works at each end of the bridge. In the containment phase these conditions do not apply and the containment structure is assumed to achieve the same environmental outcome (less than minor effects and avoidance of adversely affected parties). The consented mass of air discharges can be assumed to form a part of mass discharges calculated to discharge to the coast for garnet sand (14.6 tonnes) and zinc and paint (869 kg) and the 15% discharge to land that has not been specifically calculated.

Because the existing consents were applied for and granted on the basis of theoretical data, monitoring was undertaken to validate the assumptions and to verify that the works in the pre-containment phase could comply with conditions 30-34. Conditions included restrictions on the use of particular methods and products during periods of high wind speed and while wind was blowing in certain directions, plus avoiding adverse discharges beyond the boundary of the site and not giving rise to visible emissions. Data was collected during maintenance monitoring from locations as close as possible to the source, and then at stepped locations further downwind.

The results indicate that with one additional wind direction control, the discharges generated by maintenance carried out in the pre-containment phase would meet the existing consent conditions when managed in accordance with the EMP. This therefore achieves the intended consent outcome of causing less than minor adverse effects and not adversely affecting adjacent parties.

# 4 Reasons for Resource Consent

This section outlines the reasons for which resource consent is sought. The proposed AMF requires resource consent under the Section 15 of the RMA in accordance with the following sub-clauses:

**15 – Discharge of contaminants into environment**

*(1) No person may discharge any –*

*(a) Contaminant or water into water; or*

*(b) Contaminant onto or into land in circumstances which may result in that contaminant entering water; or*

*(c) Contaminant from any industrial or trade premises into air;*

*unless the discharge is expressly allowed by a national environmental standard or other regulations, a rule in a regional plan as well as a rule in a proposed regional plan for the same region (if there is one), or a resource consent.*

*(2) No person may discharge a contaminant into the air, or into or onto land, from a place or any other source, whether moveable or not, in a manner that contravenes a national environmental standard unless the discharge –*

*(a) is expressly allowed by other regulations; or*

*(b) is expressly allowed by a resource consent; or*

*(c) is an activity allowed by section 20A.*

*(2A) No person may discharge a contaminant into the air, or into or onto land, from a place or any other source, whether moveable or not, in a manner that contravenes a regional rule unless the discharge –*

*(a) is expressly allowed by other regulations; or*

*(b) is expressly allowed by a resource consent; or*

*(c) is an activity allowed by section 20A.*

*(3) This section shall not apply to anything which section 15A or 15B applies.*

The discharge of contaminants to air and water will exceed the permitted activity criteria of the ARP:ALW ARP:C, and PAUP, and therefore fails to comply with ss15(1) and 15(2A). Discharges do not contravene any national environmental standard, and neither s15A nor s15B apply.

As such, the Transport Agency seeks resource consents under s15 of the RMA for the following discharges:

- Discharges to the Coastal Marine Area; and
- Discharges to Air.

## 4.1 Discharges to the Coastal Marine Area

Maintenance activities will result in discharges to the CMA including but not limited to abrasive agents used in abrasive blasting, constituent contaminants within surface coats that are historic and those used in the future, and in washwater from water blasting, in accordance with the provisions identified in Table 4.1 below.

**Table 4.1. Reasons for consent for discharges to the CMA.**

| Provision | Activity | Activity Status |
|---|---|---|
| **Discharges to Coastal Marine Area** | | |
| **ARP:C 20.5.5** | *Discharges of contaminants from the maintenance of existing lawful structures in the coastal marine area.* | **Controlled** |
| **PAUP 3.I.6.1.1.7** | *Discharges into coastal water not otherwise authorised by a rule in the Unitary Plan, or covered by the Resource Management (Marine Pollution) Regulations 1998, that do not comply with the permitted activity controls* | **Discretionary** |

Resource consents are required for Discretionary Activities in accordance with s15(1) and s15(2A) of the RMA.

## 4.2 Discharges to Land

Maintenance activities over land may result in discharges to land from washwater, wet and dry abrasive blasting and overspray of surface coatings.

Overspray resulting from maintenance activities over land will comply with the Permitted Activity criteria of PAUP Rules 3.H.4.18.1 and permitted activity controls of 3.H.18.2.1.1.

Washwater, dry and wet abrasive blasting discharges generated during maintenance activities over land are proposed to be managed in a way that complies with the Permitted Activity criteria of ARP:ALW Rules 5.5.54 and 5.5.55, and PAUP Rules 3.H.4.18.1 and permitted activity controls of 3.H.18.2.1.1.

It is proposed that these discharges can be managed to meet permitted activity standards, therefore no consents under s15 are necessary (refer Appendix C).

## 4.3 Discharges to Air

Maintenance activities will result in discharges to air including but not limited to abrasive agents used in abrasive blasting, constituent contaminants within surface coats that are historic and those used in the future, in accordance with the provisions identified in Table 4.3.

**Table 4.2. Reasons for consent for discharges to air.**

| Provision | Activity | Activity Status |
|---|---|---|
| **Discharges to Air** | | |

| | | |
|---|---|---|
| **ARP:ALW 4.5.61** | *The discharge of contaminants into air from any dry abrasive, vacuum or sweep blasting process that uses abrasive material for blasting containing no more than 5 per cent dry weight free silica that does not comply with Rule 4.5.52, Rule 4.5.53 or Rule 4.5.54* | **Restricted Discretionary** |
| **ARP:ALW 4.5.96** | *The discharge of contaminants into air from any process that includes the use of diisocyanates, methylene chloride or organic plasticisers at a rate exceeding a total of 100 kg/hr.* | **Discretionary** |
| **ARP:ALW 4.5.97** | *The discharge of volatile organic compounds (including solvents) into air at a rate exceeding 20 kg/hr or 10 tonnes/yr.* | **Discretionary** |
| **PAUP 3.H.4.1.1** | *Blasting (dry abrasive, vacuum or sweep) using abrasive material containing less than 5 percent silica but not meeting the permitted activity controls.* | **Restricted Discretionary** |
| **PAUP 3.H.4.1.1** | *Any process that discharges more than 20kg/hour or 10t/year of volatile organic compounds such as large-scale application of surface coatings or printing ink without the application of heat, excluding the ventilation, displacement or dispensing of motor fuels.* | **Discretionary** |
| **PAUP 3.H.4.1.1** | *Spray application of surface coatings containing diisocyanates or hazardous organic plasticisers not in a spray booth or at a domestic premises at an application rate no more than 2L/day.* | **Discretionary** |

Wet abrasive blasting and stripe coating discharges resulting from maintenance activities will also comply with the Permitted Activity criteria of ALWP Rule 4.5.1 and PAUP Rules 3.H.4.1.1.

Overall, resource consent is required for a Discretionary Activity in accordance with s15(1) of the RMA.

## 4.4 Auckland Council District Plans

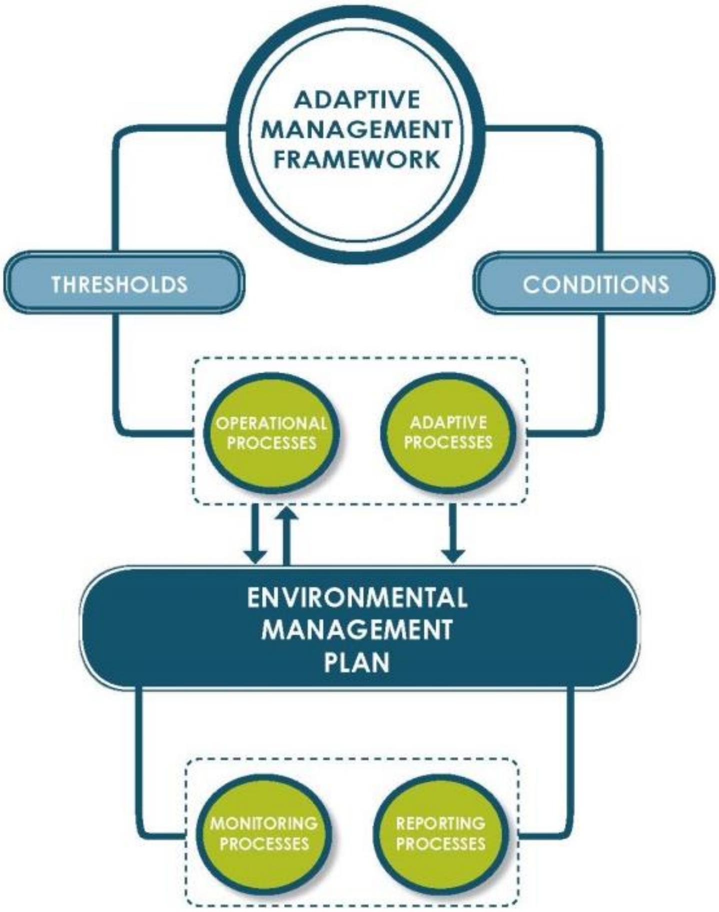
All maintenance activities regulated by the legacy District Plans are authorised under Designation 108 for the north abutment (North Shore City) and A07-01 for the southern abutment (Auckland Isthmus). These designations are identified in the PAUP as ID 6718, ID 6721, and ID 6749.No resource consents are required under the District Plans.

# 5 Proposed Adaptive Management Framework

The Transport Agency is seeking to replace the prescriptive requirement for containment to manage discharges, as discussed in Section 3.5.3 above, with a more flexible Adaptive Management Framework (AMF). The AMF will be used to manage annual discharge to achieve the same or similar outcomes anticipated by the existing consents. This will be achieved through the management of maintenance discharge activities within the key containment thresholds set out in Table 3.1 above. The AMF enables the anticipated environmental outcomes using a range of methods and mitigations rather than relying on a prescribed method (containment).

In addition to the key contaminant thresholds, the AMF also needs to be understood in terms of its relationship with the Environmental Management Plan (EMP). The operational, monitoring and reporting processes within the AMF are set out at a conceptual level (described below), and the detail will be contained within the EMP. An EMP currently exists and it is proposed this will be updated to reflect the key contaminant thresholds, conditions, and AMF upon granting of consent. The EMP is the day-to-day guidance manual for the bridge maintenance operators.

**Figure 5.1 – Adaptive Management Framework**




So that all these elements are knitted together, we have included in section 9 below a set of draft proposed conditions. In particular these conditions reference the key contaminant thresholds, the AMF and its purpose, the EMP and its contents, monitoring and reporting requirements and some specific effect management conditions.

Together the thresholds, the adaptive management processes (operational, adaptive, monitoring and reporting), the EMP and the proposed conditions form the basis of this application and demonstrate how effects are to be avoided, remedied and/or mitigated.

For clarity, this section should be read alongside the AMF in Appendix A.

## 5.1 Purpose of AMF

The purpose of the AMF is to enable the maintenance of the Auckland Harbour Bridge in a practicable way, while managing the effects of discharges to the environment at or below levels that could be achieved by full containment.

### 5.1.1 Principles

Of Effects:

- **Threshold** – the threshold of effects are the same or less than if full containment (at 85% efficiency) was in place.

Of Process:

- **Flexible** – Provide for a flexible approach that focuses on the effects of the maintenance regime (instead of methods) and a process to review and update the EMP on an on-going basis;
- **Innovative** – Allows for the introduction of new, innovative methods and/or materials where thresholds can be met and effects will not increase;
- **Certainty** – Retains certainty of outcome by setting clear processes for thresholds, monitoring, trigger levels and reporting; and
- **Iterative** – Provides for iterative decision-making based on evaluating results and adjusting actions on the basis of what has been learned. These principles help drive behaviour and promote a culture of continually improving environmental outcomes.

### 5.1.2 Outcomes

Of Effects:

- Management of discharge effects results in the same or improved environmental outcomes as full containment (at 85% efficiency) would have achieved.

Of Process:

- Environmental management can be effectively managed in a flexible manner that allows for adaptation and innovation without requiring changes/variations to the resource consents. This process drives operator behaviour toward a culture of improved outcomes.

The AMF will allow the NZ Transport Agency to undertake the proposed maintenance activities on the bridge while managing effects to achieve the same outcomes anticipated under full containment. The framework will provide a range of options to achieve this without limiting management measures to one method (i.e. containment).

The AMF also provides a process to assess new methods and products. If these new methods and/or products can be demonstrated to reduce or not change effects on the environment and reduce or not exceed the key contaminant thresholds, the AMF enables use of these new methods and /or products via amending the EMP rather than changing the consent conditions.

In summary, the AMF comprises the following components:

- Key Contaminant Thresholds
  - The thresholds proposed will enable maintenance operators to track annual progress and provide tangible targets for maintenance activities regulated by the consents so that adverse effects are managed.
- Conditions
  - The proposed conditions in section 9 provide certainty to the applicant, maintenance operators and Auckland Council that the thresholds are being achieved on an annual basis and therefore adverse effects are being managed and the consent is being complied with.
- Operational Process
  - This process enables maintenance operators to select the most appropriate methods to undertake maintenance when considering the potential environmental effects. This is the 'business as usual' approach and generally reflects how daily maintenance activities occur and are managed.
- Monitoring Process
  - This process will use an operational model to track inputs and discharges resulting from maintenance and enables the maintenance operators to adjust the operational processes accordingly to manage maintenance activities within the consented thresholds.
- Reporting Process
  - This process sets out the approach for reporting the monitoring results using the operational model to track annual discharges and any outcomes from use of the adaptation process.
- Adaptation Process
  - This process enables the inclusion of new methods and products where there is no worsening of effects, new effects or increase in discharges above the proposed annual thresholds.
- EMP
  - The EMP provides the operational day to day manual that sets out methods and procedures to guide maintenance activities so that discharges are managed within the thresholds and any specific restrictions (e.g. wind speeds) are complied with. It provides for the monitoring and reporting processes to demonstrate consent compliance.

The purpose of the AMF is set out in proposed conditions 8 and 9 in Section 9 below.

## 5.2 Key Contaminant Thresholds

Refer section 3 and Table 3.1 above for a full explanation of the following table which sets out the key contaminant thresholds and the basis or source of the threshold.

| Contaminant | Recommended Thresholds |
|---|---|
| $PM_{10}$ / Total Suspended Particulates | PM10 total: 31 kg/annum (2011 consent baseline for abrasive blasting)<br>PM10 (acute - 24hr): 50µg/$m^3$ (MfE)<br>TSP (acute - 24hr): 80µg/$m^3$ (MfE) |
| Garnet Sand / Dust | Coastal: 14,679 kg/annum (2011 consent baseline) |
| Zinc | Air (acute 1hr): 20µg/$m^3$ (TCEQ ESL)<br>Coastal: 223 kg/annum (2011 consent baseline) |
| Lead | Air (acute 0.5hr): 1.5g/$m^3$ (Ontario Ministry for the Environment) |
| Chromium | Air (acute 1hr): 3.6µg/$m^3$ (TCEQ ESL) |
| Iron | Air (acute 1hr): 50µg/$m^3$ (TCEQ ESL) |
| Volatile Organic Compounds (VOCs) | Xylene: Air (odour 1hr): 350µg/$m^3$ (TCEQ ESL)<br>Toluene; Air (odour 1hr): 640µg/$m^3$ (TCEQ ESL)<br>Naptha: Air (odour 1hr): 3500µg/$m^3$ (TCEQ ESL)<br>Ethylbenzene: Air (odour 1hr): 740µg/$m^3$ (TCEQ ESL)<br>Methyl Isobutyl Ketone; Air (odour 1hr): 820µg/$m^3$ (TCEQ ESL) |
| Diisocyanates | Air (acute 1hr): 50µg/$m^3$ (TCEQ ESL) |
| Paint | Coastal: 646kg/annum (2011 consent baseline) |

## 5.3 Conditions

Refer section 9 below for the proposed conditions that provide the statutory weight to the AMF.

## 5.4 Operational Process

The operational process describes the physical characteristics of the maintenance activities, the variables of the activities and environment, the effects on the environment, and the mitigation measures to be used. The process reflects routine operations and links to the EMP. When used as a whole it enables operators to undertake maintenance activities within the scope of the resource consent, with each method playing a role in an integrated approach to environmental management.

### 5.4.1 Maintenance Activities

The activities undertaken as part of bridge maintenance generally include, but are not limited to:

- Surface preparation:
  - Washdown / Waterblasting
  - Wet and dry abrasive blasting
  - Degreasing
  - Mechanical and chemical paint removal
  - Control of lichens and moss

- Application of coatings (exterior and interior) by hand and spray gun.

### 5.4.2 Environmental Variables

The maintenance activities have a range of potential effects. The scale of effect is influenced by environmental variables, including:

- Locations on the bridge/extent of the works;
- Timing, duration, and frequency of the maintenance methods;
- Volume of discharges to the environment (small *vs.* large);
- Sensitivity and values of the receiving environment

These variables will help determine appropriate mitigation methods and management practices to meet contaminant thresholds under the AMF.

### 5.4.3 Key Discharges

The Key Discharges that the AMF aims to manage (generated by bridge maintenance) are also those identified by Auckland Council as key contaminants, including:

- Garnet sand discharged to the CMA from abrasive sand blasting activities
- Lead and other metals from historical paint layers discharged to the air during abrasive blasting
- Zinc from spray painting discharges to the CMA
- VOCs, diisocyanates, and metals (zinc and iron) released to the air during spray painting

### 5.4.4 Environmental Effects

The effects that the AMF aims to manage will be those that are directly attributable to discharges associated with the bridge maintenance activities. The key discharges into the environment have the potential to generate the following adverse effects:

- Toxicity in marine biota
- Health effects for coastal users and nearby residents / businesses
- Sedimentation of the harbour bed
- Nuisance

The effects will be managed through compliance with the thresholds.

### 5.4.5 Mitigation Measures

The AMF relies on the operational processes to mitigate adverse effects resulting from the discharges of contaminants. This will be expanded in the EMP and the can be modified, improved, added to, and altered over time depending on efficiency of the methods or technical improvements, etc. Some examples of mitigation measures include:

- Coating application methods used – hand rolled painting *v* spray painting
- Wind speed and direction limits – to control the distance and direction contaminants can travel
- Containment – if possible at certain locations

- Communication – with residents, water users, etc.

Different mitigation measures will be appropriate for different methods, for different variables, for different discharges, and for different effects.

### 5.4.6 EMP and Conditions

The EMP as discussed below will drive operator behaviour and set out the day to day processes and methods that will be used to manage environmental effects. Proposed conditions 10, 11, 12, 13 and 17 specifically relate to the operational processes and link to the EMP's role in managing this process.

## 5.5 Monitoring Process

Monitoring is proposed to be undertaken regularly using an operational model that will enable the operators to track contaminant loads and discharges throughout the year. This will assist in:

- Consent compliance;
- Mitigation selection; and
- Works scheduling.

The operational model will be informed through recording operator inputs. The monitoring process along with the operational documents (e.g. EMP) can help determine which mitigation measures are effective for specific maintenance methods. The monitoring proposed includes the following inputs and outputs which can be measured during operations:

Inputs to the operational model:

- Activity carried out: waterblasting, wet abrasive blasting, dry abrasive blasting, or spray painting (of either Termarust, MC Ferrox, MC Miomastic or MC Zinc)
- Location where work was carried out: Coast or land
- Surface area over which the activity was carried out(m2)
- If abrasive blasting, the amount of garnet used (kg)
- If painting, the amount of paint used (L), and an estimate of the overspray (%) (some guidance will be developed on how to estimate this in the EMP)
- If containment has been used, an estimate of the percentage containment achieved (some guidance on how to estimate/ determine this will be developed in the EMP)

Outputs from the operational model:

- Annual discharge of zinc to the coast and land;
- Annual discharge of garnet to the coast and land;
- Annual discharge of paint to the coast and land; and
- Annual discharge of PM10 to the airshed.

For air discharges, logging of wind speeds and wind direction relevant to the works activity and location on the bridge will be the method of monitoring compliance with any buffer zones that are se t out in the EMP.

The EMP will set out what and how monitoring will occur and proposed condition 14 specifically addresses monitoring through the EMP.

## 5.6 Reporting Process

The reporting process will be undertaken to enable the NZ Transport Agency and its agents to manage maintenance activities within the AMF and to demonstrate to Council that those activities are being undertaken in accordance with the conditions of resource consent. The effectiveness of the AMF relies on relevant reporting that captures important information and is accepted by Council. The reporting to be provided to Council will:

- Be standardised;
- Summarise monitoring data to demonstrate how the maintenance activities have occurred within the thresholds for key contaminants, based on the monitoring data proposed above; and
- Record results and recommendations from any use of the Adaptation Process (see below).

A template for this process will be developed in the EMP to simplify reporting based on outputs that are easily computed from the operational model. Draft conditions have been proposed which set out what needs to be reported on. Reporting will be annual and provided to Council for information to show consent compliance. If this is shown, no further action is necessary.

The EMP will set out what and how reporting will occur and proposed condition 5 specifically addresses reporting through the EMP.

## 5.7 Adaptation Process

The AMF enables the potential for the NZ Transport Agency and its agents to introduce new maintenance methods and products to be used under this consent application, provided that their use can be undertaken within the proposed thresholds. It is important that there is flexibility to introduce new methods and products, as this may reduce costs, frequency, and discharges associated with bridge maintenance.

To determine the nature of the applicability of new methods and products, these will be assessed and introduced through a robust 4 step adaptation process, as set out in the AMF in Appendix A.

### 5.7.1 Step 1 – Identification

New methods and products will be assessed using material safety data sheets (MSDS) and manufacturer specifications to determine if they contain or generate any key contaminants. As part of the identification step, the following tasks will be undertaken:

- Define contaminant characteristics;
- Toxicity test, if required;
- Identify assumptions; and
- Test assumptions, if required.

### 5.7.2 Step 2 – Discharge Regulation

If it is determined that the information in Step 1 adequately describes the potential discharges, discharge regulation methods will be determined to confirm that the discharges are within the proposed thresholds and industry guidelines. Key tasks in Step 2 include:

- Confirm the relevant guidelines and standards;
- Calculate proposed annual discharges (if relevant);
- Undertake sampling during the method or product trial; and
- Confirm relevant planning regulations under Auckland Council plans.

### 5.7.3 Step 3 – Identify and Assess Effects

If it is determined that the discharge can be regulated in a manner consistent with the proposed thresholds, the potential environmental effects of the discharge will be identified and assessed. Key tasks in Step 3 include:

- Determine whether discharge of identified key contaminants can meet the current contaminant discharge thresholds;
- Model air dispersion, if required;
- Confirm that the effects of any new contaminants are within the scope of the maintenance consent or Permitted Activity criteria;
- Assess and set thresholds for new contaminants, if required; and
- Determine any new controls that are required to meet the above requirements.

### 5.7.4 Step 4 – Update Operational Documents

If it is determined that the environmental effects of the new method or product can be accommodated within the scope of the proposed consent, all operational documents will be updated to include the new discharge. Key tasks in Step 4 include:

- Updating the Operational Model;
- Updating the Environmental Management Plan and procedures; and
- Integrating the new method or product into the AMF.

### 5.7.5 Non-compliant New Methods or Products

If, during the adaptation process, any new methods or products are determined to be inconsistent with or exceed the proposed thresholds or have new effects that cannot be avoided or effects above the consented level of effects, they will be considered to be outside of the scope of the proposed consent and cannot be used without obtaining further consents.

### 5.7.6 Technical Sheets

To guide the adaptation process, each 'effect (air, land, coastal, planning) area has had a technical sheet prepared that sets out the process to be followed. As an indicative example, this process has been tested and applied using the new product 'Termarust'. The technical sheets are contained within the AMF in Appendix A.

### 5.7.7 EMP and Conditions

The Adaptive Management Process in Appendix A provides a detailed outline of this process and this is complimented by the technical sheets in the same appendix. Proposed conditions 16 and 17 formalise this process. If the adaptive process is used then the outcome would be reported to council if that outcome required a change to the EMP.

## 5.8 Environmental Management Plan

The current EMP drives operator behaviour and is used to manage day to day operations and resultant environmental effects. The Table of Contents for the EMP is provided below. It is proposed that this and the full EMP be updated following granting of consent. Largely the existing headings are suitable for adding further detail to. There will likely be a new section on the AMF. The EMP is currently being used to effectively manage maintenance activities in accordance with the consent conditions and this is proposed to continue upon granting of this application.

The content and matters for the EMP to address and its purpose it set out in proposed conditions 11- 13.

### 5.8.1 Current EMP Table of Contents

1. INTRODUCTION
2. OVERVIEW AND CONTEXT
3. ROLES AND RESPONSIBILITIES
4. MAINTENANCE ACTIVITIES
    - 4.1 Overview
    - 4.2 Maintenance Activities
    - 4.3 Related Activities
    - 4.4 Other Utilities and Services
5. ENVIRONMENTAL MANAGEMENT
    - 5.1 Overview
    - 5.2 Environmental Risks
    - 5.3 Environmental Controls 1
    - 5.4 Implementation
6. LOGGING, INSPECTIONS AND MONITORING
7. SPILLS AND OTHER INCIDENTS
8. TRAINING
9. RECORD KEEPING
10. REVIEW
11. REPORTING

# 6 Assessment of Environmental Effects

Section 3 sets out the existing environment and includes an assessment of the effects on the environment as a result of the discharge of key contaminants within the levels authorised by existing consents 38519, 38835, and 38836.

Three technical reports have been prepared to assess effects on the Marine, Land and Air receiving environments. These reports set out the existing environment and that level of anticipated effects as a result of the consents maintenance discharges.

These reports and assessments have informed the setting of the proposed key contaminant thresholds in Table 3.1. These thresholds enable maintenance discharges to be maintained at the same level as currently consented. The use and the implementation of the AMF (as explained in section 5) will provide a more flexible and cost effective approach to managing maintenance discharges. Critically this approach will result in the same or potentially less environmental effects than what is currently authorised under the existing consents.

This AEE section provides a summary of the existing consent effects thresholds and then an assessment of any actual or potential effects that result from the proposed approach differing from the existing consented approach.

These assessments have been prepared in accordance with s104 of the RMA, as well as within the statutory framework provided by the following planning documents:

- Hauraki Gulf Marine Park Act (HGMPA);
- New Zealand Coastal Policy Statement (NZCPS);
- National Environmental Standard: Air Quality (NES:AQ);
- Auckland Regional Plan: Coastal (ARP:C);
- Auckland Regional Plan: Air, Land, and Water (ARP:ALW);
- Proposed Auckland Unitary Plan (PAUP).

## 6.1 Positive Effects

The current consents require full containment (generally to 85%) by 2021. This application proposes thresholds to achieve the same level of discharge or level of effect on the receiving environment as the existing consents. As this would provide a framework for managing effects within these thresholds upon the granting of consent, this outcome would be achieved nearly 7 years earlier than anticipated under the current consents. This represents an actual positive effect on the receiving environment.

The thresholds have been set to achieve the same level of discharge or level of effect on the receiving environment so that no worsening of effect on the receiving environment occurs. The flexibility of the AMF also enables discharges to be reduced over time representing a potential positive effect.

## 6.2 Marine Ecology

As discussed above in 3.6.1, the MEA (Appendix B) describes the existing ecological values of the CMA (receiving environment) for the AHB maintenance discharges, as well as the environmental effects authorised under Coastal Permit 38519. The MEA provides a comprehensive overview of the coastal dynamics of the CWH establishes where contaminant discharges are likely to ultimately settle.

The MEA identifies three key contaminants that are discharged to the CMA as a result of the consented maintenance activities and calculates the mass annual loads of the permitted discharges for:

- Particulate (e.g. garnet sand);
- zinc, and;
- paint

Using a robust assessment framework and based on the thresholds, the MEA concludes that:

- the discharge of particulate (sand) results in a deposition depth significantly below that which would cause adverse effects on benthic communities;
- the discharge of zinc will have low to very low effects on marine ecological values;
- paint discharges will have negligible effect on marine ecological values;
- acute and chronic toxicity of current products are practically non-toxic in acute (short term) situations and have negligible chronic toxicity (in the longer term); and
- overall the adverse effects arising from the permitted mass discharge of key contaminants is low to very low, particularly given the large volume of mixing that occurs in the water column.

The existing consents require 100% containment of washwater. The "Contaminants in Waterblasting Washwater" assessment in Appendix E concludes that the effects of washwater discharges to the CMA would be negligible. The requirement to contain washwater is expensive and impracticable to achieve. Full containment as a mitigation method is not commensurate with the level of effect and does not align with the philosophy of the AMF approach that is being applied for.

The reason washwater has negligible effects is due to the limited levels of contaminants discharges and the significant volume of water beneath the bridge which after reasonable mixing dilutes the discharges to well below ANZECC guidelines. The assessment in Appendix E recommends that zinc and particulate discharges (2.4kg and 77kg respectively) are included within the total annual discharges under the key contaminant thresholds.

On this basis, the approach of not containing washwater and instead discharging washwater to the CMA is appropriate and reasonable and is concluded to cause negligible adverse effects on the marine receiving environment.

### 6.2.1 Summary

The proposed management regime under the AMF and key contaminant thresholds will have less than minor adverse effects on the marine receiving environment and will result in no material change in effects compared to the existing environment as a result of the discharge of washwater.

## 6.3 Land Discharge

The existing and potential management methods for maintenance discharges are discussed above in section 3.6.2, the "Assessment of Discharge to Soils" report (Appendix C), and the "Contaminants in Waterblasting Washwater Assessment" (Appendix E). These assess the effects of the proposed AMF approach to managing future discharges to land.

Potential discharges of key contaminants to soils are determined to arise from:

- washwater / waterblasting;
- abrasive blasting; and
- spray painting.

Discharges to land from current bridge maintenance activities are minimised as far as practicable. As a result, the effects on soil from the discharge of contaminants are currently minimised through managing, capturing or avoiding discharges through a containment system, or other methods under the EMP. While this applies to the pre-containment phase, in the full containment phase 15% of dry discharges are able to be discharged to land. As this discharge level is provided for by the existing consents it constitutes part of the existing environment.

The proposed approach to managing discharges to land is to continue minimising as far as practicable all discharges of key contaminants to soils by meeting the permitted activity standards. This can be achieved by capturing washwater and wet abrasive blasting discharges, containing dry abrasive blasting over land and containing spray painting or hand applying paint. Under the proposed AMF there is also the flexibility to consider new methods and products that may assist to minimise key contaminant discharges to soils in the future.

To demonstrate maintenance discharges are being minimised as far as practicable the following monitoring is provided as an example of what could be formalised through the EMP:

- visual monitoring during water blasting and wet abrasive blasting to check that discharges are being contained effectively.
- air monitoring, where appropriate, to show that any system (e.g. containment) used to control discharges to air (where there is a risk that may they settle out to land) are working effectively.
- internal audits to show relevant environmental procedures and processes are being followed during both surface preparation activities and paint application.

Based on this approach, discharges over land and to soils can be managed so they comply with the relevant permitted activity standards of the ALWP and PAUP. These standards are set at a level that is accepted as less than minor (and therefore do not require consent).

The assessment concludes that the effects of waterblasting, abrasive blasting and spray painting are negligible as a result of discharges to land and soils and is an improvement from the current consents which anticipate discharges of up to 15% from abrasive blasting and spray painting.

### 6.3.1 Summary

Current practices under the EMP demonstrate the ability to minimise as far as reasonably practicable discharges of key contaminants to soils and the ability to comply with the permitted activity standards. The proposal is therefore concluded to result in negligible adverse effects on the receiving environment and the effects of the proposal will (based on the technical assessments) be reduced compared to the existing environment where the existing consent allows up to 15% discharge to land of dry discharges.

## 6.4 Air Quality

As discussed in 3.6.3 above, the Air Discharge Assessment (Appendix D) describes the receiving environment, sources of contaminants from maintenance activities and the nature of key contaminants discharged from these activities. Abrasive blasting, spray painting, and strip painting (by hand) are the activities that generate discharges of key contaminants.

The assessment discusses potential effects of health, odour and nuisance from discharges. Based on a monitoring programme, the assessment discusses how effective the current pre-containment conditions of the existing permit 38519 are at mitigating effects to a level that is less than minor and does not adversely affect any parties (as concluded in the application and consent decision). The conclusion of that monitoring programme is that the conditions are mostly effective in achieving that outcome, but that an additional wind control is required and a buffer zone could be introduced.

Using the Ministry for the Environments “Good Practice Guide for Assessing Discharges to Air from Industry” key contaminant thresholds have been set to enable management of maintenance discharges to the same level of effect as under the existing consents (and therefore resulting in less than minor effects)

The key methods to manage air discharges beneath the thresholds are:

- Wind speed limits;
- Wind direction;
- The use of screens;
- The use of buffer zones.

The potential methods to manage air quality effects within the AMF include the above methods, as they are appropriate for the spray application of paint, as well as dry abrasive blasting.  These methods will be expanded and set out in the EMP.

This application proposes draft conditions in section 9 and includes two specific conditions for air discharges. These require controls (the four bullet points above) to be specified in the EMP to achieve the thresholds in Table 3.1.

The Air Discharge Assessment Report (Appendix D) has identified odour, nuisance and human health effects as the key concerns regarding discharge to air. Given the length of the bridge and its location within the Waitemata Harbour, sensitive receivers such as residences, businesses, and recreational users are generally at such a distance that no effects occur. The areas around each bridge abutment have been identified as containing potential sensitive receivers, although monitoring undertaken indicates that maintenance activities can be managed in a way so that adverse effects on these receivers arising from discharges to air can be avoided or minimised.

Based on this approach, discharges to air can be managed so they can remain within or below the key contaminant discharge thresholds proposed. These thresholds have been set so that the resulting discharge causes less than minor adverse effects and do not adversely affect any parties. As the thresholds have been set from the existing consents there is expected to be no change in effects from those anticipated under the existing environment.

## 6.5 Effects summary

The proposed AMF is expected to deliver a reduction in environmental effects resulting from discharges from maintenance activities on the AHB. On granting of this consent the use of the AMF will achieve the same environmental outcome as full containment which is currently required by 2021.

Actual or potential adverse effects on the marine receiving environment (smothering, ecosystem effects and eco-toxicity) are concluded to be negligible and the change to the existing environment is generally expected to be no different or negligible.

For discharges to land the approach of minimising discharges to soils as far as practicable and complying with Permitted Activity requirements is concluded to result in negligible adverse effects and is an improvement in outcome compared to the existing environment where 15% of dry discharges are anticipated.

Air discharge thresholds have been set so that when achieved the effects on human health, nuisance and odour will be less than minor. This is the same outcome as anticipated under the existing environment.

The proposed AMF provides the flexibility to use alternative methods and/or products while enabling the same environmental outcome and a reduced level of effects over time.

# 7 Statutory Framework

This Assessment of Environmental Effects has been undertaken in accordance with Section 104 of the RMA and within the statutory framework provided by the following planning documents:

- Resource Management Act 1991
- Hauraki Gulf Marine Park Act 2000
- Land Transport Management Act
- New Zealand Coastal Policy Statement
- Auckland Regional Policy Statement
- Resource Management (National Environmental Standards for Air Quality) Regulations 2001
- Auckland Regional Plan: Coastal
- Auckland Regional Plan: Air, Land, and Water
- Proposed Auckland Unitary Plan

The relevant matters of these statutory documents are discussed below.

## 7.1 Part 2 – Purpose and Principles

This section assesses the proposed AMF against Part 2 of the RMA.

### 7.1.1 Section 5 – Purpose

The purpose of the RMA, set out in Section 5, is to promote the sustainable management of natural and physical resources, which includes enabling "*people and communities to provide for their social, economic, and cultural wellbeing*." This must be achieved in the context of Section 5(2), in particular the responsibility of (c) for "*avoiding, remedying, or mitigating any adverse effects of activities on the environment*."

The proposed thresholds and AMF will enable the NZ Transport Agency to maintain nationally significant infrastructure that promotes the social, economic, and cultural well-being for Auckland and its surrounds. The maintenance is essential to provide for the health and safety of bridge users and the wider State Highway network. The AHB provides a critical function in assisting Aucklanders and New Zealanders provide for their wellbeing through transport, utility and freight functions.

Within the AMF, the Transport Agency has proposed a range of mitigation and avoidance management methods. The proposed threshold will not result in any further adverse effects on the environment than currently consented. The AMF approach will more likely drive operator behaviour to reduce environmental effects over time. In doing so, it is considered that the purpose of the RMA is achieved while also meeting the statutory obligations of the NZ Transport Agency under the LTMA.

### 7.1.2 Section 6 – Matters of National Importance

Section 6 sets out matters of national importance that must be recognised and provided for. The relevant matters include:

*(a) the preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development;*
*(c) The protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna;*
*(d) The maintenance and enhancement of public access to and along the coastal marine area, lakes, and rivers;*
*(e) the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga:*

The consents being sought will enable maintenance activities which generate discharges to the Waitemata Harbour, including the ecologically significant Shoal Bay, and the effects of such discharges to be managed within the thresholds and AMF proposed. The AEE and the MEA accompanying this application have determined that any significant adverse effects on the marine ecological environment are unlikely. Any particulate that is deposited on the foreshore of the harbour is dispersed over an area sufficient enough to be insignificant to ecological habitat and amenity values.

As the majority of activities occur on the AHB's steel frame above the CMA, public access will only be temporarily restricted around the bridge abutments when maintenance occurs over land. Any restrictions will be for the health and safety of the public.

Consultation with Mana Whenua is continuous. The maintenance activities have been undertaken over the past 55 years, and the NZ Transport Agency has developed good relationships with kaitiaki regarding the mauri of the Waitemata.

### 7.1.3 Section 7 – Other Matters

Section 7 sets out other matters that the Transport Agency must have particular regard to in undertaking bridge maintenance activities. Relevant matters include the following:

*(a) kaitiakitanga:*
*(aa) the ethic of stewardship:*
*(c) the maintenance and enhancement of amenity values:*
*(d) intrinsic values of ecosystems:*
*(f) maintenance and enhancement of the quality of the environment:*

The NZ Transport Agency promotes an accessible and safe transport system that contributes positively to New Zealand's economic, social, and environmental welfare. Working with stakeholders, including iwi, the Transport Agency is committed to acting in an environmentally responsible manner. As discussed above, the proposed thresholds and AMF will enable the Transport Agency to continue to provide a nationally significant transport link while achieving improvements in environmental outcomes from bridge maintenance activities.

Through a more flexible approach to environmental effects management, the amenity and ecological values of the Waitemata Harbour and Shoal Bay will be maintained and potentially enhanced compared to the existing environment and will not be degraded from bridge maintenance activities.

### 7.1.4 Section 8 – Treaty of Waitangi

As a Crown agency, the Transport Agency is partner to the Treaty of Waitangi and actively works towards achieving the treaty's principles, extending the opportunity for Maori to participate in decision making, and consult with Mana Whenua on issues such as this application that is likely to affect their interests.

### 7.1.5 Section 105 – Matters Relevant to Certain Applications

This application seeks discharge and coastal permits that contravenes s15 of the RMA. As such, the additional matters of s105 have been considered:

*(a) The nature of the discharge and the sensitivity of the receiving environment to adverse effects; and*
*(b) The applicant's reasons for the proposed choice; and*
*(c) Any possible alternative methods of discharge, including discharge into any other receiving environment.*

As discussed in the assessments of effects, the discharges from AHB maintenance to air, land, and the CMA generate less than minor effects on the environment. In particular, when compared to the existing environment the level of effects permitted by current consents relating to the maintenance discharges will be maintained or potentially improved.

As discussed in section 2.0 above, the Transport Agency has considered a range of alternatives. The feasibility report (August 2014) and the AEE supporting this application conclude that the proposed AMF approach will enable improved management of the discharge effects. Consequently it is considered by the Transport Agency to be the best practicable option.

## 7.2 Hauraki Gulf Marine Park Act 2000

The purpose of the Hauraki Gulf Marine Park Act 2000 (the HGMPA), set out in Section 3, includes the integration of "*management of the natural, historic, and physical resources of the Hauraki Gulf, its islands, and catchments*". The HGMPA enables the management of the Hauraki Gulf as a nationally significant environment, and sets out management objectives in Section 8. The Waitemata Harbour is within the Hauraki Gulf, and is therefore subject to the HGMPA.

Matters of particular relevance to this application include:

Section 8(a) – *the protection and, where appropriate, the enhancement of the life-supporting capacity of the environment of the Hauraki Gulf, its islands, and catchments*

Section 8(f) – *the maintenance and, where appropriate, the enhancement of the natural, historic, and physical resources of the Hauraki Gulf, its islands, and catchments, which contribute to the recreation and enjoyment of the Hauraki Gulf for the people and communities of the Hauraki Gulf and New Zealand.*

Under Section 9 of the HGMPA, territorial authorities must ensure that the objectives and policies of regional and district plans give effect to the HGMPA. In this respect, the proposed maintenance activities are considered to be consistent with the objectives and policies of the relevant plans, as discussed in detail below.

It is noted that the HGMPA constitutes a national policy statement under the RMA.

## 7.3 Land Transport Management Act 2003

The purpose of the Land Transport Management Act 2003 (LTMA) is to "*contribute to an effective, efficient, and safe land transport system in the public interest*". The LTMA provides the Transport Agency with a mandate under Section 95 to achieve the purpose of the LTMA, providing for the State Highway Network in particular.

The proposed maintenance activities on the AHB directly contribute to the achievement of the purpose of the LTMA through:

- increasing the operational lifespan of the AHB;
- repairing and protecting the steel structure to maintain the bridge's safety; and
- undertaking maintenance activities in a way that permits continued use of the AHB.

The application of the AMF will enable the Transport Agency to undertake such activities in an efficient manner and with the ability to adopt new methods to deliver improved environmental outcomes over time.

## 7.4 Resource Management (National Environmental Standards for Air Quality) Regulations 2004

The NES:AQ requires that discharges to air do not exceed thresholds that are specific to individual contaminants, including $PM_{10}$. As such, the Air Discharge Report (Appendix D) and this application has proposed a set of 'key contaminant' discharge thresholds that will meet the NES:AQ regulations.

## 7.5 New Zealand Coastal Policy Statement 2010

The New Zealand Coastal Policy Statement (NZCPS) is applied to the assessment of any resource consent application with effects within the CMA and is a specific matter set out in section 104 of the RMA. As such, the proposed AMF has been developed in accordance with the relevant objectives and policies of the NZCPS.

**Objectives under the NZCPS**

Objective 1 – *To safeguard the integrity, form, functioning and resilience of the coastal environment and sustain its ecosystems, including marine and intertidal areas, estuaries, dunes and land, by:*

- *maintaining or enhancing natural biological and physical processes in the coastal environment and recognising their dynamic, complex and interdependent nature;*

- *protecting representative or significant natural ecosystems and sites of biological importance and maintaining the diversity of New Zealand's indigenous coastal flora and fauna; and*
- *maintaining coastal water quality, and enhancing it where it has deteriorated from what would otherwise be its natural condition, with significant adverse effects on ecology and habitat, because of discharges associated with human activity.*

Objective 3 – *To take account of the principles of the Treaty of Waitangi, recognise the role of tangata whenua as kaitiaki and provide for tangata whenua involvement in management of the coastal environment by:*

- *recognising the on-going and enduring relationship of tangata whenua over their lands, rohe and resources;*
- *promoting meaningful relationships and interactions between tangata whenua and persons exercising functions and powers under the Act;*
- *incorporating mātauranga Māori into sustainable management practices; and*
- *recognising and protecting characteristics of the coastal environment that are of special value to tangata whenua.*

Objective 6 – *To enable people and communities to provide for their social, economic, and cultural wellbeing and their health and safety, through subdivision, use, and development, recognising that:*

- *the protection of the values of the coastal environment does not preclude use and development in appropriate places and forms, and within appropriate limits;*
- *some uses and developments which depend upon the use of natural and physical resources in the coastal environment are important to the social, economic and cultural wellbeing of people and communities;*
- *functionally some uses and developments can only be located on the coast or in the coastal marine area;*
- *the coastal environment contains renewable energy resources of significant value;*
- *the protection of habitats of living marine resources contributes to the social, economic and cultural wellbeing of people and communities;*
- *the potential to protect, use, and develop natural and physical resources in the coastal marine area should not be compromised by activities on land;*
- *the proportion of the coastal marine area under any formal protection is small and therefore management under the Act is an important means*

*by which the natural resources of the coastal marine area can be protected; and*

- *historic heritage in the coastal environment is extensive but not fully known, and vulnerable to loss or damage from inappropriate subdivision, use, and development.*

**Policies under the NZCPS**

Policy 23 – *Discharge of contaminants*

1. *In managing discharges to water in the coastal environment, have particular regard to:*
   a. *the sensitivity the sensitivity of the receiving environment;*
   b. *the nature of the contaminants to be discharged, the particular concentration of contaminants needed to achieve the required water quality in the receiving environment, and the risks if that concentration of contaminants is exceeded; and*
   c. *the capacity of the receiving environment to assimilate the contaminants; and:*
   d. *avoid significant adverse effects on ecosystems and habitats after reasonable mixing;*
   e. *use the smallest mixing zone necessary to achieve the required water quality in the receiving environment; and*
   f. *minimise adverse effects on the life-supporting capacity of water within a mixing zone.*

<u>Comment</u>

The coastal environment of the Central Waitemata Harbour is influenced by a range of physical, social, and cultural values. The harbour is:

- completely surrounded by urban development;
- used as a source of food, transportation, recreation, and economic gain;
- the discharge point of several significant catchments with widely varying land uses; and
- culturally significant.

The bridge maintenance activities will be undertaken within an effects envelope set by the proposed thresholds within the proposed AMF that will achieve the same outcomes or be an improvement over the existing environment. Monitoring has shown that the activities undertaken since the construction of the AHB in 1959 have not resulted in any significant adverse ecological effects, and are therefore consistent with the NZCPS.

Given that implementation of the proposed thresholds and AMF is able to demonstrate no change in effects from that which is already consented, the objectives and policies of the NZCPS will continue to be achieved by this the activities proposed under this consent application.

## 7.6 Auckland Regional Policy Statement 1999

The Auckland Regional Policy Statement (ARPS) sets in place the policy for promoting the sustainable management of the natural and physical resources of the Auckland Region in accordance with the RMA. The AMF has been developed in accordance with the relevant objectives and policies of the ARPS, including those discussed below.

**Objectives under Chapter 7 – Coastal Environment**

| | |
|---|---|
| Objective 1 – | *To preserve the natural character of the coastal environment and to protect it from inappropriate subdivision, use and development.* |
| Objective 2 – | *To protect outstanding natural features and landscapes, areas of significant indigenous vegetation and significant habitats of indigenous fauna, and significant historic and cultural places and areas in the coastal environment.* |
| Objective 3 – | *To enable appropriate subdivision, use and development to be undertaken in the coastal environment.* |
| Objective 4 – | *To enable the use of the coastal environment for appropriate port purposes, other water-related industrial and commercial activities and network utilities.* |

**Objectives under Chapter 10 – Air Quality**

| | |
|---|---|
| Objective 1 – | *To avoid, remedy, or mitigate deterioration of air quality within the Region.* |

<u>Comment</u>

The coastal environment and air quality surrounding the AHB will not be adversely affected by maintenance activities on the AHB undertaken in accordance with the AMF and by managing discharges within the key contaminant thresholds proposed. Such works will be able to be undertaken while achieving the objectives and policies of the ARPS.

As for the achievement of the objectives and policies of the NZCPS discussed in 7.3 above, the proposed thresholds and AMF will not result in any more than a negligible change in effects compared to the existing environment, and will likely result in improvements over time. The objectives and policies of the ARPS will be achieved by the proposal, as the natural character of the coastal environment, outstanding natural features, and significant ecological habitats will not be adversely affected. The proposal also enables communities to provide for their well-being through the maintenance of a critically important transportation and utility link for the region and New Zealand.

As discussed in 7.4 above, the proposal is consistent with the NES:AQ.

## 7.7 Auckland Regional Plan: Coastal

The purpose of the Auckland Regional Plan: Coastal (ARP:C) is to provide a framework to promote the integrated and sustainable management of Auckland's coastal environment. The AMF has been developed in accordance with the objectives and policies of Chapter 20 of the ARP:C, as discussed below.

**Objectives under Chapter 20 – Discharges of Contaminants**

Objective 20.3.1 – *To maintain appropriate water quality and sediment quality and quantity in the coastal marine area and to enhance water and sediment quality where practicable in the parts of the coastal marine area where water and sediment quality is degraded.*

Objective 20.3.2 – *To adopt the Best Practicable Option for preventing or minimising the adverse effects from stormwater and wastewater discharges in the coastal environment.*

**Policies under Chapter 20 – Discharges of Contaminants**

Policy 20.4.1 – *The discharge of contaminants within the coastal marine area shall be avoided where it will result in more than minor modification of, or damage to, or the destruction of:*

- *a. the values of any Coastal Protection Area 1 or Tangata Whenua Management Area; or*
- *b. any site, building, place or area scheduled for preservation in Cultural Heritage Schedule 1.*

Policy 20.4.3 – *Any proposal to discharge contaminants or water into the coastal marine area (unless the discharge is prohibited) shall be considered appropriate only if it can be demonstrated that it is the Best Practicable Option in terms of preventing or minimising the adverse effects on the environment having considered whether:*

- *a. it is practicable or appropriate to discharge to land above Mean High Water Springs;*
- *b. there is a reticulated wastewater system in place that should be utilised;*
- *c. the receiving environment is able to assimilate the discharged contaminants and water after reasonable mixing, with any adverse effects being avoided where practicable, or remedied or mitigated particularly within:*
  - *i. the areas identified in Tables 8.1 and 8.2 and Map Series 5, Sheets 1-4 (Degraded and Susceptible Areas and Areas of High Ecological Value Susceptible to Degradation) of the Auckland Council Regional Policy Statement;*
  - *ii. those Coastal Protection Areas, set out in this Plan, which are based upon ecological rather than geological values;*
- *d. the adverse effects on the present and foreseeable use of the receiving waters after reasonable mixing have been avoided where practicable, or remedied or mitigated, particularly in areas where there is:*
  - *i. high recreational use;*

*ii. relevant initiatives by Tangata Whenua (established under regulations relating to the conservation or management of fisheries) including Taiapure, rahui or Whakatupu areas;*
*iii. the collection of fish and shellfish for consumption;*
*iv. areas of maintenance dredging;*

*e. any adverse effects on people or communities have been avoided where practicable, or remedied or mitigated;*

*f. cleaner production methods which would result in the volume and level of contamination of the discharge being minimised, to the greatest extent practicable have been adequately investigated, and where practicable put in place;*

*g. the discharge after reasonable mixing, does not either by itself or in combination with other discharges, give rise to any or all of the following effects:*
*i. the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;*
*ii. any conspicuous change in the colour or visual clarity;*
*iii. any emission of objectionable odour;*
*iv. any significant adverse effects on aquatic life;*
*v. any significant adverse effects on aesthetics and amenity value;*

*h. the discharge complies with relevant, appropriate and accepted codes of practice and environmental guidelines.*

Comment

Water and sediment quality within the Waitemata Harbour and its embayments is susceptible to the cumulative effects of discharges from surrounding land catchments. Auckland Council has identified a range of contaminants that are the most significant contributors to water and sediment quality reduction, including lead, zinc, and chromium. These contaminants may also be released to the environment during bridge maintenance.

The proposed thresholds and AMF seek to enable the best practicable measures to manage the discharge of these key contaminants and the effects to the environment. Applying the thresholds and AMF to the AHB maintenance activities will achieve the same or better environmental outcomes as currently consented and as a result will maintain, or overall contribute to the improvement in water and sediment quality of the Waitemata Harbour and its embayments.

The AMF approach has been assessed to be the 'Best Practicable Option' for managing AHB maintenance discharges, as it provides for a range of management methods for numerous maintenance activities and situations, as discussed in 2.4 above. The AMF allows for the inclusion of new products and methods to be used which would provide not only greater efficiencies to the Transport Agency, but also potentially reduce the mass of contaminants discharged to the CMA and their resulting environmental effects.

It is relevant to consider that the mass of contaminants and sediment discharged to the Waitemata Harbour and its embayments as a result of the AHB maintenance discharges will be insignificant in contrast to the volume of water within the harbour and its natural hydrological processes.

Given the above, the proposal is consistent with the objectives and policies of the ARP:C.

## 7.8 Auckland Regional Plan: Air, Land, and Water

Discharges to Air are subject to the provisions in the Auckland Regional Plan: Air, Land, and Water (ARP:ALW). The following objectives and policies have been considered in the development of the AMF.

### 7.8.1 Air Quality

**Objectives under Chapter 4 – Air Quality**

Objective 4.3.1 – *To maintain air quality in those parts of the Auckland Region that have excellent or good air quality and enhance air quality in those parts of the Region where it is poor or unacceptable.*

Objective 4.3.2 – *To avoid, remedy or mitigate significant adverse effects from the discharge of contaminants into air on human health, amenity and the environment. In particular:*

- *a. To achieve the National Environmental Standards for Ambient Air Quality and the Auckland Regional Air Quality Targets (given in Tables 4.1 and 4.2);*
- *b. To maintain or enhance existing amenity within the Urban Air Quality Management Areas; and*
- *c. To maintain existing levels of amenity within Industrial and Rural Air Quality Management Areas and the Coastal Marine Air Quality Management Area.*

**Policies under Chapter 4 – Air Quality**

Policy 4.4.3 – *Significant adverse effects from the discharge of contaminants into air from any source shall be avoided; where this is not practicable for the cumulative effects from small sources, the effects of such discharges shall be minimised.*

Policy 4.4.9 – *The Best Practicable Option shall be employed in accordance with the definition in Section 2 of the RMA to avoid or minimise significant adverse effects from the discharge of contaminants into air.*

Policy 4.4.15 – *In assessing the effects of discharges of contaminants into air, particular regard shall be had to:*

- *a. Adverse effects on the environment, including amenity, human health and property;*
- *b. The methods to avoid or minimise adverse effects on the environment;*

c. *The location of the activity and the proximity of other activities sensitive to the discharges;*
d. *Any cumulative adverse effects on the environment;*

Comment

The Air Discharge Assessment (Appendix D) describes the air quality within the area of the AHB as characteristic of an urban/coastal environment. The discharge of airborne particles and contaminants resulting from bridge maintenance activities are to be managed in ways that will comply with the air quality standards within the NES:AQ, the ARP:ALW, and other relevant standards and guidelines. Where discharges to air would otherwise fail to meet those standards and guidelines, the AMF identifies methods (wind speed and directional controls and buffer zones (via the EMP) that result in less than minor effects on sensitive receivers.

As discussed in 6.0 above, the Air Discharge Assessment Report (Appendix D) has identified odour, nuisance and human health effects as the key concerns regarding discharge to air. Given the length of the bridge and its location within the Waitemata Harbour, sensitive receivers such as residences, businesses, and recreational users are generally at such a distance that no effects occur. The areas around each bridge abutment have been identified as potential sensitive receivers, although monitoring undertaken indicates that maintenance activities can be managed in a way so that adverse effects arising from discharges to air are avoided or minimised

The proposed approach is concluded to be the best practicable option and the AMF approach along with the proposed conditions will enable the activity to be undertaken in a way that avoids adversely affecting any parties. Given this and the above, the proposal is consistent with the air quality objectives and policies in the ARP:ALW Chapter 4.

### 7.8.2 Discharges to Land

**Objectives under Chapter 5 – Discharges to Land and Water and Land Management**

Objective 5.3.1 – *To protect, maintain, or enhance the quality of land and water in the Auckland Region by:*

*(a) Maintaining areas of high environmental quality;*
*(b) Minimising adverse effects on degraded natural and physical resources where these cannot be avoided; and*
*(c) Enhancing degraded areas where practicable.*

**Policies under Chapter 5 – Discharges to Land and Water and Land Management**

Policy 5.4.44 – *Reuse of washwater will be encouraged. Washwater disposal to land will be acceptable where it will not result in contaminant runoff or the accumulation of contaminants, such as hydrocarbons and heavy metals, above acceptable levels in the receiving environment. Washwater should only be discharged to water where other options including disposal to the sanitary sewer are impractical, and a thorough evaluation of the assimilative capacity of the receiving* *environment has been carried out proving the discharge will not give rise to any significant adverse effects.*

Comment

Key contaminant discharges to land from maintenance activities are proposed to be minimised as afar as reasonably practicable. Abrasive blasting discharges, and washwater discharges will be managed to meet Permitted Activity criteria. Considering this, and the expectation that overall contaminant discharge levels are likely to be reduced from the authorised 15% dry discharge under the existing consents, the proposal is consistent with the objectives and policies of the APR:ALW Chapter 5.

## 7.9 Proposed Auckland Unitary Plan

### 7.9.1 Discharges to the Coastal Marine Area

**Objectives under C.5.1.10 – Discharges to the General Coastal Marine Zone**

Objective 1 – *Water and sediment quality in the CMA is maintained and degraded areas enhanced.*

Objective 2 – *The mauri of coastal water is maintained and, where possible, restored to enable traditional and cultural use of the coast and its resources by Mana Whenua.*

Objective 3 – *The life-supporting capacity and natural resources, including kaimoana, of the Hauraki Gulf, are protected and, where appropriate, enhanced.*

Objective 6 – *Other discharges, including those from boats and land, are managed to minimise adverse effects on coastal water quality and ecosystems.*

**Policies under C.5.1.10 – Discharges to the General Coastal Marine Zone**

Policy 1 – *Allow discharges that are consistent with the best practicable option (BPO) approach for preventing or minimising the adverse effects from stormwater and wastewater discharges in the coastal environment.*

Policy 3 – *Avoid the discharge of contaminants where it will result in significant modification of, or damage to any areas identified as having significant values.*

Policy 4 – *Require any proposal to discharge contaminants or water into the CMA to adopt the BPO to prevent or minimise adverse effects on the environment, having regard to whether:*

*a. it is practicable or appropriate to discharge to land above MHWS*
*b. there is a reticulated wastewater system in place that should be used*
*c. contaminants in the discharge are minimised*

*d. the receiving environment has the capacity to assimilate the discharged contaminants after reasonable mixing, particularly within areas identified as having significant ecological value*

*e. the adverse effects on the present and foreseeable use of the receiving waters after reasonable mixing have been avoided, remedied or mitigated, particularly in areas where there is:*

*i. high recreational use*

*ii. relevant initiatives by Mana Whenua established under regulations relating to the conservation or management of fisheries*

*iii. the collection of fish and shellfish for consumption*

*iv. areas associated with maintenance dredging.*

*f. cleaner production methods would result in the volume and level of contamination being reduced to the greatest extent practicable*

*g. the discharge after reasonable mixing results in any of the following effects:*

*i. oil or grease films, scums or foams, or floatable or suspended materials*

*ii. conspicuous change in the colour or visual clarity*

*iii. any emission of objectionable odour*

*iv. any significant adverse effects on aquatic life*

*v. any significant effects of aesthetic or amenity values.*

*vi. the discharge complies with relevant, appropriate and accepted codes of practice and environmental guidelines.*

Comment

The proposal is consistent with the above objectives and policies. The objectives and policies of the PAUP relevant to discharges to the CMA are similar or identical to those within the RPS and the ARP:C. As such, the reasons why the proposal meets the relevant objectives and policies of the PAUP are described in detail in 7.6 and 7.7 above.

### 7.9.2 Air Quality

**Objectives under C.5.1 – Air Quality**

Objective 1 – *Air quality is maintained in those parts of Auckland that have excellent or good air quality, and air quality is enhanced in those parts of Auckland where it is poor.*

Objective 2 – *Air discharges, including PM10 and PM2.5 (particle pollution, or particulate matter), are reduced to protect public health and amenity, and to meet national and Auckland Ambient Air Quality Standards (AAAQS) in Table 1.*

Objective 3 – *Human health, amenity values, property and environment are protected from significant adverse effects of air contaminants.*

**Policies under C.5.1 – Air Quality**

Policy 1 – *Protect human health by requiring that air discharges do not cause air quality to exceed the AAAQS in Table 1 for the specified contaminants, and manage the discharge of other contaminants so that the adverse effects on human health, including cumulative adverse effects, are minimised.*

Policy 4 – *Manage the air quality amenity in the CMA and urban areas by:*

*a. avoiding offensive or objectionable odour, dust, particulate, ash, smoke, fumes, overspray and visible emissions*
*b. avoiding any significant adverse effects from industrial or rural activities air discharges*
*c. having adequate separation distances and best management practices for industrial or rural activities*
*d. minimising adverse air quality effects from urban and marine activities. Retain soil and sediment on the land, and not discharge it to water bodies and coastal water by use of best sediment and erosion control practices*

Policy 12 – *Avoid or minimise air discharges by:*

*a. using best management practices*
*b. adopting a precautionary approach where there is uncertainty and a risk of serious effects or irreversible harm to the environment from air discharges*
*c. using best practicable option emissions control at the source of the discharge*
*d. avoiding air discharges that will cause significant adverse effects.*

Policy 13 – *Avoid significant adverse effects from air discharges beyond the boundary of the premises where the discharge is occurring, including:*

*a. Noxious or dangerous effects on human health, property, or the environment from hazardous air pollutants*
*b. offensive or objectionable effects on amenity values from odour, dust, particulate matter, smoke, ash, fumes and visible emission*
*c. Overspray effects on human health, property or the environment*

Policy 14 – *Require individual sources of any discharge to air to demonstrate where relevant to the discharge type and reasonably practicable:*

*a. Low-emission fuels are used*
*b. Energy is efficiently used*
*c. Best practicable option is used*
*d. fugitive emissions are minimised*
*e. risk and adverse effects on people, property and the environment from hazardous air pollutants are avoided*
*f. the amenity provisions of any zone where the discharge is having an effect are met*
*g. recognised best-practice management and emission control standards are met*

*h. there are adequate separation distances to activities sensitive to air discharges*
*i. significant adverse effects on flora and fauna, particularly where they are food sources or in areas identified as SEAs both on land and in the CMA are avoided.*

Comment

As discussed in 6.0 above, effects of discharges from maintenance activities on the AHB will not adversely affect the ambient air quality when works are undertaken in accordance with the proposed AMF and remain within the thresholds and concentrations proposed for the key contaminants. In particular buffer zones will be set in the EMP for certain contaminants to achieve this outcome and avoid effects on sensitive receivers. In addition it is likely that a form of containment under the EMP will be used to manage overspray on neighbouring properties to avoid this type of nuisance effects and therefore avoid triggering any adversely affected parties.

The proposal is considered to be the best practicable option and proposed conditions can enable the activity to be undertaken in a way that is consistent with the Air Quality objectives and policies of the PAUP.

# 8 Mana Whenua Consultation

In the process of preparing this application, the Transport Agency has undertaken engagement with Iwi. Initially groups that were known to have Mana Whenua status and had previously engaged with the agency over AHB matters were directly communicated with, informed of the proposal and invited to comment.

Subsequently groups that have identified Mana Whenua status identified by local board area were sent emails explaining the proposal using Auckland Council's Mana Whenua Consultation Database. Table 8.1 below summarises all communications with iwi and their responses. A complete record of email communications is provided in Appendix F.

An onsite hui was schedule for 14 October 2014 with invitations extended to representatives from Ngati Whatua, Ngai Tai ki Tamaki, Te Kawerau a Maki and Ngati Paoa. All invitees were either unable to attend or did not respond. A hui for a proposal relating to the AHB is scheduled for November and the NZ Transport Agency will use that forum to continue keeping mana Whenua briefed and engaged on this consent application.

**Table 8.1. Summary of iwi consultation - communication and responses.**

| Iwi | Contact Person | Communication | Response |
|---|---|---|---|
| **Te Runganga o Ngāti Whātua** | Tame Te Rangi | Emails –<br>25/07/2014<br>09/09/2014<br>1/10/14 | Email 29/07/2014 – Deferred to Ngati Whatua o Orakei . Invited to Hui. No response received. |
| **Ngati Whatua o Kaipara** | Glen Wilcox, then Michele ? | Emails –<br>25/07/2014<br>09/09/2014 | No response received |
| **Ngāti Whātua o Ōrākei** | Pani Gleeson | Emails –<br>27/05/2014<br>25/07/2014<br>09/09/2014<br>1/10/14 | No response received |
| **Te Kawerau a Maki** | Edward Ashby | Emails –<br>27/05/2014<br>25/07/2014<br>09/09/2014<br>1/10/14 | Email 28/05/2014 - Positive response to an application that would maintain or reduce discharges. Sought a meeting. Invited to hui. Unable to attend but asked to be kept informed. |

| | | | |
|---|---|---|---|
| **Ngāi Tai ki Tāmaki** | David Beamish | Emails – 27/05/2014 25/07/2014 09/09/2014 1/10/14 | Email 25/7/2014 - Seeks best environmental outcome while acknowledging this is not always possible. Sought information on how long consent is for and whether the new consent would preclude future improvements in technology, techniques or methods. Invited to Hui. No response received. |
| **Ngāti Tamaoho** | Ted Ngataki | Emails – 25/07/2014 09/09/2014 | No response received |
| **Te Patukirikiri** | David Williams | Emails – 25/07/2014 09/09/2014 | No response received |
| **Ngāti Te Ata Waiohua** | Karl Flavell | Emails – 25/07/2014 09/09/2014 | No response received |
| **Te Akitai Waiohua** | Nigel Denny | Emails – 25/07/2014 09/09/2014 | No response received |
| **Ngāti Paoa** | Lucy Tukua | Emails – 27/05/2014 25/07/2014 09/09/2014 7/10/2014 | No response. Invited to Hui. Could not attend. Provided with the MEA for understanding of eco-toxicity effects. |
| **Ngāti Whanaunga** | Nathan Kennedy | Emails – 25/07/2014 09/09/2014 | No response received |
| **Ngāti Maru** | Geoff Cook William Peters Nikky Fisher | Emails – 25/07/2014 09/09/2014 | Email 08/09/2014 – Confirmed interest in area and that they are not opposed to this application and no further consultation or CIA is required. |
| **Ngāti Tamaterā** | Liane Ngamane | Emails – 25/07/2014 09/09/2014 | No response received |

# 9 Proposed Draft Conditions

Conditions applying to Permits 38519, 38835, and 38836 have been used as a basis to develop draft conditions for this consent application. Overall, any changes made in the existing conditions reflect the proposed replacement of the prescribed discharge containment methodology with the proposed AMF. The conditions are proposed as a draft for discussion with Council.

## Proposed General Conditions

**A. GENERAL**

1. Pursuant to section 36 of the Resource Management Act 1991, consents XXXXX and XXXXX (or any part thereof) shall not be exercised until such time as all charges in relation to the receiving, processing and granting of these resource consents are paid in full.

2. The consents referenced XXXXX and XXXXX shall expire on XX Month 2040 unless they have lapsed, been surrendered or been cancelled at an earlier date pursuant to the Resource Management Act 1991.

3. Access to the relevant parts of the AHB shall be available at all reasonable times to enable the servants or agents of the Auckland Council to carry out inspections, surveys, investigations, tests, measurements or take samples whilst adhering to the Consent Holder's health and safety policy.

**Review Condition**

4. The activities granted under these consents shall be operated in accordance with the documentation submitted to the Auckland Council, particularly the Auckland Harbour Bridge Adaptive Management Framework (AMF), as part of applications numbered XXXXX and XXXXX, where not amended by the conditions of this resource consent. The conditions of this consent may be reviewed by the Major Infrastructure Team Manager pursuant to Section 128 of the Resource Management Act (1991), by the giving of notice in accordance with Section 129 of the Act, on XX Month 2016 and annually thereafter in order to:

   a. Deal with any significant adverse effect on the environment arising from the exercise of the consent that was not foreseen at the time that the application was considered;

   b. Consider the adequacy of conditions that prevent nuisance beyond the boundary of the site, particularly if complaints have been received on a frequent basis and which have been validated by an enforcement officer; and

   c. To take into account any act of parliament, regulation, national policy statement or relevant regional plan that relates to limiting, recording or reducing emissions authorised by this consent.

**Documentation**

5. The documentation below, submitted in support of the application, forms part of this consent and supplies reference information for these permits:

   a. Report: 'Auckland Harbour Bridge Maintenance Discharge Assessment of Environmental Effects' prepared by Beca dated August 2014 including appendices A-F.

**Navigation and Safety**

6. The Consent Holder shall notify the Harbourmaster's Office in writing 10 (ten) working days prior to commencing any maintenance works within the main navigation span of the AHB specifying the duration, nature and location of works. The consent holder shall advise the Harbourmasters Office a minimum of 24 hours prior to any change in works duration, nature or location.

7. The Consent Holder shall notify the Harbourmaster's Office and the Pollution Response Team in the case of any spill of hydrocarbons which enters the Waitemata Harbour from the AHB and, in which event, the Spill Response Plan will immediately be deployed as required by the provision of the Spill Response Plan required by Condition 13.

**B. ADAPTIVE MANAGEMENT FRAMEWORK (AMF)**

8. The consents shall be implemented in accordance with the AMF. Where there is conflict between the consent conditions and the AMF, the consent condition shall prevail unless alternative agreement is reached between the Consent Holder and the Major Infrastructure Team Manager.

9. The purpose of the AMF is to enable maintenance activities on the Auckland Harbour Bridge in a flexible and practicable way and to provide for discharges to the environment that avoid remedy or mitigate significant adverse effects by maintaining or reducing discharges within prescribed thresholds. To achieve this purpose the Consent Holder shall undertake the maintenance activities following the process as set out in the AMF (Appendix A of the application documents listed in condition 5 above).

**Key Contaminant Thresholds**

10. In achieving the purpose of the AMF the Consent Holder shall not exceed the following thresholds:

| Contaminant | Recommended Thresholds |
|---|---|
| $PM_{10}$ / Total Suspended Particulates | PM10 total: 31 kg/annum (2011 consent baseline for abrasive blasting)<br>PM10 (acute - 24hr): 50µg/$m^3$ (MfE)<br>TSP (acute - 24hr): 80µg/$m^3$ (MfE) |
| Garnet Sand / Dust | Coastal: 14,679 kg/annum (2011 consent baseline) |
| Zinc | Air (acute 1hr): 20µg/$m^3$ (TCEQ ESL)<br>Coastal: 223 kg/annum (2011 consent baseline) |
| Lead | Air (acute 0.5hr): 1.5g/$m^3$ (Ontario Ministry for the Environment) |
| Chromium | Air (acute 1hr): 3.6µg/$m^3$ (TCEQ ESL) |
| Iron | Air (acute 1hr): 50µg/$m^3$ (TCEQ ESL) |
| Volatile Organic Compounds (VOCs) | Xylene: Air (odour 1hr): 350µg/$m^3$ (TCEQ ESL)<br>Toluene; Air (odour 1hr): 640µg/$m^3$ (TCEQ ESL)<br>Naptha: Air (odour 1hr): 3500µg/$m^3$ (TCEQ ESL)<br>Ethylbenzene; Air (odour 1hr): 740µg/$m^3$ (TCEQ ESL)<br>Methyl Isobutyl Ketone: Air (odour 1hr): 820µg/$m^3$ (TCEQ ESL) |
| Diisocyanates | Air (acute 1hr): 50µg/$m^3$ (TCEQ ESL) |
| Paint | Coastal: 646kg/annum (2011 consent baseline) |

**Environmental Management Plan**

11. To demonstrate how the thresholds in Condition 11 shall be achieved the Consent Holder shall submit an updated EMP to the Major Infrastructure Team Manager for written approval within 60 (sixty) working days of the commencement of this consent. The Manager shall have 20 working days from receipt of the EMP to seek changes otherwise the EMP shall be considered to be endorsed by the Manager.

12. The EMP is a 'live' document. At any time across the duration of this consent, the consent holder shall be entitled to resubmit modifications to the content to change or improve the processes used to give effect to this consent. The Manager shall have 20 working days from receipt of a revised EMP to seek changes otherwise the EMP shall be considered to be endorsed by the Manager.

13. The EMP shall provide for, but not be limited to, addressing the following matters:

    a. Methodologies (including work instructions / site audit forms / buffer zones and similar processes) designed to manage discharges within the thresholds including but not limited to the following maintenance activities:

- Washdowns
- Waterblasting
- Dry abrasive blasting
- Wet abrasive blasting
- Exterior steelwork painting (including priming, inhibitors, and paints)

b. Implementation of continuous improvement processes to modify the EMP performance in pursuit of the AMF purpose;

c. A Spill Response Plan and measures to ensure the Spill Response Plan is operational at all times;

d. Confirmation that any plant or equipment will meet applicable noise controls in the coastal environment ;

e. Any conditions when maintenance works will cease or not be carried out (e.g. wind speed, wet weather) within certain areas (e.g. buffer zones);

**Monitoring**

14. To enable summary reporting on compliance with the annual discharge thresholds the EMP shall identify methods and frequency of monitoring which shall include the following;

a. Activity carried out: waterblasting, wet abrasive blasting, dry abrasive blasting, or spray painting;

b. Location where work was carried out: Coast or land;

c. Surface area the activity was carried out on (m2);

d. If abrasive blasting, the amount of agent used (kg), lead content at that location;

e. If painting, the amount of paint used (L), and an estimate of the overspray (%) (and guidance on how to estimate this);

f. If containment has been used, an estimate of the percentage of containment achieved (and guidance on how to estimate/ determine this); and

g. If working within Buffer Zones, the wind speeds and direction.

**Reporting**

15. The Consent Holder shall submit to the Major Infrastructure Team Manager an annual report containing a summary of the results of the monitoring data collected in accordance with condition 14 to demonstrate compliance with condition 10 (contaminant thresholds). The annual monitoring report shall also include details of any new method or product that has been trailed using the adaptive process within the AMF under conditions 16 and 17 and outline how the steps of this process have been satisfied and any recommended

amendments to the EMP. The Manager shall have 20 working days from receipt of the report to seek changes or clarifications otherwise the report shall be considered to be endorsed by the Manager.

**Adaptive Process**

16. To achieve the AMF purpose the consent holder may utilise the adaptation process within the AMF. This process can be used to test and trial new products and methods to demonstrate satisfaction of the 4 step adaptation process that is guided by the supporting technical sheets that prescribe the testing and trial methodology. Field trailing of new products shall be limited to a maximum area of 100m$^2$ unless alternative agreement is reached between the Consent Holder and the Major Infrastructure Team Manager.

17. Any future amendments to the EMP or plans therein resulting from the implementation of the consent or from the implementation of the adaptation process within the AMF under condition 12 shall be forwarded to the Major Infrastructure Team Manager. The Manager shall have 20 working days from receipt of a revised EMP to seek changes otherwise the EMP shall be considered to be endorsed by the Manager..

## C. DISCHARGE SPECIFIC CONDITIONS

**Air**

18. Air discharges from maintenance activities, including but not limited to, abrasive blasting and painting, shall be managed by controls, including but not limited to, buffer zones, wind speed, wind direction and containment to meet all the relevant thresholds.

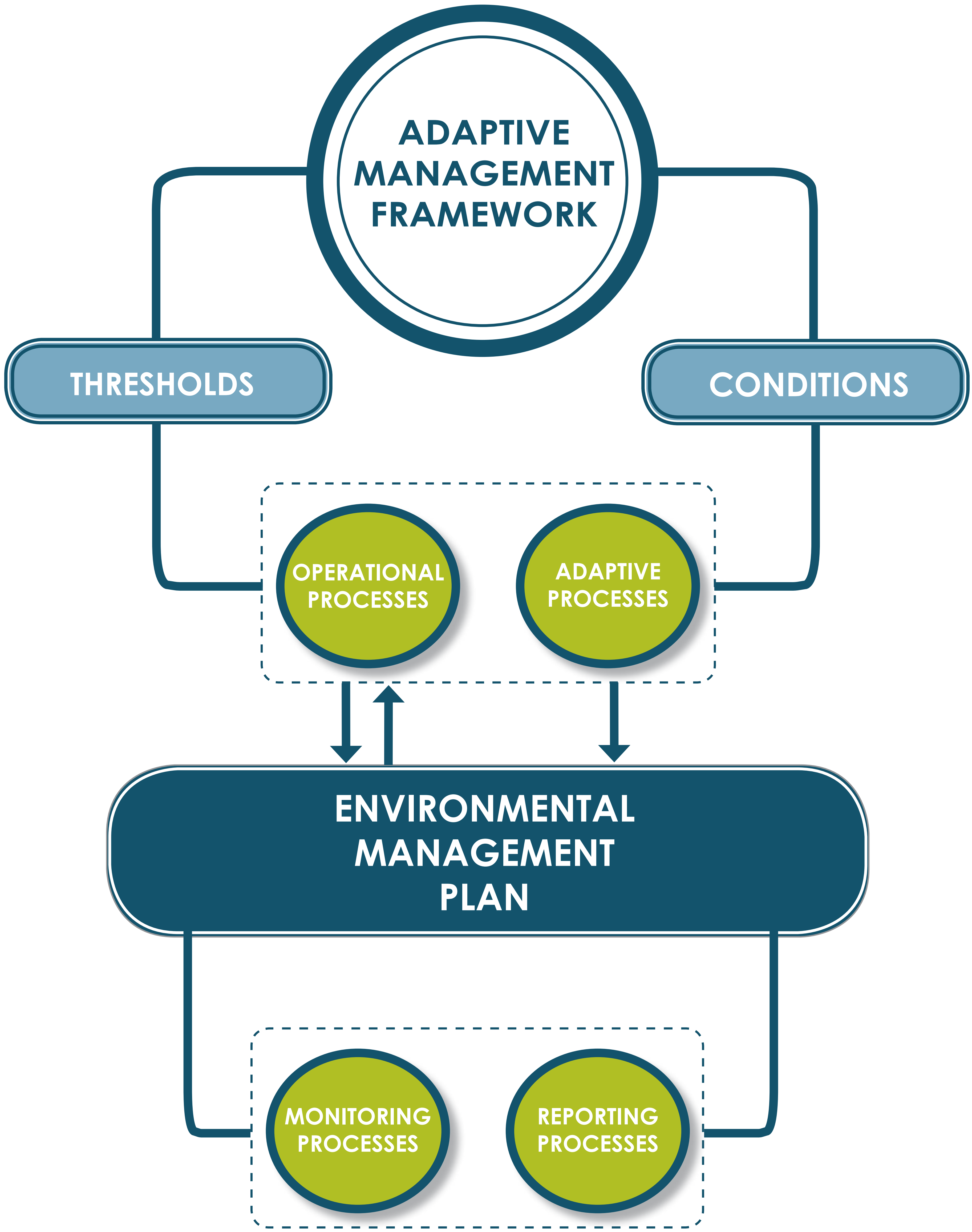
19. Controls for air discharges from maintenance activities are to be detailed in the Environmental Management Plan (EMP).

# Appendix A

## Adaptive Management Framework

# AUCKLAND HARBOUR BRIDGE

ADAPTIVE MANAGEMENT FRAMEWORK



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# AUCKLAND HARBOUR BRIDGE

## ADAPTIVE MANAGEMENT PROCESSES

### OPERATIONAL PROCESS

**MAINTENANCE METHODS**

Including:

- Abrasive blasting
- Spray and painting
- Washwater

**VARIABLES**

- Bridge location
- Duration
- Volume
- Receive Environment Sensitivity

**KEY DISCHARGES**

e.g.

- Zinc
- Lead
- Garnet sand
- PM10
- Paint

**EFFECTS**

- Toxicity
- Health
- Sedimentation
- Nuisance

**MITIGATION**

- Maintenance Methods
- Wind Speed Limits
- Restrictions on:
  - Bridge location
  - Duration
  - Volume
- Containment
- Buffer Zones

### MONITORING PROCESS

**MONITORING**

- Operational Model
- Contaminant Discharges Model

**NEW METHOD/ PRODUCT?**

yes

no

### REPORTING PROCESS

**REPORTING**

- Thresholds met
- Any new methods/ products
- Any updates to the Environmental Management Plan

### ADAPTATION PROCESS

**1 IDENTIFY KEY CONTAMINANTS AND METHODS**

Reference material:

- Safety Data Sheets (SDS)
- Manufacturers specifications for equipment and methods

Key Tasks

- Define contaminant characteristics
- Carry out toxicity testing (if required)
- Identify assumptions e.g. rate of discharge etc.
- Carry out testing to confirm assumptions (if required)
- Refer technical sheets for land/coast/air discharges

Key Question

Is there adequate information available to understand effects of product/method?

yes

no

Discard option, re-evaluate and start again, or obtain new/ vary consent

**2 DETERMINE HOW WILL DISCHARGE BE REGULATED**

Reference material:

- Contaminant Discharge Model Summary – inputs, outputs and assumptions
- Relevant Guidelines/ standards

Key Tasks

**Thresholds**

- Incorporate new methods/ controls/contaminant information into contaminant discharge model
- Update assumptions in the model
- Calculate discharges

**Guidelines or Standards***

- Determine relevant guidelines or standards
- Undertake sampling during product/method trial

* Refer to technical sheets for land/coast/air discharges

**3 IDENTIFY AND ASSESS EFFECTS**

Reference material:

- Outputs from Step 1 and 2

Key Tasks

- Check if contaminant effects are within scope of maintenance consent/Auckland Council Plans Permitted Activity criteria
- Assess and set thresholds for new contaminants (if required) based on no change in effects
- Determine whether mass discharge is within contaminant discharge thresholds
- Carry out air dispersion modelling (if required)

Key Question

Is discharge within effects scope* and thresholds?

*Refer to technical sheets

yes

no

Can new effects or an effect above a threshold be avoided?

yes

no

Product/method is outside scope of the maintenance consent

**4 UPDATE OPERATIONAL DOCUMENTS**

Reference material:

- Operational Model
- Existing EMP / AMF

Key Tasks

- Update operational model
- Update Environmental Management Plan and procedures
- Submit to Council

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Auckland Harbour Bridge
Part of Auckland Motorways

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# AUCKLAND HARBOUR BRIDGE

## ADAPTIVE MANAGEMENT PROCESS - COASTAL TECHNICAL SHEET

REQUEST AND REVIEW MATERIAL SAFETY DATA SHEET

Identify components

Request toxicology test data/reports from the manufacturer

Research water quality guidelines with components and create a list of thresholds

If toxicity testing is not comprehensive - engage toxicity laboratory to carry out acute and chronic toxicity testing* on algae amphipod and blue mussels

Compare toxicity results with existing products used based on the following acute and chronic toxicity descriptive categories (Tables 1&2)

Table 1 - Acute Toxicity

| Description | $EC_{50}$ (mg/L) |
|---|---|
| Non-toxic | >1000 |
| Practically non-toxic | >100 - <1000 |
| Slightly toxic | >10 - <100 |
| Moderately toxic | >1 - <10 |
| Highly toxic | >0.1 - <1 |
| Very highly toxic | >0.01 - <0.1 |
| Extremely toxic | <0.01 |

Table 2 - Chronic Toxicit

| Description | NOEC (mg/L) |
|---|---|
| Negligible | >1 |
| Low | >0.1 - < 1 |
| Moderate | >0.01 - < 0.1 |
| High | >0.001 - < 0.01 |
| Very high | < 0.001 |

*Using standard USEPA toxicity testing protocols

Compare contaminants to consented contaminant thresholds where appropriate

If product meets consented contaminant thresholds and toxicity characteristics of existing products, update Environmental Management Plan or model to include new product

Introduce product to maintenance regime

**Consented Effects:**

**Eco-toxicity**
- Practically non-toxic from acute toxicity testing;
- Negligible effects from chronic toxicity testing;

**Smothering - Garnet Sand**
- Up to 3mm accumulative layer of abrasive material

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# AUCKLAND HARBOUR BRIDGE

## ADAPTIVE MANAGEMENT PROCESS - LAND TECHNICAL SHEET

### STEP 1

**Is the product/ method substantially the same as existing product/ method?**
(e.g. new brand of the same type of coating system)

Key Tasks
- Check SDS for any new contaminants
- Check SDS for proportion of key contaminants
- Check manufacturer specification for details of application method

yes → STEP 4
no → STEP 2

### STEP 2

**Doe the product/ method dispearse contaminants into the air that could deposit onto land?**

yes → STEP 5
no → STEP 3

### STEP 3

**Can the product/ method be used as Permitted Activity under the relevant council plans?**

Key Tasks
- Check product and method against the Auckland Council Regional Plan: Air Land and Water and Proposed Auckland Unitary Plan rules to determine if it can meet the PA requirements.
- Determine whether any new controls are needed to meet PA requirements.

yes → STEP 5
no → RESOURCE CONSENT REQUIRED

### STEP 4

**Can the discharge from the product/ method be controlled or contained to ensure the discharge to land and any effects are negligible?**

Key Tasks
- Determine whether any new controls are needed to ensure the discharge is negligible.

yes → STEP 5
no → RESOURCE CONSENT REQUIRED

### STEP 5

**New product/ method approved for use, update operational documents.**

Key Tasks
- Add new controls to EMP
- Add new product/ method into operational model

### RESOURCE CONSENT REQUIRED

**Consented Effects:**
Less than minor effects from discharges that meet permitted activity standards / controls in the relevant regional plan.

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# AUCKLAND HARBOUR BRIDGE

## ADAPTIVE MANAGEMENT PROCESS - AIR TECHNICAL SHEET

### When a new product is to be used the following is process shall be followed:

**1** Request and review Material Safety Data Sheet for the product

**2** Identify components of the product

**3** Research air quality guidelines associated with components and create a list of thresholds (if not already covered)

**4** Assess the proposed product or activity against the relevant Auckland Plan Rules or statutory requirements outlined in the consent

**5** Define mitigation measures to be used with new products e.g. preparation method, application method, duration of application method, wind restrictions, screens, buffer zones, containment

**6** Carry out trial of the product which will require;

- Ambient air quality monitoring; and/or
- Air dispersion modelling.

**7** Compare results with thresholds and assess effectiveness of mitigation measures. Implement more mitigation where required to achieve thresholds and ensure that the offsite effects are the same or less than what has been authorised *

**8** If product meets thresholds (ambient air quality guidelines) update EMP to include new product and associated mitigations

**9** Introduce product to maintenance

**10** Update operational model to include the new discharge rate (where applicable)

### When a new method is to be used the following is process shall be followed:

**1** Review the methodology and determine discharges to air

**2** Assess the proposed activity against the relevant Auckland Plan Rules or statutory requirements outlined in the consent

**3** Research air quality guidelines associated with components and create a list of thresholds (if not already covered)

**4** Define mitigation measures to be used with new method, e.g. wind restrictions, screens, buffer zones and containment

**5** Carry out trial of the methodology which will require;

- Ambient air quality monitoring; and/or
- Air dispersion modelling

**6** Compare results with thresholds and assess effectiveness of mitigation measures. Implement more mitigation where required to achieve thresholds and ensure that the offsite effects are the same or less than what has been authorised *

**7** Introduce method to maintenance

**8** If method meets thresholds (ambient air quality guidelines) update EMP to include new product and associated mitigations

***Consented Effects:**

Human Health

- Thresholds in accordance with the most relevant national standards or international or national best practice guidelines that result in discharge concentrations that do not cause adversly affected parties or human health effects.

# Appendix B

## Marine Ecology Assessment (Boffa Miskell, September 2014)

# AUCKLAND HARBOUR BRIDGE

Marine Ecology Assessment – Maintenance Discharges
Prepared for Total Bridge Services

3 September 2014

Boffa Miskell

## Document Quality Assurance

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# 1.0 Introduction

The Auckland Harbour Bridge (AHB) is located within the Central Waitemata Harbour, Auckland. During routine maintenance of the AHB some contaminants are discharged to the Coastal Marine Area (CMA) (i.e. Waitemata Harbour). The mass of the existing consented discharges are converted to thresholds. This report assesses the effects of those currently consented discharges, based on these thresholds, on the marine ecological values that are present based on information that is currently available in the scientific literature and Auckland Council's monitoring reports.

## 1.1 Waitemata Harbour

The Waitemata Harbour is located on the east of the Auckland isthmus on the Hauraki Gulf and is described as a drowned river valley and extends from Riverhead in the north-west to Tamaki River in the east (Swales et al. 2008). The total surface area of the harbour is approximately 80 $km^2$, making it the largest estuary on the Auckland region east coast (Swales et al. 2008).

The harbour comprises a main channel with a depth of approximately 17 metres, with a large number of tidal creeks, bays and inlets (Swales et al. 2008). A wide range of marine habitats are present within the harbour, including intertidal flats, sandy beaches, deep channels, and sandstone and basalt reefs (Auckland Council 2011).

The harbour can be divided into the Central Waitemata Harbour (CWH) extending from the harbour mouth to Catalina Bay, and Upper Waitemata Harbour (UWH) from the bay to Riverhead. The AHB and surrounding marine environment is located within the CWH.

Maritime traffic within the Waitemata Harbour includes both recreational and commercial vessels.

## 1.2 Central Waitemata Harbour (CWH)

The CWH contains a number of large intertidal embayments including Hobson Bay on the southern shore, and Shoal Bay and Ngataringa Bay on the northern shore (Figure 1). Extensive intertidal flats and mangrove (*Avicennia marina* subsp. *australasica*) stands are present in the central basin and western areas.

Meola Reef (Te Tokaroa) extends 2.5 km across the central part of the harbour and is located approximately 3 km west from the AHB. Close to shore the reef is covered in mangroves and saltmarsh, and intertidal rocky habitats are exposed at low tide (Shears 2010).

The Motu Manawa (Pollen Island) marine reserve occurs to the west of the central basin and includes intertidal mud flats, mangroves, saltmarsh and shell banks.

Shoal Bay incorporates shellbanks, landforms, saline vegetation (saltmarsh and mangroves), and intertidal flats that are important feeding and roosting grounds for resident and migratory shorebirds. The Proposed Auckland Unitary Plan recognises a mosaic of Significant Ecological Areas (both category 1 and 2) within the Coastal Marine Area (CMA) of Shoal Bay. These ecological areas are the same as the Coastal Protection Areas 1 and 2 identified in the Operative Auckland Regional Plan: Coastal.

The Department of Conservation (DOC) recognises Shoal Bay as an Area of Significant Conservation Value (ASCV). The Bay is also classified as a Site of Ecological Significance (SES), a Site of Significant Wildlife Interest (SSWI), and a Significant Natural Heritage Area (SNHA).

## 1.3 Hydrodynamic Environment of CWH

The CWH has strong tidal currents (Swales et al. 2008) and small waves due to the narrow, enclosed form of the harbour (Auckland Council, 2011).

Hydrodynamic modelling carried out by Green (2008) suggests that the ultimate fate of most of the discharges originating from the AHB is the wider Hauraki Gulf, with approximately a quarter of the discharges on the northern side of the bridge being retained in Shoal Bay.

Green (2008) modelled the sources and accumulation of stormwater contaminants and sediment within subcatchments of the CWH (Figure 2).

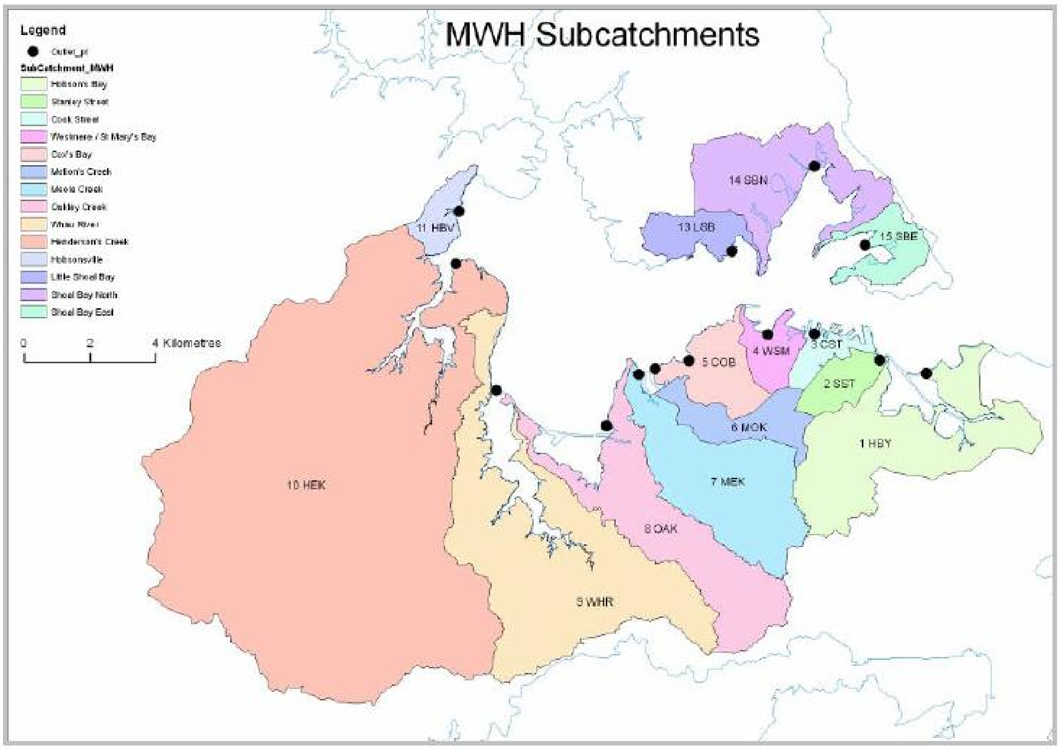


Figure 2: Division of the Central Waitemata Harbour into subcatchments (from Green, 2008, Figure 2, page 19).

Of relevance to the AHB and assessment of effects relating to maintenance discharges to the CMA, the modelling indicates the following:

- Henderson Creek (HEK) and Whau River (WHR) subcatchments were the primary sources of zinc and copper in the harbour, followed by Oakley Creek (OAK) and Shoal Bay North (SBN).
- 95% of sediment discharged from Westmere / St Mary's (WSM) (i.e. the catchment containing the southern AHB abutment) discharges to the wider Hauraki Gulf and 1% to Shoal Bay.

- Very little of the sediment from the four subcatchments that drain the southern shore of the harbour throat ultimately deposits in Shoal Bay due to the natural constriction which is spanned by the AHB.
- Shoal Bay receives sediment and metals from every subcatchment, excluding the four on the southern shore.
- Sedimentation rates in Shoal Bay are high.
- 67% of sediment discharged from Little Shoal Bay (i.e. the catchment containing the northern AHB abutment) discharges to the wider Hauraki Gulf, with 24% retained in Shoal Bay.
- Of the zinc load in Shoal Bay:
    - 23% from Henderson Creek catchment;
    - 18% from Shoal Bay North (SBN) catchment;
    - 11% from Whau River (WHR) catchment;
    - 10% from Oakley Creek (OAK);
    - 10% from Motions Creek (MOK);
    - 10% from the upper Waitemata Harbour (UWH);
    - 7% from Meola Creek (MEK); and
    - Remainder from Coxs Bay (COB), Hobsonville (HBV), Little Shoal Bay (LSB) and Shoal Bay East (SBE).

# 2.0 Marine Ecological Values

Marine ecological values for the areas adjacent to the AHB and Shoal Bay, within the Central Waitemata harbour, are discussed in the following sections.

## 2.1 Sediment Quality

Mills et al. (2012) investigated the current contamination status of Auckland's estuaries, including the Waitemata Harbour, in addition to temporal trends between 1998 and 2010. The authors observed that the highest contaminant concentrations were generally in the muddy upper reaches of the CWH, which receive runoff from highly urbanised and industrialised catchments. Contaminant concentrations at sites surveyed adjacent to the AHB (see Figure 2.1, page 8, TR2012/041) were typically in the green Environmental Response Criteria (ERC) threshold range. The exceptions are an elevated lead concentration at Shoal Hillcrest (amber) and HMW-PAHs at Chelsea (red) (Table 1).

**Table 1: Sediment quality adjacent to the AHB (Mills et al., 2012).**

| Contaminant (mg\kg) | ERC Green | ERC Amber | ERC Red | Chelsea | Shoal Hillcrest | Shoal Lower | Shoal Upperr | Coxs Creek | Meola Reef |
|---|---|---|---|---|---|---|---|---|---|
| Copper (Cu) | <19 | 19-34 | >34 | 7.0 | 17.0 | 5.4 | 4.6 | 5.0 | 9.6 |
| Lead (Pb) | <30 | 30-50 | >50 | 15.3 | 32.0 | 11.0 | 12.0 | 14.1 | 21.0 |
| Zinc (Zn) | <124 | 124-150 | >150 | 53.0 | 113.0 | 46.0 | 44.0 | 75.0 | 90.0 |
| HMW-PAH | <0.66 | 0.66-1.68 | >1.68 | 2.36 | - | - | - | - | 0.46 |

## 2.2 Saline Vegetation

Large stands of mangroves are present along most sheltered margins of the CWH to Shoal Bay. The mangroves in Shoal Bay cover approximately 140 hectares range in stature from 0.5 m to 3 m tall (Auckland Regional Council 1999).

Since December 2004, patches of seagrass (*Zostera capricorni*) have been detected at Meola Reef. Temporal trends show a gradual increase in the number and size of these patches. Seagrass has not been detected adjacent to the AHB nor within Shoal Bay (Halliday et al., 2006).

## 2.3 Benthic Invertebrate Community Composition

### 2.3.1 Subtidal Channel

Subtidal benthic soft sediment fauna was analysed by Hayward et al. (1997)[1]. These researchers concluded that seaward of the wharves and marinas, the soft-bottom fauna within the central Waitemata Harbour remains remarkably rich and diverse (compared to the survey carried out in 1930). The dominant organisms within these areas were grouped into faunal associations as follows:

- N6 – *Theora lubrica / Nucula spp / Macrophthalamus hirtipies*
- N3 – *Limaria orientalis / Ruditapes largillierti / Tawera spissa*
- N2 – *Maoricolpus roseus / Limaria orientalis / Nucula spp.*

Hayward et al. (1997) concluded that these associations occurred in horizontal bands across the main subtidal channel with N6 on the northern and southern edges, and N3 and N2 in the centre. Other common organisms present in the subtidal channel included polychaete worms, the chiton *Leptochiton inquinatus*, the crab *Paguristes pilosus*, brittle stars (*Amphiocnida pilosus* and *Amphiopolis squamata*), gastropods (*Cominella quoyana*, *Sigapatella novaezelandiae* and *Zegalerus tenius*) and the bivalves *Pleuromeris zelandica* and *Dosina zelandica*. Hayward et al. (1997) also noted the arrival of three exotic species since the 1930 survey, including *Limaria orientalis*, *Theora lubrica* and *Musculista senhousia*. Sediment comprised mud, fine sand and shell.

[1] Hayward, B.W., Stephenson, A.B., Morley, M., Riley, J.L., Grenfell, H.R., 1997. Faunal changes in Waitemata Harbour sediments 1930s-1990s. Journal of the Royal Society of New Zealand, 27(1): 1-20.

On the sides of the main channel under the AHB the community structure was found to be dominated by the bivalves *Theora lubrica*[2], and nut shells (*Nucula hartivigiana)* and *Nucula nitidula*, occurring in mud, shell and fine sand sediment.

### 2.3.2 Shoal Bay

This ecologically sgnificant embayment is largely intertidal and comprises estuarine muds, sandflats and sand/shell banks. It is valued for the extensive areas of mangrove, saltmarsh vegetation, adjacent saline wetlands and the habitat and feeding areas that the bay provides for coastal bird species (including the *Threatened* wrybill and northern New Zealand dotterel) (PAUP, Appendix 6.1, 2014).

Surveys carried out by Boffa Miskell Ltd (BML) in 2001, 2007 and 2009 provide information on the intertidal marine invertebrate communities present Benthic invertebrates that inhabit the mangrove stands include mudsnail (*Amphibola crenata*), mud crabs (*Helice crassa* and *Macrophthalmus hirtipes*), cat's eye (*Lunella smaragdus*), and whelks including *Cominella glandiformis* and *Zeacumantus* spp. The 2001 surveys undertaken in the intertidal mudflats adjacent to the northern motorway (see Figure 1), revealed a diversity of both sensitive and tolerant invertebrate organisms with the more abundant organisms being cockles (*Austrovenus stutchburyi*), nut shell (*Nucula hartvigiana*), wedge shell (*Macomona liliana*) and at least ten species of polychaete worms (including *Boccardia polybranchia*, *Orbinia papillosa* and Nereidae).

The BML surveys carried out in 2007 and 2009 within the intertidal habitat adjacent to the Onewa Interchange and to the south towards the northern abutment of the AHB, revealed a high diversity of organisms. Species richness was highest at the site closest to the AHB where, in addition to the same species of gastropods, bivalves and polychaete worms that were found at the northern sites, abundant isopods, amphipods, anemones, nematode worms, sipunculid worms, oliochaete worms, mysid shrimps, cumaceans, ostracods, barnacles, chaetognathan worms, and both red and green algae were also detected.

In recent years, bivalves (e.g. cockle (*Austrovenus stuchburyi),* wedge shell (*Macomona liliana*)*,* and nut shell have declined in Shoal Bay, while silt-tolerant polychaete worms (e.g. *Heteromastus filiformis, Prionospio sp., Aricidea sp.)* have increased in abundance. Mud content has also increased at Shoal Bay. Other common species in Shoal Bay include segmented worms (*Aonides sp. and Macroclymenella sp.*) and the estuarine limpit (*Notoacmea helsmii*) (Halliday et al., 2012).

## 2.4 Fish

Typical fish species in the central and upper Waitemata Harbour include snapper (*Chrysophrys auratus*), kahawai (*Arripis trutta*), koheru (*Decapterus koheru*), yellow-eyed mullet (*Aldrichetta forsteri*), gurnard (*Chelidonichthys kumu*), John Dory (*Zeus faber*), terakihi (*Nemadactylus macropterus*), trevally (*Caranx georgianus*), rig (*Mustelus lenticalatus*), yellow-belly flounder (*Rhombosolea leporina*), sand flounder (*Rhombosolea plebeian*), parore (*Girella tricuspidata*), jack mackerel (*Trachurus symmetricus*), grey mullet (*Mugil cephalus*), school shark (*Galeorhinus australis*), anchovy (*Engraulidae spp.),* common sole (*Peltorhamphus novaezeelandiae*), eagle ray (*Aeotobatus narinari*) (Morrison, pers. com.). Species of fish that occupy channels include snapper, rig, jack mackerel, school shark and rays, whereas grey mullet, juvenile kahawai, yellow eyed mullet and anchovies are found in the shallows. Flounder and parore can be present through the central and upper Waitemata Harbour.

---

[2] Introduced species.

## 2.5 Assessment of Ecological Values

Our assessment of estuarine ecological value is guided by the following characteristics and determining on balance which of the low, medium or high ecological characteristics apply to a specific habitat or marine area, in this instance Shoal Bay and the benthic habitat beneath the Auckland Harbour Bridge (Table 2).

**Table 2: Marine ecological value characteristics.**

| ECOLOGICAL VALUE | CHARACTERISTICS |
|---|---|
| LOW | • Benthic invertebrate community has low species diversity.<br>• Benthic invertebrate community dominated by organic enrichment tolerant and mud tolerant organisms with few/no sensitive taxa present.<br>• Marine sediments dominated by silt and clay grain sizes.<br>• Surface sediment predominantly anoxic (lacking oxygen).<br>• Elevated contaminant concentrations in surface sediment, above ISQG-high or ARC-red effects threshold concentrations[3].<br>• Invasive, opportunistic and disturbance tolerant species dominant.<br>• Saline vegetation provides minimal/limited habitat for native fauna.<br>• Habitat highly modified. |
| MEDIUM | • Benthic invertebrate community typically has moderate species diversity.<br>• Benthic invertebrate community has both (organic enrichment and mud) tolerant and sensitive taxa present.<br>• Marine sediments typically comprise less than 50-70% silt and clay grain sizes.<br>• Shallow depth of oxygenated surface sediment.<br>• Contaminant concentrations in surface sediment generally below ISQG-high or ARC-red effects threshold concentrations.<br>• Few invasive opportunistic and disturbance tolerant species present.<br>• Saline vegetation provides moderate habitat for native fauna.<br>• Habitat modification limited. |

[3] ANZECC (2000) Interim Sediment Quality Guideline (ISQG) High contaminant threshold concentrations or Auckland Regional Council's Environmental Response Criteria Red contaminant threshold concentrations (Auckland Regional Council, 2004).

| ECOLOGICAL VALUE | CHARACTERISTICS |
|---|---|
| HIGH | • Benthic invertebrate community typically has high species diversity.<br>• Benthic invertebrate community contains many taxa that are sensitive to organic enrichment and mud.<br>• Marine sediments typically comprise <50% smaller grain sizes.<br>• Surface sediment oxygenated.<br>• Contaminant concentrations in surface sediment rarely exceed low effects threshold concentrations.<br>• Invasive opportunistic and disturbance tolerant species largely absent.<br>• Saline vegetation provides significant habitat for native fauna.<br>• Habitat largely unmodified. |

The two primary marine receiving environments for maintenance discharges from the AHB are the benthic environment immediately beneath the bridge itself and Shoal Bay. Discharges that are large grained particulates (e.g. garnet) will settle beneath and adjacent to the bridge and may be dispersed further with the current, whereas other contaminants that are more readily moved by physical coastal processes (e.g. those contained in overspray, paint flakes and washwater) will be transported to and accumulate in Shoal Bay.

The benthic habitat beneath the AHB is likely to comprise:

- a mix of fine and coarse grained sediment;
- low to moderate species diversity;
- both sensitive and tolerant species;
- both exotic and native species; and
- low concentrations of contaminants.

The benthic habitat within Shoal Bay comprises:

- sediment which is a mixture of sand and mud;
- moderate to high species diversity;
- tolerant and sensitive taxa;
- the depth of oxygenated sediment is likely to be shallow;
- contaminant concentrations typically below ISQG-high and ARC-red thresholds;
- invasive species do not dominate;
- saline vegetation provides moderate habitat for native fauna (e.g. wading birds); and
- habitat modification is moderate.

Thus, based on the criteria in Table 2 above and the ecological information available, it is considered that the benthic habitat beneath the AHB has medium ecological values, whereas Shoal Bay has medium to high ecological values.

# 3.0 Assessment of Effect of Currently Consented Regime

## 3.1 Approach to Assessment and Significance of Effect

We assess the magnitude of ecological effects using the following criteria[4]:

**Table 3: Criteria for describing potential effect magnitude.**

| Magnitude | Description |
|---|---|
| Very High | Total loss or very major alteration to key elements/ features of the baseline conditions such that the post development character/ composition/ attributes will be fundamentally changed and may be lost from the site altogether. |
| High | Major loss or major alteration to key elements/ features of the baseline (pre-development) conditions such that post development character/ composition/ attributes will be fundamentally changed. |
| Moderate | Loss or alteration to one or more key elements/features of the baseline conditions such that post development character/composition/attributes of baseline will be partially changed. |
| Low | Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible but underlying character/composition/attributes of baseline condition will be similar to pre-development circumstances/patterns. |
| Negligible | Very slight change from baseline condition. Change barely distinguishable, approximating to the "no change" situation. |

We then assess the significance of ecological effects using ecological value (determined in Table 2) and effect magnitude (Table 3 above) as shown in the following matrix:

**Table 4: Matrix combining magnitude and value for determining the significance of adverse ecological effects.**

<table>
<tr><th colspan="2" rowspan="2">SIGNIFICANCE</th><th colspan="3">Ecological &/or Conservation Value</th></tr>
<tr><th>High</th><th>Medium</th><th>Low</th></tr>
<tr><td rowspan="5">Magnitude</td><td>Very High</td><td>Very High</td><td>High</td><td>Moderate</td></tr>
<tr><td>High</td><td>Very High</td><td>Moderate</td><td>Low</td></tr>
<tr><td>Moderate</td><td>High</td><td>Moderate</td><td>Very Low</td></tr>
<tr><td>Low</td><td>Moderate</td><td>Low</td><td>Very Low</td></tr>
<tr><td>Negligible</td><td>Low</td><td>Very Low</td><td>Very Low</td></tr>
</table>

4 Regini, K. (2002). *Draft Guidelines for Ecological Evaluation and Impact Assessment*. Institute of Ecology and Environmental Management (IEEM).

## 3.2 Deposition of sediment

The annual deposition of garnet beneath and adjacent to the bridge was previously estimated by Tonkin & Taylor (2011) to cover an area of 12,000 $m^2$ at a depth of 2.5mm, in addition to a depth of 0.02 mm over a wider area, due to dispersal patterns, of 480,000 $m^2$. These calculations were based on an annual mass of sand discharge of 62,500 kg/annum. The currently consented regime under full containment, which forms the basis of the AMF, is for up to 14,679 kg of sand to be discharged per annum.

Assuming the same sand characteristics (e.g. grain size range, density, and fall velocity), the same current velocity and width of channel beneath the bridge as used in the 2011 calculations, and that the maintenance works are spread somewhat evenly over the year, the current proposal would result in an average deposition depth of 0.6 mm of sand over 12,000 $m^2$ of benthic habitat beneath the bridge, and 0.09 mm over a 480,000 $m^2$ area adjacent to the bridge. Over time, some sand will be redistributed within the benthic environment, which will result in the sand being spread in thinner layers over a wider area.

Lohrer et al. (2004 and 2006) reported that benthic marine invertebrate communities can be adversely affected when >3mm of silt and mud is deposited on coarse grained sediment. Because the benthic sediment is a mixture of sand and mud, and the material that will be deposited is sand, the community present is likely to be able to tolerate sediment deposition >3mm. However, the annual deposition depth estimated to arise from AHB maintenance works is significantly below that which would cause adverse effects on benthic invertebrate communities (i.e. approximately 0.6mm).

With reference to Tables 2 and 3 above, it is considered that the magnitude of effect arising from the deposition of sand would be barely distinguishable from the baseline and therefore negligible. Thus, combining ecological value (moderate) and magnitude of effect (negligible), we determine (based on Table 4 above) there would be an adverse effect of very low significance.

## 3.3 Discharge of contaminants

### 3.3.1 Zinc

The contaminant discharge modelling that has been undertaken, provides estimates of contaminant loads arising from maintenance works on an annual basis. The primary contaminant of concern in regards to maintenance discharges is zinc. An annual threshold of 223 kg discharged from the AHB is assessed below.

Simplistically, it is assumed that half of the zinc load is discharged to the northern side of the bridge and half to the southern. The subcatchment modelling carried out by Green (2008) can be used as an estimate for the ultimate fate of contaminants. The modelling indicates that 95% of sediment and contaminants discharged from the southern side of the bridge from the Westmere / St Mary's catchment is discharged to the wider Hauraki Gulf, with the ultimate fate of 1% of discharges being Shoal Bay. The load of zinc discharged from the southern side of the bridge to Shoal Bay can be estimated to be 1.1 kg/annum. The 95% (or 105.9 kg) of zinc that is discharged to the wider Hauraki Gulf is expected to be widely distributed and significantly diluted in this high energy environment.

Approximately 67% of the sediment and contaminants discharged from the northern side of the bridge (from Little Shoal Bay) is discharged to the wider Hauraki Gulf where it is diluted and widely distributed, whereas 24% is retained within Shoal Bay. Of the annual zinc load discharged on the northern half of the bridge, approximately 26.8 kg of zinc is retained within Shoal Bay. The total annual load of zinc retained in Shoal Bay from the AHB is therefore approximately 27.9kg (i.e. 26.8kg plus 1.1 kg).

It is estimated that Shoal Bay covers an area of approximately 6,465,000 $m^2$. Contaminants accumulate in surface sediment layers, which are often referred to as the top 2-3cm. The volume of sediment in the top 2cm within Shoal Bay can be estimated to be 129,300 $m^3$. Assuming an even distribution of zinc discharged to Shoal Bay within the top 2cm of sediment, the concentration of zinc would be 215 $mg/m^3$. Further assuming that 1 $m^3$ of marine sediment weighs between 2000 - 2500kg, the contribution of zinc (relating to the maximum threshold in the existing AHB maintenance consent) in surface sediment would be 0.09-0.1 mg/kg of zinc of sediment per year. In addition to other discharges of contaminants from the contributing catchments, it is predicted that 227,000 tonnes of sediment will deposit in Shoal Bay over the next 100 years (Green, 2008), or 2,270 tonnes per year. This sediment dilutes discharged contaminants.

Auckland Council's ERC amber threshold concentration for zinc is 124 mg/kg. The average concentration of zinc in sediment in Shoal Bay is 68 mg/kg (Mills et al., 2012), of which the AHB contribution is small proportion. The concentration of zinc in Shoal Bay at sites monitored by Auckland Council has increased over recent years e.g. at the Upper Shoal Bay site the concentration of zinc was 35 mg/kg in 2004 and 46 mg/kg in 2009.

Modelling by Green (2008) indicated that Shoal Bay receives sediment and metals from every subcatchment in the CWH, excluding the four on the southern shore. The concentration of zinc remains significantly below Auckland Council's ERC amber threshold. The amber threshold is conservative, being developed by Auckland Council to enable time to respond to emerging trends in stormwater contaminants in marine sediment. ANZECC's interim sediment quality guideline for Low zinc concentration is 200 mg/kg.

More recent stormwater contaminant source modelling work carried out by Dr Green for Auckland Council (unpublished[5]) estimates the total zinc load from a variety of land use activities discharged into the CWH is 18,623 kg/annum. The zinc load from the AHB maintenance activities forms approximately 1.2% of that total annual load.

The ecological values of Shoal Bay have been assessed as medium to high. The impact magnitude for the discharge of zinc from the AHB maintenance work is considered to be negligible i.e. the change in sediment concentration of zinc arising from the discharge would be barely discernible, approximately to the "no change" situation. The character / composition / attributes of baseline condition would be unchanged. Combining the ecological values and impact magnitude indicates that the significance of adverse effect is very low to low (refer to Tables 2, 3 and 4).

### 3.3.2 Paint

The currently consented regime, under full containment, assumes a discharge of 646 kg of paint from 15% overspray per annum. Overspray of paint is expected to be diffuse, relatively insoluble and redistributed by current flows under the AHB.

Given the negligible acute and chronic toxicity of the products used, the magnitude of adverse effects on marine ecological values is assessed as negligible (based on Table 3 above). If we conservatively assume moderate to high ecological values in the receiving environment, the significance of the potential adverse is low to very low.

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[5] Approved for use for this assessment by Judy Anson at Auckland Council.

## 3.4 Ecotoxicity of Existing Products

The current products that are used are MC Ferrox, MC M10 and zinc. The acute (short term exposure to contaminants) and chronic (longer term exposure to contaminants) toxicity of the water available fraction (WAF) of these products have been tested by NIWA[6] using standard United States Environmental Protection Agency (USEPA) guidelines.

Tests were carried out on standard marine organisms i.e. alga (*Minutocellus polymorphus*), an amphipod (*Chaetocorophium* c.f. *lucasi*) and blue mussels embryos (*Mytilus galloprovincialis*). These organisms are routinely used by NIWA as test organisms because they represent a range of life histories, habitats and feeding types, and are successfully reared or held in laboratory conditions (see the standard operating procedures referenced on page 7 of the NIWA report). The ecotoxicological response tested in alga was cell growth (48 hr), whereas survival over 96 hr was the test for the amphipod and development of embryo over 48 hrs was the test for blue mussel.

The general descriptive categories for toxicity are based on acute $EC_{50}$[7] values (for acute toxicity, Table 5) and NOEC[8] values (for chronic toxicity, Table 6) as follows:

**Table 5: Acute Toxicity**

| Description | $EC_{50}$ (mg/L) |
|---|---|
| Non-toxic | >1000 |
| Practically non-toxic | >100 - ≤1000 |
| Slightly toxic | >10 - ≤100 |
| Moderately toxic | >1 - ≤10 |
| Highly toxic | >0.1 - ≤1 |
| Very highly toxic | >0.01 - ≤0.1 |
| Extremely toxic | ≤0.01 |

**Table 6: Chronic Toxicity**

| Description | NOEC (mg/L) |
|---|---|
| Negligible | >1 |
| Low | >0.1 - ≤ 1 |
| Moderate | >0.01 - ≤ 0.1 |
| High | >0.001 - ≤ 0.01 |
| Very High | ≤ 0.001 |

Acute test results indicated[9]:

---

[6] See report in Appendix A.

[7] Effect concentration - 50%

[8] No observable effect concentration.

[9] See page 4 of NIWA report, Appendix A.

- MC Ferrox was non-toxic to all three organisms;
- MC M10 was practically non-toxic to algae and non-toxic to amphipods and blue mussels; whereas
- Zinc was non-toxic to algae and amphipods and practically non-toxic to blue mussels.

Chronic testing indicated all products had negligible toxicity to the three organisms.[10]

## 3.5 Summary of Assessment of Effects of Currently Consented Regime

The effects of current discharges of sediment and contaminants arising from maintenance of the AHB have been assessed above in terms of marine ecological values. No significant adverse effects on marine ecological values have been identified from the discharge of garnet sand, zinc nor paint.

The annual discharge of 14,679 kg of garnet sand from works on the bridge is estimated to result in the deposition of 0.6 mm deposition of sand over 12,000m$^2$ of benthic habitat beneath the bridge. This deposition depth is significantly below that which would cause adverse effects on benthic invertebrate communities. It is considered that the deposition of sand would not result in significant adverse effects on marine ecological values.

It is estimated that maintenance works will results in an annual discharge of 223 kg of zinc per annum to the CWH, which is 1.2% of the load of zinc discharged to the CWH from other land use activities (i.e. 18,623 kg per annum).

The average concentration of zinc in sediment in Shoal Bay is currently 68 mg/kg. AHB maintenance works is estimated to contribute less than 1 mg per year. The contribution of zinc from AHB maintenance works on marine ecological values within Shoal Bay would result in low to very low significance of adverse effects.

The discharge of paint from overspray is considered to have negligible effects on marine ecological values based on the low toxicity and diffuse distribution once entering the CMA.

The acute and chronic toxicity of current products used on marine organisms has been assessed, with all products being practically non-toxic in the acute situation or having negligible toxicity in longer term tests (i.e. chronic exposure).

In conclusion under the currently consented regime, with full containment, the significance of adverse effects on marine ecological values is considered to be very low to low.

[10] NIWA conclude on page 6 of their report that "care must be taken when extrapolating these results for protection of organisms present in a particular receiving water environment". Dr Hickey confirmed that this sentence and the "moderate degree of confidence" stated in the preceding sentence are standard phrases they include at the end of the toxicology reports as they do not know the context of the receiving environments when undertaking such tests. Dr Hickey confirmed that it does not mean that they consider there is a risk to the receiving environment (pers. comm).

# 4.0 Proposed Activity – Adaptive Management of Bridge Maintenance

## 4.1 Adaptive Management Framework (AMF)

The purpose of the Adaptive Management Framework (AMF) is to enable the maintenance of the AHB, while managing the effects of discharges to the environment below agreed upon thresholds, based on the existing consents for containment, with the aim of reducing contaminant discharges over time.

The AMF provides for the same environmental outcomes as the existing resource consent with full containment, with the flexibility for improved environmental outcomes. The environmental management approach enables this flexible approach to be taken and allows for adaptation and innovation without requiring amendments to the resource consent.

The AMF comprises[11]:

- operational processes – selection of the most appropriate tools for maintenance while considering the potential environmental effects;
- monitoring processes – tracking contaminant discharges;
- reporting processes – standardised recording of monitoring results and outcomes of the adaptation process;
- adaptation processes – enabling the consideration and potential incorporation of new methods and products with a view to achieving improved environmental, cost or maintenance period outcomes;
- The Environmental Management Plan; and
- The proposed conditions (which will evolve through the consent process to become the conditions of consent).

## 4.2 Contaminants

The bottom line for the discharge of contaminants used in the proposed adaptive management of the maintenance works is the load of contaminants that would have arisen if full containment was installed[12]. The AMF establishes the load of contaminants that would have been discharged under full containment as the new consented baseline (Table 7), with flexibility to reduce these contaminants as the opportunity arises.

**Table 7: Consented Baseline Contaminant Loads**

| Contaminant | Annual Threshold |
|---|---|
| Garnet | 14,679 kg |
| Zinc | 223 kg |

[11] Refer to Appendix A of the application.

[12] Refer section 3.5 in the AEE.

| | |
|---|---|
| Paint | 646 kg |

Therefore, based on the existing consent, with full containment, the following contaminant load thresholds have been calculated for discharges to the CMA.

### 4.2.1 Garnet

The coastal annual discharge limit for garnet has been calculated as 14,679 kg/annum. This has been calculated from the limits permitted under the 2011 consent:

- Annual amount of garnet discharged: 92,000 kg.
- Required containment: 0% containment for lower overarch (3.72% of the bridge), 85% containment of discharges to air for remainder of bridge over coast (81.60%).
- Assumptions:
    1. Contaminants from maintenance work undertaken over the coast are discharged to the coast.

### 4.2.2 Zinc

The coastal annual discharge limit for zinc has been calculated as 223 kg/annum. This has been calculated from the limits permitted under the 2011 consent:

- 10% bridge maintained per year (water blasting, abrasive blasting and painting).
- Required containment: 0% containment for lower overarch (3.72% of the bridge), 85% containment of discharges to air and 100% containment of washwater discharges for remainder of the bridge over the coast (81.60%) of bridge.
- Sampling results: Mass of zinc discharged from waterblasting (based on washwater sampling results[13]).
- Assumptions:
    1. Mass of zinc discharged from abrasive blasting (based on semi-quantitative assessment in 2011 consent application).
    2. 15% overspray of paint.
    3. Contaminants from maintenance work undertaken over the coast are discharged to the coast.
    4. An additional 0.58 kg/annum may be discharged (via existing stormwater system) to the CMA from washwater from the areas of AHB over land. This additional load, whilst a point source discharge, is negligible in terms of the load discharged to the CMA directly from maintenance works (0.26%) and from other sources within the CWH (0.003%). Comparing the washwater contaminant load that may be discharged to stormwater, if we assume 50% is discharged to western side[14] and 50% to the eastern side[15] of the peninsula,

[13] Refer Appendix E of the application.

[14] Auckland Council Stormwater Management Unit 29.

the load forms 0.4% and 0.6% of the annual zinc load discharged from the subcatchments as modelled by Green (2008).

### 4.2.3 Paint

The coastal annual discharge limit for paint (including 'non-contaminant' components) has been calculated as 646 kg/annum. This has been calculated from the limits permitted under the 2011 consent:

- 10% bridge maintained per year (abrasive blasting and painting).
- Required containment: 0% containment for lower overarch (3.72% of the bridge), 85% containment of discharges to air, remainder of the bridge over the coast (81.60%).
- Assumptions:
  1. 15% overspray of paint.
  2. Contaminants from maintenance work undertaken over the coast are discharged to the coast.

## 4.3 Toxicity of Products

### 4.3.1 Current Products

As discussed above in section 3.4, the acute and chronic toxicity of existing products used are practically non-toxic or non-toxic for acute tests and of negligible toxicity for chronic tests.

### 4.3.2 Proposed Products

The approach to considering new products is to firstly examine the reference material of the product in order to characterise contaminants and toxicity. Such reference material could include materials safety data sheets (MSDS) and manufacturers toxicity test information.

Contaminants will also be assessed against relevant toxicity guidelines (e.g. ANZECC).

Where information on acute and chronic toxicity to marine organisms is not provided by the manufacturer, the supplied data is not considered relevant to New Zealand's marine organisms or where the information is not sufficiently detailed, testing of potential new products shall be carried out. In this situation, both acute and chronic toxicity testing of the water available fraction, using a standard loading factor[16], would be carried out on the same species of alga, amphipods and blue mussels as used in the tests discussed in section 3.4[17].

The toxicity of proposed products would inform whether products would be considered for use; new products would have to have similar or less toxicity than those currently used under the existing consent.

---

[15] Auckland Council Stormwater Management Unit 39.

[16] The USEPA Loading Factor of 50 g/L should be applied.

[17] Toxicity tests should be undertaken by an appropriately qualified and experienced ecotoxicologist.

## 4.4 Example of New Product Tested under AMF

Appendix A contains an assessment of a potential new paint product, as a case study, as per the AMF methodology detailed in section 4.1 above.

The conclusions from assessment of the product following the 9 steps detailed in 3.1 of the Termarust report in Appendix A are that the toxicity of Termarust to marine organisms is practically non-toxic in the acute situation and has negligible toxicity from chronic exposure. In addition, the assessment indicated that Termarust does not contain key contaminants of concern, nor additional contaminants that present a risk to marine organisms for which additional thresholds need to be developed. It is confirmed that the threshold for "paint" will not be exceeded in use of this product. Therefore, the existing contaminant thresholds remain appropriate.

Under the current consented regime, adverse effects on marine ecological values fall within that previously assessed (i.e. minor to negligible). It is concluded in the Termarust report that the AMF process proposed is robust and provides appropriate protection of marine ecological values whilst enabling a flexible approach to maintenance of the AHB.

# 5.0 Assessment of Effects

This report summarises the findings from two separate, but critically linked, assessments:

1. Assessment of effects on marine ecological values of the existing consented maintenance discharges from the AHB under containment.

2. Assessment of the framework for determining if new maintenance products and/or methods would have the same level of effects as that already consented under the full containment scenario.

Section 3.5 above summarises the effect on marine ecological values from the existing consented discharges under the full containment scenario. The significance of adverse effects from smothering (garnet sand), the discharge of potentially toxic paint products and the discharge of key contaminants (garnet sand, zinc and paint) were found to be very low to low.

Section 4.2.1-4.2.3 and section 4.3.1-4.3.2 above summarise the key contaminant thresholds already consented and the toxicity of products currently in use. These thresholds and toxicity characteristics form the baseline against which any proposed alteration to methods or products would be tested against. Before any proposed method or product changes could be implemented compliance with (as a minimum) the key contaminant discharge thresholds and toxicity characteristics would need to be demonstrated. That is, the same level of effects (or less) as assessed in section 3 above (under the full containment regime) would need to be demonstrated (using the methodology in section 4 above) in order to change AHB maintenance methodology or products.

The approach proposed for identifying key contaminants and methods, regulation and monitoring of discharges, identification of effects and operational processes proposed to manage AHB discharges in this consent application are robust and provide appropriate protection to the marine environment and ecological values present.

Managing discharges of contaminants within the thresholds established from the existing consented level of discharge under a full containment scenario will results in no change to adverse ecological effects on the marine environment identified in the previous resource consent application. The use of the AMF approach proposed provides for improved environmental outcomes through reduced discharges of contaminants over time and the ability to modify methods and products where these thresholds will not be exceeded and effects on marine ecological values remain low to very low significance.

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# Appendix A: Assessment of Potential New Product – Maintenance Discharges

# AUCKLAND HARBOUR BRIDGE

Assessment of Potential New Product – Maintenance Discharges
Prepared for Total Bridge Services

9 September 2014

Boffa Miskell

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# 1.0 Introduction

The purpose of this report is to demonstrate and test the Adaptive Management Framework (AMF) through a case study which assesses a potential new paint product (Termarust) for use on the Auckland Harbour Bridge (AHB), in terms of potential adverse effects on marine ecological values that may arise from discharges to the CMA. The AMF and this assessment of Termarust have been developed in parallel through an iterative process.

# 2.0 Potential New Product - Termarust

The Termarust system is based on a proprietary formulation of high-ratio calcium sulfonate alkyd (HRCSA) that consists of a penetrating sealer (TR2200LV) for use on crevices and a high-build coating product (TR2100) that is used as caulking or stripe coat on crevices or fasteners, and as a self-priming topcoat.

Termarust can be applied over various levels of surface preparation ranging from a hot water wash at 6,000 psi to remove loosely adherent material and salt contamination when used as an encapsulation coating, through to abrasive blast cleaning to a SSPC SP7 (Brush off) or SP14 (Industrial) finish. It has a “volume solids” of 63% and is thinned or cleaned with mineral spirits. It is usually applied as two “wet on wet” coats (i.e. caulk and stripe coat immediately followed by a full coat)

Termarust is particularly suitable for use on riveted steel work with crevices and has been used to successfully treat many bridges where de-icing salt has been used and the bridge structure has developed pack rust. It has also been used as an encapsulating coating to avoid the costs associated with the removal of lead-based paint.

The principal disadvantage of this product is that it may take several days to harden enough to walk on. Even when fully cured, Termarust has low abrasion resistance, so is not recommended on surfaces subject to impact or that are accessible to the public.

It is envisaged that Termarust could be a useful option to coat the inside of lattice posts and diagonals of the original bridge, and similar elements where it is difficult to access for abrasive blasting or painting, and to treat any joints with rust bleed. Termarust could also be used in enclosed spaces where the elimination of odour and hazards from conventional solvents may be desirable. Its main benefit could be from extending the life of the existing coating system without the use dry abrasive blasting and negative pressure containment of chromate dust.

# 3.0 Methodology for Adaptive Management Framework Assessment

Termarust will be assessed based on the protocol developed as part of the Adaptive Management Framework (AMF) for new products and methods utilised for bridge maintenance. The procedural methodology is:

1) Request and review Material Safety Data Sheet for the product;
2) Identify components of the product;
3) Request toxicology test data/reports from the manufacturer;
4) Research water quality guidelines associated with components and create a list of thresholds (if not already covered);
5) If manufacturer's toxicity testing of the product is considered insufficient engage an ecotoxicology expert to carry out acute and chronic toxicity testing, based on USEPA standard protocols, on algae (*Minutocellus polymorphus* – 48 hr cell growth), an amphipod (*Chaetocorophium* c.f. *lucasi* – 96 hr mobility survival) and blue mussels (*Mytilus galloprovincialis* – 48 hr embryo development);
6) Compare toxicity results with existing products used to ensure toxicity is similar or better than that of existing products (see Tables 1 and 2 containing USEPA characterisation for acute and chronic toxicity);

**Table 1: Acute Toxicity**

| Description | $EC_{50}$ (mg/L) |
|---|---|
| Non-toxic | >1000 |
| Practically non-toxic | >100 - ≤1000 |
| Slightly toxic | >10 - ≤100 |
| Moderately toxic | >1 - ≤10 |
| Highly toxic | >0.1 - ≤1 |
| Very highly toxic | >0.01 - ≤0.1 |
| Extremely toxic | ≤0.01 |

**Table 2: Chronic Toxicity**

| Description | NOEC (mg/L) |
|---|---|
| Negligible | >1 |
| Low | >0.1 - ≤ 1 |
| Moderate | >0.01 - ≤ 0.1 |
| High | >0.001 - ≤ 0.01 |
| Very High | ≤ 0.001 |

7) Compare contaminants to consented thresholds to determine whether contaminant type and loads are within consented thresholds;

8) If product meets consented contaminant thresholds and toxicity characteristics of existing products, update Environmental Management Plan or model to include new product; and

9) Introduce product to maintenance regime.

## 3.1 Review of Termarust based on AMF methodology

**1) Termarust Series Organic Coating 2100/2200 and Termarust thinner (TRT01) (see Appendix 1).**

**2) Material Safety Data Sheet (MSDS)**

The MSDS for Termarust Series Organic Coating 2100/2200 and Termarust thinner (TRT01) identifies mineral spirits (CAS# 64742-88-7) at 10-30% in the coating and 60-100% in the thinner. Mineral spirits is also known as solvent naptha and is identified as a general petroleum solvent with a boiling range of 130° to 220°C. The mineral spirits used in Termarust has a boiling point of 150°C.

Mineral spirits is a complex mixture of saturated aliphatic and aromatic $C_7$ to $C_{13}$ hydrocarbons. The literature defines mineral spirits as having 80-86% aliphatic (straight chain) hydrocarbons and 14-20% aromatic hydrocarbons which includes such things as xylene and ethylbenzene. However, it will contain only very low levels of the more toxic aromatics such as benzene and naphthalene.

The product can be applied in various ways, strip coated by hand or sprayed coated. From assessments of other coating products used on the bridge, spray painting is the only application method that contributes significant solvents and particulate to the air. Total suspended particulate (TSP) in the form of overspray is identified as a contaminant of concern where spray painting is carried out. Spray painting also produces a certain amount of fine particulate $PM_{10}$ (up to 50% depending on nozzle size etc).

**3) Toxicology data/report from manufacturer.**

The acute toxicity of Termarust to rainbow trout was tested by EVS Environment Consultants in Canada in 2005 (see Appendix 2). The report indicated that the concentration that caused a lethal effect on 50% of the test organisms was 41,017 mg/L, with 95% confidence limits of 33,414 mg/L and 50,349 mg/L.

**4) Threshold values for the key contaminants of Termarust.**

The contaminants identified in Termarust are naphtha, xylene, trimethylbenzene, ethylbenzene, and methyl isobutyl ketone. These contaminants readily volatilise and are unlikely to remain present in overspray of the product or in cured paint.

The product can be included under the paint threshold. Confirmation that this threshold will not be exceeded needs to be provided by the AHB Operational Team.

**5) Decision to engage toxicology laboratory to test product.**

As only one species of freshwater fish was used as a test organism in the testing carried out by the manufacturer, and only acute testing was carried out, NIWA was engaged to test Termarust on three standard marine organisms used in toxicity testing (see Appendix 3).

**6) Compare toxicity with existing products.**

Acute toxicity testing of Termarust indicated it was practically non-toxic to algae (*Minutocellus polymorphus* 48 hr cell growth test), and non-toxic to an amphipod (*Chaeocorophium* c.f. *lucasi* 96 hr survival and mobility test) and blue mussels (*Mytilus galloprovincialis* 48 hr embryo development test). Chronic toxicity testing indicated negligible toxicity. These toxicity results are similar/identical to the results for the existing products that are used (Table 1).

**Table 1: Toxicity description of existing products and proposed new product**

| | Existing products (MC Ferrox, MC MIO, Zinc) | | Proposed new product (Termarust) | | Is toxicity of new product the same or less than existing products? |
|---|---|---|---|---|---|
| | **Acute Toxicity** | **Chronic Toxicity** | **Acute Toxicity** | **Chronic Toxicity** | |
| **Algae cell growth** | Non-toxic, practically non-toxic | Negligible | Practically non-toxic | Negligible | Yes |
| **Amphipod survival** | Non-toxic | Negligible | Non-toxic | Negligible | Yes |
| **Amphipod mobility** | Non-toxic | Negligible | Non-toxic | Negligible | Yes |
| **Blue mussel embryo development** | Non-toxic, practically non-toxic | Negligible | Non-toxic | Negligible | Yes |

The alga used in the toxicity testing is the most sensitive of the three organisms tested. The lowest concentration ($EL_{50}$) of Termarust that induced a 50% effect on algae cell growth was 900 mg/L. In order to provide some context regarding dilution, 972,000 tonnes of Termarust would need to be discharged into the neap tidal prism[1] of the Central Waitemata Harbour (CWH) to produce the same $EL_{50}$ concentration. If a smaller area of the CWH is considered, say 10,000m$^2$ around the bridge itself, then approximately 135,000 kg of Termarust would need to be discharged to achieve the $EL_{50}$ concentration[2]. It is noted that under the existing consent 646 kg per annum of paint is the current threshold. If the entire annual load of paint was discharged at one time the concentration in the smaller 10,000m$^2$ area immediately adjacent to the bridge would be 4.3 mg/L, which is significantly less than the 900 mg/L that induced a 50% effect on the most sensitive laboratory species tested.

Given that the tested toxicity of Termarust is the same as the existing products, on the basis of toxicity to marine organisms Termarust would be acceptable to use on the AHB.

**7) Compare contaminants to consented thresholds**

The contaminants identified in point 4 above are not key contaminants of concern and given that they volatilise rapidly and would not accumulate in the marine environment it is not necessary to develop thresholds for these. Contaminants arising from surface preparation of the bridge structure are unchanged and therefore within the consented thresholds.

**8) The model can be updated to incorporate the new product.**

[1] 108,000,000 m$^3$ (Tonkin and Taylor, 2011).

[2] Based on an average water depth of 15m (Tonkin and Taylor, 2011).

**9) Product can be introduced to maintenance regime.**

# 4.0 Conclusions

- This case study shows the steps that will be taken under the AMF if a product or maintenance process is proposed to be changed.
- The assessment of Termarust clearly indicates that the toxicity of Termarust to marine organisms is practically non-toxic in the acute situation and has negligible toxicity from chronic exposure. In addition Termarust does not contain key contaminants of concern, nor additional contaminants that present a risk to marine organisms for which additional thresholds need to be developed. It is confirmed that the threshold for "paint" will not be exceeded in use of this product. Therefore, the existing contaminant thresholds remain appropriate.
- Under the current consented regime, adverse effects on marine ecological values fall within that previously assessed (i.e. minor to negligible).
- It is concluded that the AMF process proposed is robust and provides appropriate protection of marine ecological values whilst enabling a flexible approach to maintenance of the AHB.

# Appendix B: Adaptive Management Framework Summary

# Adaptive Management Framework

## Assessment of potential new product use with respect to discharges to the CMA.

The process that will be followed to assess whether a potential new maintenance product fits within the consented contaminant thresholds and toxicity characteristics with respect to discharges to the marine environment is as follows:

1) Request and review Material Safety Data Sheet for the product;
2) Identify components of the product;
3) Request toxicology test data/reports from the manufacturer;
4) Research water quality guidelines associated with components and create a list of thresholds (if not already covered);
5) If manufacturer's toxicity testing not sufficiently comprehensive, engage toxicology laboratory to carry out acute (short-term) and chronic (long-term) toxicity testing[1] on algae (*Minutocellus polymorphus* – 48 hr cell growth test), amphipod (*Chaetocorophium* c.f. *lucsi* - 96 hr survival and mobility test) and blue mussels (*Mytilus galloprovincialis* - 48 hr embryo development test);
6) Compare toxicity results with existing products used based on the following acute and chronic toxicity descriptive categories (Tables 1 and 2);

**Table 1: Acute Toxicity**

| Description | $EC_{50}$ (mg/L) |
|---|---|
| Non-toxic | >1000 |
| Practically non-toxic | >100 - ≤1000 |
| Slightly toxic | >10 - ≤100 |
| Moderately toxic | >1 - ≤10 |
| Highly toxic | >0.1 - ≤1 |
| Very highly toxic | >0.01 - ≤0.1 |
| Extremely toxic | ≤0.01 |

[1] Using standard USEPA toxicity testing protocols.

**Table 2: Chronic Toxicity**

| Description | NOEC (mg/L) |
|---|---|
| Negligible | >1 |
| Low | >0.1 - ≤ 1 |
| Moderate | >0.01 - ≤ 0.1 |
| High | >0.001 - ≤ 0.01 |
| Very High | ≤ 0.001 |

7) Compare contaminants to consented contaminant thresholds where appropriate;

8) If product meets consented contaminant thresholds and toxicity characteristics of existing products, update Environmental Management Plan or model to include new product[2]; and

9) Introduce product to maintenance regime.

[2] Assuming that the same process for assessing discharges to air meets the corresponding thresholds.

# Appendix C: Termarust MSDS Report

TERMARUST TECHNOLOGIES

Products
2100 series

Other branches in this section

## TERMARUST SERIES 2100

Please note that there are three options: [Stealth Grey] [Grey] [Green]

### MATERIAL SAFETY DATA SHEET

***Section I - Material identification and use***

| | | | | | |
|---|---|---|---|---|---|
| Product code : | 032TR2100 | Health : | Moderate | Whmis Class : | B3 D2B |
| Product name : | Termarust Stealth Grey | Fire : | Moderate | TDG Class : | 3 |
| Chemical family : | Organic coating | Reactivity : | Minimal | TDG UN : | 1263 |
| Product use : | Protective coating | | | | |

***Section II - Hazardous ingredients of material***

| Hazardous ingredients | Concentration % | C.A.S. Num. | LD50 Oral rat & dermal rabbit | LC50 Inhalation rate PPM/H |
|---|---|---|---|---|
| Mineral spirits | 10.0 - 30.0 | 64742-88-7 | 5600 mg/kg 3160 mg/kg | 51000/4 |

***Section III - Physical data for material***

| | | | | | |
|---|---|---|---|---|---|
| Physical state : | Liquid | Specific gravity : | 1.118-1.168 | Vapor pressure (mm): | 7.00 Boiling point (°C) : 150.00 |
| Odor : | Hydrocarbon | Solubility in water : | 0.09/20°C | Vapor density : | 4.80 Freezing point (°C) : N/A |
| | | % Volatile/Volume | 30.0 - 60.0 | Heavier than air : | PH : N/A |

Coefficient of water/oil distribution : N/A
Evaporation rate (nBu Ac=1) : 0.10

***Section IV - Fire and explosion hazard of material***

***Flammability :*** Yes, by open flame, sparks, excessive heat, smoking and other sources of ignition.
***Note*** : Vapor may travel some distance to a source of ignition and flash back along the vapor trail.
***Means of extinction :*** Dry chemical, carbon dioxide, foam, water fog.
***Special procedures :*** Do not enter confined fire space without adequate protective clothing and an approved positive self contained breathing apparatus. Exclude air. Do not use water except as a fog. Use water to cool fire exposed containers.

***Explosion :*** Vapor forms explosive mixture with air between upper and lower flammable limits.
**Flash point :** (c) and method : 42.00 **Upper explosion limit (% by volume) :** 5.00
**Auto-ignition** (c) : N/A **Lower explosion limit (% by volume) :** 0.80
**Sensitivity to mechanical impact :** None **Sensitivity to static discharge :** Yes

***Section V - Toxicological properties of material***

**Exposure limits (TVL ppm) :** 100.00 **Irritancy of material :** Slight to moderate skin irritant
CARINOGENICITY, REPRODUCTIE EFFECTS, TERATOGENICITY and MULTAGENICITY
No adverse affects are anticipated.

Emergency telephone number: Canutec (613) 996-6666, Termarust technical department (514) 351-7600

***Section VI - Toxicological properties of material (cont'd)***

**Route of entry :** Skin contact, skin absorption, inhalation acute, ingestion
**Effects of acute exposure to material :** Direct contact with skin may cause drying and cracking. Contact with eyes may cause conjunctivitis, irritation, and inflammation of mucous membranes. Inhaled, may cause irritation of eyes, nose, throat, and respiratory tract. Ingestion may cause irritation of mucous membranes of mouth and throat.
**Effects of chronic exposure to material :** Prolonged or repeated skin contact may cause drying resulting in irritation and possible dermatitis. Prolonged exposure to high vapor concentration can cause headache, dizziness, nausea, depression and narcosis. Ingestion may cause nausea, vomiting and/or diarrhea.

***Section VII - Reactivity data***

**Chemical stability :** Yes
**Incompatibility with other substances :** Yes, with strong Oxidizing agents, mineral acids
**Reactivity and under what conditions :** Avoid excessive heat, open flame, spark and all ignition sources
**Hazardous decomposition products :** Carbon monoxide and Carbon dioxide when heated

***Section VIII - Preventive measures, Personal protective equipment***

**Gloves :** Impervious (Nitrile, PVC) **Eyes :** Chemical safety goggles of full face shield
**Respiratory :** Wear a CSA approved respirator
**Other :** Where the risk of skin exposure is higher, impervious clothing should be worn. A positive demand, self-contained or airline breathing apparatus for extremely high concentrations.
**Engineering controls :** Local and mechanical ventilation to maintain below LEL and TLV values
**Leak and spill procedure :** Eliminate all sources of ignition. Prevent from entering water sources or sewers. Ventilate enclosed spaces. **Large spills:** Warn public of potential down wind explosion hazard due to flash back of flammable vapors. Contain by dyking. Recover product and collect contaminated soil or water for treatment and/or disposal. **Small spills :** Contain by applying absorbent. Collect waste absorbent and contaminated soil for disposal. Notify appropriate environmental agency.
**Waste disposal :** Reclaim or dispose of waste material in an approved incinerator or waste treatment disposal facility in accordance with applicable regulations by the environmental authority.
**Handling procedures and equipment :** Flammable. Avoid breathing vapors and prolonged or repeated contact with skin. Launder contaminated clothing. Use good personal hygiene. Ground equipment. Use sparks resistant tools. Avoid splash filling.
**Storage requirement :** Keep container closed. Store in a cool, dry, well-ventilated area, from heat and ignition sources.
**Special shipping information :** Handle as flammable liquid.

*Section IX - First aid measures*

**Inhaled :** Remove to fresh air. If not breathing give artificial respiration. Obtain medical attention immediately
**Skin contact :** Flush affected areas with mild soap and water. Remove contaminated clothing
**Eye contact :** Flush eyes with water for at least 15 minutes holding eyelids open. Obtain medical attention immediately.
**Ingestion :** Do not induce vomiting. Obtain medical attention immediately.
**Additional information :** If accidentally ingested or inhaled, liquid can produce chemical pneumonia. Cardiac arrhythmia has been reported with solvent exposure.

*Section X - Preparation of M.S.D.S.*

**Additional notes or references :**
**N/A** = not or none available
**OSHA** = Occupational Safety and Health Administration
**IARC** = International Agency for Research on Cancer
**ACGIH** = American Conference of Governmental Industrial Hygienists

We believe that the information contained herein is current as of the date of this Material Safety Data Sheet. Since the use of this information and the conditions of the use of the product are beyond the control of the company, it is the user's responsibility to establish conditions for safe use of the product.

**MATERIAL SAFETY DATA SHEET**

*Section I – Material identification and use*

| | | | | | |
|---|---|---|---|---|---|
| Product code : | 200TR2100 | Health : | Moderate | Whmis Class : | B3 D2B |
| Product name : | Termarust 501-212 Grey | Fire : | Moderate | TDG Class : | 3 |
| Chemical family : | Organic coating | Reactivity : | Minimal | TDG UN : | 1263 |
| Product use : | Protective coating | | | | |

*Section II – Hazardous ingredients of material*

| Hazardous ingredients | Concentration % | C.A.S. Num. | LD50 Oral rat & dermal rabbit | LC50 Inhalation rate PPM/H |
|---|---|---|---|---|
| Mineral spirits | 10.0 - 30.0 | 64742-88-7 | 5600 mg/kg 3160 mg/kg | 51000/4 |

*Section III – Physical data for material*

| | | | | | |
|---|---|---|---|---|---|
| Physical state : | Liquid | Specific gravity : | 1.114-1.164 | Vapor pressure (mm): | 7.00 Boiling point (°C) : 150.00 |
| Odor : | Hydrocarbon | Solubility in water : | 0.05/20°C | Vapor density : | 4.80 Freezing point (°C) : N/A |
| | | % Volatile/Volume | 30.0 - 60.0 | Heavier than air : | PH : N/A |

Coefficient of water/oil distribution : N/A
Evaporation rate (nBu Ac=1) : 0.10

# Appendix D: Termarust Manufacturer’s Toxicology Report

EVS environment consultants
A member of the Golder group of companies

Golder Associates

**Golder Associates Ltd.**

195 Pemberton Avenue
North Vancouver, British Columbia, Canada V7P 2R4
Telephone 604-986-4331
Fax 604-662-8548

E/05/0298
05-1424-009

July 25, 2005

ICI Canada Inc.
1609 Boundary Road
Vancouver, BC V5K 4X7

Attention: Peter Roberts

**RE: TOXICITY TESTING ON THE SAMPLE IDENTIFIED AS TR2100 RAVCS.**
**WORK ORDER 0500213**

Dear Mr. Roberts:

We have conducted one rangefinder and a 96-h LC50 toxicity test using rainbow trout on the above sample, received at EVS/Golder on May 31, 2005. The test was performed according to the Environment Canada protocol for conducting acute toxicity tests using rainbow trout (EPS 1/RM/13, Second Edition, 2000). The results of the 96-h LC50 test are based on the appended data and are presented in Table 1 on the following page.

If you wish to schedule additional testing or have any questions regarding the data presented in this report, please do not hesitate to contact me by e-mail (rharrison@evsenvironment.com) or telephone.

Yours very truly,
**EVS ENVIRONMENT CONSULTANTS**
**A Member of the Golder Group of Companies**

Robert Harrison, B.Sc.Hons.
Laboratory Biologist

**Verified By:**

QA/QC Committee:
Cathy McPherson, B.Sc.
Julianna Kalocai, M.Sc.
John Wilcockson, M.Sc.

Attachment: Table 1
RH/ljk
Z:\DATA\FINAL\2005\1424\05-1424-009\LET 0725 2005 TOX TEST WO 0500213.DOC

**TABLE 1**
**96-H TOXICITY TEST RESULTS**

| Sample Identification | Sample Collection Date (Time) | 96-h LC50 (95% Confidence Limits) [mg/L] |
|---|---|---|
| TR2100 RAVCS | n/a (n/a) | 41,017 (33,414 and 50,349) |

Note: The paint sample was observed to be not readily soluble to our laboratory dilution water even after thorough mixing of the sample test treatments. Paint material was observed to settle at the bottom of test vessels during testing and, therefore, the full extent of sample toxicity may not have been properly measured by this particular toxicity test.

**EVS ENVIRONMENT CONSULTANTS**
**RAINBOW TROUT ACUTE TOXICITY TEST DATA SUMMARY**

Client: ICI Canada
Golder ~~EVS~~ REH Project No.: 05-1424-009
EVS Work Order No.: 0500213

EVS Analysts: MJG, REH
Test Type: 96-h LC50
Test Initiation Date: June 10/05 @ 1730

**SAMPLE**

Identification: TR2100 RAUCS
Amount Received: 1 x 4L
Date Collected: n/a ~~May 31/05~~ REH
Date Received: May 31/05
Other: –

**DILUTION/CONTROL WATER** (initial water quality)

Fresh Water (dechlorinated): ✓
Temperature (°C): 14
pH: 7.0
Dissolved Oxygen (mg/L): 10.2
Conductivity ($\mu$S/cm): 30
Hardness (mg/L as $CaCO_3$): 8
Alkalinity (mg/L as $CaCO_3$): 6
Other: ✓

**TEST SPECIES INFORMATION**

Source: Sun Valley
Collection Date/Batch: 050905
Control Fish Size (mean, SD and range measured at end of test)
Date Measured: June 14/05
Fork Length (mm): 36±2 (31–40)
Wet Weight (g): 0.52±0.11 (0.37–0.69)
Reference Toxicant: SDS
Current Reference Toxicant Result
Reference Toxicant Test Date: June 3/05
Duration of Acclimation (days): 25
96-h LC50 (and 95% CL): ~~42 (32 and 56)~~ REH 37 (28 and 49)
Reference Toxicant Warning Limits (mean ± 2SD) and CV
29 ± 12 mg/L SDS CV: 21%

**TEST CONDITIONS**

Dissolved Oxygen Range (mg/L): 6.2–10.2
Temperature Range (°C): 14
pH Range: 6.3–7.2
Conductivity Range ($\mu$S/cm): 30–62
Aeration Provided? (give rate): 6.5±1 mL/min/L
Photoperiod (L:D h): 16:8
No. Organisms/Volume: 10/12L
Loading Density (g/L): 0.43
Acclimation Before Testing (days): 32
Mortality In Previous Week of Acclimation (%): 0
Other: –

**TEST RESULTS** The 96-h LC50 is estimated to be 41,017 mg/L with 95% CL of 33,414 and 50,349 mg/L.

Data Verified By: [signature]  Date Verified: July 11/05

Forms\Lab\Datasheets\Trout\SUMMARY.DOC  February 13, 2003

**EVS ENVIRONMENT CONSULTANTS**
**RAINBOW TROUT ACUTE TOXICITY TEST DATA**

WHOLE SAMPLE WATER QUALITY

| | Initial | pH Adjustment[1] | After 30-min Pre-aeration |
|---|---|---|---|
| Temp. (°C) | | | |
| pH | | | |
| DO (mg/L) | | | |
| Cond. (µS/cm) | | | |

1 Document pH adjustment procedure (if used) under "Comments".

Total Pre-Aeration Time n/a min

Client ICI Canada
Golder ~~EVS~~ Project No. 05-1424-009
EVS Work Order No. 0500213
Trout Batch No. and 7-d Acclimation Mortality 050905/0%
No. Fish/Volume 10 / 12L
Sample ID TR2100 RAUCS
Date/Time Collected n/a
Test Initiation Date/Time June 10/05 @ 1730

| Concentration Conc (mg/L) | Number of Survivors (1 to 96 hours) 1 | 2 | 4 | 24 | 48 | 72 | 96 | Dissolved Oxygen (mg/L) 0 | 24 | 48 | 72 | 96 | Temperature (°C) 0 | 24 | 48 | 72 | 96 | pH 0 | 24 | 48 | 72 | 96 | Conductivity (µS/cm) 0 | 96 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| control | | | | 10 | 10 | 10 | 10 | 10.2 | 9.5 | 9.6 | 9.9 | 9.8 | 14 | 14 | 14 | 14 | 14 | 7.0 | 6.9 | 6.9 | 7.2 | 6.9 | 30 | 32 |
| 3125 | | | | 10 | 10 | 10 | 10 | 10.2 | 9.6 | 9.5 | 9.2 | 9.6 | 14 | 14 | 14 | 14 | 14 | 6.9 | 6.8 | 6.6 | 6.9 | 6.6 | 31 | 33 |
| 6250 | | | | 10 | 10 | 10 | 10 | 10.2 | 9.6 | 9.7 | 9.8 | 9.6 | 14 | 14 | 14 | 14 | 14 | 6.9 | 6.8 | 6.5 | 6.8 | 6.6 | 32 | 35 |
| 12500 | | | | 10 | 10 | 10 | 10 | 10.2 | 9.7 | 9.8 | 9.7 | 9.8 | 14 | 14 | 14 | 14 | 14 | 6.8 | 6.7 | 6.1 | 6.8 | 6.6 | 33 | 38 |
| 25000 | | | | 10 | 10 | 10 | 10 | 10.2 | 9.6 | 9.8 | 9.6 | 9.8 | 14 | 14 | 14 | 14 | 14 | 6.6 | 6.6 | 6.3 | 6.7 | 6.5 | 33 | 40 |
| 50000 | | | | 10 | 6 | 4 | 3 (1) | 10.2 | 9.6 | 8.7 | 8.2 | 6.2 | 14 | 14 | 14 | 14 | 14 | 6.6 | ~~6.6~~ 6.6 | 6.3 | 6.7 | 6.4 | 33 | 62 |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| Technician Initials | | | | TTL | TTL | RCH | RCH | RCH | TTL | TTL | RCH | RCH | RCH | TTL | TTL | RCH | RCH | RCH | TTL | TTL | RCH | RCH | RCH | RCH |

WQ Instruments Used: Temperature calibrated lab thermometer pH II-4-030302 DO II-4-3 Conductivity II-4-030303

Sample Description chemical - ~~white~~ grey

Comments (1) fish swimming upsidedown w/ periodic spasms
Not soluable

Test Set Up By RCH Data Verified By [illegible] Date Verified July 4/05

Form/Lab/Datasheets/Trout/ACUTE.DOC August 26, 2002

| | | | | | |
|---|---|---|---|---|---|
| | | | Acute Fish Test-96-h | | |
| Start Date: | 10/06/2005 | Test ID: | 500213 | Sample ID: | TR2100 RAVCS |
| End Date: | 14/06/2005 | Lab ID: | BCEVS-EVS Environment Cc | Sample Type: | OC-Other Chemical |
| Sample Date: | | Protocol: | EPS1/RM/13-EC 2000 (Raint | Test Species: | OM-Oncorhynchus mykiss |
| Comments: | | | | | |

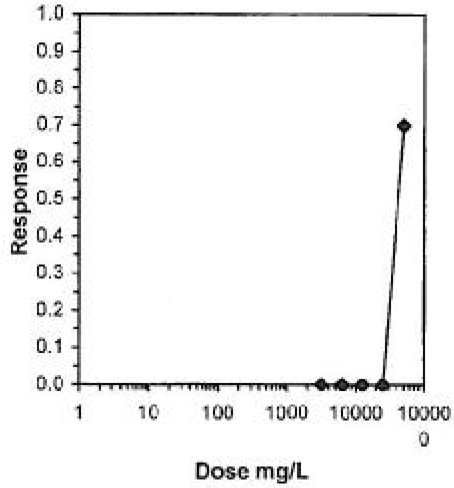
| Conc-mg/L | 1 |
|---|---|
| control | 1.0000 |
| 3125 | 1.0000 |
| 6250 | 1.0000 |
| 12500 | 1.0000 |
| 25000 | 1.0000 |
| 50000 | 0.3000 |

| Conc-mg/L | Mean | SD | Resp | Not Resp | Total | N | Fisher's Exact P | 1-Tailed Critical | Number Resp | Total Number |
|---|---|---|---|---|---|---|---|---|---|---|
| control | 1.0000 | 0.0000 | 0 | 10 | 10 | 1 | | | 0 | 10 |
| 3125 | 1.0000 | 0.0000 | 0 | 10 | 10 | 1 | 1.0000 | 0.0500 | 0 | 10 |
| 6250 | 1.0000 | 0.0000 | 0 | 10 | 10 | 1 | 1.0000 | 0.0500 | 0 | 10 |
| 12500 | 1.0000 | 0.0000 | 0 | 10 | 10 | 1 | 1.0000 | 0.0500 | 0 | 10 |
| 25000 | 1.0000 | 0.0000 | 0 | 10 | 10 | 1 | 1.0000 | 0.0500 | 0 | 10 |
| *50000 | 0.3000 | 0.0000 | 7 | 3 | 10 | 1 | 0.0015 | 0.0500 | 7 | 10 |

| Hypothesis Test (1-tail, 0.05) | NOEC | LOEC | ChV | TU |
|---|---|---|---|---|
| Fisher's Exact Test | 25000 | 50000 | 35355.3 | |

Trimmed Spearman-Karber

| Trim Level | EC50 | 95% CL | | |
|---|---|---|---|---|
| 0.0% | | | | |
| 5.0% | | | | |
| 10.0% | | | | |
| 20.0% | | | | |
| Auto-30.0% | 41016.8 | 33414.4 | 50348.8 | mg/L |






ToxCalc v5.0.23

Reviewed by [signature] 2014/11/05

# CHAIN-OF-CUSTODY/TEST REQUEST FORM

EVS environment consultants
195 Pemberton Avenue
North Vancouver, BC
Canada V7P 2R4
Tel: (604) 986-4331
Fax: (604) 662-8548
www.evsenvironment.com

Client Name: Devoe Coatings
Client Contact: Peter Roberts
Ship to:
Address: 1609 Boundary Rd
Vancouver, BC
V5K 4X7
Phone: 604-637-1152 ext 24
Fax: 604-637-1156
Sampled by:
Attn:
Shipping Date:

| Collection Date (DD/MMM/YYYY) [1] | Time (24-h clock) [1] | Sample Identification | Type of Each Sample [2] | Material Safety Data Sheet Attached? (✓) | Sample Collection Method G = grab; C = composite | Number of Sample Containers x Volume of Sample Container (i.e., 1 x 20 L) | Sample Container Type by Code [3] | Test(s) Requested: 96 h RBT LC50 | | | | | Sample Notes (e.g. preserved, saltwater, freshwater, may contain sewage) [4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| — | — | Bar Rust 231 | PAINT | ✓ | | 1×4L 1×1L | | ✓ | | | | | |
| | | Devthane 389 | PAINT | ✓ | | 1×4L 1×2L | | ✓ | | | | | |
| | | Devthane 379 | PAINT | ✓ | | 1×4L 1×1L | | ✓ | | | | | |
| | | TR2100 RAVCS | PAINT | ✓ | | 1×4L | | ✓ | | | | | |
| | | 475C Series | PAINT | ✓ | | 1×4L 1×1L | | ✓ | | | | | |
| | | 485C Series | PAINT | ✓ | | 1×4L 1×1L | | ✓ | | | | | |
| | | 68 Series | PAINT | ✓ | | 1×4L 1×1L | | ✓ | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | COC generated in-house |
| | | | | | | | | | | | | | |

PO/Reference No.:
Project Title:
Results Needed By:
Comments/Instructions: All Samples have a 1×1L Converter except for TR2100 RAVCS.

| 1) Released by: | Date: | 2) Released by: | Date: | *Shaded area to be completed by EVS Laboratory upon sample receipt.* | |
|---|---|---|---|---|---|
| Company: | Time: | Company: | Time: | EVS Project No. | |
| Courier name: | | Courier name: | | EVS Work Order (WO) No. | 0500213 |
| 1) Received: JAP | Date: 31 May 05 | 2) Received by: | Date: | Condition Upon Receipt | Good |
| Company: Golder | Time: 0945 | Company: | Time: | Receipt Sample Temp. (C) | 20.0 |

1 For composite effluent or water samples, the sample collection date/time is the end of the compositing period.
2 Receiving Water (RW); Effluent (E); Elutriate (ELU); Sediment (SED); Chemical (CHEM); Stormwater (SW); Other (Please Specify)
3 Collapsible Carboy (CC); Glass Jar (GJ); Jerry Can (JC); Plastic HDPE (P); Other (Please Specify)
4 Please note any conditions the lab should be aware of for safety and storage concerns

Distribution of copies: White, yellow - accompany the shipment
Pink - kept by consignor (e.g., shipper)
Yellow - kept by consignee (e.g., receiver)
White - returned to consignor by consignee

*Please see instructions for completion on back of form.*

Revision Date: March 6, 2004

# Appendix E: NIWA Toxicology Report

# ECOTOXICOLOGY RESULTS

NIWA
Taihoro Nukurangi

| | | | |
|---|---|---|---|
| **Client:** | Total Bridge Services<br>PO Box 56416<br>Dominion Rd<br>Auckland 1446 | **Project Code:**<br>**Sampling Date** | TBS14201<br>N/A |
| | | **Sample Received:**<br>**Report Date:** | 19/11/13<br>31/1/14 |
| **Attention:** | Alex Ingram | | |

**Project Outline:** Undertake an aquatic ecotoxicity assessment of rust-proof paints and topcoats using a marine alga (*Minutocellus polymorphus* – 48 h cell growth), a marine amphipod (*Chaetocorophium* c.f. *lucasi* – 96 h survival) and blue mussel embryos (*Mytilus galloprovincialis* – 48 h embryo development).

**Sample Preparation:** A water available fraction (WAF) of each sample was prepared from the supplied samples using a 1:20 ratio of the sample (50 g sample + 1.0 L offshore water, mixed in a 1 L glass jar on a rotary tumbler (16 rpm) for 24 h at 20 °C. The WAF was then cold settled (4°C) for 24 h, decanted and the supernatant used for the toxicity assessments.

## RESULTS:

**Sample ID:** Total Bridge Services **Sample Type:** Paint
**Collected by:** Not dated **Sample Method:** N/A

| | $EC_{50}$[1](95%CI) % WAF | $EC_{20}$[1] % WAF | NOEC[2] % WAF | LOEC[2] % WAF | TEC[2] % WAF |
|---|---|---|---|---|---|
| **Algae** | | | | | |
| MC Ferrox | 53.1(58.8-43.7) | 22.5 | 4.5 | 9 | 6.4 |
| Termarust 2100 | 1.8(2.1-1.5) | 0.9 | 0.56 | 1.1 | 0.8 |
| MC MIO | 1.5(1.7-1.3) | 0.8 | 0.56 | 1.1 | 0.8 |
| Zinc | 5.2(7.1-3.6) | 1.1 | 2.25 | 4.5 | 3.2 |
| **Amphipods - survival** | | | | | |
| MC Ferrox | 38.0(44.0-33.0) | 31.0 | 25 | 57.1 | 37.8 |
| Termarust 2100 | 29.0(35.0-25.0) | _[3] | 6.25 | 25.0 | 12.5 |
| MC MIO | 23.0(29.0-19.0) | _[3] | 6.25 | 25.0 | 12.5 |
| Zinc | 21.0(27.0-17.0) | _[3] | 6.25 | 25.0 | 12.5 |
| **Amphipods - mobility** | | | | | |
| MC Ferrox | 38.0(44.0-33.0) | 31.0 | 25 | 57.1 | 37.8 |
| Termarust 2100 | 20.0(25.0-17.0) | _[3] | 6.25 | 25.0 | 12.5 |
| MC MIO | 13.0(16.0-9.7) | _[3] | 6.25 | 25.0 | 12.5 |
| Zinc | 14.0(17.0-12.0) | _[3] | 6.25 | 25.0 | 12.5 |
| **Blue mussels** | | | | | |
| MC Ferrox | 29.0(31.0-27.0) | 18.0 | 6.25 | 25.0 | 12.5 |
| Termarust 2100 | 3.0(3.1-2.9) | _[3] | 1.56 | 6.25 | 3.1 |
| MC MIO | 3.1(3.2-3.0) | _[3] | 1.56 | 6.25 | 3.1 |
| Zinc | 1.1(1.2-1.0) | _[3] | 0.39 | 1.56 | 0.78 |

1 $EC_N$: The percentage effluent concentration causing an N% effect to the test organisms relative to the controls. A lower value indicates greater toxicity.
2 NOEC: no observed effect concentration, LOEC = lowest observed effect concentration, TEC: threshold effect concentration (geometric mean of NOEC and LOEC).
3 Trimmed Spearman Karber method used to calculate $EC_{50}$ values, $EC_{20}$ value not calculated with this method.

Water available fractions (50 g $L^{-1}$; 1:20) were extracted from four paint and surface coating formulations (MC Ferrox, Termarust 2100, MC M10, Zinc) and tested for aquatic toxicity using three marine species. Based on the most sensitive $EC_{50}$ (acute) and NOEC (chronic) values which were converted to equivalent loading rates, the test substances would be classified as:

**GESAMP (2002) aquatic toxicity classification**

| | Acute | Chronic |
|---|---|---|
| MC Ferrox | Non-toxic | Negligible |
| Termarust 2100 | Practically non-toxic | Negligible |
| MC MI0 | Practically non-toxic | Negligible |
| Zinc | Non-toxic | Negligible |

## COMMENTS

Proposed maintenance of the Auckland Harbour Bridge involves the use of rust-proof paints and topcoats. Details of the sample composition and active ingredients are confidential and were not supplied. Chemical analysis of the WAF was not included in the project scope.

In the likelihood of significant product loss during the application process, either from spray-drift or from accidental spillage, toxicity testing using marine organisms would be beneficial for assessing the potential for adverse effects of these coating formulations on marine biota. The four test substances are complex mixtures of chemicals, including thinners, sterilisers fillers, solvents, and pigments. Aquatic toxicity data is not available for the mixtures, but some data for individual components were available from MSDS reports supplied by Boffa Miskell. The products supplied for toxicity testing were:

| Product ID | Description |
|---|---|
| Termarust 2100 | Co-polymerized calcium sulfonate HR CSA (with thinners) |
| MC Ferrox | Micaceous iron oxide (MIO) enriched, matte-finish, aliphatic moisture cure urethane topcoat |
| Zinc | Zinc-pigmented, one-component, moisture-cure polyurethane primer |
| MC MI0 | A blend of micaceous iron oxide (MIO) and corrosion inhibiting pigments |

A 500 mL sample of each formulation was received on 19/11/13. The samples were mixed using a plastic spatula and the WAFs were prepared on 2/12/13, mixed for 24 hours (rotary tumbler 16 rpm) and cold settled for 24 hours before the toxicity tests were initiated (USEPA 1992). The WAFs had the following characteristics after settling:

| 100% WAF | pH[a] | Dissolved oxygen mg $L^{-1}$ | Salinity ppt |
|---|---|---|---|
| MC Ferrox | 7.95 | 7.5 | 35.7 |
| Termarust 2100 | 7.82 | 7.5 | 35.5 |
| MC MI0 | 6.10 | 6.5 | 35.8 |
| Zinc | 6.77 | 7.3 | 35.6 |

[a] Initial pH of the WAF before the test initiation.

The initial pH of MC M10 and Zinc WAFs were slightly acidic, but in the test dilutions pH values at the blue mussel test termination were 7.7 to 8.0. Testing was undertaken on an "as supplied" basis using clean offshore seawater from the Chatham Rise for the WAF preparation, and for the algal and blue mussel test dilutions and controls. For the amphipod test, nearshore seawater from Manu Bay[1] was used for the test dilutions and controls.

*Alga*

Algal cell growth in the offshore seawater controls achieved the minimum acceptability criteria (at least 16x increase after 48 hours). There was about a 35-fold range of the $EC_{50}$ values, MC MIO had the greatest adverse effect on algal growth ($EC_{50}$ = 1.5% WAF), and MC Ferrox had the least effect ($EC_{50}$ = 53.1% WAF). The highest tested concentration of the WAF was 72%, due to salinity adjustment for optimum algal growth. At this concentration algal growth was reduced by 62% (MC Ferrox), 44% (Termarust 2100), 72% (MC MIO) and 43% (Zinc) relative to the seawater controls. Algae were the most sensitive test species for Termarust 2100 and MC MIO.

*Amphipods*

Mean amphipod survival in the Manu Bay nearshore seawater control (100%) achieved the minimum test acceptability criterion (>90% survival). The $EC_{50}$ values were from 21% WAF (Zinc) to 38% WAF (MC Ferrox). The highest tested concentration was 57.1% WAF due to salinity adjustments. At this concentration survival was reduced by 97% (MC Ferrox), 100% (Termarust 2100, MC MIO and Zinc) relative to the control.

The mobility (morbidity) endpoint measures the ability of the test organisms to swim when stimulated by a jet of clean seawater2. This sub-lethal endpoint is more sensitive than survival, and organisms that are immobile are considered to be adversely affected by the test substance. There was no difference between survival and mobility for MC Ferrox. However, some surviving amphipods in Termarust 2100, MC MIO and Zinc test solutions were immobile at the test conclusion. The immobility EC50 values were 31% (Termarust 2100), 43% (MC MIO) and 33% (Zinc) lower than the respective survival $EC_{50}$ values.

*Blue Mussels*

Normal embryo development in the controls achieved the test acceptability criterion (at least 80% normal development). MC Ferrox had the lowest adverse effect on embryo development ($EC_{50}$ = 29.0% WAF), and Zinc the greatest adverse effect ($EC_{50}$ = 1.1% WAF). Salinity adjustments were not required for the blue mussel test, and for undiluted WAF (i.e., 100%) embryo development was 100% abnormal for each test substance. Blue mussels were the most sensitive test species for MC Ferrox and Zinc.

*Hazard classification*

GESAMP (2002) considers acute toxicity test data the most practical measure available to rate the hazard posed by chemical substances to aquatic organisms. The rating scheme is based on the effect loading (EL) rate for 50% effect to the test organisms ($EL_{50}$). The hazard evaluation procedure classifications are provided in Appendix 1. The $EC_{50}$ values for the WAFs were used to calculate the $EL_{50}$ values for each organism, and the lowest value was

[1] NIWA seawater collected from Manu Bay, Raglan.
[2] Organisms is considered immobile if it is unable to swim after 10 seconds when it is stimulated with a jet of clean seawater.

used to classify the test substances. **MC Ferrox and Zinc would be classified as 'non-toxic', Termarust 2100 and MC M10 would be classified as 'practically non-toxic'.**

| | | Acute classification (GESAMP 2002) | | | | |
|---|---|---|---|---|---|---|
| | | $EC_{50}$ % WAF[a] | Dilution factor[b] | $EL_{50}$[c] mg/L | Rating | Description |
| Algae[d] | MC Ferrox | 53.1 | 1.9 | 26,550 | 0 | Non-toxic |
| | Termarust 2100 | 1.8 | 55.6 | 900 | 1 | Practically non-toxic |
| | MC MIO | 1.5 | 66.7 | 750 | 1 | Practically non-toxic |
| | Zinc | 5.2 | 19.2 | 2,600 | 0 | Non-toxic |
| Amphipods (survival) | MC Ferrox | 38.0 | 2.6 | 19,000 | 0 | Non-toxic |
| | Termarust 2100 | 29.0 | 3.4 | 14,500 | 0 | Non-toxic |
| | MC MIO | 23.0 | 4.3 | 11,500 | 0 | Non-toxic |
| | Zinc | 21.0 | 4.8 | 10,500 | 0 | Non-toxic |
| Amphipods (mobility) | MC Ferrox | 38.0 | 2.6 | 19,000 | 0 | Non-toxic |
| | Termarust 2100 | 20.0 | 5.0 | 10,000 | 0 | Non-toxic |
| | MC MIO | 13.0 | 7.7 | 6,500 | 0 | Non-toxic |
| | Zinc | 14.0 | 7.1 | 7,000 | 0 | Non-toxic |
| Blue Mussels[d] | MC Ferrox | 29.0 | 3.4 | 14,500 | 0 | Non-toxic |
| | Termarust 2100 | 3 | 33.3 | 1,500 | 0 | Non-toxic |
| | MC MIO | 3.1 | 32.3 | 1,550 | 0 | Non-toxic |
| | Zinc | 1.1 | 90.9 | 550 | 1 | Practically non-toxic |

[a] Loading rate 50 g/L

[b] $(1/EC_{50})*100$

[c] (Loading rate*1000)/dilution factor

[d] Normally considered a short term chronic toxicity test. The $EC_{50}$ value is therefore considered highly conservative.

(shaded) Final rating and descriptor using lowest $EL_{50}$

| | | Chronic classification (GESAMP 2002) | | | | |
|---|---|---|---|---|---|---|
| | | NOEC % WAF[a] | Dilution factor[b] | NOEC-L[c] mg/L | Rating | Description |
| Algae | MC Ferrox | 4.5 | 22.2 | 2,250 | 0 | Negligible |
| | Termarust 2100 | 0.56 | 178.6 | 280 | 0 | Negligible |
| | MC MIO | 0.56 | 178.6 | 280 | 0 | Negligible |
| | Zinc | 2.25 | 44.4 | 1,125 | 0 | Negligible |
| Amphipods[d] (survival) | MC Ferrox | 3.8 | 26.3 | 1,900 | 0 | Negligible |
| | Termarust 2100 | 2.9 | 34.5 | 1,450 | 0 | Negligible |
| | MC MIO | 2.3 | 43.5 | 1,150 | 0 | Negligible |
| | Zinc | 2.1 | 47.6 | 1,050 | 0 | Negligible |
| Amphipods[d] (mobility) | MC Ferrox | 3.8 | 26.3 | 1,900 | 0 | Negligible |
| | Termarust 2100 | 2.0 | 50.0 | 1,000 | 0 | Negligible |
| | MC MIO | 1.3 | 76.9 | 650 | 0 | Negligible |
| | Zinc | 1.4 | 71.4 | 700 | 0 | Negligible |
| Blue Mussels | MC Ferrox | 6.25 | 16.0 | 3,125 | 0 | Negligible |
| | Termarust 2100 | 1.56 | 64.1 | 780 | 0 | Negligible |
| | MC MIO | 1.56 | 64.1 | 780 | 0 | Negligible |
| | Zinc | 0.39 | 256.4 | 195 | 0 | Negligible |

[a] Loading rate 50 g/L

[b] (1/NOEC)*100

[c] (NOEC Loading rate*1000)/dilution factor

(shaded) Rating and descriptor using lowest NOEC-L

[d] NOEC estimated using $EC_{50}/10$

Chronic toxicity addresses the potential impact of longer-term exposures and considers the influence of operational discharges in heavily used shipping lanes, accidental spills where the time-scales involved are longer than expected, such as involving large volumes which may bioaccumulate or slowly degrade (GESAMP (2002).

The algal growth and blue mussel embryo development tests may also be considered as short-term chronic tests as the test exposure is for a relatively long portion of the life stage. However for the acute amphipod survival test an estimate of chronic toxicity can be made by application of an acute to chronic ratio (ACR) of 10-fold to the $EC_{50}$ value (ANZECC 2000). The supplied substances would each have a **chronic toxicity rating of 'negligible'** indicating little potential for chronic toxicity.

The four test substances are complex mixtures of chemicals, including thinners, sterilisers fillers, solvents, and pigments. Aquatic toxicity data was not available for the mixtures, but some data for individual components were available from MSDS reports supplied by Boffa Miskell. However, they did not contain test details such as sample preparation. A previous toxicity study of Termarust TR2100 using rainbow trout survival in freshwater yielded an $LC_{50}$ of 41 g $L^{-1}$. However the authors noted the paint was not readily soluble, settled to the bottom of the test containers, and the $LC_{50}$ value probably did not accurately reflect toxicity (EVS/Golder 2005).

To adequately the low solubility issue, toxicity of these products was assessed using the water available fraction (WAF), which is prepared using the USEPA (1992) toxicity characteristic leaching procedure (TCLP). This approach is recommended by GESAMP (2002) for poorly soluble substances and estimates the mobility of both organic and inorganic compounds in solid, liquid and multiphasic substances in aquatic environments. In this study the test substances had low solubility, but the WAF extraction method simulated what may occur if any material was introduced to the marine environment from an event like a spill. This assessment method did not simulate input from overspray. The low hazard ratings for acute and chronic aquatic toxicity most likely reflect the low solubility of the test substance ingredients.

With respect to potential toxicity from exposure to cured/dried paint flakes entering the marine environment, we assume that there would probably be low risk to benthic macro-invertebrates. Exposure would only be by ingestion, and we would anticipate that they would have to ingest a large quantity before toxic thresholds were reached. Current flows under the Auckland Harbour Bridge would be expected to result in a wide dispersion of paint flakes prior to this threshold being reached.

*Reference toxicant*

The amphipod zinc sulphate sensitivity was within the normal and expected range (± 2SD of long term mean – NIWA unpublished data). The blue mussel sensitivity for zinc was slightly outside of the expected range, but still within the action limits (± 3SD of long term mean). The calculated zinc sensitivity for the alga was outside the action limits, but still two times more sensitive than the lost sensitive organism more sensitive than the most sensitive used to derive water quality criteria for zinc (ANZECC 2000).

Nevertheless, by using three test species (*M. polymorphus, C. lucasi,* and *M. galloprovincialis*) which exhibit such sensitivity to zinc, the results from this suite of toxicity tests provide a moderate degree of confidence in assessing the toxic hazard of the sample. However, care must be taken when extrapolating these results for protection of organisms present in a particular receiving water environment.

Michael L Martin
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Reviewed by:
Dr Chris Hickey
**Principal Scientist**
**Ecology & Ecotoxicology**

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# Appendix 1

## HAZARD EVALUATION PROCEDURE

A summary of the GESAMP (2002) hazard evaluation procedure for chemical substances carried by ships. The procedure uses general descriptive categories for toxicity based on acute $EC_{50}$ values (for acute toxicity) and NOEC values (for chronic toxicity):

*Table 5 Revised GESAMP rating scheme for acute aquatic toxicity*

| Rating | Description | $LC/LL_{50}$, $EC/EL_{50}$, $IC/IL_{50}$ (mg/L) |
|---|---|---|
| 0 | Non-toxic | > 1000 |
| 1 | Practically non-toxic | >100 - ≤1000 |
| 2 | Slightly toxic | >10 - ≤100 |
| 3 | Moderately toxic | >1 - ≤10 |
| 4 | Highly toxic | >0.1 - ≤1 |
| 5 | Very highly toxic | >0.01 - ≤0.1 |
| 6 | Extremely toxic | ≤0.01 |

*Table 6 Ratings for chronic aquatic toxicity*

| Rating | Description | No Observed Effect Concentration (mg/l) |
|---|---|---|
| 0 | negligible | > 1 |
| 1 | low | > 0.1 – ≤ 1 |
| 2 | moderate | > 0.01– ≤ 0.1 |
| 3 | high | > 0.001– ≤ 0.01 |
| 4 | very high | ≤ 0.001 |

# APPENDIX2:

## METHODS:

| | | | |
|---|---|---|---|
| **Project Name:** | Total Bridge Services | **Project Number** | TBS14201 |
| **Test Material:** | Paint formulations WAFs[a] | **Reference Toxicant:** | Zinc sulphate |
| **Dilution Water:** | Alga and blue mussels – 0.2 µm filtered offshore seawater; amphipods – Manu Bay seawater. | | |

| | **Algae** | **Amphipod** | **Bivalve – blue mussel embryos** |
|---|---|---|---|
| Test Initiation: | 4/12/2013 | 5/12/2013 | 6/12//2013 |
| Reference Method: | USEPA (1987) modified with Environment Canada (1992) | ASTM (1993) | Williams & Hall (1999) |
| Test Protocol: | NIWA SOP 14.1 - NIWA (1996) | NIWA SOP 4.0 NIWA (1995) | NIWA SOP 21.2 - (NIWA 2008) |
| Test Organisms: | *Minutocellus polymorphus* | *Chaetocorophium* cf. *lucasi* | *Mytilus galloprovincialis* |
| Source: | Lab culture (500), imported from Bigelow Laboratories, USA | Waingaro Landing, Raglan Harbour | Coromandel Harbour |
| Organisms/Container: | 10,000 cells $mL^{-1}$ | 10 | 600 fertilised embryos |
| Test Concentrations | Control, 0.14, 0.28, 0.56, 1.13, 2.25, 4.5, 9.0, 18.0, 36.0, 72.0% | Control, Brine Control, 0.1, 0.39, 1.56, 6.25, 25.0, 57.1% | Control, 0.1, 0.39, 1.56, 6.25, 25.0, 100% |
| Test Duration: | 48 hours | 96 hours | 48 hours |
| Replicates: | 10 for controls, 5 for treatments | 5 for controls, 3 for treatments | 10 for controls, 5 for treatments |
| Sample preparation: | 50 g sample + 1.0 L offshore water, mixed in a 1 L glass jar on a rotary tumbler (16 rpm) for 24 h at 20 °C. The WAF was then cold settled (4°C) for 24 h, decanted and the supernatant used for the toxicity assessments. | | |
| Salinity: | 26‰ adjusted with UVNP water | 20‰ adjusted with UVNP water | 35 ± 1‰ |
| Sample pretreatment: | 0.45 µm filtration | Nil | Nil |
| Test Chambers: | 96 well sterile microplates | 55 ml polystyrene beakers | 16x100mm glass tubes |
| Lighting: | Continuous overhead lighting | Complete darkness | 16:8h light:dark |
| Temperature: | 25 ± 1°C | 20 ± 1°C | 20 ± 1°C |
| Aeration: | Nil | Nil | Nil |
| Chemical Data: | Initial sample salinity, pH, temperature, dissolved oxygen. | Initial and final salinity, pH, temperature, dissolved oxygen, final conductivity. | Initial and final salinity, pH, temperature, dissolved oxygen. |
| Effect Measured: | Growth inhibition | Survival, mobility | Larvae abnormality and retarded embryo development |
| Zn sensitivity ($EC_{50}$±2sd)[b]: | 0.024(0.041-0.007) mg $L^{-1}$ $Zn^{2+}$ (n=16) | 2.4(3.9-0.9) mg $L^{-1}$ $Zn^{2+}$ (n=6) | 0.19(0.25-0.13) mg $L^{-1}$ $Zn^{2+}$ (n=18) |
| Test Acceptability: | Control CV<20%; at least 16x cell growth increase in controls | At least 90% survival and mobility in control | 80% of control embryos normally developed |
| Method Detection Limit: | 17.3 % reduction relative to controls | 11% reduction relative to controls | 7.2% reduction relative to controls |
| Percent Minimum Significant Difference[c] (PMSD): | 10.2%, 15.7%, 11.0%, 27.1% | 6.0%, 4.2%, 5.2%, 11.0% | 11.0%, 10.0%, 6.7%, 11.0% |
| Test Compliance: | **Achieved** | **Achieved** | **Achieved** |

[a] USEPA (1992).
[b] NIWA long-term average.
[c] The percent minimum significant difference (PMSD) represents the smallest difference between the control mean and a treatment mean that leads to the statistical rejection of the null hypothesis (i.e., no toxicity) at each concentration of the toxicity test dilution series. Listed values in order: MC Ferrox, Termarust 2100, MC MIO, Zinc.

# Appendix 3:
## STATISTICS

### CETIS Analytical Report

Report Date: 07 Jan-14 15:49 (p 1 of 2)
Test Code: 15-9035-5032/2558/OT1 MP5

**Phytoplankton Growth Inhibition Test** — NIWA Ecotoxicology

| | | | | | |
|---|---|---|---|---|---|
| **Analysis ID:** | 15-8928-7900 | **Endpoint:** | Cell Density | **CETIS Version:** | CETISv1.7.0 |
| **Analyzed:** | 09 Dec-13 11:18 | **Analysis:** | Parametric-Multiple Comparison | **Official Results:** | Yes |

| | | | | | |
|---|---|---|---|---|---|
| **Batch ID:** | 08-7892-9559 | **Test Type:** | Cell Growth | **Analyst:** | A Albert |
| **Start Date:** | 06 Dec-13 11:00 | **Protocol:** | NIWA (1996) | **Diluent:** | Offshore seawater |
| **Ending Date:** | 08 Dec-13 11:00 | **Species:** | Minutocellus polymorphus | **Brine:** | Not Applicable |
| **Duration:** | 48h | **Source:** | CCMP Bigelow Laboratory for Ocean Scien | **Age:** | |

| | | | | | |
|---|---|---|---|---|---|
| **Sample ID:** | 00-6140-8991 | **Code:** | 2558/OT1 MP5 | **Client:** | Total Bridge Services |
| **Sample Date:** | 03 Dec-13 | **Material:** | Paint WAF | **Project:** | Special Studies |
| **Receive Date:** | 04 Dec-13 | **Source:** | Client Supplied | | |
| **Sample Age:** | 83h | **Station:** | In House | | |

**Batch Note:** Auckland Harbour Bridge Paints Dec 2013

**Sample Note:** MC Ferrox

| Data Transform | Zeta | Alt Hyp | Monte Carlo | NOEL | LOEL | TOEL | TU | PMSD |
|---|---|---|---|---|---|---|---|---|
| Untransformed | 0 | C > T | Not Run | 4.5 | 9 | 6.4 | 22 | 10.0% |

**Bonferroni Adj t Test**

| Control | vs | Conc-% | Test Stat | Critical | MSD | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|---|
| SW Control | | 0.14 | -0.06 | 2.7 | 78000 | 1.0000 | Non-Significant Effect |
| | | 0.28 | 0.96 | 2.7 | 78000 | 1.0000 | Non-Significant Effect |
| | | 0.56 | -1.9 | 2.7 | 78000 | 1.0000 | Non-Significant Effect |
| | | 1.125 | 2.6 | 2.7 | 78000 | 0.0619 | Non-Significant Effect |
| | | 2.25 | 2 | 2.7 | 78000 | 0.2668 | Non-Significant Effect |
| | | 4.5 | 1.1 | 2.7 | 78000 | 1.0000 | Non-Significant Effect |
| | | 9* | 3.4 | 2.7 | 78000 | 0.0073 | Significant Effect |
| | | 18* | 3.1 | 2.7 | 78000 | 0.0177 | Significant Effect |
| | | 36* | 8.9 | 2.7 | 78000 | <0.0001 | Significant Effect |
| | | 72* | 16 | 2.7 | 78000 | <0.0001 | Significant Effect |

**Auxiliary Tests**

| Attribute | Test | Test Stat | Critical | P-Value | Decision |
|---|---|---|---|---|---|
| Extreme Value | Grubbs Single Outlier | 3 | 3.2 | 0.0949 | No Outliers Detected |

**ANOVA Table**

| Source | Sum Squares | Mean Square | DF | F Stat | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|
| Between | 1.143716E+12 | 1.143716E+11 | 10 | 41 | <0.0001 | Significant Effect |
| Error | 1.382806E+11 | 2822052000 | 49 | | | |
| Total | 1.281996E+12 | 1.171936E+11 | 59 | | | |

**ANOVA Assumptions**

| Attribute | Test | Test Stat | Critical | P-Value | Decision(1%) |
|---|---|---|---|---|---|
| Variances | Bartlett Equality of Variance | 22 | 23 | 0.0145 | Equal Variances |
| Distribution | Shapiro-Wilk Normality | 0.96 | | 0.0369 | Normal Distribution |

**Cell Density Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | SW Control | 10 | 7.6E+5 | 7.4E+5 | 7.9E+5 | 6.5E+5 | 9.0E+5 | 1.2E+4 | 6.6E+4 | 8.7% | 0.0% |
| 0.14 | | 5 | 7.7E+5 | 7.4E+5 | 7.9E+5 | 6.6E+5 | 8.3E+5 | 1.2E+4 | 6.4E+4 | 8.3% | -0.23% |
| 0.28 | | 5 | 7.4E+5 | 7.3E+5 | 7.5E+5 | 7.1E+5 | 7.8E+5 | 4.8E+3 | 2.6E+4 | 3.5% | 3.7% |
| 0.56 | | 5 | 8.2E+5 | 8.1E+5 | 8.3E+5 | 8.0E+5 | 8.4E+5 | 3.7E+3 | 2.0E+4 | 2.4% | -7.1% |
| 1.125 | | 5 | 6.9E+5 | 6.8E+5 | 7.0E+5 | 6.5E+5 | 7.1E+5 | 4.1E+3 | 2.2E+4 | 3.2% | 9.9% |
| 2.25 | | 5 | 7.1E+5 | 6.8E+5 | 7.3E+5 | 6.2E+5 | 7.7E+5 | 1.4E+4 | 7.4E+4 | 10.0% | 7.5% |
| 4.5 | | 5 | 7.3E+5 | 7.2E+5 | 7.5E+5 | 7.1E+5 | 8.0E+5 | 6.9E+3 | 3.7E+4 | 5.1% | 4.1% |
| 9 | | 5 | 6.7E+5 | 6.3E+5 | 7.0E+5 | 5.9E+5 | 8.1E+5 | 1.6E+4 | 8.7E+4 | 13.0% | 13.0% |
| 18 | | 5 | 6.7E+5 | 6.7E+5 | 6.8E+5 | 6.5E+5 | 7.0E+5 | 4.6E+3 | 2.5E+4 | 3.7% | 12.0% |
| 36 | | 5 | 5.0E+5 | 4.8E+5 | 5.3E+5 | 4.4E+5 | 5.7E+5 | 1.1E+4 | 6.1E+4 | 12.0% | 34.0% |
| 72 | | 5 | 2.9E+5 | 2.8E+5 | 3.0E+5 | 2.7E+5 | 3.2E+5 | 3.9E+3 | 2.1E+4 | 7.3% | 62.0% |

In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

Taihoro Nukurangi

**Linear Interpolation Options**

| X Transform | Y Transform | Seed | Resamples | Exp 95% CL | Method |
|---|---|---|---|---|---|
| Log(X+1) | Linear | 57951 | 200 | Yes | Two-Point Interpolation |

**Residual Analysis**

| Attribute | Method | Test Stat | Critical | P-Value | Decision(5%) |
|---|---|---|---|---|---|
| Extreme Value | Grubbs Extreme Value | 3 | 3.2 | 0.0949 | No Outliers Detected |

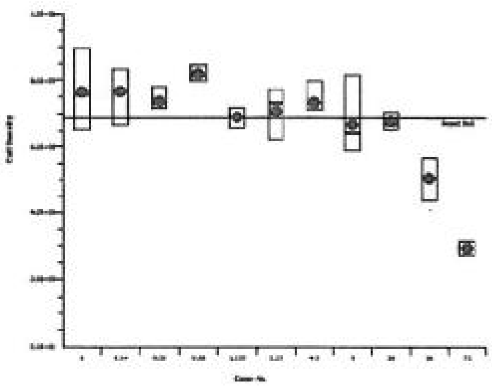
**Point Estimates**

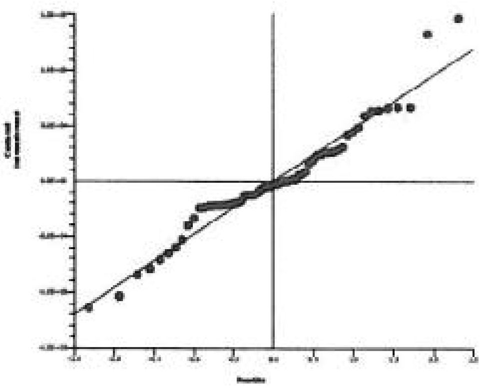
| Level | % | 95% LCL | 95% UCL | TU | 95% LCL | 95% UCL |
|---|---|---|---|---|---|---|
| IC5 | 0.89 | 0.46 | 6.4 | 110 | 16 | 220 |
| IC10 | 6 | N/A | 24 | 17 | 4.1 | N/A |
| IC15 | 19 | N/A | 22 | 5.2 | 4.5 | N/A |
| IC20 | 23 | 17 | 26 | 4.4 | 3.8 | 6.1 |
| IC25 | 26 | 21 | 32 | 3.8 | 3.2 | 4.9 |
| IC40 | 41 | 31 | 47 | 2.4 | 2.1 | 3.2 |
| IC50 | 53 | 44 | 59 | 1.9 | 1.7 | 2.3 |

**Cell Density Detail**

| Conc % | Control Type | Rep 1 | Rep 2 | Rep 3 | Rep 4 | Rep 5 | Rep 6 | Rep 7 | Rep 8 | Rep 9 | Rep 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | SW Control | 8.1E+5 | 6.5E+5 | 7.7E+5 | 7.4E+5 | 7.5E+5 | 7.6E+5 | 7.0E+5 | 8.1E+5 | 9.0E+5 | 7.5E+5 |
| 0.14 | | 7.7E+5 | 8.0E+5 | 6.6E+5 | 7.7E+5 | 8.3E+5 | | | | | |
| 0.28 | | 7.8E+5 | 7.3E+5 | 7.3E+5 | 7.1E+5 | 7.2E+5 | | | | | |
| 0.56 | | 8.0E+5 | 8.1E+5 | 8.1E+5 | 8.4E+5 | 8.3E+5 | | | | | |
| 1.125 | | 6.9E+5 | 6.9E+5 | 6.5E+5 | 7.0E+5 | 7.1E+5 | | | | | |
| 2.25 | | 6.3E+5 | 7.7E+5 | 7.3E+5 | 7.7E+5 | 6.2E+5 | | | | | |
| 4.5 | | 7.1E+5 | 7.1E+5 | 7.3E+5 | 8.0E+5 | 7.1E+5 | | | | | |
| 9 | | 6.3E+5 | 6.4E+5 | 5.9E+5 | 8.1E+5 | 6.6E+5 | | | | | |
| 18 | | 6.5E+5 | 7.0E+5 | 6.6E+5 | 7.0E+5 | 6.6E+5 | | | | | |
| 36 | | 4.4E+5 | 5.6E+5 | 4.5E+5 | 5.7E+5 | 5.0E+5 | | | | | |
| 72 | | 3.1E+5 | 2.7E+5 | 2.9E+5 | 2.7E+5 | 3.2E+5 | | | | | |

**Graphics**





In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

NIWA
Taihoro Nukurangi

**CETIS Analytical Report**

| | |
|---|---|
| Report Date: | 07 Jan-14 15:51 (p 1 of 2) |
| Test Code: | 05-5308-3647/2558/OT2 MP5 |

Phytoplankton Growth Inhibition Test — NIWA Ecotoxicology

| | | | | | |
|---|---|---|---|---|---|
| **Analysis ID:** | 11-4531-1835 | **Endpoint:** | Cell Density | **CETIS Version:** | CETISv1.7.0 |
| **Analyzed:** | 09 Dec-13 11:20 | **Analysis:** | Nonparametric-Multiple Comparison | **Official Results:** | Yes |
| **Batch ID:** | 08-7892-9559 | **Test Type:** | Cell Growth | **Analyst:** | A Albert |
| **Start Date:** | 06 Dec-13 11:00 | **Protocol:** | NIWA (1996) | **Diluent:** | Offshore seawater |
| **Ending Date:** | 08 Dec-13 11:00 | **Species:** | Minutocellus polymorphus | **Brine:** | Not Applicable |
| **Duration:** | 48h | **Source:** | CCMP Bigelow Laboratory for Ocean Scien | **Age:** | |
| **Sample ID:** | 07-6796-2934 | **Code:** | 2558/OT2 MP5 | **Client:** | Total Bridge Services |
| **Sample Date:** | 03 Dec-13 | **Material:** | Paint WAF | **Project:** | Special Studies |
| **Receive Date:** | 04 Dec-13 | **Source:** | Client Supplied | | |
| **Sample Age:** | 83h | **Station:** | In House | | |

**Batch Note:** Auckland Harbour Bridge Paints Dec 2013

**Sample Note:** Termarust 2100

| Data Transform | Zeta | Alt Hyp | Monte Carlo | NOEL | LOEL | TOEL | TU | PMSD |
|---|---|---|---|---|---|---|---|---|
| Log(Y+Z) | 1 | C > T | Not Run | 0.56 | 1.125 | 0.79 | 180 | 16.0% |

**Wilcoxon/Bonferroni Adj Test**

| Control | vs | Conc-% | Test Stat | Critical | Ties | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|---|
| SW Control | | 0.14 | 22 | | 0 | 0.1399 | Non-Significant Effect |
| | | 0.28 | 21 | | 0 | 0.0966 | Non-Significant Effect |
| | | 0.56 | 27 | | 0 | 0.6460 | Non-Significant Effect |
| | | 1.125* | 15 | | 0 | 0.0033 | Significant Effect |
| | | 2.25* | 10 | | 0 | 0.0100 | Significant Effect |
| | | 4.5* | 15 | | 0 | 0.0033 | Significant Effect |
| | | 9* | 15 | | 0 | 0.0033 | Significant Effect |
| | | 18* | 15 | | 0 | 0.0033 | Significant Effect |
| | | 36* | 15 | | 0 | 0.0033 | Significant Effect |
| | | 72* | 15 | | 0 | 0.0033 | Significant Effect |

**ANOVA Table**

| Source | Sum Squares | Mean Square | DF | F Stat | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|
| Between | 53.12582 | 5.312582 | 10 | 2200 | <0.0001 | Significant Effect |
| Error | 0.1177392 | 0.0024529 | 48 | | | |
| Total | 53.24356 | 5.315034 | 58 | | | |

**ANOVA Assumptions**

| Attribute | Test | Test Stat | Critical | P-Value | Decision(1%) |
|---|---|---|---|---|---|
| Variances | Bartlett Equality of Variance | 26 | 23 | 0.0042 | Unequal Variances |
| Distribution | Shapiro-Wilk Normality | 0.96 | | 0.0434 | Normal Distribution |

**Cell Density Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | SW Control | 10 | 9.8E+5 | 9.5E+5 | 1.0E+6 | 8.6E+5 | 1.1E+6 | 1.6E+4 | 8.5E+4 | 8.7% | 0.0% |
| 0.14 | | 5 | 8.9E+5 | 8.7E+5 | 9.1E+5 | 8.4E+5 | 9.8E+5 | 1.1E+4 | 5.8E+4 | 6.5% | 9.6% |
| 0.28 | | 5 | 8.7E+5 | 8.6E+5 | 8.8E+5 | 8.3E+5 | 9.1E+5 | 5.9E+3 | 3.2E+4 | 3.6% | 11.0% |
| 0.56 | | 5 | 9.0E+5 | 8.8E+5 | 9.2E+5 | 8.3E+5 | 9.4E+5 | 7.7E+3 | 4.2E+4 | 4.6% | 8.3% |
| 1.125 | | 5 | 7.1E+5 | 6.7E+5 | 7.4E+5 | 5.6E+5 | 7.8E+5 | 1.6E+4 | 8.7E+4 | 12.0% | 28.0% |
| 2.25 | | 4 | 4.0E+5 | 3.8E+5 | 4.2E+5 | 3.6E+5 | 4.7E+5 | 9.1E+3 | 4.9E+4 | 12.0% | 59.0% |
| 4.5 | | 5 | 1.4E+5 | 1.3E+5 | 1.4E+5 | 1.2E+5 | 1.6E+5 | 3.2E+3 | 1.7E+4 | 12.0% | 86.0% |
| 9 | | 5 | 3.6E+4 | 3.5E+4 | 3.8E+4 | 3.1E+4 | 4.0E+4 | 6.9E+2 | 3.7E+3 | 10.0% | 96.0% |
| 18 | | 5 | 6.8E+3 | 6.7E+3 | 7.0E+3 | 6.4E+3 | 7.4E+3 | 6.5E+1 | 3.5E+2 | 5.1% | 99.0% |
| 36 | | 5 | 9.6E+3 | 9.3E+3 | 9.8E+3 | 8.6E+3 | 1.0E+4 | 1.3E+2 | 7.1E+2 | 7.4% | 99.0% |
| 72 | | 5 | 2.3E+3 | 2.1E+3 | 2.6E+3 | 1.5E+3 | 3.0E+3 | 1.1E+2 | 5.7E+2 | 25.0% | 100.0% |

In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

Log(Y+Z) Transformed Summary

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | SW Control | 10 | 6 | 6 | 6 | 5.9 | 6 | 0.007 | 0.038 | 0.63% | 0.0% |
| 0.14 | | 5 | 5.9 | 5.9 | 6 | 5.9 | 6 | 0.0051 | 0.027 | 0.46% | 0.72% |
| 0.28 | | 5 | 5.9 | 5.9 | 5.9 | 5.9 | 6 | 0.0029 | 0.016 | 0.27% | 0.84% |
| 0.56 | | 5 | 6 | 5.9 | 6 | 5.9 | 6 | 0.0038 | 0.02 | 0.34% | 0.61% |
| 1.125 | | 5 | 5.8 | 5.8 | 5.9 | 5.8 | 5.9 | 0.011 | 0.057 | 0.97% | 2.4% |
| 2.25 | | 4 | 5.6 | 5.6 | 5.6 | 5.6 | 5.7 | 0.0095 | 0.051 | 0.91% | 6.5% |
| 4.5 | | 5 | 5.1 | 5.1 | 5.2 | 5.1 | 5.2 | 0.0097 | 0.052 | 1.0% | 14.0% |
| 9 | | 5 | 4.6 | 4.5 | 4.6 | 4.5 | 4.6 | 0.0084 | 0.045 | 0.99% | 24.0% |
| 18 | | 5 | 3.8 | 3.8 | 3.8 | 3.8 | 3.9 | 0.0041 | 0.022 | 0.57% | 36.0% |
| 36 | | 5 | 4 | 4 | 4 | 3.9 | 4 | 0.006 | 0.032 | 0.82% | 34.0% |
| 72 | | 5 | 3.4 | 3.3 | 3.4 | 3.2 | 3.5 | 0.021 | 0.12 | 3.4% | 44.0% |

**Linear Interpolation Options**

| X Transform | Y Transform | Seed | Resamples | Exp 95% CL | Method |
|---|---|---|---|---|---|
| Log(X+1) | Linear | 57951 | 200 | Yes | Two-Point Interpolation |

**Residual Analysis**

| Attribute | Method | Test Stat | Critical | P-Value | Decision(5%) |
|---|---|---|---|---|---|
| Extreme Value | Grubbs Extreme Value | 2.8 | 3.2 | 0.2165 | No Outliers Detected |

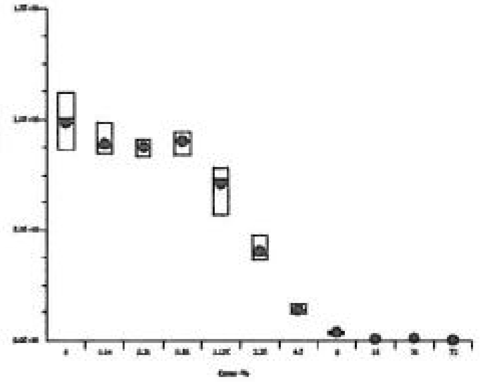
**Point Estimates**

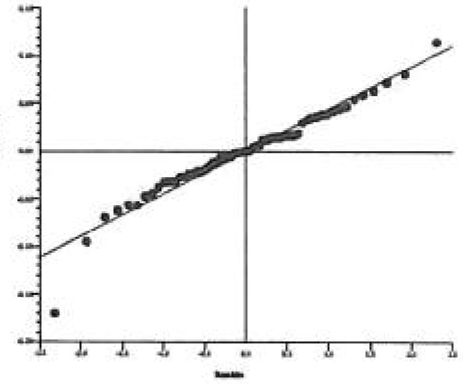
| Level | % | 95% LCL | 95% UCL | TU | 95% LCL | 95% UCL |
|---|---|---|---|---|---|---|
| IC5 | 0.071 | 0.036 | 0.81 | 1400 | 120 | 2800 |
| IC10 | 0.57 | N/A | 0.75 | 180 | 130 | N/A |
| IC15 | 0.7 | 0.5 | 0.95 | 140 | 110 | 200 |
| IC20 | 0.85 | 0.61 | 1.2 | 120 | 84 | 160 |
| IC25 | 1 | 0.72 | 1.3 | 99 | 76 | 140 |
| IC40 | 1.5 | 1.1 | 1.7 | 68 | 58 | 90 |
| IC50 | 1.8 | 1.5 | 2.1 | 56 | 48 | 68 |

**Cell Density Detail**

| Conc-% | Control Type | Rep 1 | Rep 2 | Rep 3 | Rep 4 | Rep 5 | Rep 6 | Rep 7 | Rep 8 | Rep 9 | Rep 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | SW Control | 1.0E+6 | 1.0E+6 | 9.0E+5 | 8.6E+5 | 9.1E+5 | 9.1E+5 | 9.9E+5 | 1.1E+6 | 1.0E+6 | 1.1E+6 |
| 0.14 | | 8.7E+5 | 8.4E+5 | 9.0E+5 | 9.8E+5 | 8.5E+5 | | | | | |
| 0.28 | | 9.1E+5 | 9.0E+5 | 8.6E+5 | 8.3E+5 | 8.7E+5 | | | | | |
| 0.56 | | 9.4E+5 | 9.0E+5 | 9.3E+5 | 8.3E+5 | 9.0E+5 | | | | | |
| 1.125 | | 7.7E+5 | 7.2E+5 | 5.6E+5 | 7.8E+5 | 6.9E+5 | | | | | |
| 2.25 | | 4.7E+5 | 3.8E+5 | 2.4E+5 | 3.6E+5 | 3.9E+5 | | | | | |
| 4.5 | | 1.6E+5 | 1.3E+5 | 1.2E+5 | 1.3E+5 | 1.4E+5 | | | | | |
| 9 | | 4.0E+4 | 3.1E+4 | 3.6E+4 | 4.0E+4 | 3.5E+4 | | | | | |
| 18 | | 6.4E+3 | 6.6E+3 | 6.8E+3 | 7.4E+3 | 6.9E+3 | | | | | |
| 36 | | 8.6E+3 | 9.1E+3 | 9.8E+3 | 9.9E+3 | 1.0E+4 | | | | | |
| 72 | | 2.0E+3 | 1.5E+3 | 3.0E+3 | 2.6E+3 | 2.6E+3 | | | | | |

**Graphics**





In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

Taihoro Nukurangi

**CETIS Analytical Report**

**Report Date:** 07 Jan-14 15:53 (p 1 of 2)
**Test Code:** 18-0285-3969/2558/OT3 MP5

**Phytoplankton Growth Inhibition Test** — **NIWA Ecotoxicology**

| | | | | | |
|---|---|---|---|---|---|
| **Analysis ID:** | 21-1241-4162 | **Endpoint:** | Cell Density | **CETIS Version:** | CETISv1.7.0 |
| **Analyzed:** | 09 Dec-13 11:22 | **Analysis:** | Nonparametric-Multiple Comparison | **Official Results:** | Yes |
| **Batch ID:** | 08-7892-9559 | **Test Type:** | Cell Growth | **Analyst:** | A Albert |
| **Start Date:** | 06 Dec-13 11:00 | **Protocol:** | NIWA (1996) | **Diluent:** | Offshore seawater |
| **Ending Date:** | 08 Dec-13 11:00 | **Species:** | Minutocellus polymorphus | **Brine:** | Not Applicable |
| **Duration:** | 48h | **Source:** | CCMP Bigelow Laboratory for Ocean Scien | **Age:** | |
| **Sample ID:** | 10-8532-4600 | **Code:** | 2558/OT3 MP5 | **Client:** | Total Bridge Services |
| **Sample Date:** | 03 Dec-13 | **Material:** | Paint WAF | **Project:** | Special Studies |
| **Receive Date:** | 04 Dec-13 | **Source:** | Client Supplied | | |
| **Sample Age:** | 83h | **Station:** | In House | | |

**Batch Note:** Auckland Harbour Bridge Paints Dec 2013

**Sample Note:** MC M10

| Data Transform | Zeta | Alt Hyp | Monte Carlo | NOEL | LOEL | TOEL | TU | PMSD |
|---|---|---|---|---|---|---|---|---|
| Log(Y+Z) | 1 | C > T | Not Run | 0.56 | 1.125 | 0.79 | 180 | 61.0% |

**Wilcoxon/Bonferroni Adj Test**

| Control | vs | Conc-% | Test Stat | Critical | Ties | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|---|
| SW Control | | 0.14 | 45 | | 0 | 1.0000 | Non-Significant Effect |
| | | 0.28 | 41 | | 0 | 1.0000 | Non-Significant Effect |
| | | 0.56 | 26 | | 0 | 0.4962 | Non-Significant Effect |
| | | 1.125* | 15 | | 0 | 0.0033 | Significant Effect |
| | | 2.25* | 15 | | 0 | 0.0033 | Significant Effect |
| | | 4.5* | 15 | | 0 | 0.0033 | Significant Effect |
| | | 9* | 15 | | 0 | 0.0033 | Significant Effect |
| | | 18* | 15 | | 0 | 0.0033 | Significant Effect |
| | | 36* | 15 | | 0 | 0.0033 | Significant Effect |
| | | 72* | 15 | | 0 | 0.0033 | Significant Effect |

**Auxiliary Tests**

| Attribute | Test | Test Stat | Critical | P-Value | Decision |
|---|---|---|---|---|---|
| Extreme Value | Grubbs Single Outlier | 6.6 | 3.2 | <0.0001 | Outlier Detected |

**ANOVA Table**

| Source | Sum Squares | Mean Square | DF | F Stat | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|
| Between | 111.656 | 11.1656 | 10 | 150 | <0.0001 | Significant Effect |
| Error | 3.67402 | 0.07497999 | 49 | | | |
| Total | 115.33 | 11.24058 | 59 | | | |

**ANOVA Assumptions**

| Attribute | Test | Test Stat | Critical | P-Value | Decision(1%) |
|---|---|---|---|---|---|
| Variances | Bartlett Equality of Variance | 140 | 23 | <0.0001 | Unequal Variances |
| Distribution | Shapiro-Wilk Normality | 0.45 | | <0.0001 | Non-normal Distribution |

**Cell Density Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | SW Control | 10 | 8.1E+5 | 7.8E+5 | 8.5E+5 | 7.3E+5 | 9.7E+5 | 1.5E+4 | 8.2E+4 | 10.0% | 0.0% |
| 0.14 | | 5 | 8.3E+5 | 8.1E+5 | 8.5E+5 | 7.5E+5 | 8.8E+5 | 1.0E+4 | 5.4E+4 | 6.5% | -1.8% |
| 0.28 | | 5 | 8.0E+5 | 7.8E+5 | 8.2E+5 | 7.4E+5 | 8.9E+5 | 1.0E+4 | 5.5E+4 | 6.9% | 1.5% |
| 0.56 | | 5 | 7.4E+5 | 7.1E+5 | 7.8E+5 | 6.4E+5 | 8.8E+5 | 1.6E+4 | 8.5E+4 | 11.0% | 8.7% |
| 1.125 | | 5 | 5.5E+5 | 5.2E+5 | 5.8E+5 | 4.1E+5 | 6.2E+5 | 1.6E+4 | 8.5E+4 | 15.0% | 33.0% |
| 2.25 | | 5 | 2.2E+5 | 2.0E+5 | 2.3E+5 | 1.7E+5 | 2.6E+5 | 6.5E+3 | 3.5E+4 | 16.0% | 73.0% |
| 4.5 | | 5 | 6.1E+4 | 6.0E+4 | 6.3E+4 | 5.6E+4 | 6.7E+4 | 8.4E+2 | 4.5E+3 | 7.4% | 92.0% |
| 9 | | 5 | 1.4E+4 | 1.2E+4 | 1.5E+4 | 8.6E+3 | 1.7E+4 | 5.9E+2 | 3.2E+3 | 23.0% | 98.0% |
| 18 | | 5 | 7.4E+3 | 7.3E+3 | 7.6E+3 | 6.9E+3 | 7.9E+3 | 7.4E+1 | 4.0E+2 | 5.4% | 99.0% |
| 36 | | 5 | 7.2E+2 | 6.8E+2 | 7.6E+2 | 6.0E+2 | 8.8E+2 | 2.0E+1 | 1.1E+2 | 15.0% | 100.0% |
| 72 | | 5 | 9.9E+1 | 6.8E+1 | 1.3E+2 | 0.0E+0 | 2.2E+2 | 1.5E+1 | 8.2E+1 | 82.0% | 100.0% |

In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

Log(Y+Z) Transformed Summary

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | SW Control | 10 | 5.9 | 5.9 | 5.9 | 5.9 | 6 | 0.0079 | 0.043 | 0.72% | 0.0% |
| 0.14 | | 5 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 0.0053 | 0.029 | 0.48% | -0.15% |
| 0.28 | | 5 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 0.0055 | 0.03 | 0.5% | 0.09% |
| 0.56 | | 5 | 5.9 | 5.9 | 5.9 | 5.8 | 5.9 | 0.009 | 0.048 | 0.83% | 0.67% |
| 1.125 | | 5 | 5.7 | 5.7 | 5.8 | 5.6 | 5.8 | 0.013 | 0.072 | 1.3% | 2.9% |
| 2.25 | | 5 | 5.3 | 5.3 | 5.4 | 5.2 | 5.4 | 0.013 | 0.072 | 1.4% | 9.7% |
| 4.5 | | 5 | 4.8 | 4.8 | 4.8 | 4.6 | 4.8 | 0.0059 | 0.032 | 0.67% | 19.0% |
| 9 | | 5 | 4.1 | 4.1 | 4.2 | 3.9 | 4.2 | 0.021 | 0.11 | 2.8% | 30.0% |
| 18 | | 5 | 3.9 | 3.9 | 3.9 | 3.8 | 3.9 | 0.0043 | 0.023 | 0.6% | 34.0% |
| 36 | | 5 | 2.9 | 2.8 | 2.9 | 2.8 | 2.9 | 0.012 | 0.062 | 2.2% | 52.0% |
| 72 | | 5 | 1.6 | 1.3 | 2 | 0 | 2.3 | 0.17 | 0.94 | 57.0% | 72.0% |

Linear Interpolation Options

| X Transform | Y Transform | Seed | Resamples | Exp 95% CL | Method |
|---|---|---|---|---|---|
| Log(X+1) | Linear | 57951 | 200 | Yes | Two-Point Interpolation |

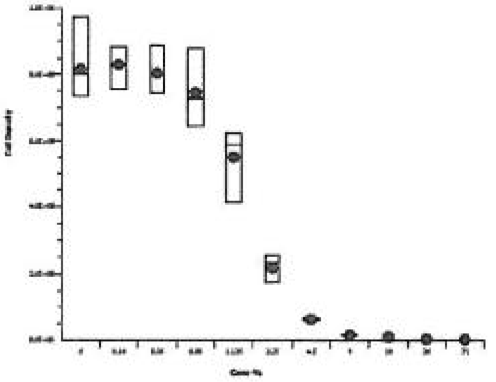
Residual Analysis

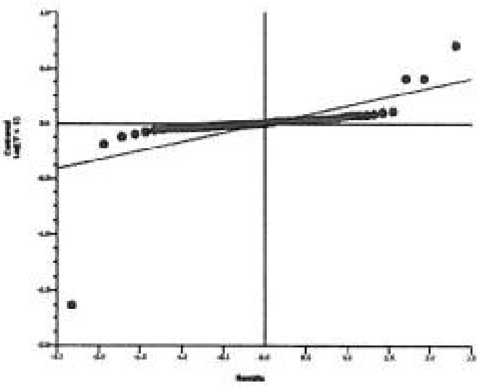
| Attribute | Method | Test Stat | Critical | P-Value | Decision(5%) |
|---|---|---|---|---|---|
| Extreme Value | Grubbs Extreme Value | 3.2 | 3.2 | 0.0576 | No Outliers Detected |

Point Estimates

| Level | % | 95% LCL | 95% UCL | TU | 95% LCL | 95% UCL |
|---|---|---|---|---|---|---|
| IC5 | 0.38 | 0.015 | 0.75 | 270 | 130 | 6500 |
| IC10 | 0.57 | 0.21 | 0.79 | 180 | 130 | 480 |
| IC15 | 0.68 | 0.38 | 0.88 | 150 | 110 | 260 |
| IC20 | 0.79 | 0.51 | 1 | 130 | 99 | 200 |
| IC25 | 0.91 | 0.65 | 1.2 | 110 | 85 | 150 |
| IC40 | 1.3 | 0.96 | 1.5 | 78 | 68 | 100 |
| IC50 | 1.5 | 1.3 | 1.7 | 65 | 59 | 80 |

Graphics





In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

NIWA Taihoro Nukurangi

**CETIS Analytical Report**

| | |
|---|---|
| **Report Date:** | 07 Jan-14 15:55 (p 1 of 2) |
| **Test Code:** | 04-9743-3086/2558/OT4 MP5 |

**Phytoplankton Growth Inhibition Test** — **NIWA Ecotoxicology**

| | | | | | |
|---|---|---|---|---|---|
| **Analysis ID:** | 08-4500-0733 | **Endpoint:** | Cell Density | **CETIS Version:** | CETISv1.7.0 |
| **Analyzed:** | 09 Dec-13 11:23 | **Analysis:** | Parametric-Multiple Comparison | **Official Results:** | Yes |

| | | | | | |
|---|---|---|---|---|---|
| **Batch ID:** | 08-7892-9559 | **Test Type:** | Cell Growth | **Analyst:** | A Albert |
| **Start Date:** | 06 Dec-13 11:00 | **Protocol:** | NIWA (1996) | **Diluent:** | Offshore seawater |
| **Ending Date:** | 08 Dec-13 11:00 | **Species:** | Minutocellus polymorphus | **Brine:** | Not Applicable |
| **Duration:** | 48h | **Source:** | CCMP Bigelow Laboratory for Ocean Scien | **Age:** | |

| | | | | | |
|---|---|---|---|---|---|
| **Sample ID:** | 19-0550-9802 | **Code:** | 2558/OT4 MP5 | **Client:** | Total Bridge Services |
| **Sample Date:** | 03 Dec-13 | **Material:** | Paint WAF | **Project:** | Special Studies |
| **Receive Date:** | 04 Dec-13 | **Source:** | Client Supplied | | |
| **Sample Age:** | 83h | **Station:** | In House | | |

**Batch Note:** Auckland Harbour Bridge Paints Dec 2013

**Sample Note:** Zinc

| Data Transform | Zeta | Alt Hyp | Monte Carlo | NOEL | LOEL | TOEL | TU | PMSD |
|---|---|---|---|---|---|---|---|---|
| Log(Y+Z) | 1 | C > T | Not Run | 2.25 | 4.5 | 3.2 | 44 | 27.0% |

**Bonferroni Adj t Test**

| Control | vs | Conc-% | Test Stat | Critical | MSD | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|---|
| SW Control | | 0.14 | -0.72 | 2.7 | 0.13 | 1.0000 | Non-Significant Effect |
| | | 0.28 | -0.38 | 2.7 | 0.13 | 1.0000 | Non-Significant Effect |
| | | 0.56 | 0.22 | 2.7 | 0.13 | 1.0000 | Non-Significant Effect |
| | | 1.125 | 2.3 | 2.7 | 0.13 | 0.1197 | Non-Significant Effect |
| | | 2.25 | 1.5 | 2.7 | 0.13 | 0.7626 | Non-Significant Effect |
| | | 4.5* | 5 | 2.7 | 0.13 | <0.0001 | Significant Effect |
| | | 9* | 9.8 | 2.7 | 0.13 | <0.0001 | Significant Effect |
| | | 18* | 23 | 2.7 | 0.13 | <0.0001 | Significant Effect |
| | | 36* | 40 | 2.7 | 0.13 | <0.0001 | Significant Effect |
| | | 72* | 51 | 2.7 | 0.13 | <0.0001 | Significant Effect |

**Auxiliary Tests**

| Attribute | Test | Test Stat | Critical | P-Value | Decision |
|---|---|---|---|---|---|
| Extreme Value | Grubbs Single Outlier | 2.5 | 3.2 | 0.7085 | No Outliers Detected |

**ANOVA Table**

| Source | Sum Squares | Mean Square | DF | F Stat | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|
| Between | 41.9150 | 4.19158 | 10 | 510 | <0.0001 | Significant Effect |
| Error | 0.4025554 | 0.008215417 | 49 | | | |
| Total | 42.31835 | 4.199795 | 59 | | | |

**ANOVA Assumptions**

| Attribute | Test | Test Stat | Critical | P-Value | Decision(1%) |
|---|---|---|---|---|---|
| Variances | Bartlett Equality of Variance | 17 | 23 | 0.0690 | Equal Variances |
| Distribution | Shapiro-Wilk Normality | 0.99 | | 0.8253 | Normal Distribution |

**Cell Density Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | SW Control | 10 | 8.8E+5 | 8.3E+5 | 9.2E+5 | 6.0E+5 | 1.0E+6 | 2.2E+4 | 1.2E+5 | 13.0% | 0.0% |
| 0.14 | | 5 | 9.4E+5 | 9.1E+5 | 9.7E+5 | 8.7E+5 | 1.0E+6 | 1.5E+4 | 7.8E+4 | 8.3% | -7.8% |
| 0.28 | | 5 | 9.1E+5 | 8.8E+5 | 9.4E+5 | 8.4E+5 | 1.0E+6 | 1.4E+4 | 7.4E+4 | 8.1% | -3.7% |
| 0.56 | | 5 | 8.5E+5 | 8.0E+5 | 9.1E+5 | 6.6E+5 | 1.0E+6 | 2.5E+4 | 1.3E+5 | 16.0% | 2.4% |
| 1.125 | | 5 | 6.9E+5 | 6.1E+5 | 7.7E+5 | 4.6E+5 | 9.4E+5 | 3.8E+4 | 2.1E+5 | 30.0% | 21.0% |
| 2.25 | | 5 | 7.4E+5 | 7.0E+5 | 7.8E+5 | 6.2E+5 | 8.7E+5 | 1.8E+4 | 9.6E+4 | 13.0% | 16.0% |
| 4.5 | | 5 | 5.0E+5 | 4.6E+5 | 5.3E+5 | 4.0E+5 | 6.4E+5 | 1.7E+4 | 9.3E+4 | 19.0% | 43.0% |
| 9 | | 5 | 3.0E+5 | 2.6E+5 | 3.4E+5 | 1.8E+5 | 4.4E+5 | 2.0E+4 | 1.1E+5 | 36.0% | 66.0% |
| 18 | | 5 | 6.7E+4 | 5.9E+4 | 7.4E+4 | 4.9E+4 | 9.5E+4 | 3.6E+3 | 1.9E+4 | 29.0% | 92.0% |
| 36 | | 5 | 9.6E+3 | 8.9E+3 | 1.0E+4 | 7.3E+3 | 1.2E+4 | 3.8E+2 | 2.0E+3 | 21.0% | 99.0% |
| 72 | | 5 | 2.5E+3 | 2.3E+3 | 2.7E+3 | 2.0E+3 | 2.9E+3 | 8.5E+1 | 4.6E+2 | 18.0% | 100.0% |

In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

Log(Y+Z) Transformed Summary

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | SW Control | 10 | 5.9 | 5.9 | 6 | 5.8 | 6 | 0.012 | 0.065 | 1.1% | 0.0% |
| 0.14 | | 5 | 6 | 6 | 6 | 5.9 | 6 | 0.0057 | 0.036 | 0.6% | -0.6% |
| 0.28 | | 5 | 6 | 5.9 | 6 | 5.9 | 6 | 0.0064 | 0.034 | 0.57% | -0.32% |
| 0.56 | | 5 | 5.9 | 5.9 | 6 | 5.8 | 6 | 0.013 | 0.071 | 1.2% | 0.18% |
| 1.125 | | 5 | 5.8 | 5.8 | 5.9 | 5.7 | 6 | 0.026 | 0.14 | 2.4% | 1.9% |
| 2.25 | | 5 | 5.9 | 5.8 | 5.9 | 5.8 | 5.9 | 0.01 | 0.056 | 0.96% | 1.2% |
| 4.5 | | 5 | 5.7 | 5.7 | 5.7 | 5.6 | 5.8 | 0.015 | 0.08 | 1.4% | 4.2% |
| 9 | | 5 | 5.5 | 5.4 | 5.5 | 5.2 | 5.6 | 0.03 | 0.16 | 3.0% | 8.2% |
| 18 | | 5 | 4.8 | 4.8 | 4.9 | 4.7 | 5 | 0.022 | 0.12 | 2.5% | 19.0% |
| 36 | | 5 | 4 | 3.9 | 4 | 3.9 | 4.1 | 0.017 | 0.091 | 2.3% | 33.0% |
| 72 | | 5 | 3.4 | 3.4 | 3.4 | 3.3 | 3.5 | 0.015 | 0.083 | 2.4% | 43.0% |

Linear Interpolation Options

| X Transform | Y Transform | Seed | Resamples | Exp 95% CL | Method |
|---|---|---|---|---|---|
| Log(X+1) | Linear | 57951 | 200 | Yes | Two-Point Interpolation |

Residual Analysis

| Attribute | Method | Test Stat | Critical | P-Value | Decision(5%) |
|---|---|---|---|---|---|
| Extreme Value | Grubbs Extreme Value | 2.9 | 3.2 | 0.1920 | No Outliers Detected |

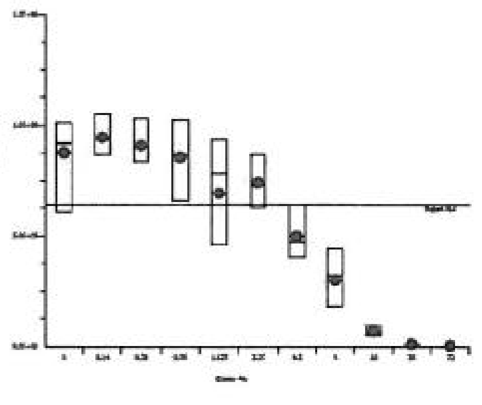
Point Estimates

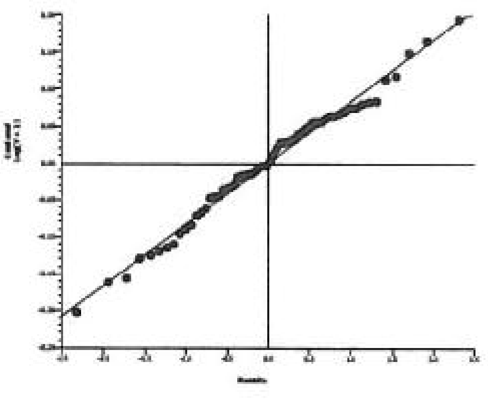
| Level | % | 95% LCL | 95% UCL | TU | 95% LCL | 95% UCL |
|---|---|---|---|---|---|---|
| IC5 | 0.51 | 0.095 | 1 | 200 | 99 | 1100 |
| IC10 | 0.69 | 0.23 | 1.8 | 150 | 57 | 440 |
| IC15 | 0.87 | 0.28 | 3.1 | 120 | 32 | 360 |
| IC20 | 1.1 | 0.31 | 3.4 | 94 | 30 | 320 |
| IC25 | 2.5 | 0.061 | 3.2 | 40 | 31 | 1700 |
| IC40 | 3.9 | 2.8 | 5.4 | 26 | 18 | 36 |
| IC50 | 5.2 | 3.6 | 7.1 | 19 | 14 | 27 |

Cell Density Detail

| Conc-% | Control Type | Rep 1 | Rep 2 | Rep 3 | Rep 4 | Rep 5 | Rep 6 | Rep 7 | Rep 8 | Rep 9 | Rep 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | SW Control | 9.7E+5 | 1.0E+6 | 9.3E+5 | 9.5E+5 | 8.4E+5 | 8.4E+5 | 6.0E+5 | 7.8E+5 | 9.1E+5 | 9.3E+5 |
| 0.14 | | 9.3E+5 | 8.7E+5 | 1.0E+6 | 1.0E+6 | 8.7E+5 | | | | | |
| 0.28 | | 1.0E+6 | 9.1E+5 | 8.7E+5 | 9.0E+5 | 8.4E+5 | | | | | |
| 0.56 | | 9.0E+5 | 1.0E+6 | 8.7E+5 | 8.3E+5 | 6.6E+5 | | | | | |
| 1.125 | | 9.4E+5 | 7.9E+5 | 4.6E+5 | 4.9E+5 | 7.8E+5 | | | | | |
| 2.25 | | 7.9E+5 | 8.7E+5 | 7.3E+5 | 6.9E+5 | 6.2E+5 | | | | | |
| 4.5 | | 6.4E+5 | 5.4E+5 | 4.7E+5 | 4.4E+5 | 4.0E+5 | | | | | |
| 9 | | 4.4E+5 | 2.1E+5 | 1.8E+5 | 3.4E+5 | 3.2E+5 | | | | | |
| 18 | | 5.6E+4 | 9.5E+4 | 5.6E+4 | 7.9E+4 | 4.9E+4 | | | | | |
| 36 | | 1.1E+4 | 1.2E+4 | 7.3E+3 | 9.1E+3 | 8.5E+3 | | | | | |
| 72 | | 2.8E+3 | 2.9E+3 | 2.9E+3 | 2.0E+3 | 2.0E+3 | | | | | |

Graphics





In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

Taihoro Nukurangi

**CETIS Analytical Report**

Report Date: 09 Jan-14 09:02 (p 1 of 2)
Test Code: 06-7853-5759/2558/OT1 AAC

**Amphipod 96 h survival and morbidity test** — **NIWA Ecotoxicology**

| | | | | | |
|---|---|---|---|---|---|
| **Analysis ID:** | 06-5262-1663 | **Endpoint:** | 96 h Survival | **CETIS Version:** | CETISv1.7.0 |
| **Analyzed:** | 09 Dec-13 16:23 | **Analysis:** | Parametric-Multiple Comparison | **Official Results:** | Yes |
| **Batch ID:** | 04-5184-2984 | **Test Type:** | Survival morbidity | **Analyst:** | M Martin |
| **Start Date:** | 05 Dec-13 11:30 | **Protocol:** | NIWA (1995) | **Diluent:** | Nearshore seawater |
| **Ending Date:** | 09 Dec-13 11:30 | **Species:** | Chaetocorophium cf lucasi | **Brine:** | Not Applicable |
| **Duration:** | 96h | **Source:** | Waingaro Landing, Raglan Harbour | **Age:** | |
| **Sample ID:** | 09-5338-9796 | **Code:** | 2558/OT1 | **Client:** | Total Bridge Services |
| **Sample Date:** | 03 Dec-13 09:00 | **Material:** | Paint WAF | **Project:** | Special Studies |
| **Receive Date:** | 04 Dec-13 09:00 | **Source:** | Client Supplied | | |
| **Sample Age:** | 50h | **Station:** | In House WAF | | |

**Sample Note:** MC Ferrox

| Data Transform | Zeta | Alt Hyp | Monte Carlo | NOEL | LOEL | TOEL | TU | PMSD |
|---|---|---|---|---|---|---|---|---|
| Angular (Corrected) | 0 | C > T | Not Run | 25 | 57.1 | 38 | 4 | 6.0% |

**Bonferroni Adj t Test**

| Control | vs | Conc-% | Test Stat | Critical | MSD | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|---|
| Dilution Water | | 0.1 | 0.087 | 2.7 | 0.092 | 1.0000 | Non-Significant Effect |
| | | 0.39 | 0.087 | 2.7 | 0.092 | 1.0000 | Non-Significant Effect |
| | | 1.56 | 0.087 | 2.7 | 0.092 | 1.0000 | Non-Significant Effect |
| | | 6.25 | 0.014 | 2.7 | 0.092 | 1.0000 | Non-Significant Effect |
| | | 25 | 1.7 | 2.7 | 0.092 | 0.3459 | Non-Significant Effect |
| | | 57.1* | 35 | 2.7 | 0.092 | <0.0001 | Significant Effect |

**Auxiliary Tests**

| Attribute | Test | Test Stat | Critical | P-Value | Decision |
|---|---|---|---|---|---|
| Extreme Value | Grubbs Single Outlier | 2.7 | 2.8 | 0.0708 | No Outliers Detected |

**ANOVA Table**

| Source | Sum Squares | Mean Square | DF | F Stat | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|
| Between | 3.713789 | 0.6189649 | 6 | 280 | <0.0001 | Significant Effect |
| Error | 0.03551598 | 0.002219749 | 16 | | | |
| Total | 3.749305 | 0.6211846 | 22 | | | |

**ANOVA Assumptions**

| Attribute | Test | Test Stat | Critical | P-Value | Decision(1%) |
|---|---|---|---|---|---|
| Variances | Mod Levene Equality of Variance | 1.1 | 5.8 | 0.4434 | Equal Variances |
| Distribution | Shapiro-Wilk Normality | 0.77 | | 0.0001 | Non-normal Distribution |

**96 h Survival Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Dilution Water | 5 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 0.1 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 0.39 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 1.56 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 6.25 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 25 | | 3 | 0.97 | 0.94 | 0.99 | 0.9 | 1 | 0.011 | 0.058 | 6.0% | 3.3% |
| 57.1 | | 3 | 0.033 | 0.011 | 0.055 | 0 | 0.1 | 0.011 | 0.058 | 170.0% | 97.0% |

**Angular (Corrected) Transformed Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Dilution Water | 5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0.00076 | 0.0041 | 0.29% | 0.0% |
| 0.1 | | 3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0 | 0 | 0.0% | 0.21% |
| 0.39 | | 3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0 | 0 | 0.0% | 0.21% |
| 1.56 | | 3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0 | 0 | 0.0% | 0.21% |
| 6.25 | | 3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0.0008 | 0.0043 | 0.3% | 0.04% |
| 25 | | 3 | 1.4 | 1.3 | 1.4 | 1.2 | 1.4 | 0.017 | 0.094 | 6.9% | 4.0% |
| 57.1 | | 3 | 0.21 | 0.18 | 0.25 | 0.16 | 0.32 | 0.017 | 0.094 | 44.0% | 85.0% |

In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

**Linear Regression Options**

| Model Function | Threshold Option | Threshold | Optimized | Pooled | Het Corr | Weighted |
|---|---|---|---|---|---|---|
| Log-Normal [NED=A+B*log(X)] | Control Threshold | 0 | Yes | No | No | Yes |

**Regression Summary**

| Iters | LL | AICc | Mu | Sigma | G Stat | Chi-Sq | Critical | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|---|---|---|
| 5 | -8.8 | 22 | -1.1 | 0.098 | 0.11 | 4.1 | 26 | 1.0000 | Non-Significant Heterogeneity |

**Point Estimates**

| Level | % | 95% LCL | 95% UCL | TU | 95% LCL | 95% UCL |
|---|---|---|---|---|---|---|
| LC5 | 26 | 20 | 30 | 3.8 | 3.3 | 4.9 |
| LC10 | 28 | 23 | 33 | 3.5 | 3.1 | 4.4 |
| LC15 | 30 | 25 | 34 | 3.3 | 2.9 | 4.1 |
| LC20 | 31 | 26 | 36 | 3.2 | 2.8 | 3.9 |
| LC25 | 32 | 27 | 37 | 3.1 | 2.7 | 3.7 |
| LC40 | 36 | 31 | 41 | 2.8 | 2.4 | 3.3 |
| LC50 | 38 | 33 | 44 | 2.6 | 2.3 | 3.1 |

**Regression Parameters**

| Parameter | Estimate | Std Error | 95% LCL | 95% UCL | t Stat | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|---|
| Slope | 10 | 1.7 | 6.8 | 14 | 5.9 | <0.0001 | Significant Parameter |
| Intercept | -11 | 2.8 | -17 | -5.7 | -4 | 0.0010 | Significant Parameter |

**Residual Analysis**

| Attribute | Method | Test Stat | Critical | P-Value | Decision(5%) |
|---|---|---|---|---|---|
| Extreme Value | Grubbs Extreme Value | 2.4 | 2.7 | 0.1680 | No Outliers Detected |
| Variances | Mod Levene Equality of Variance | 0.8 | 4.4 | 0.5677 | Equal Variances |
| Distribution | Shapiro-Wilk Normality | 0.81 | | 0.0020 | Non-normal Distribution |

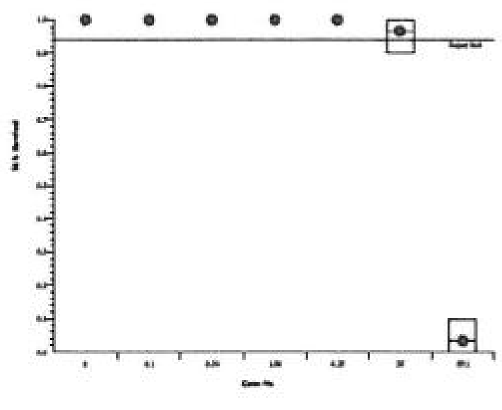
**96 h Survival Detail**

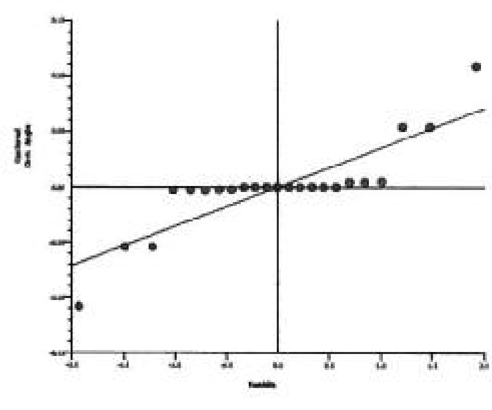
| Conc.-% | Control Type | Rep 1 | Rep 2 | Rep 3 | Rep 4 | Rep 5 |
|---|---|---|---|---|---|---|
| 0 | Dilution Water | 1 | 1 | 1 | 1 | 1 |
| 0.1 | | 1 | 1 | 1 | | |
| 0.39 | | 1 | 1 | 1 | | |
| 1.56 | | 1 | 1 | 1 | | |
| 6.25 | | 1 | 1 | 1 | | |
| 25 | | 1 | 1 | 0.9 | | |
| 57.1 | | 0 | 0 | 0.1 | | |

**96h morbidity Detail**

| Conc.-% | Control Type | Rep 1 | Rep 2 | Rep 3 | Rep 4 | Rep 5 |
|---|---|---|---|---|---|---|
| 0 | Dilution Water | 1 | 1 | 1 | 1 | 1 |
| 0.1 | | 1 | 1 | 1 | | |
| 0.39 | | 1 | 1 | 1 | | |
| 1.56 | | 1 | 1 | 1 | | |
| 6.25 | | 1 | 1 | 1 | | |
| 25 | | 1 | 1 | 0.9 | | |
| 57.1 | | 0 | 0 | 0.1 | | |

**Graphics**





In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

NIWA
Taihoro Nukurangi

**CETIS Analytical Report**

| | |
|---|---|
| **Report Date:** | 09 Jan-14 11:07 (p 1 of 2) |
| **Test Code:** | 04-6494-0953/2558/OT2 AAC |

**Amphipod 96 h survival and morbidity test** — **NIWA Ecotoxicology**

| | | | | | |
|---|---|---|---|---|---|
| **Analysis ID:** | 18-8699-8845 | **Endpoint:** | 96 h Survival | **CETIS Version:** | CETISv1.7.0 |
| **Analyzed:** | 09 Dec-13 16:36 | **Analysis:** | Parametric-Multiple Comparison | **Official Results:** | Yes |

| | | | | | |
|---|---|---|---|---|---|
| **Batch ID:** | 04-5184-2984 | **Test Type:** | Survival morbidity | **Analyst:** | M Martin |
| **Start Date:** | 05 Dec-13 11:00 | **Protocol:** | NIWA (1995) | **Diluent:** | Nearshore seawater |
| **Ending Date:** | 09 Dec-13 11:00 | **Species:** | Chaetocorophium cf lucasi | **Brine:** | Not Applicable |
| **Duration:** | 96h | **Source:** | Waingaro Landing, Raglan Harbour | **Age:** | |

| | | | | | |
|---|---|---|---|---|---|
| **Sample ID:** | 10-0862-9854 | **Code:** | 2558/OT2 | **Client:** | Total Bridge Services |
| **Sample Date:** | 03 Dec-13 09:00 | **Material:** | Paint WAF | **Project:** | Special Studies |
| **Receive Date:** | 04 Dec-13 09:00 | **Source:** | Client Supplied | | |
| **Sample Age:** | 50h | **Station:** | In House WAF | | |

**Sample Note:** Termarust 2100

| Data Transform | Zeta | Alt Hyp | Monte Carlo | NOEL | LOEL | TOEL | TU | PMSD |
|---|---|---|---|---|---|---|---|---|
| Angular (Corrected) | 0 | C > T | Not Run | 6.25 | 25 | 13 | 16 | 4.2% |

**Bonferroni Adj t Test**

| Control | vs | Conc-% | Test Stat | Critical | MSD | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|---|
| Dilution Water | | 0.1 | 0.15 | 2.7 | 0.051 | 1.0000 | Non-Significant Effect |
| | | 0.39 | 0.026 | 2.7 | 0.051 | 1.0000 | Non-Significant Effect |
| | | 1.56 | 0.15 | 2.7 | 0.051 | 1.0000 | Non-Significant Effect |
| | | 6.25 | 0.13 | 2.7 | 0.059 | 1.0000 | Non-Significant Effect |
| | | 25* | 18 | 2.7 | 0.051 | <0.0001 | Significant Effect |

**Auxiliary Tests**

| Attribute | Test | Test Stat | Critical | P-Value | Decision |
|---|---|---|---|---|---|
| Extreme Value | Grubbs Single Outlier | 3.4 | 2.7 | 0.0002 | Outlier Detected |

**ANOVA Table**

| Source | Sum Squares | Mean Square | DF | F Stat | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|
| Between | 0.3006006 | 0.06012013 | 5 | 86 | <0.0001 | Significant Effect |
| Error | 0.009072987 | 0.0006979221 | 13 | | | |
| Total | 0.3096736 | 0.06081805 | 18 | | | |

**ANOVA Assumptions**

| Attribute | Test | Test Stat | Critical | P-Value | Decision(1%) |
|---|---|---|---|---|---|
| Variances | Mod Levene Equality of Variance | 1.3 | 6.6 | 0.3598 | Equal Variances |
| Distribution | Shapiro-Wilk Normality | 0.61 | | <0.0001 | Non-normal Distribution |

**96 h Survival Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Dilution Water | 5 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 0.1 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 0.39 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 1.56 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 6.25 | | 2 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 25 | | 3 | 0.77 | 0.74 | 0.79 | 0.7 | 0.8 | 0.011 | 0.058 | 7.5% | 23.0% |
| 57.1 | | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 100.0% |

**Angular (Corrected) Transformed Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Dilution Water | 5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0.00076 | 0.0041 | 0.29% | 0.0% |
| 0.1 | | 3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0 | 0 | 0.0% | 0.21% |
| 0.39 | | 3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0.0008 | 0.0043 | 0.3% | 0.04% |
| 1.56 | | 3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0 | 0 | 0.0% | 0.21% |
| 6.25 | | 2 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0 | 0 | 0.0% | 0.21% |
| 25 | | 3 | 1.1 | 1 | 1.1 | 0.99 | 1.1 | 0.012 | 0.067 | 6.3% | 24.0% |
| 57.1 | | 3 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0 | 0 | 0.0% | 89.0% |

**Spearman-Kärber Estimates**

| Threshold Option | Threshold | Trim | Mu | Sigma | LC50 | 95% LCL | 95% UCL |
|---|---|---|---|---|---|---|---|
| Control Threshold | 0 | 0.00% | 1.5 | 0.037 | 29 | 25 | 35 |

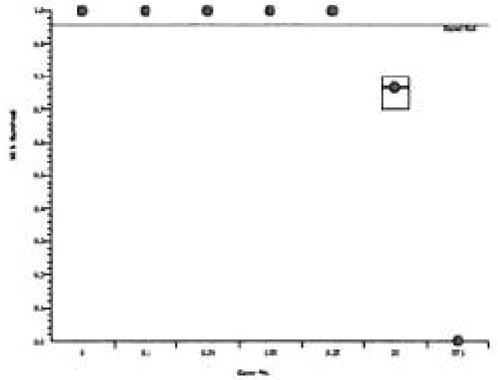
In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

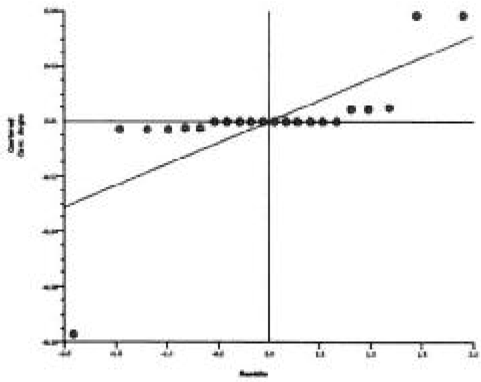
# Appendix 3:
## STATISTICS

96 h Survival Detail

| Conc-% | Control Type | Rep 1 | Rep 2 | Rep 3 | Rep 4 | Rep 5 |
|---|---|---|---|---|---|---|
| 0 | Dilution Water | 1 | 1 | 1 | 1 | 1 |
| 0.1 | | 1 | 1 | 1 | | |
| 0.39 | | 1 | 1 | 1 | | |
| 1.56 | | 1 | 1 | 1 | | |
| 6.25 | | 1 | 1 | | | |
| 25 | | 0.8 | 0.7 | 0.8 | | |
| 57.1 | | 0 | 0 | 0 | | |

Graphics





In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

NIWA
Taihoro Nukurangi

### CETIS Analytical Report

| | |
|---|---|
| Report Date: | 09 Jan-14 09:14 (p 1 of 2) |
| Test Code: | 04-6494-0953/2558/OT2 AAC |

Amphipod 96 h survival and morbidity test — NIWA Ecotoxicology

| | | | | | |
|---|---|---|---|---|---|
| Analysis ID: | 02-7239-4417 | Endpoint: | 96h morbidity | CETIS Version: | CETISv1.7.0 |
| Analyzed: | 09 Dec-13 16:37 | Analysis: | Parametric-Multiple Comparison | Official Results: | Yes |

| | | | | | |
|---|---|---|---|---|---|
| Batch ID: | 04-5184-2984 | Test Type: | Survival morbidity | Analyst: | M Martin |
| Start Date: | 05 Dec-13 11:00 | Protocol: | NIWA (1995) | Diluent: | Nearshore seawater |
| Ending Date: | 09 Dec-13 11:00 | Species: | Chaetocorophium cf lucasi | Brine: | Not Applicable |
| Duration: | 96h | Source: | Waingaro Landing, Raglan Harbour | Age: | |

| | | | | | |
|---|---|---|---|---|---|
| Sample ID: | 10-0862-9854 | Code: | 2558/OT2 | Client: | Total Bridge Services |
| Sample Date: | 03 Dec-13 09:00 | Material: | Paint WAF | Project: | Special Studies |
| Receive Date: | 04 Dec-13 09:00 | Source: | Client Supplied | | |
| Sample Age: | 50h | Station: | In House WAF | | |

Sample Note: Termarust 2100

| Data Transform | Zeta | Alt Hyp | Monte Carlo | NOEL | LOEL | TOEL | TU | PMSD |
|---|---|---|---|---|---|---|---|---|
| Angular (Corrected) | 0 | C > T | Not Run | 6.25 | 25 | 13 | 16 | 7.3% |

**Bonferroni Adj t Test**

| Control | vs | Conc-% | Test Stat | Critical | MSD | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|---|
| Dilution Water | | 0.1 | 0.067 | 2.7 | 0.12 | 1.0000 | Non-Significant Effect |
| | | 0.39 | 0.011 | 2.7 | 0.12 | 1.0000 | Non-Significant Effect |
| | | 1.56 | 0.067 | 2.7 | 0.12 | 1.0000 | Non-Significant Effect |
| | | 6.25 | 0.058 | 2.7 | 0.14 | 1.0000 | Non-Significant Effect |
| | | 25* | 16 | 2.7 | 0.12 | <0.0001 | Significant Effect |

**Auxiliary Tests**

| Attribute | Test | Test Stat | Critical | P-Value | Decision |
|---|---|---|---|---|---|
| Extreme Value | Grubbs Single Outlier | 3.3 | 2.7 | 0.0011 | Outlier Detected |

**ANOVA Table**

| Source | Sum Squares | Mean Square | DF | F Stat | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|
| Between | 1.225932 | 0.2451864 | 5 | 66 | <0.0001 | Significant Effect |
| Error | 0.04860039 | 0.003738492 | 13 | | | |
| Total | 1.274533 | 0.2489249 | 18 | | | |

**ANOVA Assumptions**

| Attribute | Test | Test Stat | Critical | P-Value | Decision(1%) |
|---|---|---|---|---|---|
| Variances | Mod Levene Equality of Variance | 13 | 6.6 | 0.0010 | Unequal Variances |
| Distribution | Shapiro-Wilk Normality | 0.55 | | <0.0001 | Non-normal Distribution |

**96h morbidity Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Dilution Water | 5 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 0.1 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 0.39 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 1.56 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 6.25 | | 2 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 25 | | 3 | 0.43 | 0.38 | 0.49 | 0.3 | 0.6 | 0.028 | 0.15 | 35.0% | 57.0% |
| 57.1 | | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 100.0% |

**Angular (Corrected) Transformed Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Dilution Water | 5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0.00076 | 0.0041 | 0.29% | 0.0% |
| 0.1 | | 3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0 | 0 | 0.0% | 0.21% |
| 0.39 | | 3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0.0008 | 0.0043 | 0.3% | 0.04% |
| 1.56 | | 3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0 | 0 | 0.0% | 0.21% |
| 6.25 | | 2 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0 | 0 | 0.0% | 0.21% |
| 25 | | 3 | 0.72 | 0.66 | 0.78 | 0.58 | 0.89 | 0.029 | 0.16 | 22.0% | 49.0% |
| 57.1 | | 3 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0 | 0 | 0.0% | 89.0% |

In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

Taihoro Nukurangi

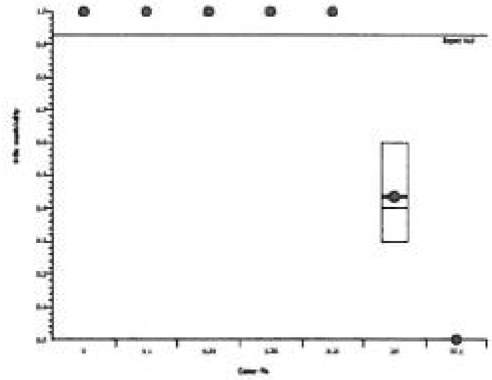
**Spearman-Kärber Estimates**

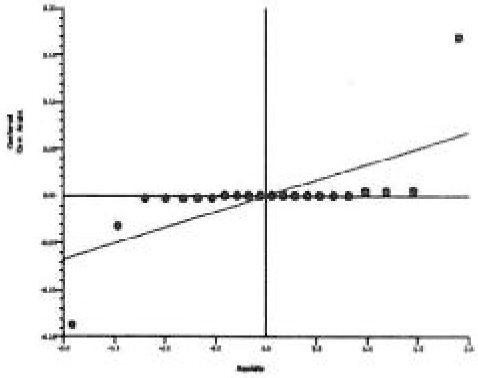
| Threshold Option | Threshold | Trim | Mu | Sigma | EC50 | 95% LCL | 95% UCL |
|---|---|---|---|---|---|---|---|
| Control Threshold | 0 | 0.00% | 1.3 | 0.043 | 20 | 17 | 25 |

**96h morbidity Detail**

| Conc-% | Control Type | Rep 1 | Rep 2 | Rep 3 | Rep 4 | Rep 5 |
|---|---|---|---|---|---|---|
| 0 | Dilution Water | 1 | 1 | 1 | 1 | 1 |
| 0.1 | | 1 | 1 | 1 | | |
| 0.39 | | 1 | 1 | 1 | | |
| 1.56 | | 1 | 1 | 1 | | |
| 6.25 | | 1 | 1 | | | |
| 25 | | 0.6 | 0.4 | 0.3 | | |
| 57.1 | | 0 | 0 | 0 | | |

Graphics





In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

NIWA
Taihoro Nukurangi

### CETIS Analytical Report

Report Date: 09 Jan-14 09:11 (p 1 of 2)
Test Code: 05-0803-9449/2558/OT3 AAC

**Amphipod 96 h survival and morbidity test** — **NIWA Ecotoxicology**

| | | | | | |
|---|---|---|---|---|---|
| **Analysis ID:** | 07-4625-0328 | **Endpoint:** | 96 h Survival | **CETIS Version:** | CETISv1.7.0 |
| **Analyzed:** | 09 Dec-13 15:50 | **Analysis:** | Parametric-Multiple Comparison | **Official Results:** | Yes |
| **Batch ID:** | 04-5184-2984 | **Test Type:** | Survival morbidity | **Analyst:** | M Martin |
| **Start Date:** | 05 Dec-13 11:30 | **Protocol:** | NIWA (1995) | **Diluent:** | Nearshore seawater |
| **Ending Date:** | 09 Dec-13 11:30 | **Species:** | Chaetocorophium cf lucasi | **Brine:** | Not Applicable |
| **Duration:** | 96h | **Source:** | Waingaro Landing, Raglan Harbour | **Age:** | |
| **Sample ID:** | 06-9292-5601 | **Code:** | 2558/OT3 | **Client:** | Total Bridge Services |
| **Sample Date:** | 03 Dec-13 09:00 | **Material:** | Paint WAF | **Project:** | Special Studies |
| **Receive Date:** | 04 Dec-13 09:00 | **Source:** | Client Supplied | | |
| **Sample Age:** | 50h | **Station:** | In House WAF | | |

**Sample Note:** MC MIO

| Data Transform | Zeta | Alt Hyp | Monte Carlo | NOEL | LOEL | TOEL | TU | PMSD |
|---|---|---|---|---|---|---|---|---|
| Angular (Corrected) | 0 | C > T | Not Run | 6.25 | 25 | 13 | 16 | 5.2% |

**Bonferroni Adj t Test**

| Control | vs | Conc-% | Test Stat | Critical | MSD | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|---|
| Dilution Water | | 0.1 | 0.1 | 2.6 | 0.075 | 1.0000 | Non-Significant Effect |
| | | 0.39 | 0.1 | 2.6 | 0.075 | 1.0000 | Non-Significant Effect |
| | | 1.56 | 0.017 | 2.6 | 0.075 | 1.0000 | Non-Significant Effect |
| | | 6.25 | 0.21 | 2.6 | 0.075 | 1.0000 | Non-Significant Effect |
| | | 25* | 19 | 2.6 | 0.075 | <0.0001 | Significant Effect |

**Auxiliary Tests**

| Attribute | Test | Test Stat | Critical | P-Value | Decision |
|---|---|---|---|---|---|
| Extreme Value | Grubbs Single Outlier | 3.1 | 2.7 | 0.0055 | Outlier Detected |

**ANOVA Table**

| Source | Sum Squares | Mean Square | DF | F Stat | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|
| Between | 0.7036613 | 0.1407323 | 5 | 92 | <0.0001 | Significant Effect |
| Error | 0.02132512 | 0.001523223 | 14 | | | |
| Total | 0.7249864 | 0.1422555 | 19 | | | |

**ANOVA Assumptions**

| Attribute | Test | Test Stat | Critical | P-Value | Decision(1%) |
|---|---|---|---|---|---|
| Variances | Mod Levene Equality of Variance | 210 | 6.6 | <0.0001 | Unequal Variances |
| Distribution | Shapiro-Wilk Normality | 0.53 | | <0.0001 | Non-normal Distribution |

**96 h Survival Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Dilution Water | 5 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 0.1 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 0.39 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 1.56 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 6.25 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 25 | | 3 | 0.6 | 0.56 | 0.64 | 0.5 | 0.7 | 0.019 | 0.1 | 17.0% | 40.0% |
| 57.1 | | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 100.0% |

**Angular (Corrected) Transformed Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Dilution Water | 5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0.00076 | 0.0041 | 0.29% | 0.0% |
| 0.1 | | 3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0 | 0 | 0.0% | 0.21% |
| 0.39 | | 3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0 | 0 | 0.0% | 0.21% |
| 1.56 | | 3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0.0008 | 0.0043 | 0.3% | 0.04% |
| 6.25 | | 3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0.00093 | 0.005 | 0.36% | 0.41% |
| 25 | | 3 | 0.89 | 0.85 | 0.93 | 0.79 | 0.99 | 0.019 | 0.1 | 12.0% | 37.0% |
| 57.1 | | 3 | 0.15 | 0.16 | 0.16 | 0.16 | 0.16 | 0 | 0 | 0.0% | 89.0% |

In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

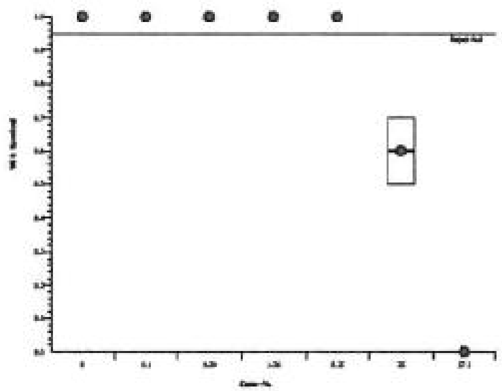
Spearman-Kärber Estimates

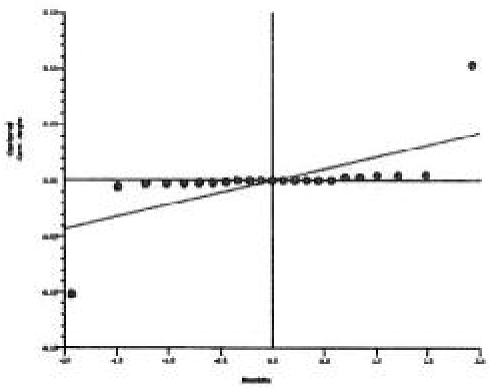
| Threshold Option | Threshold | Trim | Mu | Sigma | LC50 | 95% LCL | 95% UCL |
|---|---|---|---|---|---|---|---|
| Control Threshold | 0 | 0.00% | 1.4 | 0.043 | 24 | 20 | 30 |

96 h Survival Detail

| Conc-% | Control Type | Rep 1 | Rep 2 | Rep 3 | Rep 4 | Rep 5 |
|---|---|---|---|---|---|---|
| 0 | Dilution Water | 1 | 1 | 1 | 1 | 1 |
| 0.1 | | 1 | 1 | 1 | | |
| 0.39 | | 1 | 1 | 1 | | |
| 1.56 | | 1 | 1 | 1 | | |
| 6.25 | | 1 | 1 | 1 | | |
| 25 | | 0.7 | 0.5 | 0.6 | | |
| 57.1 | | 0 | 0 | 0 | | |

Graphics





In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

NIWA Taihoro Nukurangi

**CETIS Analytical Report**

Report Date: 09 Jan-14 09:09 (p 1 of 2)
Test Code: 05-0803-9449/2558/OT3 AAC

**Amphipod 96 h survival and morbidity test** — **NIWA Ecotoxicology**

| | | | | | |
|---|---|---|---|---|---|
| **Analysis ID:** | 00-9435-2126 | **Endpoint:** | 96h morbidity | **CETIS Version:** | CETISv1.7.0 |
| **Analyzed:** | 09 Dec-13 16:51 | **Analysis:** | Parametric-Multiple Comparison | **Official Results:** | Yes |

| | | | | | |
|---|---|---|---|---|---|
| **Batch ID:** | 04-5184-2984 | **Test Type:** | Survival morbidity | **Analyst:** | M Martin |
| **Start Date:** | 05 Dec-13 11:30 | **Protocol:** | NIWA (1995) | **Diluent:** | Nearshore seawater |
| **Ending Date:** | 09 Dec-13 11:30 | **Species:** | Chaetocorophium cf lucasi | **Brine:** | Not Applicable |
| **Duration:** | 96h | **Source:** | Waingaro Landing, Raglan Harbour | **Age:** | |

| | | | | | |
|---|---|---|---|---|---|
| **Sample ID:** | 06-9292-5601 | **Code:** | 2558/OT3 | **Client:** | Total Bridge Services |
| **Sample Date:** | 03 Dec-13 09:00 | **Material:** | Paint WAF | **Project:** | Special Studies |
| **Receive Date:** | 04 Dec-13 09:00 | **Source:** | Client Supplied | | |
| **Sample Age:** | 50h | **Station:** | In House WAF | | |

**Sample Note:** MC MIO

| Data Transform | Zeta | Alt Hyp | Monte Carlo | NOEL | LOEL | TOEL | TU | PMSD |
|---|---|---|---|---|---|---|---|---|
| Angular (Corrected) | 0 | C > T | Not Run | 6.25 | 25 | 13 | 16 | 2.6% |

**Bonferroni Adj t Test**

| Control | vs | Conc-% | Test Stat | Critical | MSD | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|---|
| Dilution Water | | 0.1 | 1.1 | 2.6 | 0.0067 | 0.5530 | Non-Significant Effect |
| | | 0.39 | 1.1 | 2.6 | 0.0067 | 0.5530 | Non-Significant Effect |
| | | 1.56 | 0.19 | 2.6 | 0.0067 | 1.0000 | Non-Significant Effect |
| | | 6.25 | 2.2 | 2.6 | 0.0067 | 0.0887 | Non-Significant Effect |

**Auxiliary Tests**

| Attribute | Test | Test Stat | Critical | P-Value | Decision |
|---|---|---|---|---|---|
| Extreme Value | Grubbs Single Outlier | 1.9 | 2.6 | 0.8647 | No Outliers Detected |

**ANOVA Table**

| Source | Sum Squares | Mean Square | DF | F Stat | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|
| Between | 7.690577E-05 | 1.922644E-05 | 4 | 1.5 | 0.2629 | Non-Significant Effect |
| Error | 0.0001536252 | 1.28021E-05 | 12 | | | |
| Total | 0.000230531 | 3.202855E-05 | 16 | | | |

**ANOVA Assumptions**

| Attribute | Test | Test Stat | Critical | P-Value | Decision(1%) |
|---|---|---|---|---|---|
| Variances | Mod Levene Equality of Variance | 0.59 | 7.8 | 0.6817 | Equal Variances |
| Distribution | Shapiro-Wilk Normality | 0.93 | | 0.1843 | Normal Distribution |

**96h morbidity Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Dilution Water | 5 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 0.1 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 0.39 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 1.56 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 6.25 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 25 | | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 100.0% |
| 57.1 | | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 100.0% |

In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

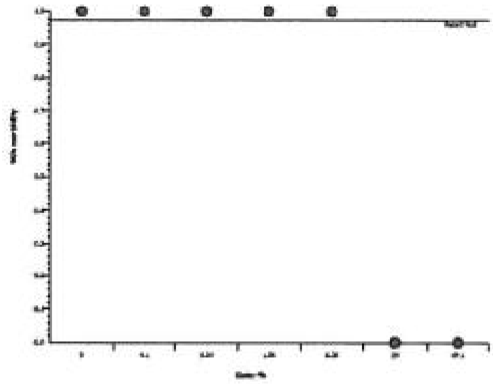
Binomial/Graphical Estimates

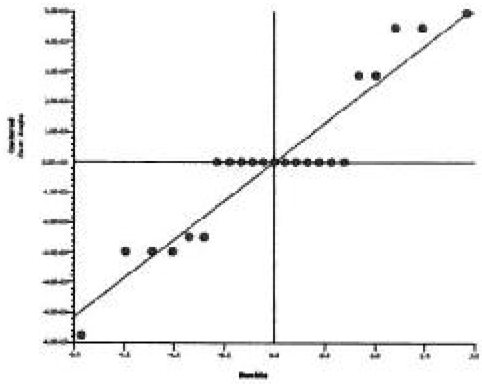
| Threshold Option | Threshold | Trim | Mu | Sigma | EC50 | 95% LCL | 95% UCL |
|---|---|---|---|---|---|---|---|
| Control Threshold | 0 | 0.00% | 1.1 | 0 | 13 | 9.7 | 16 |

96h morbidity Detail

| Conc-% | Control Type | Rep 1 | Rep 2 | Rep 3 | Rep 4 | Rep 5 |
|---|---|---|---|---|---|---|
| 0 | Dilution Water | 1 | 1 | 1 | 1 | 1 |
| 0.1 | | 1 | 1 | 1 | | |
| 0.39 | | 1 | 1 | 1 | | |
| 1.56 | | 1 | 1 | 1 | | |
| 6.25 | | 1 | 1 | 1 | | |
| 25 | | 0 | 0 | 0 | | |
| 57.1 | | 0 | 0 | 0 | | |

Graphics





In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

NIWA
Taihoro Nukurangi

### CETIS Analytical Report

| | |
|---|---|
| Report Date: | 09 Jan-14 13:14 (p 1 of 2) |
| Test Code: | 12-7445-5769/2558/OT4 AAC |

**Amphipod 96 h survival and morbidity test** — **NIWA Ecotoxicology**

| | | | | | |
|---|---|---|---|---|---|
| **Analysis ID:** | 16-5407-6440 | **Endpoint:** | 96 h Survival | **CETIS Version:** | CETISv1.7.0 |
| **Analyzed:** | 09 Dec-13 16:55 | **Analysis:** | Parametric-Multiple Comparison | **Official Results:** | Yes |

| | | | | | |
|---|---|---|---|---|---|
| **Batch ID:** | 04-5184-2984 | **Test Type:** | Survival morbidity | **Analyst:** | M Martin |
| **Start Date:** | 05 Dec-13 11:00 | **Protocol:** | NIWA (1995) | **Diluent:** | Nearshore seawater |
| **Ending Date:** | 09 Dec-13 11:00 | **Species:** | Chaetocorophium cf lucasi | **Brine:** | Not Applicable |
| **Duration:** | 96h | **Source:** | Waingaro Landing, Raglan Harbour | **Age:** | |

| | | | | | |
|---|---|---|---|---|---|
| **Sample ID:** | 13-7284-1324 | **Code:** | 2558/OT4 | **Client:** | Total Bridge Services |
| **Sample Date:** | 03 Dec-13 09:00 | **Material:** | Paint WAF | **Project:** | Special Studies |
| **Receive Date:** | 04 Dec-13 09:00 | **Source:** | Client Supplied | | |
| **Sample Age:** | 50h | **Station:** | In House WAF | | |

**Sample Note:** Zinc

| Data Transform | Zeta | Alt Hyp | Monte Carlo | NOEL | LOEL | TOEL | TU | PMSD |
|---|---|---|---|---|---|---|---|---|
| Angular (Corrected) | 0 | C > T | Not Run | 6.25 | 25 | 13 | 16 | 11.0% |

**Bonferroni Adj t Test**

| Control | vs | Conc-% | Test Stat | Critical | MSD | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|---|
| Dilution Water | | 0.1 | 0.042 | 2.6 | 0.19 | 1.0000 | Non-Significant Effect |
| | | 0.39 | 0.81 | 2.6 | 0.19 | 1.0000 | Non-Significant Effect |
| | | 1.56 | 0.042 | 2.6 | 0.19 | 1.0000 | Non-Significant Effect |
| | | 6.25 | 0.81 | 2.6 | 0.19 | 1.0000 | Non-Significant Effect |
| | | 25* | 7.8 | 2.6 | 0.19 | <0.0001 | Significant Effect |

**Auxiliary Tests**

| Attribute | Test | Test Stat | Critical | P-Value | Decision |
|---|---|---|---|---|---|
| Extreme Value | Grubbs Single Outlier | 3 | 2.7 | 0.0123 | Outlier Detected |

**ANOVA Table**

| Source | Sum Squares | Mean Square | DF | F Stat | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|
| Between | 0.7409257 | 0.1481851 | 5 | 16 | <0.0001 | Significant Effect |
| Error | 0.1328478 | 0.009489128 | 14 | | | |
| Total | 0.8737735 | 0.1576743 | 19 | | | |

**ANOVA Assumptions**

| Attribute | Test | Test Stat | Critical | P-Value | Decision(1%) |
|---|---|---|---|---|---|
| Variances | Mod Levene Equality of Variance | 2.3 | 6.6 | 0.1382 | Equal Variances |
| Distribution | Shapiro-Wilk Normality | 0.83 | | 0.0025 | Non-normal Distribution |

**96 h Survival Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Dilution Water | 5 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 0.1 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 0.39 | | 3 | 0.97 | 0.94 | 0.99 | 0.9 | 1 | 0.011 | 0.058 | 6.0% | 3.3% |
| 1.56 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 6.25 | | 3 | 0.97 | 0.94 | 0.99 | 0.9 | 1 | 0.011 | 0.058 | 6.0% | 3.3% |
| 25 | | 3 | 0.57 | 0.49 | 0.65 | 0.4 | 0.8 | 0.039 | 0.21 | 37.0% | 43.0% |
| 57.1 | | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 100.0% |

**Angular (Corrected) Transformed Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Dilution Water | 5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0.00076 | 0.0041 | 0.29% | 0.0% |
| 0.1 | | 3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0 | 0 | 0.0% | 0.21% |
| 0.39 | | 3 | 1.4 | 1.3 | 1.4 | 1.2 | 1.4 | 0.017 | 0.094 | 6.9% | 4.0% |
| 1.56 | | 3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0 | 0 | 0.0% | 0.21% |
| 6.25 | | 3 | 1.4 | 1.3 | 1.4 | 1.2 | 1.4 | 0.017 | 0.094 | 6.9% | 4.0% |
| 25 | | 3 | 0.86 | 0.78 | 0.94 | 0.68 | 1.1 | 0.041 | 0.22 | 26.0% | 39.0% |
| 57.1 | | 3 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0 | 0 | 0.0% | 89.0% |

In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

Taihoro Nukurangi

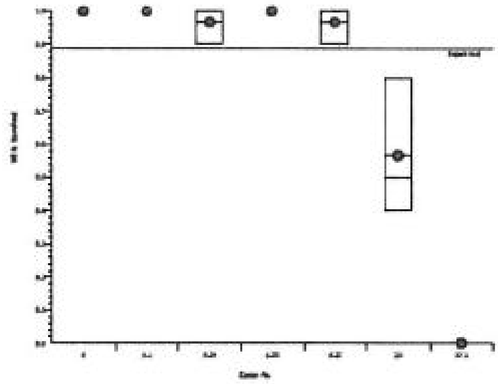
**Spearman-Kärber Estimates**

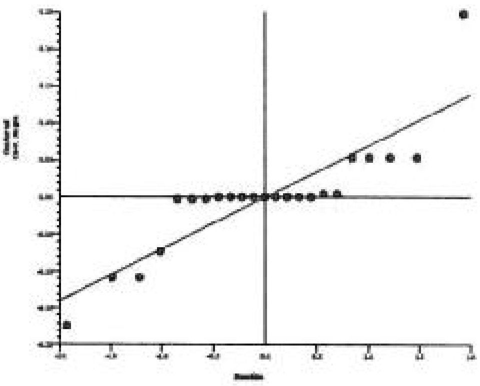
| Threshold Option | Threshold | Trim | Mu | Sigma | LC50 | 95% LCL | 95% UCL |
|---|---|---|---|---|---|---|---|
| Control Threshold | 0 | 0.00% | 1.3 | 0.052 | 21 | 17 | 27 |

**96 h Survival Detail**

| Conc-% | Control Type | Rep 1 | Rep 2 | Rep 3 | Rep 4 | Rep 5 |
|---|---|---|---|---|---|---|
| 0 | Dilution Water | 1 | 1 | 1 | 1 | 1 |
| 0.1 | | 1 | 1 | 1 | | |
| 0.39 | | 1 | 0.9 | 1 | | |
| 1.56 | | 1 | 1 | 1 | | |
| 6.25 | | 0.9 | 1 | 1 | | |
| 25 | | 0.4 | 0.5 | 0.8 | | |
| 57.1 | | 0 | 0 | 0 | | |

Graphics





In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

NIWA
Taihoro Nukurangi

**CETIS Analytical Report**

Report Date: 09 Jan-14 09:18 (p 1 of 2)
Test Code: 12-7445-5769/2558/OT4 AAC

Amphipod 96 h survival and morbidity test — NIWA Ecotoxicology

| | | | | | |
|---|---|---|---|---|---|
| Analysis ID: | 05-3117-8482 | Endpoint: | 96h morbidity | CETIS Version: | CETISv1.7.0 |
| Analyzed: | 09 Dec-13 16:56 | Analysis: | Parametric-Multiple Comparison | Official Results: | Yes |
| Batch ID: | 04-5184-2984 | Test Type: | Survival morbidity | Analyst: | M Martin |
| Start Date: | 05 Dec-13 11:00 | Protocol: | NIWA (1995) | Diluent: | Nearshore seawater |
| Ending Date: | 09 Dec-13 11:00 | Species: | Chaetocorophium cf lucasi | Brine: | Not Applicable |
| Duration: | 96h | Source: | Waingaro Landing, Raglan Harbour | Age: | |
| Sample ID: | 13-7284-1324 | Code: | 2558/OT4 | Client: | Total Bridge Services |
| Sample Date: | 03 Dec-13 09:00 | Material: | Paint WAF | Project: | Special Studies |
| Receive Date: | 04 Dec-13 09:00 | Source: | Client Supplied | | |
| Sample Age: | 50h | Station: | In House WAF | | |

Sample Note: Zinc

| Data Transform | Zeta | Alt Hyp | Monte Carlo | NOEL | LOEL | TOEL | TU | PMSD |
|---|---|---|---|---|---|---|---|---|
| Angular (Corrected) | 0 | C > T | Not Run | 6.25 | 25 | 13 | 16 | 11.0% |

**Bonferroni Adj t Test**

| Control | vs | Conc-% | Test Stat | Critical | MSD | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|---|
| Dilution Water | | 0.1 | 0.043 | 2.6 | 0.18 | 1.0000 | Non-Significant Effect |
| | | 0.39 | 0.84 | 2.6 | 0.18 | 1.0000 | Non-Significant Effect |
| | | 1.56 | 0.043 | 2.6 | 0.18 | 1.0000 | Non-Significant Effect |
| | | 6.25 | 0.84 | 2.6 | 0.18 | 1.0000 | Non-Significant Effect |
| | | 25* | 14 | 2.6 | 0.18 | <0.0001 | Significant Effect |

**Auxiliary Tests**

| Attribute | Test | Test Stat | Critical | P-Value | Decision |
|---|---|---|---|---|---|
| Extreme Value | Grubbs Single Outlier | 3 | 2.7 | 0.0098 | Outlier Detected |

**ANOVA Table**

| Source | Sum Squares | Mean Square | DF | F Stat | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|
| Between | 2.318181 | 0.4636362 | 5 | 53 | <0.0001 | Significant Effect |
| Error | 0.1233098 | 0.008807844 | 14 | | | |
| Total | 2.441491 | 0.4724441 | 19 | | | |

**ANOVA Assumptions**

| Attribute | Test | Test Stat | Critical | P-Value | Decision(1%) |
|---|---|---|---|---|---|
| Variances | Mod Levene Equality of Variance | 0.99 | 6.6 | 0.4806 | Equal Variances |
| Distribution | Shapiro-Wilk Normality | 0.81 | | 0.0011 | Non-normal Distribution |

**96h morbidity Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Dilution Water | 5 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 0.1 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 0.39 | | 3 | 0.97 | 0.94 | 0.99 | 0.9 | 1 | 0.011 | 0.058 | 6.0% | 3.3% |
| 1.56 | | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0.0% | 0.0% |
| 6.25 | | 3 | 0.97 | 0.94 | 0.99 | 0.9 | 1 | 0.011 | 0.058 | 6.0% | 3.3% |
| 25 | | 3 | 0.2 | 0.13 | 0.27 | 0.1 | 0.4 | 0.032 | 0.17 | 87.0% | 80.0% |
| 57.1 | | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 100.0% |

**Angular (Corrected) Transformed Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Dilution Water | 5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0.00076 | 0.0041 | 0.29% | 0.0% |
| 0.1 | | 3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0 | 0 | 0.0% | 0.21% |
| 0.39 | | 3 | 1.4 | 1.3 | 1.4 | 1.2 | 1.4 | 0.017 | 0.094 | 6.9% | 4.0% |
| 1.56 | | 3 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 0 | 0 | 0.0% | 0.21% |
| 6.25 | | 3 | 1.4 | 1.3 | 1.4 | 1.2 | 1.4 | 0.017 | 0.094 | 6.9% | 4.0% |
| 25 | | 3 | 0.44 | 0.36 | 0.52 | 0.32 | 0.68 | 0.039 | 0.21 | 47.0% | 69.0% |
| 57.1 | | 3 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0 | 0 | 0.0% | 89.0% |

In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

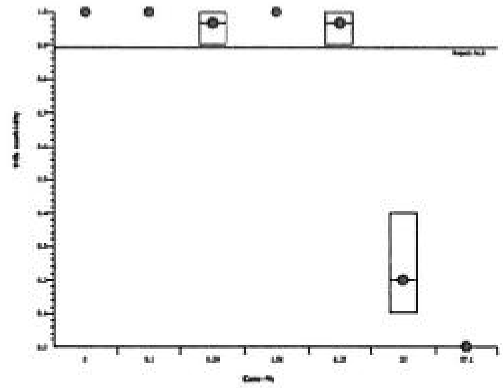
**Spearman-Kärber Estimates**

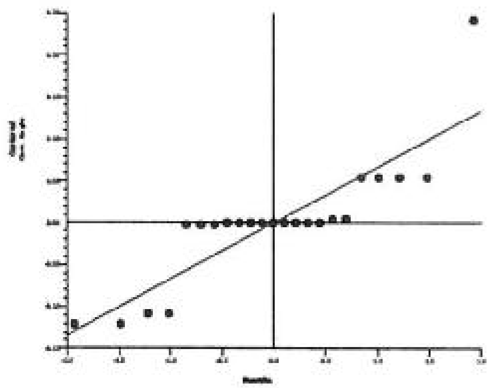
| Threshold Option | Threshold | Trim | Mu | Sigma | EC50 | 95% LCL | 95% UCL |
|---|---|---|---|---|---|---|---|
| Control Threshold | 0 | 0.00% | 1.2 | 0.045 | 14 | 12 | 17 |

**96h morbidity Detail**

| Conc-% | Control Type | Rep 1 | Rep 2 | Rep 3 | Rep 4 | Rep 5 |
|---|---|---|---|---|---|---|
| 0 | Dilution Water | 1 | 1 | 1 | 1 | 1 |
| 0.1 | | 1 | 1 | 1 | | |
| 0.39 | | 1 | 0.9 | 1 | | |
| 1.56 | | 1 | 1 | 1 | | |
| 6.25 | | 0.9 | 1 | 1 | | |
| 25 | | 0.4 | 0.1 | 0.1 | | |
| 57.1 | | 0 | 0 | 0 | | |

**Graphics**





In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

Taihoro Nukurangi

**CETIS Analytical Report**

Report Date: 07 Jan-14 14:17 (p 1 of 2)
Test Code: 20-7082-2627/2558/OT1 MyG

**Bivalve Larval Survival and Development Test** — **NIWA Ecotoxicology**

| | | | | | |
|---|---|---|---|---|---|
| **Analysis ID:** | 01-6672-2624 | **Endpoint:** | Proportion Normal | **CETIS Version:** | CETISv1.7.0 |
| **Analyzed:** | 07 Jan-14 11:13 | **Analysis:** | Parametric-Multiple Comparison | **Official Results:** | Yes |

| | | | | | |
|---|---|---|---|---|---|
| **Batch ID:** | 04-8368-5973 | **Test Type:** | Development | **Analyst:** | M Martin |
| **Start Date:** | 05 Dec-13 11:00 | **Protocol:** | NIWA (2008) | **Diluent:** | Offshore seawater |
| **Ending Date:** | 07 Dec-13 11:00 | **Species:** | Mytilus galloprovincialis | **Brine:** | Not Applicable |
| **Duration:** | 48h | **Source:** | Coromandel | **Age:** | |

| | | | | | |
|---|---|---|---|---|---|
| **Sample ID:** | 08-3736-7167 | **Code:** | 2558/OT1 | **Client:** | Total Bridge Services |
| **Sample Date:** | 02 Dec-13 09:00 | **Material:** | Paint WAF | **Project:** | Special Studies |
| **Receive Date:** | 03 Dec-13 09:00 | **Source:** | Client Supplied | | |
| **Sample Age:** | 74h | **Station:** | In House WAF | | |

**Sample Note:** MC Ferrox

| Data Transform | Zeta | Alt Hyp | Monte Carlo | NOEL | LOEL | TOEL | TU | PMSD |
|---|---|---|---|---|---|---|---|---|
| Angular (Corrected) | 0 | C > T | Not Run | 6.25 | 25 | 13 | 16 | 11.0% |

**Bonferroni Adj t Test**

| Control | vs | Conc-% | Test Stat | Critical | MSD | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|---|
| SW Control | | 0.1 | 0.072 | 2.5 | 0.093 | 1.0000 | Non-Significant Effect |
| | | 0.39 | -3.6 | 2.5 | 0.093 | 1.0000 | Non-Significant Effect |
| | | 1.56 | -2.5 | 2.5 | 0.093 | 1.0000 | Non-Significant Effect |
| | | 6.25 | -0.82 | 2.5 | 0.093 | 1.0000 | Non-Significant Effect |
| | | 25* | 9.7 | 2.5 | 0.093 | <0.0001 | Significant Effect |
| | | 100* | 24 | 2.5 | 0.11 | <0.0001 | Significant Effect |

**Auxiliary Tests**

| Attribute | Test | Test Stat | Critical | P-Value | Decision |
|---|---|---|---|---|---|
| Extreme Value | Grubbs Single Outlier | 1.9 | 3 | 1.0000 | No Outliers Detected |

**ANOVA Table**

| Source | Sum Squares | Mean Square | DF | F Stat | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|
| Between | 3.775622 | 0.6292703 | 6 | 140 | <0.0001 | Significant Effect |
| Error | 0.1380377 | 0.004452828 | 31 | | | |
| Total | 3.913659 | 0.6337231 | 37 | | | |

**ANOVA Assumptions**

| Attribute | Test | Test Stat | Critical | P-Value | Decision(1%) |
|---|---|---|---|---|---|
| Variances | Bartlett Equality of Variance | 5.8 | 17 | 0.4511 | Equal Variances |
| Distribution | Shapiro-Wilk Normality | 0.97 | | 0.4005 | Normal Distribution |

**Proportion Normal Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | SW Control | 10 | 0.83 | 0.82 | 0.85 | 0.79 | 0.88 | 0.0058 | 0.031 | 3.7% | 0.0% |
| 0.1 | | 5 | 0.83 | 0.8 | 0.86 | 0.74 | 0.91 | 0.013 | 0.072 | 8.7% | 0.72% |
| 0.39 | | 5 | 0.91 | 0.9 | 0.93 | 0.85 | 0.97 | 0.0089 | 0.048 | 5.2% | -9.6% |
| 1.56 | | 5 | 0.89 | 0.88 | 0.91 | 0.85 | 0.94 | 0.007 | 0.038 | 4.2% | -7.2% |
| 6.25 | | 5 | 0.85 | 0.84 | 0.87 | 0.79 | 0.92 | 0.0087 | 0.047 | 5.5% | -2.4% |
| 25 | | 5 | 0.51 | 0.5 | 0.53 | 0.45 | 0.55 | 0.0082 | 0.044 | 8.7% | 39.0% |
| 100 | | 3 | 0.01 | 0.0034 | 0.017 | 0 | 0.03 | 0.0032 | 0.017 | 170.0% | 99.0% |

In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

NIWA
Taihoro Nukurangi

# Appendix 3:
## STATISTICS

**Linear Regression Options**

| Model Function | Threshold Option | Threshold | Optimized | Pooled | Het Corr | Weighted |
|---|---|---|---|---|---|---|
| Log-Normal [NED=A+B*log(X)] | Control Threshold | 0.166 | Yes | No | No | Yes |

**Regression Summary**

| Iters | LL | AICc | Mu | Sigma | G Stat | Chi-Sq | Critical | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|---|---|---|
| 11 | -6.5 | 17 | -0.25 | 0.24 | 0.032 | 32 | 39 | 0.1900 | Non-Significant Heterogeneity |

**Point Estimates**

| Level | % | 95% LCL | 95% UCL | TU | 95% LCL | 95% UCL |
|---|---|---|---|---|---|---|
| EC5 | 11 | 9.3 | 13 | 8.7 | 7.5 | 11 |
| EC10 | 14 | 12 | 16 | 7.1 | 6.3 | 8.4 |
| EC15 | 16 | 14 | 18 | 6.2 | 5.6 | 7.2 |
| EC20 | 18 | 16 | 20 | 5.6 | 5.1 | 6.3 |
| EC25 | 20 | 18 | 21 | 5.1 | 4.7 | 5.7 |
| EC40 | 25 | 23 | 27 | 4 | 3.8 | 4.4 |
| EC50 | 29 | 27 | 31 | 3.5 | 3.3 | 3.8 |

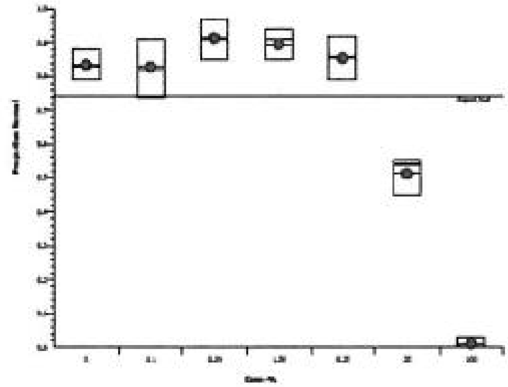
**Regression Parameters**

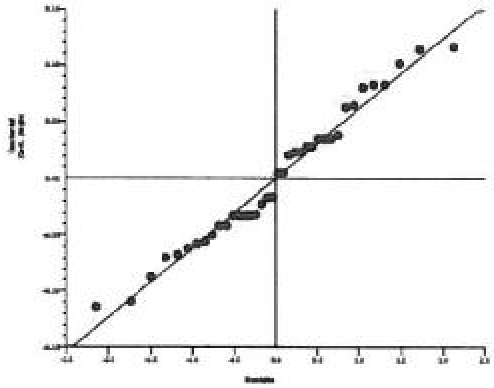
| Parameter | Estimate | Std Error | 95% LCL | 95% UCL | t Stat | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|---|
| Threshold | 0.14 | 0.0064 | 0.13 | 0.15 | 22 | <0.0001 | Significant Parameter |
| Slope | 4.2 | 0.38 | 3.4 | 4.9 | 11 | <0.0001 | Significant Parameter |
| Intercept | -1.1 | 0.55 | -2.1 | 0.028 | -1.9 | 0.0673 | Non-Significant Parameter |

**Proportion Normal Detail**

| Conc-% | Control Type | Rep 1 | Rep 2 | Rep 3 | Rep 4 | Rep 5 | Rep 6 | Rep 7 | Rep 8 | Rep 9 | Rep 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | SW Control | 0.81 | 0.86 | 0.85 | 0.88 | 0.79 | 0.86 | 0.81 | 0.81 | 0.81 | 0.86 |
| 0.1 | | 0.89 | 0.74 | 0.91 | 0.82 | 0.78 | | | | | |
| 0.39 | | 0.89 | 0.85 | 0.91 | 0.95 | 0.97 | | | | | |
| 1.56 | | 0.86 | 0.85 | 0.91 | 0.94 | 0.91 | | | | | |
| 6.25 | | 0.92 | 0.84 | 0.86 | 0.86 | 0.79 | | | | | |
| 25 | | 0.54 | 0.55 | 0.45 | 0.54 | 0.48 | | | | | |
| 100 | | 0 | 0 | 0.03 | | | | | | | |

**Graphics**





In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

NIWA
Taihoro Nukurangi

**CETIS Analytical Report**

Report Date: 07 Jan-14 14:19 (p 1 of 2)
Test Code: 13-7521-3988/2558/OT2 MyG

**Bivalve Larval Survival and Development Test** — **NIWA Ecotoxicology**

| | | | | | |
|---|---|---|---|---|---|
| **Analysis ID:** | 04-1102-4816 | **Endpoint:** | Proportion Normal | **CETIS Version:** | CETISv1.7.0 |
| **Analyzed:** | 07 Jan-14 11:20 | **Analysis:** | Parametric-Multiple Comparison | **Official Results:** | Yes |

| | | | | | |
|---|---|---|---|---|---|
| **Batch ID:** | 01-9828-4088 | **Test Type:** | Development | **Analyst:** | M Martin |
| **Start Date:** | 06 Dec-13 11:00 | **Protocol:** | NIWA (2008) | **Diluent:** | Offshore seawater |
| **Ending Date:** | 08 Dec-13 11:00 | **Species:** | Mytilus galloprovincialis | **Brine:** | Not Applicable |
| **Duration:** | 48h | **Source:** | Coromandel | **Age:** | |

| | | | | | |
|---|---|---|---|---|---|
| **Sample ID:** | 01-2035-7720 | **Code:** | 2558/OT2 | **Client:** | Total Bridge Services |
| **Sample Date:** | 02 Dec-13 09:00 | **Material:** | Paint WAF | **Project:** | Special Studies |
| **Receive Date:** | 03 Dec-13 09:00 | **Source:** | Client Supplied | | |
| **Sample Age:** | 4d 2h | **Station:** | In House WAF | | |

**Sample Note:** Termarust 2100

| Data Transform | Zeta | Alt Hyp | Monte Carlo | NOEL | LOEL | TOEL | TU | PMSD |
|---|---|---|---|---|---|---|---|---|
| Angular (Corrected) | 0 | C > T | Not Run | 1.56 | 6.25 | 3.1 | 64 | 10.0% |

**Bonferroni Adj t Test**

| Control | vs | Conc-% | Test Stat | Critical | MSD | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|---|
| SW Control | | 0.1 | 0.28 | 2.5 | 0.09 | 1.0000 | Non-Significant Effect |
| | | 0.39 | -2 | 2.5 | 0.09 | 1.0000 | Non-Significant Effect |
| | | 1.56 | 0.95 | 2.5 | 0.09 | 0.8751 | Non-Significant Effect |
| | | 6.25* | 28 | 2.5 | 0.09 | <0.0001 | Significant Effect |
| | | 25* | 25 | 2.5 | 0.11 | <0.0001 | Significant Effect |

**Auxiliary Tests**

| Attribute | Test | Test Stat | Critical | P-Value | Decision |
|---|---|---|---|---|---|
| Extreme Value | Grubbs Single Outlier | 2 | 3 | 1.0000 | No Outliers Detected |

**ANOVA Table**

| Source | Sum Squares | Mean Square | DF | F Stat | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|
| Between | 6.822266 | 1.364453 | 5 | 310 | <0.0001 | Significant Effect |
| Error | 0.1204962 | 0.004462823 | 27 | | | |
| Total | 6.942762 | 1.368916 | 32 | | | |

**ANOVA Assumptions**

| Attribute | Test | Test Stat | Critical | P-Value | Decision(1%) |
|---|---|---|---|---|---|
| Variances | Bartlett Equality of Variance | 5.5 | 15 | 0.3542 | Equal Variances |
| Distribution | Shapiro-Wilk Normality | 0.95 | | 0.1350 | Normal Distribution |

**Proportion Normal Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | SW Control | 10 | 0.83 | 0.82 | 0.85 | 0.79 | 0.88 | 0.0058 | 0.031 | 3.7% | 0.0% |
| 0.1 | | 5 | 0.82 | 0.8 | 0.85 | 0.76 | 0.9 | 0.011 | 0.059 | 7.2% | 1.2% |
| 0.39 | | 5 | 0.88 | 0.86 | 0.9 | 0.82 | 0.95 | 0.01 | 0.056 | 6.4% | -5.5% |
| 1.56 | | 5 | 0.81 | 0.78 | 0.83 | 0.73 | 0.87 | 0.01 | 0.055 | 6.9% | 3.4% |
| 6.25 | | 5 | 0.018 | 0.0098 | 0.026 | 0 | 0.05 | 0.004 | 0.022 | 120.0% | 98.0% |
| 25 | | 3 | 0.0033 | 0.0011 | 0.0055 | 0 | 0.01 | 0.0011 | 0.0058 | 170.0% | 100.0% |

In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

Taihoro Nukurangi

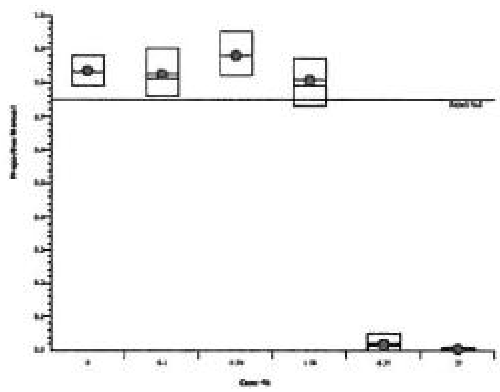
**Trimmed Spearman-Kärber Estimates**

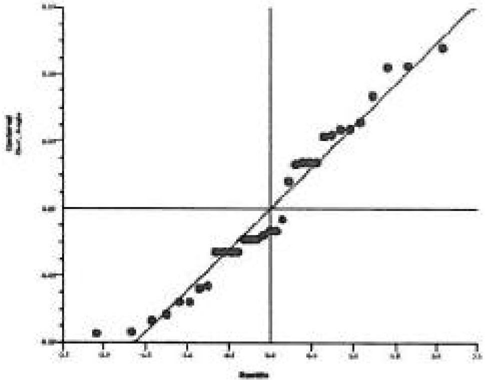
| Threshold Option | Threshold | Trim | Mu | Sigma | EC50 | 95% LCL | 95% UCL |
|---|---|---|---|---|---|---|---|
| Control Threshold | 0.17 | 0.39% | 0.48 | 0.007 | 3 | 2.9 | 3.1 |

**Proportion Normal Detail**

| Conc-% | Control Type | Rep 1 | Rep 2 | Rep 3 | Rep 4 | Rep 5 | Rep 6 | Rep 7 | Rep 8 | Rep 9 | Rep 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | SW Control | 0.81 | 0.86 | 0.85 | 0.88 | 0.79 | 0.86 | 0.81 | 0.81 | 0.81 | 0.86 |
| 0.1 | | 0.81 | 0.87 | 0.78 | 0.76 | 0.9 | | | | | |
| 0.39 | | 0.95 | 0.88 | 0.82 | 0.83 | 0.92 | | | | | |
| 1.56 | | 0.87 | 0.79 | 0.79 | 0.73 | 0.85 | | | | | |
| 6.25 | | 0.05 | 0 | 0.01 | 0 | 0.03 | | | | | |
| 25 | | 0 | 0.01 | 0 | | | | | | | |

Graphics





In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

NIWA
Taihoro Nukurangi

**CETIS Analytical Report**

Report Date: 07 Jan-14 14:21 (p 1 of 2)
Test Code: 00-1755-0458/2556/OT3 MyG

**Bivalve Larval Survival and Development Test** — **NIWA Ecotoxicology**

| | | | | | |
|---|---|---|---|---|---|
| **Analysis ID:** | 04-7257-8436 | **Endpoint:** | Proportion Normal | **CETIS Version:** | CETISv1.7.0 |
| **Analyzed:** | 07 Jan-14 13:58 | **Analysis:** | Parametric-Multiple Comparison | **Official Results:** | Yes |

| | | | | | |
|---|---|---|---|---|---|
| **Batch ID:** | 01-9828-4086 | **Test Type:** | Development | **Analyst:** | M Martin |
| **Start Date:** | 06 Dec-13 11:00 | **Protocol:** | NIWA (2008) | **Diluent:** | Offshore seawater |
| **Ending Date:** | 08 Dec-13 11:00 | **Species:** | Mytilus galloprovincialis | **Brine:** | Not Applicable |
| **Duration:** | 48h | **Source:** | Coromandel | **Age:** | |

| | | | | | |
|---|---|---|---|---|---|
| **Sample ID:** | 01-4619-1119 | **Code:** | 2558/OT3 | **Client:** | Total Bridge Services |
| **Sample Date:** | 02 Dec-13 09:00 | **Material:** | Paint WAF | **Project:** | Special Studies |
| **Receive Date:** | 02 Dec-13 09:00 | **Source:** | Client Supplied | | |
| **Sample Age:** | 4d 2h | **Station:** | In House WAF | | |

**Sample Note:** MC M10

| Data Transform | Zeta | Alt Hyp | Monte Carlo | NOEL | LOEL | TOEL | TU | PMSD |
|---|---|---|---|---|---|---|---|---|
| Angular (Corrected) | 0 | C > T | Not Run | 1.56 | 6.25 | 3.1 | 64 | 6.7% |

**Bonferroni Adj t Test**

| Control | vs | Conc-% | Test Stat | Critical | MSD | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|---|
| SW Control | | 0.1 | 0.36 | 2.4 | 0.072 | 1.0000 | Non-Significant Effect |
| | | 0.39 | -1.9 | 2.4 | 0.072 | 1.0000 | Non-Significant Effect |
| | | 1.56 | 0.85 | 2.4 | 0.072 | 0.8100 | Non-Significant Effect |
| | | 6.25* | 34 | 2.4 | 0.072 | <0.0001 | Significant Effect |

**Auxiliary Tests**

| Attribute | Test | Test Stat | Critical | P-Value | Decision |
|---|---|---|---|---|---|
| Extreme Value | Grubbs Single Outlier | 1.8 | 2.9 | 1.0000 | No Outliers Detected |

**ANOVA Table**

| Source | Sum Squares | Mean Square | DF | F Stat | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|
| Between | 4.483107 | 1.120777 | 4 | 360 | <0.0001 | Significant Effect |
| Error | 0.07684111 | 0.003073644 | 25 | | | |
| Total | 4.559947 | 1.12385 | 29 | | | |

**ANOVA Assumptions**

| Attribute | Test | Test Stat | Critical | P-Value | Decision(1%) |
|---|---|---|---|---|---|
| Variances | Bartlett Equality of Variance | 2.3 | 13 | 0.6829 | Equal Variances |
| Distribution | Shapiro-Wilk Normality | 0.96 | | 0.2566 | Normal Distribution |

**Proportion Normal Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | SW Control | 10 | 0.83 | 0.82 | 0.85 | 0.79 | 0.88 | 0.0058 | 0.031 | 3.7% | 0.0% |
| 0.1 | | 5 | 0.82 | 0.8 | 0.85 | 0.75 | 0.88 | 0.011 | 0.057 | 6.9% | 1.2% |
| 0.39 | | 5 | 0.87 | 0.86 | 0.89 | 0.83 | 0.93 | 0.0076 | 0.042 | 4.8% | -4.6% |
| 1.56 | | 5 | 0.81 | 0.8 | 0.83 | 0.76 | 0.87 | 0.0078 | 0.042 | 5.2% | 2.4% |
| 6.25 | | 5 | 0.016 | 0.012 | 0.02 | 0 | 0.03 | 0.0021 | 0.011 | 71.0% | 98.0% |

In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

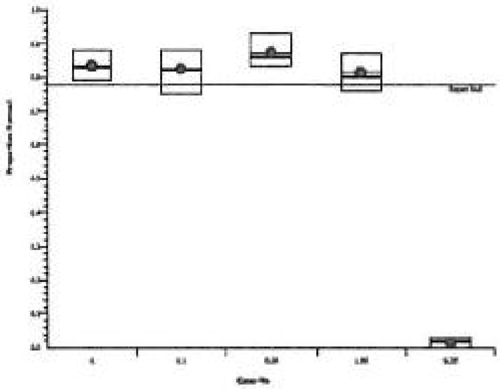
Trimmed Spearman-Kärber Estimates

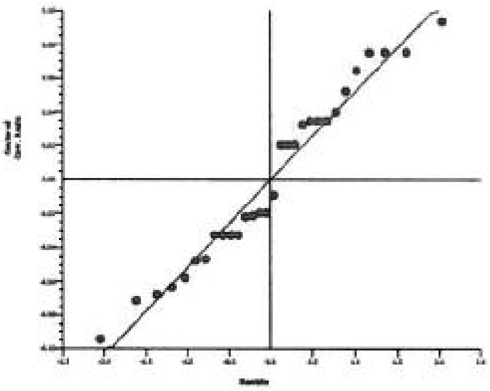
| Threshold Option | Threshold | Trim | Mu | Sigma | EC50 | 95% LCL | 95% UCL |
|---|---|---|---|---|---|---|---|
| Control Threshold | 0.17 | 1.90% | 0.49 | 0.0062 | 3.1 | 3 | 3.2 |

Proportion Normal Detail

| Conc-% | Control Type | Rep 1 | Rep 2 | Rep 3 | Rep 4 | Rep 5 | Rep 6 | Rep 7 | Rep 8 | Rep 9 | Rep 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | SW Control | 0.81 | 0.86 | 0.85 | 0.88 | 0.79 | 0.86 | 0.81 | 0.81 | 0.81 | 0.86 |
| 0.1 | | 0.88 | 0.82 | 0.79 | 0.75 | 0.88 | | | | | |
| 0.39 | | 0.84 | 0.83 | 0.9 | 0.86 | 0.93 | | | | | |
| 1.56 | | 0.8 | 0.76 | 0.8 | 0.87 | 0.84 | | | | | |
| 6.25 | | 0.02 | 0 | 0.02 | 0.03 | 0.01 | | | | | |

Graphics





In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

Taihoro Nukurangi

**CETIS Analytical Report**

Report Date: 07 Jan-14 14:22 (p 1 of 2)
Test Code: 00-8937-4136/2558/OT4 MyG

**Bivalve Larval Survival and Development Test** — **NIWA Ecotoxicology**

| | | | | | |
|---|---|---|---|---|---|
| **Analysis ID:** | 08-3112-3501 | **Endpoint:** | Proportion Normal | **CETIS Version:** | CETISv1.7.0 |
| **Analyzed:** | 07 Jan-14 14:05 | **Analysis:** | Nonparametric-Multiple Comparison | **Official Results:** | Yes |

| | | | | | |
|---|---|---|---|---|---|
| **Batch ID:** | 06-7364-3794 | **Test Type:** | Development | **Analyst:** | M Martin |
| **Start Date:** | 06 Dec-13 11:00 | **Protocol:** | NIWA (2008) | **Diluent:** | Offshore seawater |
| **Ending Date:** | 08 Dec-13 11:00 | **Species:** | Mytilus galloprovincials | **Brine:** | Not Applicable |
| **Duration:** | 48h | **Source:** | Coromandel | **Age:** | |

| | | | | | |
|---|---|---|---|---|---|
| **Sample ID:** | 13-0674-4293 | **Code:** | 2558/OT4 | **Client:** | Total Bridge Services |
| **Sample Date:** | 02 Dec-13 09:00 | **Material:** | Paint WAF | **Project:** | Special Studies |
| **Receive Date:** | 03 Dec-13 09:00 | **Source:** | Client Supplied | | |
| **Sample Age:** | 4d 2h | **Station:** | In House WAF | | |

**Sample Note:** Zinc

| Data Transform | Zeta | Alt Hyp | Monte Carlo | NOEL | LOEL | TOEL | TU | PMSD |
|---|---|---|---|---|---|---|---|---|
| Angular (Corrected) | 0 | C > T | Not Run | 0.39 | 1.56 | 0.78 | 260 | 11.0% |

**Wilcoxon/Bonferroni Adj Test**

| Control | vs | Conc-% | Test Stat | Critical | Ties | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|---|
| SW Control | | 0.1 | 56 | | 1 | 1.0000 | Non-Significant Effect |
| | | 0.39 | 55 | | 0 | 1.0000 | Non-Significant Effect |
| | | 1.56* | 10 | | 0 | 0.0040 | Significant Effect |
| | | 6.25* | 6 | | 0 | 0.0140 | Significant Effect |

**Auxiliary Tests**

| Attribute | Test | Test Stat | Critical | P-Value | Decision |
|---|---|---|---|---|---|
| Extreme Value | Grubbs Single Outlier | 3.2 | 2.9 | 0.0068 | Outlier Detected |

**ANOVA Table**

| Source | Sum Squares | Mean Square | DF | F Stat | P-Value | Decision(5%) |
|---|---|---|---|---|---|---|
| Between | 4.393018 | 1.098254 | 4 | 210 | <0.0001 | Significant Effect |
| Error | 0.1137644 | 0.005171108 | 22 | | | |
| Total | 4.506782 | 1.103426 | 26 | | | |

**ANOVA Assumptions**

| Attribute | Test | Test Stat | Critical | P-Value | Decision(1%) |
|---|---|---|---|---|---|
| Variances | Bartlett Equality of Variance | 15 | 13 | 0.0046 | Unequal Variances |
| Distribution | Shapiro-Wilk Normality | 0.9 | | 0.0128 | Normal Distribution |

**Proportion Normal Summary**

| Conc-% | Control Type | Count | Mean | 95% LCL | 95% UCL | Min | Max | Std Err | Std Dev | CV% | Diff% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | SW Control | 10 | 0.83 | 0.82 | 0.85 | 0.79 | 0.88 | 0.0058 | 0.031 | 3.7% | 0.0% |
| 0.1 | | 5 | 0.88 | 0.86 | 0.9 | 0.8 | 0.93 | 0.0094 | 0.051 | 5.7% | -5.7% |
| 0.39 | | 5 | 0.9 | 0.87 | 0.94 | 0.76 | 0.96 | 0.016 | 0.084 | 9.3% | -8.4% |
| 1.56 | | 4 | 0.21 | 0.21 | 0.21 | 0.2 | 0.22 | 0.0015 | 0.0082 | 3.9% | 75.0% |
| 6.25 | | 3 | 0.0098 | 0.0033 | 0.016 | 0 | 0.029 | 0.0032 | 0.017 | 170.0% | 99.0% |

In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 3:
## STATISTICS

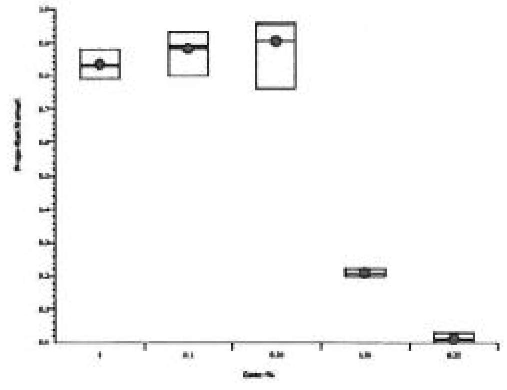
Trimmed Spearman-Kärber Estimates

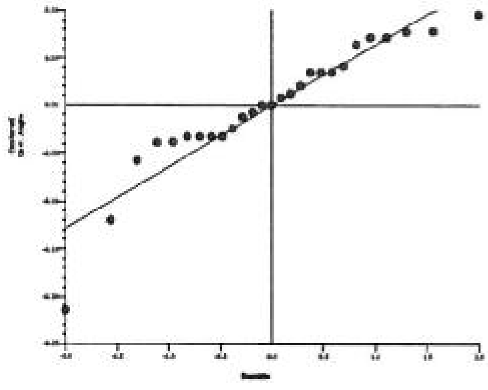
| Threshold Option | Threshold | Trim | Mu | Sigma | EC50 | 95% LCL | 95% UCL |
|---|---|---|---|---|---|---|---|
| Control Threshold | 0.17 | 1.00% | 0.037 | 0.013 | 1.1 | 1 | 1.2 |

Proportion Normal Detail

| Conc-% | Control Type | Rep 1 | Rep 2 | Rep 3 | Rep 4 | Rep 5 | Rep 6 | Rep 7 | Rep 8 | Rep 9 | Rep 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | SW Control | 0.81 | 0.86 | 0.85 | 0.88 | 0.79 | 0.86 | 0.81 | 0.81 | 0.81 | 0.86 |
| 0.1 | | 0.8 | 0.88 | 0.91 | 0.89 | 0.93 | | | | | |
| 0.39 | | 0.9 | 0.76 | 0.95 | 0.96 | 0.95 | | | | | |
| 1.56 | | 0.21 | 0.22 | 0.2 | 0.21 | | | | | | |
| 6.25 | | 0.029 | 0 | 0 | | | | | | | |

Graphics





In the following statistics appendix, the NOEL (No observable effect level) equals the NOEC (no observed effect concentration), LOEL (lowest observed effect level) equals the LOEC (lowest observed effect concentration), and TOEL (toxic effect level) equals the TEC (threshold effect concentration).

# Appendix 4:

### Chemical data at test terminations

Blue Mussels:

| Date | Day | Sample | Conc | Temp | pH | DO | Salinity |
|---|---|---|---|---|---|---|---|
| | | | % or ppm | °C | | mg/L | ppt |
| Instruments used: | | | | Trace | Orion | HACH | HACH |
| 7/12/2013 | 2 | Control | 0 | 20.0 | 8.18 | 7.0 | 35.2 |
| | | 2558/OT1 | 0.1 | 20.4 | 8.11 | 6.7 | 35.7 |
| | | MC Ferrox | 0.39 | 20.2 | 8.07 | 7.0 | 35.6 |
| | | | 1.56 | 20.2 | 8.02 | 7.1 | 35.6 |
| | | | 6.25 | 20.2 | 7.98 | 6.9 | 35.6 |
| | | | 25.0 | 20.3 | 7.96 | 7.2 | 35.7 |
| | | | 100.0 | 20.4 | 7.95 | 7.5 | 35.7 |
| 7/12/2013 | 2 | 2558/OT2 | 0.1 | 20.4 | 7.96 | 7.1 | 35.7 |
| | | Termarust 2100 | 0.39 | 20.3 | 7.97 | 6.7 | 35.5 |
| | | | 1.56 | 20.3 | 7.97 | 6.6 | 35.6 |
| | | | 6.25 | 20.3 | 7.96 | 6.5 | 35.6 |
| | | | 25.0 | 20.3 | 7.97 | 6.1 | 35.5 |
| | | | 100.0 | 20.4 | 7.89 | 6.9 | 35.6 |
| 7/12/2013 | 2 | 2558/OT3 | 0.1 | 20.6 | 7.96 | 6.4 | 35.7 |
| | | MC M10 | 0.39 | 20.5 | 7.98 | 6.4 | 35.5 |
| | | | 1.56 | 20.5 | 7.98 | 6.0 | 35.4 |
| | | | 6.25 | 20.5 | 7.97 | 5.9 | 35.5 |
| | | | 25.0 | 20.7 | 7.93 | 6.7 | 35.7 |
| | | | 100.0 | 20.7 | 7.74 | 7.2 | 35.7 |
| 7/12/2013 | 2 | 2558/OT4 | 0.1 | 20.9 | 7.86 | 6.2 | 35.7 |
| | | Zinc | 0.39 | 20.8 | 7.94 | 6.3 | 35.7 |
| | | | 1.56 | 20.7 | 7.97 | 6.0 | 35.5 |
| | | | 6.25 | 20.6 | 7.98 | 6.1 | 35.5 |
| | | | 25.0 | 20.7 | 7.97 | 5.9 | 35.6 |
| | | | 100.0 | 21.1 | 7.94 | 6.9 | 35.7 |

# Appendix 4:

## Chemical data at test terminations

Amphipods:

| Date | Day | Sample | Conc % | Temp °C | pH | DO mg/L | Salinity ppt |
|---|---|---|---|---|---|---|---|
| Instruments used: | | | | Trace | Orion | HACH | HACH |
| 9/12/2013 | 4 | Control | 0 | 19.9 | 7.73 | 7.2 | 21.6 |
| | | 2558/OT1 | 0.1 | 19.7 | 7.76 | 7.1 | 21.7 |
| | | MC Ferrox | 0.39 | 19.6 | 7.74 | 6.9 | 21.6 |
| | | | 1.56 | 19.6 | 7.72 | 6.7 | 21.5 |
| | | | 6.25 | 19.6 | 7.62 | 5.9 | 21.4 |
| | | | 25.0 | 19.6 | 7.61 | 6.3 | 21.1 |
| | | | 57.1 | 19.6 | 7.57 | 5.5 | 20.5 |
| 9/12/2013 | 4 | 2558/OT2 | 0.1 | 19.6 | 7.67 | 6.9 | 21.9 |
| | | Termarust 2100 | 0.39 | 19.6 | 7.74 | 7.1 | 21.6 |
| | | | 1.56 | 19.6 | 7.75 | 7.1 | 21.6 |
| | | | 6.25 | 19.6 | 7.76 | 7.1 | 21.4 |
| | | | 25.0 | 19.6 | 7.63 | 5.9 | 20.9 |
| | | | 57.1 | 19.6 | 7.46 | 5.3 | 20.0 |
| 9/12/2013 | 4 | 2558/OT3 | 0.1 | 19.5 | 7.67 | 6.7 | 21.7 |
| | | MC M10 | 0.39 | 19.6 | 7.76 | 7.1 | 21.5 |
| | | | 1.56 | 19.6 | 7.79 | 7.2 | 21.4 |
| | | | 6.25 | 19.6 | 7.8 | 7.2 | 21.3 |
| | | | 25.0 | 19.6 | 7.76 | 7.1 | 20.7 |
| | | | 57.1 | 19.6 | 7.63 | 6.9 | 19.7 |
| 9/12/2013 | 4 | 2558/OT4 | 0.1 | 19.5 | 7.74 | 6.9 | 21.7 |
| | | Zinc | 0.39 | 19.5 | 7.8 | 7 | 21.5 |
| | | | 1.56 | 19.5 | 7.8 | 6.9 | 21.5 |
| | | | 6.25 | 19.5 | 7.83 | 7 | 21.3 |
| | | | 25.0 | 19.5 | 7.78 | 6.1 | 20.8 |
| | | | 57.1 | 19.5 | 7.72 | 5.3 | 20.0 |

## Appendix C

## Discharges to Land – Assessment of Effects (Opus, October 2014)

| | |
|---|---|
| To | AHB Maintenance Discharge Consent Project Team |
| From | Liz Coombes, Kat McDonald (Total Bridge Services) |
| Date | 3 October 2014 |
| Subject | Assessment of Discharges to Soils |

# 1. Introduction

Discharges to land from bridge maintenance activities arise from waterblasting washwater, dry and wet abrasive blasting, and spray painting. Maintenance discharges from the Auckland Harbour Bridge (AHB) are currently authorised under Consents 38519, 38835 and 38836. These consents require the progressive introduction of a containment system to control maintenance discharges and reduce environmental impacts. In the period during 'partial containment' (containment implemented north of Pier 1 and south of Pier 5) 100% of washwater and wastewater are to be contained over land, however up to 15% of dry discharges can be discharged.

A new consent is now being sought to improve flexibility in maintenance operations and allow a range of methodologies to control discharges from maintenance works on the AHB. The aim is to achieve the same or better environmental outcomes as the current consent but without being tied into the use of specific controls such as containment.

This technical report is intended to inform the new application by assessing the potential and/or actual effects of discharges to land from maintenance activities on the AHB. This report:

- Sets the level of effects and discharges allowed under the current consents;
- Sets out the proposed management approach for discharges from areas of the AHB over the land;
- Identifies methods for enabling this management approach; and
- Assesses effects of this approach and the Permitted Activity criteria.

# 2. Existing Environment

## 2.1 Location, site characteristics/values

The AHB spans the Waitemata Harbour with the southern abutment adjacent to the Westhaven Marina and the northern abutment located within the residential area of Stokes Point, Northcote. The land areas adjacent to the northern and southern abutments of the bridge are both highly modified environments.

Northcote Point is a residential area with a number of dwellings located adjacent to the northern end of the AHB. The Stokes Point-Te Onewa Reserve is also located at the northern end of the AHB. The Reserve is characterised by cliffs along the northern boundary of the bridge comprising inter-bedded thick sandstone and thin siltstone layers of the East Coast Bays Formation (part of the Waitemata Group).

At the southern end of the bridge, the majority of the land was reclaimed during the construction of the bridge, and as such is likely to be predominantly composed of fill. At this end of the bridge much of the site is paved, with the exception of a grassed area to the southwest of the end of the bridge along the edge of Curran Street, and some landscaped areas between SH1 and Westhaven Drive to the southeast of the bridge. There are a number of commercial facilities in this area including a cafe, a retail outlet (for marine products) and a yacht club. Members of the public have access to walkways and cycle paths along Westhaven Drive and the area to the east of the southern abutment is also used by local fishermen.

The historic use of the land at either end of the AHB is likely to have affected the quality of the soils in these areas. Sources such as fill imported onto site during construction of the AHB, traffic exhaust deposition, historic bridge maintenance activities, and other historic uses may have contributed contaminants to the soils at the site.

## 2.2 Bridge Structure

The AHB is considered the most strategically important bridge in New Zealand and is recognised as nationally significant infrastructure. The bridge also plays an important role in the growth and development of Auckland as it is the main conduit between Auckland, North Shore, and beyond.

The AHB is made of different structural components which are shown on Figure 2.1. The landward components of the bridge consist of three viaducts, namely the South Steel Viaduct, North Steel Viaduct and North Concrete Viaduct.

The current paint system on the bridge is a zinc rich moisture-cured urethane. Historical paint coatings include zinc phosphate, zinc chromate and a lead primer paint, which has not been used on the bridge since the very limited applications in 1959.

## 2.3 Current Consented Activity

Maintenance of the AHB involves cleaning and repainting of the structure. Washing and waterblasting are used to clean the bridge, then sections of the bridge that require repainting are prepared by dry abrasive blasting or wet abrasive blasting prior to repainting. Currently these activities are undertaken in accordance with discharge consents: 38519, 38836 and 38835.

Over land areas, washwater from waterblasting and wastewater from wet abrasive blasting are currently contained and collected for disposal (refer to Figure 2.2 for example); dry abrasive blasting is currently only carried out over land within an enclosed containment system. Paint application over land is currently managed to minimise discharges to soils; this is achieved by undertaking painting by hand or spray painting within an enclosed containment system.

Additional controls are used to manage discharges to air from paint overspray which can potentially settle out to soils if not managed appropriately. Restrictions are in place for works on the landward side of Piers 1 and 5, when the wind direction is blowing towards land, and wind speed restrictions apply to works in any area of the bridge. These controls prevent airborne discharges drifting onto land during maintenance works (see air discharges technical report for further details of these controls).

Southern Northern

**Figure 2.1:** Structural Components of Bridge

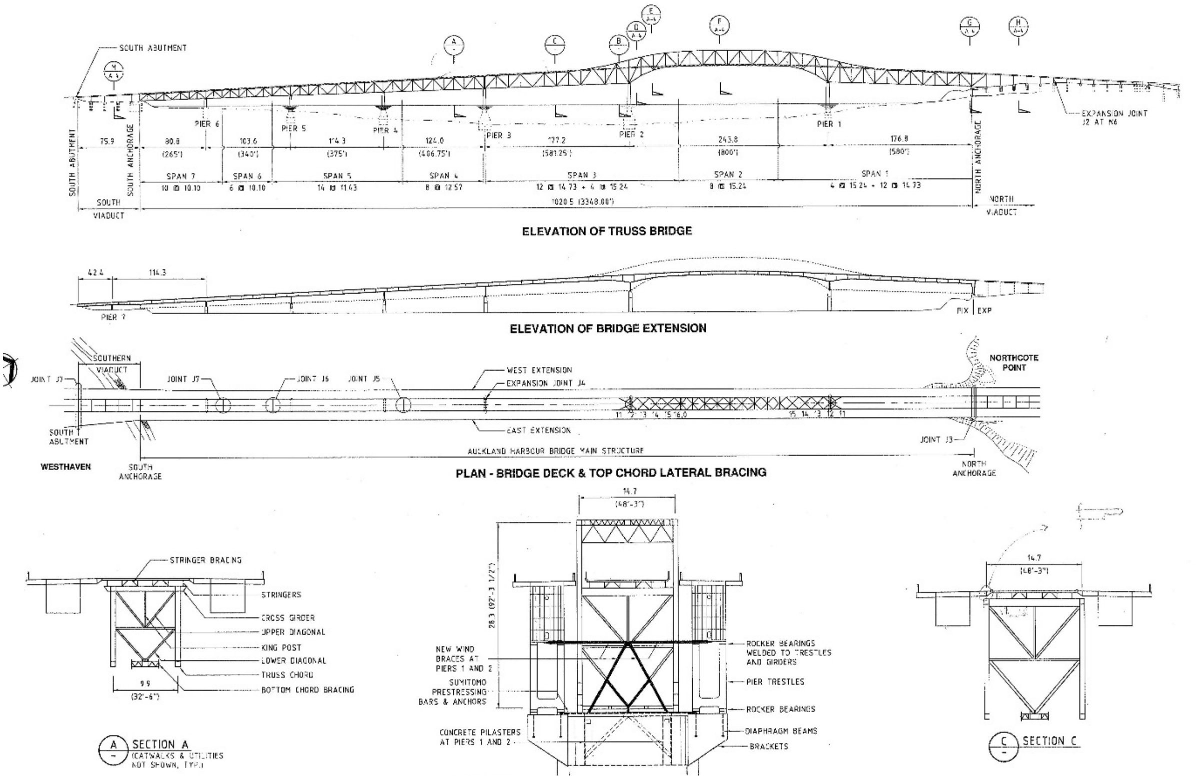



**Figure 2.2:** Containment system over Stokes Point to collect wet abrasive blasting wastewater

# 3. Proposed Activity: Adaptive Management Approach

New resource consents are being sought for AHB maintenance discharges which will allow greater flexibility in the management of maintenance discharges while still ensuring the same or better environmental outcomes as under the current consents. The new consents propose an adaptive management approach that will allow the bridge maintenance contractors to test new solutions and adapt maintenance methods or products over time to incorporate new innovations and improve environmental outcomes.

While containment is likely to continue to be used as a key environmental control for managing maintenance discharges to soils, the proposed adaptive management approach would allow for new products or methodologies to be introduced if they can be shown to achieve the same or better environmental performance as the currently used products and methods.

It is proposed that maintenance discharges from spray paint application over land will be managed to ensure that any discharge to land and associated effects are negligible, while discharges from waterblasting and wet abrasive blasting over land will be managed to ensure that they comply with the Permitted Activity requirements of relevant planning documents.

## 3.1 Example Operational Methodologies

The following are examples of methodologies that could be implemented to manage discharges to soils from waterblasting, abrasive blasting, and paint application. It should be noted however, that other methodologies not listed here might be used in the future to control discharges from these activities.

- **Waterblasting:** Washwater from waterblasting over land will be discharged to the harbour (via the stormwater system) as a Permitted Activity under the relevant planning documents (see technical memo: *Contaminants in Waterblasting Washwater* for further details). The contaminants in the washwater will be minimised as far as practicable by filtering out particulate matter through a geotextile fabric prior to discharge.
- **Abrasive Blasting:** Wet abrasive blasting will be carried out over land instead of dry abrasive blasting, because wet abrasive blasting discharges are easier to control; dry abrasive blasting will no longer be carried out over land. Wastewater from wet abrasive blasting will be contained (see Figure 2.2) and disposed of off-site at an appropriate facility. Hand preparation with power tools such as a sanding disk or a bristle blaster may be used for very small areas of work, (less than 1% of the surface area of the bridge), which can be effectively managed to avoid discharges of dust to land and therefore can comply with the relevant Permitted Activity requirements in planning documents.
- **Paint application:** will either be carried out within an enclosed containment system, or applied by hand to avoid overspray. Spray paint discharges are addressed further in the air discharges technical report.

## 3.2 Adaptive Management Framework

The Adaptive Management Framework (AMF) will be used to enable changes and improvements to the products or methodologies used for bridge maintenance. If new paint products or maintenance methods are proposed in the future, they will be assessed using the AMF to ensure there will be no increase in environmental effects and that the same or better environmental outcomes can be achieved as through using current products/ methods.

For discharges of washwater and/or wet abrasive blasting wastewater, if the methods used to control discharges change in the future, any new methods will be assessed under the AMF to confirm that discharges continue to meet relevant Permitted Activity rule requirements. Any new paint products or product application methods will be assessed to ensure any potential discharge is negligible.

The adaptive management process to assess a new product or method under this framework in relation to its potential discharge to land is given in Appendix A. An example of how this process might be applied to test a new product with respect to discharges to land is given below.

**Example:**

'Termarust' is a new encapsulating coating system for some of the bridge structures over land. This new system will encapsulate existing and historic layers of paint reducing the need for abrasive blasting surface preparation (only water blasting is required), however it cannot be used on parts of the bridge that are accessible to the public due to its low resistance to abrasion and long curing time.

An example of the steps taken to assess this new product under the adaptive management framework is given below.

| Termarust Example: Assessment under adaptive management process | |
|---|---|
| 1. **Is product/ method substantially the same as existing product/ method?** (E.g. new brand of the same type of coating system)<br>• *If 'Yes', product/ method can be used under current operational documents (further assessment not required - proceed to Step 5.*<br>• *If 'No' proceed to Step 2.* | No, Termarust has a different composition to all currently consented products. |
| 2. **Does product/ method disperse contaminants into the air that could deposit onto land? (such as spray application of paint)**<br>• *If 'Yes' proceed to Step 4.*<br>• *If 'No' proceed to Step 3.* | Yes, Termarust can only be applied by spray application. |
| 3. **Can the product/ method be used as Permitted Activity under the relevant council plans?**<br>• *If 'Yes' proceed to Step 5.*<br>• *If 'No' then resource consent is required before the product/ method can be used.* | n/a |
| 4. **Can the discharge be controlled or contained to ensure the discharge to land and any effects are negligible?**<br>• *If 'Yes' proceed to Step 5.*<br>• *If 'No' then resource consent is required before the product/ method can be used.* | Yes, current containment of spray paint overspray to achieve a negligible discharge will be similarly effective for Termarust overspray. |
| 5. **New product/ method approved for use, update operational documents** | Application of Termarust to be added to operational documents (no additional controls are required). |

## 3.3 Mitigation

Discharges to soils will be controlled through the Environmental Management Plan (EMP). The EMP will set out roles and responsibilities of AHB staff and ensure that maintenance works cause no nuisance or harm to the general public or environment. At the current time, the main mechanisms for ensuring that maintenance discharges to land are minimised as far as is practicable include:

- Spray paint encapsulated containment systems
- Containment systems to capture washwater/ wastewater discharges over land
- Hand application of paints to avoid overspray
- Hand surface preparation methods to reduce dust discharges
- Using wet abrasive blasting instead of dry abrasive blasting over land to avoid dust discharges.

Other mitigation controls may be adopted if approved under the AMF (as described in Section 3.2).

# 4. Assessment of Environmental Effects

As discussed above, discharges to land from bridge maintenance activities may arise from waterblasting, wet abrasive blasting, and spray paint application. It is proposed that discharges from waterblasting and wet abrasive blasting over land will be managed to comply with the Permitted Activity requirements under the relevant planning documents, and discharges from paint application over land will be managed to ensure that any discharge to land and associated effects are negligible.

## 4.1 Assessment against Permitted Activity Criteria

Discharges of washwater from waterblasting and wastewater from wet abrasive blasting will be managed to ensure that they comply with the relevant Permitted Activity rules and controls of the ACRP: ALW (Rule 5.5.54) and the PAUP (Rule H.4.18.1). An assessment of the potential discharges against the relevant Permitted Activity criteria is provided in the table below:

| Auckland Council Regional Plan: Air, Land and Water Rule 5.5.55 | Assessment |
|---|---|
| The activities in Rule 5.5.54 are subject to the following conditions:<br>The discharge shall be either:<br>(a) collected for reuse; or<br>(b) discharged to land so that runoff or the accumulation of contaminants does not occur;<br>(c) recycled or collected for disposal at an authorised facility; or<br>(d) discharged onto land resulting in runoff, including to any natural or man-made stormwater drainage system, where the discharge has been minimised to the greatest extent practicable, in a manner that does not give rise, after reasonable mixing, in the receiving waterbody to any or all of the following: | **Wet Abrasive Blasting Wastewater**<br>Discharges of wastewater from wet abrasive blasting over land will be contained and disposed of at an authorised facility.<br><br>**Waterblasting Washwater**<br>Discharges of washwater from waterblasting may be discharged onto land resulting in runoff to the stormwater drainage system, which discharges to the Waitemata Harbour. Prior to discharge, the contaminants in the washwater will be minimised as much as practicable by filtering through |

| | |
|---|---|
| (i) the production of any conspicuous oil or grease films, scum, foams, of floatable or suspended material;<br>(ii) any conspicuous change in the colour or visual clarity;<br>(iii) a change in the natural pH of more than 1 pH unit; or<br>(iv) any significant adverse effect on aquatic life | a geotextile to remove particulate matter. The extent of contaminants in the washwater is not expected to cause any of the effects listed in (d) (i-iv) (see technical report *Marine Ecology Assessment – Maintenance Discharges* and technical memo: *Contaminants in Waterblasting Washwater* for further details). |

| Proposed Auckland Unitary Plan Permitted Activity Controls H.4.18.2.1.1 | Assessment |
|---|---|
| **General Permitted Activity Controls**<br>1. The discharge must not, after reasonable mixing, give rise to:<br>a. the production of any conspicuous oil or grease film, scum or foam, or floatable or suspended materials; or<br>b. any conspicuous change in the colour or visual clarity; or<br>c. any emission of objectionable odour; or<br>d. the rendering of freshwater unsuitable for consumption by farm animals; or<br>e. a change the natural temperature of the receiving water by more than 3° C; or<br>f. a change in the natural pH of the water by more than 1pH unit.<br>2. The contaminant discharged must not either by itself or in combination with other contaminants after reasonable mixing exceed the greater of the 95 per cent trigger values for freshwater (groundwater) specified in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000, or the natural background level.<br>3. The discharge must not enter into any water supply catchment, Wetland, Natural Lake or Natural Stream Management Area.<br>4. The discharge must not cause erosion or scouring at the point of discharge or alter the natural course of the water body | **Wet Abrasive Blasting Wastewater**<br>Discharges of wastewater from maintenance activities over land will be contained and disposed of at an authorised facility, and so will not cause any of the described effects, and the discharge will not enter any of the listed areas.<br><br>**Waterblasting Washwater**<br>Washwater from waterblasting will be discharged onto land resulting in runoff to the stormwater drainage system, which discharges to the Waitemata Harbour.<br>1. The extent of contaminants in the washwater is not expected to cause any of the effects listed in 1. a – f (see technical report *Marine Ecology Assessment – Maintenance Discharges* and technical memo *Contaminants in Waterblasting Washwater* for further details).<br>2. Based on washwater sampling results, the contaminants are not expected to result in an exceedance of the ANZECC guidelines after reasonable mixing (see technical memo *Contaminants in Waterblasting Washwater*).<br>3. The discharges of washwater will not enter any of the types of areas listed.<br>4. The washwater will be discharged into a man-made stormwater system, and so will not cause erosion or scouring at the point of discharge or alter the natural course of a waterbody. |
| **Proposed Auckland Unitary Plan Permitted Activity Controls H.4.18.2.2.1** | **Assessment** |
| **Discharge of Wastewater or Washwater**<br>1. Discharges from the following activities must not enter any Wetland Management Area, Natural Lake Management Area or Natural Stream Management Area:<br>a. the cleaning, maintenance and preparation of surfaces of buildings, associated structures e.g. | The discharges of washwater and wastewater will not enter any of the types of areas listed. |

| | |
|---|---|
| driveways and garages bridges and other structures<br>b. installation, repair, maintenance and removal of network utility infrastructure<br>c. construction, installation, alteration, removal or upgrading of any component of the stormwater or wastewater network.<br>d. wet or dry abrasive blasting activities. | |

## 4.2 Effects of Waterblasting

The effects from the discharge of washwater from waterblasting over the land are discussed in technical report *Marine Ecology Assessment – Maintenance Discharges* and technical memo *Contaminants in Waterblasting Washwater*. Discharging the waterblasting washwater is considered unlikely to have more than a negligible environmental effect on the Waitemata Harbour. This is partially based on the recommendation that washwater discharges be managed within the key contaminant thresholds. These thresholds have been set to control the effects from all consented maintenance activities so that the total discharges of zinc and particulate to the coast do not exceed the calculated 'thresholds' that are permitted under the current maintenance discharge consents: Zinc: 223kg/annum, Particulate (garnet): 14679 kg/annum.

## 4.3 Effects of Abrasive Blasting

The effects from abrasive blasting over land are expected to be less than those that are currently consented, particularly because of the approach to comply with the permitted activity standards for abrasive blasting over land. To achieve this, wet abrasive blasting will predominantly be used, and some limited surface preparation using hand tools (as described in Section 3.1). Wet abrasive blasting (which uses water to blast the abrasive agent onto the surface) and hand preparation methods significantly reduce dust generation, and mean that the discharges from these activities can be managed much more effectively. The move away from dry abrasive blasting to wet abrasive blasting over land will allow more of the discharge to be captured and disposed of appropriately rather than discharging to the soils.

## 4.4 Effects of Spray Painting

The current consent allows for the discharge of up to 15% of overspray from spray painting, once containment is required from 30 August 2014. However, under the new consent it is proposed that discharges of spray paint will be managed so that any discharges to soils are minimised as far as practicable. A range of mitigation options will be used to ensure that the discharge to land from spray painting is reduced to a negligible amount. Because the discharge of spray paint will be negligible, effects on the environment are also expected to be negligible.

Initially mitigation may include the use of a containment system to capture as much paint overspray as practicable. Alternatively hand application of paints may be carried out where practicable to avoid overspray. The options used to control paint overspray in the future may differ, however the Adaptive Management Framework (as described in Section 3 above) will be used to ensure that any new products or methods will have the same or less effect than what is currently consented (i.e. negligible effects). An example of how the Adaptive Management Framework will be used in practice is given in Section 3.2. If the same or less effect cannot be achieved, either the new product or method will not be used, or a variation or new consent will be sought for it.

# 5. Monitoring and Reporting

Any controls implemented over land will be monitored to ensure they are effective, this will include:

1. Visual monitoring during water blasting and wet abrasive blasting to check that discharges are being contained effectively.
2. Air monitoring, where appropriate, to ensure that any system (e.g. containment) used to control discharges to air (where there is a risk that may they settle out to land) are working effectively (see Air Discharges technical report).
3. Internal audits to ensure relevant environmental procedures and processes are being followed during both surface preparation activities and paint application.

A summary of monitoring and audit results will be provided to Auckland Council through the reporting process outlined in the AMF and Environmental Management Plan (EMP). This is likely to include:

- Photographs from visual monitoring of containment systems for washwater or wet abrasive blasting wastewater;
- Summary of any air monitoring that has been carried out to verify the effectiveness of any control system;
- Evidence of internal audits.

# 6. Conclusions

It is concluded that the discharges to land from waterblasting and wet abrasive blasting on the AHB can be undertaken as Permitted Activities under the ACRP: ALW and PAUP. The discharge from paint application can be managed to ensure that the discharge and any consequential effects are negligible.

# Appendix A

## Adaptation Process for Work over Land

| Step | Tasks |
|---|---|
| 1. **Is product/ method substantially the same as existing product/ method?** (E.g. new brand of the same type of coating system)<br>• *If 'Yes', product/ method can be used under current operational documents (further assessment not required - proceed to Step 5.*<br>• *If 'No' proceed to Step 2.* | • Check SDS for any new contaminants<br>• Check SDS for proportion of key contaminants - are they the same as in the currently used product?<br>• Check manufacturer specification for details of application method |
| 2. **Does product/ method disperse contaminants into the air that could deposit onto land? (such as spray application of paint)**<br>• *If 'Yes' proceed to Step 4.*<br>• *If 'No' proceed to Step 3.* | |
| 3. **Can the product/ method be used as Permitted Activity under the relevant council plans?**<br>• *If 'Yes' proceed to Step 5.*<br>• *If 'No' then resource consent is required before the product/ method can be used.* | • Check product and method against the Auckland Council Regional Plan: Air Land and Water and Proposed Auckland Unitary Plan rules to determine if it can meet the PA requirements.<br>• Determine whether any new controls are needed to meet PA requirements. |
| 4. **Can the discharge be controlled or contained to ensure the discharge to land and any effects are negligible?**<br>• *If 'Yes' proceed to Step 5.*<br>• *If 'No' then resource consent is required before the product/ method can be used.* | • Determine whether any new controls are needed to ensure the discharge is negligible. |
| 5. **New product/ method approved for use, update operational documents.** | • Add new controls to EMP<br>• Add new product/ method into operational model |

## Appendix D

## Air Quality Assessment (Air Matters Ltd, September 2014)

# ASSESSMENT OF DISCHARGES TO AIR

# FROM AUCKLAND HARBOUR BRIDGE MAINTENANCE

REPORT NUMBER: 14502

18/09/2014

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Report prepared for Auckland Harbour Bridge Alliance by Air Matters Limited

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| | |
|---|---|
| Air Matters Report: | 14502 |
| Date: | 21/05/2014 |
| Status: | DRAFT 1 |
| Air Matters Report: | 14502 |
| Date: | 12/06/2014 |
| Status: | DRAFT 2 |
| Air Matters Report: | 14502 |
| Date: | 07/08/2014 |
| Status: | DRAFT 3 |
| Air Matters Report: | 14502 |
| Date: | 17/08/2014 |
| Status: | DRAFT 4 |
| Air Matters Report: | 14502 |
| Date: | 03/09/2014 |
| Status: | DRAFT 5 |
| Air Matters Report: | 14502 |
| Date: | 18/09/2014 |
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# 1. SCOPE

This technical report is designed to support the resource consent applications relating to the maintenance of the Auckland Harbour Bridge (AHB). The report will;

1) Describe the existing environment by assessing the discharges to air authorised under consented maintenance practices in the pre containment phase.
2) Develop acceptable threshold values for air discharges that will result from maintenance activities.
3) Outline methodologies and mitigation specific to air quality to be used for achieving and monitoring threshold compliance along with assessing future changes to maintenance activities (methodology or products) in accordance with the proposed Adaptive Management Framework (AMF).

# 2. INTRODUCTION

## 2.1 NEW ZEALAND TRANSPORT AGENCY – AUCKLAND HARBOUR BRIDGE

The New Zealand Transport Agency (NZTA) has a statutory responsibility under the Land Transport Management Act 2003 to manage state highways. The AHB is part of the State Highway network and is strategically important. The safe operation of the AHB requires a comprehensive maintenance programme for all components of the structure.

Key maintenance activities that contribute to air discharges primarily involve cleaning/surface preparation and repainting of the structure. This technical report will focus on the effects of dry abrasive blasting (DAB), spray painting and stripe coating (hand painting). Wet abrasive blasting is noted in the report but not assessed as discharges to air are a Permitted Activity.

Maintenance works are currently carried out under consent 38519 which includes pre-containment conditions followed by a requirement for partial containment (2014) then full containment (2021) to be in place during the course of the consent (excluding the overarch section of the AHB). Some of the air discharges would therefore have been controlled with containment. The suggested framework for moving forward with bridge maintenance is to use a variety of controls which may or may not include containment to achieve the same level or reduce discharges as would have been achieved under full containment.

Discharges of key contaminants to air will be assessed against pre-determined threshold levels that have been derived from the current maintenance permit. This will include a total annual emission for $PM_{10}$ from abrasive blasting along with other specific air quality thresholds set for acute effects both in respect to health and odour. Chronic effects are not assessed due to the intermittent nature of the maintenance activities involved.

Replacement consents are being sought based on these thresholds and an Adaptive Management Framework (AMF) which is outlined in more detail in the Assessment of Environmental Effects which is the lead document for the consent application. In essence, this framework manages (in conjunction with the Environmental Management Plan (EMP)) out the operational processes so that annual discharges of key contaminants remain within the thresholds and it sets out monitoring and reporting processes to demonstrate compliance. It also includes an adaptive process for new products or methods and the effects of their discharge to be assessed. Before a product or methodology can be used, the effects must be shown to be no worse and met the prescribed thresholds. The process can be applied to currently used products or methods and may also be used in the future to assess new products and/or maintenance methodologies.

This document will review the products and methodologies currently used and provide a basis for ongoing assessment during the term of consent using the proposed AMF for any products or new methods that may be used.

## 2.2 REASONS FOR CONSENT

AHB maintenance requires resource consent under Section 15 of the Resource Management Act 1991 (RMA). This document outlines the current consent and the supports the applications for a new resource consent in relation to air discharges under the following Auckland Council plan statutory provisions:

*Table 1: Auckland Council Regional Plan: Air Land and Water Plan (Operative 30 September 2013)*

<table>
<tr><th colspan="2">Air, Land and Water Plan Rule and Project Relevance</th><th>Status</th></tr>
<tr><td rowspan="2">Discharge to Air (Chapter 4)</td><td>Rule 4.5.1: Unless provided for otherwise in this plan, activities that discharge contaminants into air are Permitted Activities, subject to the following conditions:<br>(a) That beyond the boundary of the premises where the activity is being undertaken there shall be no noxious, dangerous, offensive or objectionable odour, dust, particulate, smoke or ash; and<br>(b) That there shall be no noxious, dangerous, offensive or objectionable visible emissions; and<br>(c) That beyond the boundary of the premises where the activity is being undertaken there shall be no discharge into air of hazardous air pollutants that does, or is likely to, cause adverse effects on human health, ecosystems or property; and<br>This Rule is relevant to the following phases of the maintenance work:<br>• Wet Abrasive Blasting (assessment covered in technical reports for discharges to land and the coastal marine environment)<br>• Stripe coating</td><td>Permitted</td></tr>
<tr><td>4.5.61 The discharge of contaminants into air from any dry abrasive, vacuum or sweep blasting process that uses abrasive material for blasting containing no more than 5 per cent dry weight free silica that does not comply with Rule 4.5.52, Rule 4.5.53 or Rule 4.5.54 is a Restricted Discretionary Activity.<br>This Rule is relevant to the following phases of the maintenance work:<br>• Dry Abrasive Blasting<br><br>Rules 4.5.52, 4.5.53 and 4.5.54 are detailed below:<br>4.5.52 The discharge of contaminants into air from dry abrasive blasting within a permanent facility (abrasive blasting booth) that uses abrasive material for blasting containing less than 5 % dry weight free silica is a Permitted Activity, subject to the following conditions:<br>(a) Conditions (a) to (c) of Rule 4.5.1; and<br>(b) Before discharge to atmosphere, all emissions from the abrasive blasting booth shall pass through a fabric filter or dry filtration system capable of achieving a discharge rate for particulate of 30 milligrams per cubic metre, corrected to 0 degrees Celsius, 1 atmosphere pressure and a dry gas basis; and</td><td>Restricted Discretionary</td></tr>
</table>

| | | |
|---|---|---|
| | *(c) A differential pressure gauge shall be installed across the fabric filter and the processing monitoring equipment shall be fitted with audible alarms; and*<br>*(d) The control equipment shall be certified by an independent chartered professional engineer to demonstrate that the control equipment is adequate to meet the criteria specified in (b) and(c) above; and*<br>*(e) All work areas and surrounding areas shall be kept clean and substantially free of accumulations of deposited blasting material and other debris; and*<br>*(f) Abrasive material used for the blasting shall contain less than 2 % by dry weight dust able to pass a 0.15 mm sieve.*<br><br>***4.5.53*** *The discharge of contaminants to air from vacuum blasting that uses abrasive material for blasting containing less than 5% dry weight free silica is a Permitted Activity, subject to the following conditions:*<br>*(a) Conditions (a) to (c) of Rule 4.5.1; and*<br>*(b) Material collected by the vacuum device shall pass through a fabric filter or other collection system capable of achieving a non-visible discharge; and*<br>*(c) All work areas and surrounding areas shall be kept clean and substantially free of accumulations of deposited abrasive blasting material and other debris.*<br><br>***4.5.54*** *The discharge of contaminants to air from sweep blasting that uses abrasive material for blasting containing less than 5% dry weight free silica is a Permitted Activity, subject to the following conditions:*<br>*(a) Conditions (a) to (c) of Rule 4.5.1; and*<br>*(b) All work areas and surrounding areas shall be kept clean and substantially free of accumulations of deposited abrasive blasting material and other debris.* | |
| | **Rule 4.5.97:** The discharge of volatile organic compounds (including solvents) into air at a rate exceeding 20 kilograms per hour or 10 tonnes per year (excluding the ventilation, displacement or dispensing of *motor fuels* covered by Rules 4.5.100 to 4.5.103) is a Discretionary Activity.<br>This Rule is relevant to the following maintenance activities:<br>• Spray Painting | Discretionary |

| | | |
|---|---|---|
| | **Rule 4.5.96:** The discharge of contaminants into air from any *process* that includes the use of diisocyanates, methylene chloride or organic plasticisers at a rate exceeding a total of 100 kilograms per hour is a Discretionary Activity.<br>This Rule is relevant to the following phases of the maintenance<br>• Spray Painting | Discretionary |

*Table 2: Proposed Auckland Unitary Plan (Notified 30th September 2013)*

| **Unitary Plan Rule and Project Relevance** | | **Status** |
|---|---|---|
| Part 3 Regional and District Rules | The following controls apply to all permitted activities that discharge contaminants to air except from mobile sources. No permitted activity controls apply to mobile sources.<br><br>1. The discharge must not contain contaminants that cause, or are likely to cause, adverse effects on human health, property or the environment beyond the boundary of the premises where the activity takes place.<br>2. The discharge must not cause noxious, dangerous, offensive or objectionable odour, dust, particulate, smoke or ash beyond the boundary of the premises where the activity takes place.<br>3. There must be no, dangerous, offensive or objectionable visible emissions.<br>4. There must be no spray drift or overspray beyond the boundary of the premises where the activity takes place<br>This Rule is relevant to the following phases of the maintenance work:<br>• Wet Abrasive Blasting<br>• Stripe Coating | Permitted |
| | Blasting (dry abrasive, vacuum or sweep) using abrasive material containing less than 5 percent silica but not meeting the permitted activity controls<br>This Rule is relevant to the following phases of the maintenance work:<br>• Dry Abrasive Blasting<br>NOTE: this Rule is the same as 4.5.61 in ALWP | Restricted Discretionary |
| | Any process that discharges more than 20kg/hour or 10t/year of volatile organic compounds such as large-scale application of surface coatings or printing ink without the application of heat, excluding the ventilation, displacement or dispensing of motor fuels<br>This Rule is relevant to the following phases of the maintenance<br>• Spray Painting | Discretionary |

| | | |
|---|---|---|
| | NOTE: this Rule is the same as 4.5.97 in ALWP | |
| | Spray application of surface coatings containing diisocyanates or hazardous organic plasticisers not in a spray booth or at a domestic premises at an application rate no more than 2L/day<br>This Rule is relevant to the following phases of the maintenance<br>• Spray Painting (if more than 2L/day) | Restricted Discretionary |

# 3. EXISTING ENVIRONMENT

## 3.1 RECEIVING ENVIRONMENTS

The AHB spans the Waitemata Harbour with the majority of the Bridge being directly over the Coastal Marine Area (CMA). The northern extent of the AHB is adjacent to a residential area and above Stokes Point public reserve. The southern extent of the Bridges is to the west of Westhaven marina which includes commercial facilities such as the Sitting Duck Café and the east of an area used by local fishermen and the Bridge Climb and Bungy Jump office.

The receiving environment for discharges to air is a mixture of urban and coastal air quality management areas. These environments are currently impacted by vehicle emissions and other urban activities. It is necessary to assess the short term acute health and odour effects on these environments as well as longer term chronic effects. The proposed AMF will be used to control effects of air discharges below both acute and chronic the threshold values.

## 3.2 CURRENT SOURCES OF CONTAMINANTS

Maintenance of the AHB involves cleaning and repainting of the structure. Some sections of the bridge surface which require repainting are initially prepared by dry abrasive blasting or wet abrasive blasting followed by zinc coating and repainting. Only small sections of the bridge are prepared at a time using this technique as exposure of the bare metal to the atmosphere is to be minimised.

The dry abrasive blasting process generates particulate from both the garnet used as the abrasive agent and the paint which is removed and to a lesser extent the bridge structure itself. Historically the AHB has been coated with paint that is known to contain zinc chromate and some sections have been coated with lead based paint.

After the surface has been suitably prepared, a protective coating is applied by either hand painting (stripe coating) or spray painting. The current coating system includes Wasser MC Zinc Coating, Wasser Mio Mastic, MC Ferrox A Columbia Grey and Wasser Thinner R175.

Example sources of discharges to air and the associated activity from which it is generated in relation to AHB maintenance is outlined in Table 3 below.

*Table 3: Example discharges to air from current AHB Maintenance*

| Contaminant | Maintenance Activity | Source of Discharge |
|---|---|---|
| Particulate Matter (TSP) | Dry Abrasive Blasting | Garnet, Paint Flakes and AHB Structure |
| | Spray Painting | Paint Overspray |
| Particulate Matter ($PM_{10}$) | Dry Abrasive Blasting | Garnet, Paint Flakes and AHB Structure |
| | Spray Painting | Paint Overspray |
| Particulate Matter ($PM_{2.5}$) | Dry Abrasive Blasting | Garnet, Paint Flakes and AHB Structure |
| | Spray Painting | Paint Overspray |
| Iron | Dry Abrasive Blasting | Paint Flakes and AHB Structure |
| | Spray Painting | Paint Overspray |
| Zinc | Dry Abrasive Blasting | Paint Flakes and AHB Structure |
| | Spray Painting | Paint Overspray |
| Lead | Dry Abrasive Blasting | Paint Flakes, other Depositions (vehicle sources) |
| Chromium | Dry Abrasive Blasting | Paint Flakes |
| Volatile Organic Compounds | Spray Painting | Mixing, Cleaning, Application and Paint Overspray |
| | Stripe Painting | Mixing, Cleaning and Application |
| Isocyanates | Spray Painting | Mixing, Cleaning, Application and Paint Overspray |
| | Stripe Painting | Mixing, Cleaning and Application |

Products currently used and consented for in the maintenance of the AHB and their components are listed below in Table 4.

*Table 4: Products used for current AHB maintenance*

| | Blasting Agent | MC Zinc | Wasser Mio Mastic | MC Ferrox A Columbia Grey | Wasser Thinner R175 |
|---|---|---|---|---|---|
| Garnet Sand | √ | | | | |
| Iron oxide | | | | √ | |
| Zinc Dust | | √ | √ | | |
| Aromatic Hydrocarbon Mixture (naphtha) | | √ | √ | √ | |
| Xylene | | √ | √ | √ | √ |
| 1,2,4 trimethylbenzene | | √ | √ | | |
| Ethylbenzene | | √ | √ | √ | √ |
| Toluene | | | | | √ |
| Heptan-2-one | | | | √ | |
| Methyl isobutyl Ketone | | | | | √ |
| Methylene Diphenyl Diisocyanate (MDI) | | √ | √ | √ | |
| Total Isocyanate | | √ | √ | √ | |
| Quartz | | | √ | √ | |

The components identified in the products above are likely to be similar in other coating products that may be used over the 35 year duration sought for the discharge consent.

## 3.3 NATURE OF KEY CONTAMINANTS AND THRESHOLDS

Key contaminants discharged from the maintenance of the AHB have been assessed as recommended by the Good Practice Guide for Assessing Discharges to Air from Industry[1]. TP152[2] also provides guidance on air quality criteria, but as a national and more recent document, the Good Practice Guide for Assessing Discharges to Air from Industry takes precedent.

According to this document, assessments are to be compared to air quality criteria in the following order of priority depending on what is provided in the various documents:

1. National Environmental Standards for Air Quality (NESAQ)

[1] Ministry for the Environment, *Good Practice Guide for Assessing Discharges to Air from Industry*, 2008.
[2] Auckland Regional Council, Assessing Discharges of Contaminants into Air – Draft, 2002

2. National Ambient Air Quality Guidelines (AAQG)
3. Regional objectives (unless more stringent than above criteria). The Auckland Regional Air Quality Targets are the same as the AAQG
4. World Health Organisation Air Quality Guidelines (WHO)
5. California Office of Environmental Health Hazard Assessment Reference Exposure Levels (OEHHA acute, 8 hr and chronic) and unit risk factors
6. US EPA inhalation reference concentrations (USEPA RfC) and unit risk factors
7. Other standards and guidelines. The Texas Commission on Environmental Quality (TCEQ) Effects Screening Levels (ESL) or Ontario Ministry of the Environment Ambient Air Quality Guidelines have been used as these are recommended in TP152.

Standards/guidelines were referred to for each contaminant in turn based on the above order of priority. However, as the processes involved in the maintenance of the AHB are short term, appropriate short term guidelines have been used. For instance lead has been compared to the Ontario Ministry of the Environment half hour guideline as opposed to the Auckland Regional Air Quality Objective which is based on a 3 month rolling average.

Key contaminants and their associated thresholds are detailed in Appendix 1.
Thresholds are summarised in the Table 5 below:

*Table 5: Summary of Proposed Thresholds for Discharges to Air*

| | **Short term acute odour values** | | | **Short term acute toxicity values** | | |
|---|---|---|---|---|---|---|
| **Contaminant** | **Concentration µg.m$^{-3}$** | **Averaging period** | **Authority** | **Concentration µg.m$^{-3}$** | **Averaging period** | **Authority** |
| TSP | - | - | - | 80 | 24 hour | Ministry for the Environment |
| $PM_{10}$ | - | - | - | 50 | 24 hour | National Environmental Standard |
| | - | - | - | 31kg | Annual | AHB EMP |
| Iron | - | - | - | 50 | 1 hour | TCEQ ESL |
| Zinc | - | - | - | 20 | 1 hour | TCEQ ESL |
| Lead | - | - | - | 1.5 | 30 min | Ontario |
| Chromium | - | - | - | 3.6 | 1 hour | TCEQ ESL |
| Naphtha | 3500 | 1 hour | TCEQ ESL | 18,000 | 30 min | Ontario |

| | | | | | | |
|---|---|---|---|---|---|---|
| Xylene | 350 | 1 hour | TCEQ ESL | 22000 | 1 hour | OEHHA |
| Trimethylbenzene | No data | No data | No data | 1250 | 1 hour | TCEQ ESL |
| Toluene | 640 | 1 hour | TCEQ ESL | - | - | - |
| Ethylbenzene | 740 | 1 hour | TCEQ ESL | 1100 | 1 hour | ATSDR |
| Methyl Isobutyl ketone | 820 | 1 hour | TCEQ ESL | No data | No data | No data |
| Isopropylbenzene | 230 | 1 hour | TCEQ ESL | - | - | - |
| Isocyanate (MDI) | - | - | - | 0.5 | 1 hour | TCEQ ESL |
| Isocyanate (TDI) | - | - | - | 0.36 | 1 hour | TCEQ ESL |

## 3.4 CONTAMINANT PATHWAYS AND RECEIVING ENVIRONMENTS

- **Particulate Matter (TSP and $PM_{10}$) –** Particulate will be transported from the source and deposited on any solid surfaces or into water. The distance travelled will depend on the particle size and finer will particles remain airborne for longer periods. It is well-recognised that large particles settle out more quickly than smaller ones and Appendix 1 of the Good Practice Guide for Assessing and Managing the Environmental Effects of Dust Emissions[3] states "in a 5 m/s wind, the 100 µm particles would only be blown about 10 metres away from the source while the 10 µm particles have the potential to travel about a kilometre".
- **Iron, Zinc, Lead and Chromium –** The paint pieces removed from the bridge, which include iron, zinc, lead and chromium, would be relatively large as they have been generated via mechanical means. Therefore, it is expected that, without any controls, the discharge would deposit close to source and may be carried further in stronger winds. Refer to the paragraph above for more details on particulate transport. Metals will be deposited in the surrounding marine or terrestrial environment and the effects of these discharges are covered in other technical reports in this application.

[3] Ministry for the Environment, *Good Practice Guide for Assessing and Managing the Environmental Effects of Dust Emissions',* Ministry for the Environment, Wellington, September 2001

When spray painting using products that contain iron and zinc these elements will be discharged to air as particulate in any overspray.

- **Volatile Organic Compounds**
  - **Aromatic Hydrocarbon Mixture (Naphtha) -** According to a model of gas/particle partitioning of semivolatile organic compounds in the atmosphere, naphtha, which has a vapour pressure range of about 211 to 514 mm Hg at 25°C, is expected to exist solely as a vapour in the ambient atmosphere. Vapour-phase naphtha is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 3-4 days. The chemical is readily biodegradable and does not bioaccumulate.[4]
  - **Xylene -** According to a model of gas/particle partitioning of semivolatile organic compounds in the atmosphere, xylenes, which have vapour pressure values ranging from 6.61-8.80 mm Hg at 25°C for the individual isomers are expected to exist solely in the vapour phase in the ambient atmosphere. Vapour-phase xylenes are degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-lives for this reaction in air are estimated to be 16-28 hours. The chemical is readily biodegradable and does not bioaccumulate.[5]
  - **Trimethylbenzene -** Degradation of 1,2,4-trimethylbenzene in the atmosphere occurs by reaction with hydroxyl radicals. Reaction also occurs with ozone but very slowly (half life, 8820 days). In the atmosphere, two estimates of the half-life are approximately 6 hours and, in the presence of hydroxyl radicals, 0.5 days. The chemical is readily biodegradable and does not bioaccumulate.[6]
  - **Ethylbenzene -** According to a model of gas/particle partitioning of semivolatile organic compounds in the atmosphere, ethylbenzene, which has a vapour pressure of 9.6 mm Hg at 25°C, is expected to exist solely as a vapour. Vapour-phase ethylbenzene is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is 55 hr. The chemical is readily biodegradable and does not bioaccumulate.[7]
  - **Toluene -** According to a model of gas/particle partitioning of semivolatile organic compounds in the atmosphere, toluene, which has a vapour pressure of 28.4 mm Hg at 25°C, is expected to exist solely as a vapour in the ambient atmosphere. Vapour-phase

[4] US National Library of Medicine, *Wireless Information System for Emergency Responders,* http://webwiser.nlm.nih.gov, March 2014
[5] US National Library of Medicine, *Wireless Information System for Emergency Responders,* http://webwiser.nlm.nih.gov, March 2014
[6] Office of Pollution Prevention and Toxics, US Environmental Protection Agency, *Chemical Summary for 1,2,4-Trimethylbenzene,* August 1994
[7] US National Library of Medicine, *Wireless Information System for Emergency Responders,* http://webwiser.nlm.nih.gov, March 2014

toluene is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals, nitrate radicals and ozone molecules. The half-life for the reaction with hydroxyl radicals is estimated to be 3 days. The half-life for the nighttime reaction with nitrate radicals is estimated as 491 days). The half-life for the reaction with ozone is estimated as 27,950 days. The chemical is readily biodegradable and does not bioaccumulate.[8]

- **Heptan-2-one -** If released to air, a vapour pressure of 3.85 mm Hg at 25°C indicates 2-heptanone will exist solely as a vapour in the atmosphere. Vapour-phase 2-heptanone will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 1.4 days. It may undergo atmospheric removal by wet deposition. 2-Heptanone is not expected to undergo significant atmospheric removal by direct photolytic processes. The chemical is readily biodegradable and does not bioaccumulate.[9]
- **Methyl isobutyl ketone -** According to a model of gas/particle partitioning of semivolatile organic compounds in the atmosphere, methyl isobutyl ketone, which has a vapour pressure of 19.9 mm Hg at 25°C, is expected to exist solely as a vapour in the ambient atmosphere. Vapour-phase methyl isobutyl ketone is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 27 hours. The chemical is readily biodegradable and does not bioaccumulate.[10]
- **Isopropylbenzene (cumene) -** According to a model of gas/particle partitioning of semivolatile organic compounds in the atmosphere, cumene, which has a vapour pressure of 4.5 mm Hg at 25°C, is expected to exist solely as a vapour in the ambient atmosphere. Vapour-phase cumene is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 2.5 days. Vapour-phase cumene is also degraded in the atmosphere by reaction with ozone radicals; the half-life for this reaction in air is estimated to be 3 years. The chemical is readily biodegradable and does not bioaccumulate.[11]

- **Isocyanates –** most of the isocyanate used in the process is in the polymeric form which is not volatile. Free isocyanate vapour will react with water in the atmosphere and break down. Short term levels should remain below the threshold value.

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[8] US National Library of Medicine, *Wireless Information System for Emergency Responders,* http://webwiser.nlm.nih.gov, March 2014
[9] US National Library of Medicine, *Toxicology Data Network*, http://toxnet.nlm.nih.gov/, March 2014
[10] US National Library of Medicine, *Wireless Information System for Emergency Responders,* http://webwiser.nlm.nih.gov, March 2014
[11] US National Library of Medicine, *Wireless Information System for Emergency Responders,* http://webwiser.nlm.nih.gov, March 2014

- **Silica** - Silica in the form of respirable quartz may be transported in the environment as fine particulate and deposited at a distance far from origin (refer to paragraph on Particulate Matter above). It will eventually be deposited on the ground or into water.

## 3.5 RESOURCE CONSENT 38519

### *3.5.1 OVERVIEW*

Discharges to air associated with AHB maintenance activities are currently authorised under Resource Consent 38519 which was granted in 2010 as part of a suite of consents for maintenance activities associated with the AHB. The application was based on the concept of containment as a best practicable option to manage adverse effects of the maintenance discharges to receiving environments. The existing consent is based on the provision that containment would generally achieve an 85% reduction of discharges from the pre-containment 'existing' situation[12]. Other mitigation measures were also included in the consent to control discharges to air where sensitive receivers were in close proximity.

### *3.5.2 PRE-CONTAINMENT PHASE*

Consent 38519 does not permit any dry abrasive blasting over land and requires the amount of dry abrasive blasting out to Pier 1 and Pier 5 to be minimised prior to containment. Containment in this area was set for 2014 and full containment was set for 2021. Some sections of the AHB surface which require repainting are initially prepared by dry abrasive blasting. Under present operations, only small sections of the AHB are prepared at a time using this abrasive blasting technique and all discharges to air are released to the environment. To minimise the effects of the discharge, the applicant uses screens and undertakes work during speeds of ≤7m/s. There are additional wind direction restrictions out to Pier 1 and Pier 5 due to their proximity to land, residential properties and businesses (sensitive receptors).

Consent conditions 30-34 relate to contaminant discharges to air in the pre containment phase (2011-2014);

*Condition 30. Beyond the boundary of the site there shall be no dust or odour caused by discharges from the site, which in the opinion of an enforcement officer, is noxious, offensive or objectionable.*

*Condition 31. No discharges from any activity on site shall give rise to visible emissions, other than water vapour and clean steam, to an extent which, in the opinion of an enforcement officer, is noxious, dangerous, offensive or objectionable.*

*Condition 32. Beyond the boundary of the site, there shall be no discharges to air of any hazardous air pollutant, caused by discharges from the site, which is present at a concentration that causes, or is likely to cause adverse effects to human health, the environment or property.*

*Condition 33. No dry abrasive blasting shall be undertaken when wind speeds are greater than 7m/s, averaged over 5 minutes, or when;*

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[12] Where containment is possible which does not include the overarch section of the AHB

*a) undertaking maintenance work north of Pier 1 when the wind is blowing from the southwest or southeast quarters.*
*b) undertaking maintenance work south of Pier 5 when the wind is from the northwest quarter.*
*Condition 34. That in order to minimise the drift of blast debris and paint spray, suitable screens shall be used at all times when undertaking dry abrasive blasting and/or spray painting of the AHB and extensions north of Pier 1 and south of Pier 5.*

### *3.5.3 PARTIAL CONTAINMENT*

Partial containment commenced on the 30/08/2014 and covers the area north of Pier 1 and south of Pier 5. This containment must capture 85% of all dry discharges and spray paint generated during maintenance works.

### *3.5.4 FULL CONTAINMENT*

Full containment is set to commence by the 30 August 2021 and covers the entire bridge except the lower overarch. This containment must capture 85% of all dry discharges and spray paint generated during maintenance works.

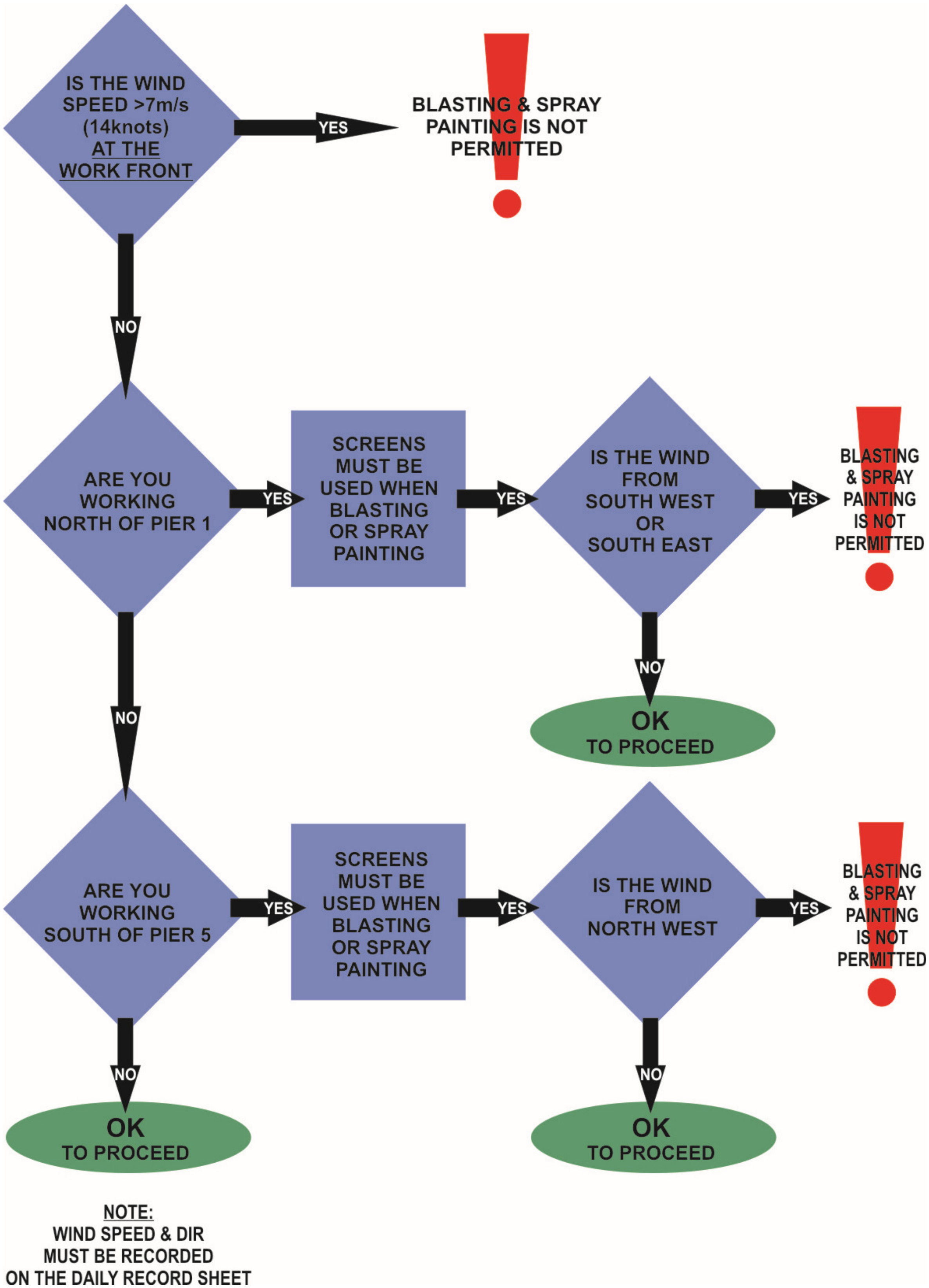
### *3.5.5 SUMMARY*

Across the staged consent, conditions or plans were required to be complied with. The purpose of these is to achieve a level of discharge to air that causes less than minor adverse environmental effects and avoid creating any adversely affected parties.

## 3.6 AUCKLAND HARBOUR BRIDGE ALLIANCE ENVIRONMENTAL MANAGEMENT PLAN

Maintenance activities carried out on the AHB are currently in the pre-containment phase. The management of environmental effects from maintenance activities on the AHB are covered under an Environmental Management Plan (EMP). This plan describes the roles and responsibilities of AHB staff and covers the current consent conditions in relation to wind speed and wind direction and other mitigation methods. The proposal for the new consent is to continue to use the EMP as a way of managing the effects from the air discharges below the proposed threshold values described above. The EMP will therefore be amended as required to achieve this. An example of the controls used in the current environment is outlined below in Diagram 1.

*Diagram 2: AHB Mitigation Measures for Dry Abrasive Blasting and Spray Painting – Pre Containment*



## 3.7 ASSESSMENT OF EFFECTS OF CURRENTLY CONSENTED REGIME

### *3.7.1 INTRODUCTION*

In order to determine the environmental effects from the discharges to air associated with maintenance activities, the NZTA and AHBA has carried out air quality monitoring. The objectives of this monitoring exercise were as follows:

1. The application pertaining to Air Discharge Consent 38519 was submitted based largely on theoretical data and minimal measured data. Monitoring data was to be used to confirm the theoretical data submitted to the Auckland Council was accurate.
2. Assess compliance with consent conditions 30-34 (refer to Section 4.1) in the pre-containment phase (2011-2014).
3. Assess the effectiveness of mitigation measured implemented during maintenance activities.
4. Frame the effects authorised by the existing consent.

Consent conditions have been put in place so that effects of discharges from maintenance operations can avoided, remedied or mitigated particularly on sensitive receptors which include the Westhaven Marina, Sitting Duck Cafe, residential properties and recreational uses of the waterfront on Curran St and around Stokes Point.

Sampling for dust, metals (specifically iron, lead, chromium and zinc), volatile organic compounds (VOC) and isocyanates was carried out during routine maintenance works. Sampling has been carried out under varying meteorological conditions to assess compliance with air discharge consent 38519, and to assess any offsite effects and to better quantify the overall impact that maintenance work is having on the environment in relation to air quality. Monitoring data was gathered at the source (or as close as practicable) of work and then at stepped downwind locations from the source. Data allowed for the quantification of contaminant concentrations and the nature of dispersion. Full copies of the reports can be found in Appendix 2 and sampling results are summarised below.

The buffer distances provided below are based on the usage at the time of testing. Other mitigating procedures may be used to reduce the concentrations below the threshold values. This will be part of the AMF going forward.

### *3.7.2 TOTAL PARTICULATE (INHALABLE)*

Monitoring results show that there is significant particulate discharge from the process of abrasive blasting. Monitoring indicates that the coarser particulate fraction measured drops out of the air within a short distance downwind.

One 24 hour total dust (Inhalable Dust) sample located at the southern compound of the AHB was below the Ministry for the Environment Dust Trigger Level for Highly Sensitive Receiving Environments when controls were in place. Sampling over this 24 hour period has indicated that the threshold can be met.

Monitoring has been carried out during spray painting in order to quantify particulate levels from overspray. Particulate levels were detected at source and 5m downwind from the source, other samples located further away did not detect any increased particulate. These results indicate that particulate discharges from overspray are localised at source when screens are used. Paint overspray is likely to have a nuisance effect on property and will be managed with screens, containment or application practice (stripe or hand painting) when close to property.

The current consent used a total overspray of 989.07Kg/year based on 6720 litres of various paint products. Based on the proposed reduction in paint use, an annual threshold of 646kg/annum will apply (based on the 2011 consent baseline). This is considered as a discharge to the coast rather than an air discharge.

### *3.7.3 PARTICULATE LESS THAN 10 MICRONS ($PM_{10}$)*

$PM_{10}$ concentrations measured at source during abrasive blasting were considered high but decrease rapidly with distance. At 10m downwind of the source, concentrations are below the proposed threshold (NES) of 50μg/$m^3$. Concentrations were affected by the meteorological conditions on the days of sampling.

Concentrations measured offsite during blasting were below the NES of 50μg/$m^3$.

Using Advanced Technology Institute Emission Factors[13] and the amount of $PM_{10}$ discharged from abrasive blasting using garnet, $PM_{10}$ emissions are estimated at approximately 0.4% of the total garnet used during abrasive blasting. Annual emissions will be calculated and managed within the AMF to ensure the total discharge of $PM_{10}$ is below the 31kg/year threshold (2011 consent baseline).

Monitoring results and applied emission factors show that there is significant particulate discharge from the process of abrasive blasting. Overall, monitoring indicates that $PM_{10}$ is unlikely to exceed the NES over a 24 hour period due to the frequency and duration of abrasive blasting activities. (Total particulate when measured over a 24 hour period was just above the NES and $PM_{10}$ will only be a fraction of this value).

$PM_{10}$ was not assessed during spray painting. Literature suggests that the $PM_{10}$ component of spray painting may be 50%[14], however, this value is not applicable to the AHB situation and as total particulate levels measured during spray painting were low, it is therefore assumed that $PM_{10}$ from overspray will be minor.

### *3.7.4 PARTICULATE LESS THAN 2.5 MICRONS ($PM_{2.5}$)*

$PM_{2.5}$ has not been measured under the current maintenance operations. $PM_{2.5}$ is more likely to be thermally generated than mechanically generated therefore detailed assessment is not required other than noting that discharges are expected to be less than minor.

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[13] Advanced Technology Institute, *Residual Risk From Abrasive Blasting Emissions: Particle Size and Metal Speciation*, December 2005

[14] Rania A. Sabty-Daily, William C. Hinds and John R. Froine, Size Distribution of Chromate Paint Aerosol Generated in a Bench-Scale Spray Booth, Annals of Occupational Hygiene, (2005) 49 (1): 33-45.

### *3.7.5 CHROMIUM*

Chromium concentrations measured at source during abrasive blasting are considered high and are influenced by the elemental makeup of surface coating being removed which appears to vary by location on the AHB. When the surface coating being removed by abrasive blasting contains a high percentage of chromium, measured concentrations of this element in the air up to 20m downwind from the blasting source have been found to exceed the threshold.

Concentrations of chromium measured offsite were below the threshold.

If no mitigation measures are implemented during abrasive blasting, an estimated buffer zone for chromium of 183m from land has been calculated from the results. At this point there is more certainty that concentrations measured on land will be below the threshold. The buffer zones can be reduced or eliminated with the implementation of mitigation measures such as wind direction controls or containment.

### *3.7.6 IRON*

Iron concentrations measured at source during abrasive blasting are considered high and are influenced by the elemental makeup of surface coating being removed which appears to vary by location on the AHB. Iron from the structure as well as the surface coating will be present in the abrasive blasting particulate. Measured concentrations of iron in the air up to 30m downwind from the blasting source have been found to exceed the threshold (for soiling).

Concentrations of iron measured offsite were below the threshold.

Where no mitigation measures are implemented, an estimated buffer zone for iron of 49m from land has been calculated from the results. At this point there is more certainty that concentrations measured on land will be below the Effects Screening Level. The buffer zones can be reduced or eliminated with the implementation of mitigation measures such as wind controls or containment.

Monitoring has been carried out during spray painting in order to quantify iron concentrations in air from overspray. The work was based on a concentration calculated from the percentage of iron in the product being sprayed. Iron concentrations were detected at source and 5m downwind from the source, other samples located further away did not detect any increased iron concentrations above the field blank. These results indicate that iron discharges from overspray are less than minor.

### *3.7.7 LEAD*

Lead concentrations measured at source during abrasive blasting are considered high and are influenced by the elemental makeup of surface coating being removed which appears to vary by location on the AHB. When the surface coating being removed by abrasive blasting contains a high percentage of lead, measured concentrations of this element in the air up to 150m downwind from the blasting source have been found to exceed the threshold.

Lead concentrations measured offsite at one downwind location were above the threshold.

Where no mitigation measures are implemented, an estimated buffer zone for lead of 343m from land has been calculated from the results. At this point there is more certainty concentrations measured on land will be below the threshold.

### *3.7.8 ZINC*

Zinc concentrations measured at source during abrasive blasting are considered high and are influenced by the elemental makeup of surface coating being removed which appears to vary by location on the AHB. When the surface coating being removed by abrasive blasting contains a high percentage of zinc, measured concentrations of this element in the air up to 30m downwind from the blasting source have been found to exceed the threshold.

Concentrations of zinc measured offsite were below the threshold.

Where no mitigation measures are implemented, an estimated buffer zone for zinc of 216m from land has been calculated from the results. At this point there is more certainty that concentrations measured on land will be below the threshold.

Monitoring has been carried out during spray painting in order to quantify zinc concentrations in air from overspray. The work was based on a concentration calculated from the percentage of zinc in the product being sprayed. Zinc concentrations were detected at source and 5m downwind from the source, other samples located further away did not detect any increased zinc concentrations above the field blank. These results indicate that zinc discharges from overspray less than minor.

### *3.7.9 VOLATILE ORGANIC COMPOUNDS*

*Stripe Coating*

Speciated VOCs measured during stripe coating were not detected in this sampling exercise.

*Spray Painting*

VOC concentrations for ethylbenzene, isopropylbenzene, 1,2,4 trimethylbenzene, 1,2,5 trimethylbenzene, toluene, xylene and methyl isobutyl ketone measured at source during spray painting exceeded their respective thresholds.

VOC concentrations measured 5-10m downwind of spray painting for ethylbenzene, isopropylbenzene, trimethylbenzene, toluene, and methyl isobutyl ketone were below the threshold.

Measured xylene concentrations up to 20m downwind from spray painting exceed the threshold. The threshold used for xylene is based on odour effects as opposed to health effects and where there are no mitigation measures implemented an estimated buffer zone for xylene (odour effects) of 152m from land has been calculated. At this point concentrations measured on land will be below the odour threshold.

### *3.7.10 ISOCYANATES*

*Stripe Coating*

No isocyanates were detected during stripe coating.

*Spray painting*

High levels of methylene bisphenyl isocyanate (MDI) were measured at source during spray painting Miomastic at a spray rate of 2.6l/hour.

However, the concentration of MDI measured 5-10m downwind was below the threshold. A buffer zone can be applied as a control to ensure that there is no isocyanate risk is associated with spray painting.

### *3.7.11 SUMMARY*

Overall, monitoring results indicate that when maintenance activities are carried out in the pre containment phase, the consent conditions (wind speed, wind direction, screens and restricted zones) are adequate to ensure that threshold levels are not exceeded at sensitive receptor sites.

However, conditions around wind direction need to be increased. The consent condition restricting abrasive blasting based on wind direction is proving effective with the exception of the sample measured offsite to the SW of the AHB during work on the 29/01/2013 where guidelines were exceeded for lead. This would contravene Condition 32 of Air Discharge Consent 38519. This consent condition focussed more on the sensitive receptors to the SE of the AHB, where all results were below relevant guidelines.

A second specific condition relates to the use of screens to prevent overspray from painting activities on the bridge when painting Pier 5 and south. Results show that compliance with consent conditions are resulting in less than minor effects at offsite locations sampled during this monitoring exercise.

Where there are no mitigation measures in place or required by consent conditions, buffer zones have been created from the monitoring results above. These buffer zones are displayed in Appendix 3.

Results are summarised below in Table 6.

*Table 6: Monitoring summary and outcomes based on currently consented activities and products used for AHB maintenance*

| **Maintenance Activity** | **Key Contaminant** | **Compliance** | **Implication** |
|---|---|---|---|
| Abrasive Blasting | Dust | One 24 hour total dust sample located at the southern compound of the AHB was below the Auckland Council Dust Trigger Level for Highly Sensitive Receiving Environments. | Threshold for dust can be met under the current regime. Buffer zones created for metals will ensure that compliance is ongoing. |
| | $PM_{10}$ | Concentrations measured offsite during blasting were below the NES of 50µg/m$^3$.<br>Using Advanced Technology Institute Emission Factors and the amount of $PM_{10}$ discharged from abrasive blasting using garnet can be estimated at approximately 0.4kg/hour. | Threshold can be met for $PM_{10}$ under the current regime.<br><br>Annual emissions under the AMF need to be under 31kg/year. This will require either a reduction in the amount of DAB, containment or the adoption of other methods to prevent the release of $PM_{10}$ to the airshed. |
| | Chromium | Concentrations of chromium measured offsite were below the Effects Screening Level. | An estimated buffer zone for chromium of 183m from land has been calculated from the results. Where works are undertaken at 183m or more from land wind direction controls are not required for chromium. At this point there is more certainty that concentrations measured on land will be below the Effects Screening Level. |
| | Iron | Concentrations of iron measured offsite were below the Effects Screening Level. | An estimated buffer zone for iron of 49m from land has been calculated from the results. Where works are undertaken at 49m or more from land wind direction controls are not required for iron. At this point there is more certainty that concentrations measured on land will be below the Effects Screening Level. |
| | Lead | Lead concentrations measured offsite at one downwind location were above the Ontario Guideline. | An estimated buffer zone for lead of 343m from land has been calculated from the results. Where works are undertaken at 343m or more from land wind direction controls are not required for lead At this point there is more certainty concentrations measured on land will be below the Ontario Guideline. |

| Maintenance Activity | Key Contaminant | Compliance | Implication |
|---|---|---|---|
| | Zinc | Concentrations of zinc measured offsite were below the Effects Screening Level. | An estimated buffer zone for zinc of 216m from land has been calculated from the results. Where works are undertaken at 216m or more from land wind direction controls are not required for zinc. At this point there is more certainty that concentrations measured on land will be below the Effects Screening Level. |
| Spray Painting | Dust | Particulate levels measured beyond 5m were negligible | Localised effects from overspray and considered on a nuisance level |
| | $PM_{10}$ | Not assessed in this exercise but emission factors indicate that levels will be minor | No restrictions around $PM_{10}$ from spray painting |
| | VOCs | VOC concentrations measured 5-10m downwind of spray painting for ethylbenzene, isopropylbenzene, trimethylbenzene, toluene, and methyl isobutyl ketone are below the Effects Screening Levels. Measured xylene concentrations up to 20m downwind from spray painting exceed the ESL. The ESL for xylene is based on odour effects as opposed to health effects. | An estimated buffer zone for xylene (odour effects) of 152m from land has been calculated. Where works are undertaken at 152m or more from land wind direction controls are not required for xylene. At this point concentrations measured on land will be below the Effects Screening Level for odour. |
| | Isocyanates | The concentration of MDI measured 5-10m downwind was below the ESL | Any buffer zone implemented for xylene will suitably reduce any isocyanate risk associated with spray painting |
| Stripe Coating | VOCs | Not detected during sampling | No restrictions around stripe coating |
| | Isocyanates | Not detected during sampling | No restrictions around stripe coating |

# 4. ASSESSMENT OF EFFECTS OF FUTURE REGIME

## 4.1 THRESHOLDS

Monitoring work of maintenance activities carried out under the pre-containment conditions was compared to thresholds for key contaminants. These threshold values have been developed from a number of air quality criteria, with precedence given to regulatory requirements, averaging times and applications as outlined in the Good Practice Guide for Assessing Discharges to Air published by MfE in 2008. The mass emission threshold for $PM_{10}$ is based on the post containment condition in the current consent that requires an 85% reduction in dry abrasive blasting emissions post containment. Thresholds for new contaminants identified with the introduction of new products/methodologies will be developed using a similar procedure. . The current thresholds are outlined below in Table 7.

*Table 7: Summary of Thresholds for Discharges to Air*

| | Short term acute odour values | | | Short term acute toxicity values | | |
|---|---|---|---|---|---|---|
| **Contaminant** | **Concentration µg.m-3** | **Averaging period** | **Authority** | **Concentration µg.m-3** | **Averaging period** | **Authority** |
| TSP | - | - | - | 80 | 24 hour | Ministry for the Environment |
| $PM_{10}$ | - | - | - | 50 | 24 hour | National Environmental Standard |
| | - | - | - | 31kg[1] | Annual | AHB EMP |
| Iron | - | - | - | 50 | 1 hour | TCEQ ESL |
| Zinc | - | - | - | 20 | 1 hour | TCEQ ESL |
| Lead | - | - | - | 1.5 | 30 min | Ontario |
| Chromium | - | - | - | 3.6 | 1 hour | TCEQ ESL |
| Naphtha | 3500 | 1 hour | TCEQ ESL | 18,000 | 30 min | Ontario |
| Xylene | 350 | 1 hour | TCEQ ESL | 22000 | 1 hour | OEHHA |
| Trimethylbenzene | No data | No data | No data | 1250 | 1 hour | TCEQ ESL |

| | | | | | | |
|---|---|---|---|---|---|---|
| Toluene | 640 | 1 hour | TCEQ ESL | - | - | - |
| Ethylbenzene | 740 | 1 hour | TCEQ ESL | 1100 | 1 hour | ATSDR |
| Methyl Isobutyl ketone | 820 | 1 hour | TCEQ ESL | No data | No data | No data |
| Isopropylbenzene | 230 | 1 hour | TCEQ ESL | - | - | - |
| Isocyanate (MDI) | - | - | - | 0.5 | 1 hour | TCEQ ESL |
| Isocyanate (TDI) | - | - | - | 0.36 | 1 hour | TCEQ ESL |

[1] Based on an 85% reduction of $PM_{10}$ emissions to atmosphere from pre-containment

The setting of these thresholds has been designed so that the effects of discharges to air will be the same as would be achieved by full containment (less than minor). Monitoring work undertaken in 2013 during the pre-contaminant phase has shown that these thresholds can be met provided additional controls are implemented such as wind speed and wind direction restrictions and the use of screens. In the future, buffer zones and other mitigation measures may be required to meet these thresholds which will be tested and implemented through the EMP.

## 4.2 ADAPTIVE MANAGEMENT FRAMEWORK & AIR QUALITY

### *4.2.1 INITIAL RECOMMENDATIONS*

Monitoring has resulted in the following recommendations which will need to be implemented by AHBA via the EMP and operational practises in order to meet the above thresholds. Recommendations which should be implemented are summarised below in Table 8.

*Table 8: Controls to be used to meet threshold values for air discharges*

| Maintenance Activity | Key Contaminant | Recommendation |
|---|---|---|
| Abrasive Blasting | Dust | Threshold can be met through buffer zones implemented for metals (chromium, iron, lead and zinc) via the EMP. |
| | $PM_{10}$ | Include annual emission reporting of mass emission of $PM_{10}$.<br>All future methods and products must comply with the annual emission threshold of 31kg/yr. This will require either a reduction in the amount of DAB, containment or the adoption of methods which do not generate $PM_{10}$. |
| | Chromium | Implement buffer zone through EMP;<br>Wind direction controls or other forms of containment are required when working less that 183m from land at either end of the bridge. |
| | Iron | Implement buffer zone through EMP; |

| Maintenance Activity | Key Contaminant | Recommendation |
|---|---|---|
| | | Wind direction controls or other forms of containment are required when working less that 49m from land at either end of the bridge. |
| | Lead | Implement buffer zone through EMP;<br>Wind direction controls or other forms of containment are required when working less that 343m from land at either end of the bridge. |
| | Zinc | Implement buffer zone through EMP;<br>Wind direction controls or other forms of containment are required when working less that 216m from land at either end of the bridge. |
| Spray Painting | Dust | Continue to use screens when spray painting. |
| | $PM_{10}$ | Minimised with overall control methods. |
| | VOCs | Implement buffer zone through EMP;<br>Wind direction controls or other forms of containment are required when working less that 152m from land at either end of the bridge. |
| | Isocyanates | Minimised with buffer zone for VOCs. |
| Stripe Coating | VOCs | None. |
| | Isocyanates | None. |

Buffer zones for inclusion in the EMP can be viewed in Appendix 3. It is recommended that these buffer zones are not specified as consent conditions but instead they are generated under the AMF and implemented through the EMP. This is because these buffer distances are based on initial monitoring and are likely to be conservative. If further testing is commissioned that can refine the buffer zones or new products or methods are used that enable a reduced buffer zone and still meet the thresholds, under the AMF the ability to do so via the EMP is more appropriate than a change to consent conditions.

If these recommendations are implemented then the effects of discharges to air from AHB maintenance based on current practices methods and products will be less than minor.

### *4.2.2 AMF AND BUFFER ZONES*

Under the AMF, current products and maintenance methodologies along with future products and new maintenance methodologies can be assessed and used in bridge maintenance without the need to apply for a new consent or a variation to the current consent. Under the currently consented maintenance activities (dry abrasive blasting and painting), discharges to air are required to be controlled by the use of buffer zones, wind speed, wind direction (when working above the CMA) so that there are no more than minor effects on sensitive receptors. These controls have been calculated from the monitoring carried out which is detailed in Section 3 of this report. These proposed mitigation procedures are more effective in protecting sensitive receptors than the conditions currently imposed by air discharge consent 38519 (detailed in Section 3.5 of this report). These controls shall be implemented through the EMP and will likely be;

BUFFER ZONE FOR DRY ABRASIVE BLASTING

There are two key Buffer Zones that will be implemented

BZ-1 = 343m from land (lead based)

BZ-2 = 216m from land (metals based - zinc)

It is proposed that on granting of consent the EMP be updated so that from an operational point of view it will work as follows:

- DAB cannot be undertaken on the AHB when the wind speed is >7m/s.
- When working on the AHB within 343m of land (at either the north or south end) then operations are being undertaken within BZ-1. This is a lead based Buffer Zone. If it can be confirmed that historic lead based coatings are not present in the paint that is to be removed from the structure the DAB activities can be carried out without mitigation. If there is lead in the historic coating or it cannot be proven otherwise then DAB cannot be undertaken when the wind is from the seaward quarter (i.e. from the northern quarter when working on the southern end of the AHB (and vice versa for the northern end) without suitable mitigation (most likely containment).
- If working within 216m from land (at either the north or south end) then operations are being undertaken within BZ-2. This is ma metals based Buffer Zone (based on zinc). DAB cannot be undertaken when the wind is from the seaward quarter (i.e. from the northern quarter when working on the southern end of the AHB and vice versa for the northern end) without suitable mitigation (most likely containment).

BUFFER ZONE FOR SPRAY PAINTING

There is one key Buffer Zone that will be implemented

BZ-A = 152m from land (odour from xylene when solvent based paint is used)

It is proposed that on granting of consent the EMP be updated so that from an operational point of view it will work as follows:

- If working within 152m from land (at either the north or south end) then operations are being undertaken within BZ-A. This is an odour based Buffer Zone for xylene. Spray painting with solvent based paint cannot be undertaken when the wind is from the seaward quarter (i.e. from the northern quarter when working on the southern end of the AHB and vice versa for the northern end) without suitable mitigation (most likely containment).

These Buffer Zones are illustrated in Pictures 4 and 5 in Appendix 3.

### *4.2.3 THE ROLE OF THE AMF IN FUTURE MANAGEMENT OF DISCHARGES TO AIR*

Maintenance methodologies may alter in the future with advances in technology and the AHBA may choose to adopt some of these new methodologies or products. If this is to happen the AHBA will follow the AMF process which can be viewed general Assessment of Environmental Effects section of this document.

Using the AMF for a new product the following is proposed in relation to air quality:

1. Request and review Material Safety Data Sheet for the product;

2. Identify components of the product;
3. Research air quality guidelines associated with components and create a list of thresholds (if not already covered);
4. Assess the proposed product or activity against the relevant Auckland Plan Rules or statutory requirements outlined in the consent;
5. Define mitigation measures to be used with new products e.g. preparation method, application method, duration of application method, wind restrictions, screens, buffer zones, containment;
6. Carryout trial of product which will require:
   - Ambient air quality monitoring; and/or
   - Air dispersion modelling. The modelling may be used as part of the AMF to test the effect on the threshold values for off-site effects against various mitigation procedures. Modelling may not be necessary for each application but maybe a useful tool when further verification of monitoring is required or when monitoring is not possible. Modelling may also be useful to assess the accuracy of previously recommended buffer zones and generate new buffer zones.
7. Compare results with thresholds and assess effectiveness of mitigation measures. Implement more mitigation where required to achieve thresholds and ensure that the offsite effects are the same or less than what has been authorised;
8. If product meets thresholds (ambient air quality guidelines) update EMP to include new product and associated mitigations;
9. Introduce product to maintenance; and
10. Update operational model to include the new discharge rate (where applicable).

Termarust has been proposed as a new type of coating system to be used on the AHB and has been assessed under the above AMF process to demonstrate how it would operate in practice. These air discharge assessment indicates that the product has an odour effect close to the works (30 metres) which will need to be controlled when using the product close to sensitive receptors (over land). Health effects for sensitive receptors were identified as low risk with the prescribed threshold values being met within 5 metres of the works. These buffers can be used to manage the use of this product without further adverse effects and therefore within the thresholds and scope of the proposed consent. A technical report for this can be viewed in Appendix 4.

If Termarust is adopted then the required mitigation is required to be implemented through the EMP;
BUFFER ZONE FOR SPRAY PAINTING - TERMARUST
There is one key Buffer Zone that will be implemented
BZ-T1 = 40m from land (odour)

The EMP will be updated so that from an operational point of view it will work as follows:

- If working within 40m from land (at either the north or south end) then operations are being undertaken within BZ-T1. This is an odour based Buffer Zone. Spray painting cannot be undertaken when the wind is from the seaward quarter (i.e. from the northern quarter when working on the southern end of the AHB and vice versa for the northern end) without suitable mitigation (most likely containment).

There is no Buffer Zone for nuisance particulate from the application of Termarust. This is calculated from a wind speed matrix which can be viewed in Appendix 4.

# 5. CONCLUSION AND RECOMMENDATIONS

The monitoring of discharges to air from current maintenance activities (pre-containment phase) have shown that the existing pre-containment consent conditions are generally proving adequate in protecting sensitive receptors in relation to threshold values set out in this document. These are specific conditions which include restrictions around works south of Pier 1 and north of Pier 5, controls around wind direction and wind speed, and the requirement to use screens.

This document has identified the current contaminants released to air during abrasive blasting and surface coating and classifies an appropriate environmental threshold level for that contaminant that is either already consented by the current permit or is set at a level that results in less than minor effects on sensitive receiving environments (which is the same level of effect anticipated to be achieved by full containment of 85% of dry discharges). Under the proposed AMF and conditions, the above control measures will continue to be used along with other controls, to enable compliance with the threshold values for contaminants of concern.

Through the AMF, proposed conditions and the associated EMP, the effects on sensitive receptors can be maintained at concentrations that are below the thresholds and therefore are less than minor with no adversely affected parties. This can be achieved through a combination of wind speed and direction controls and buffer zones.

The current consent proposed to reduce discharges to air from maintenance activities by 85% and this was to be achieved with containment. Through the AMF and prior to 2021 the same effect can be achieved using various control tools and in a shorter timeframe. This will have a significant benefit by reducing the overall discharges to the Auckland Airshed, particularly of $PM_{10}$ from abrasive blasting. Monitoring in the pre-containment phase has also shown that with specific controls and an effective EMP (outlining operational procedures), concentrations below the threshold values can be achieved for sensitive receptor sites. Therefore containment is not a necessity to enable sensitive receptors to be protected from nuisance, health and odour effects due to discharges to air from the maintenance activities on the AHB.

This application has illustrated how the AMF can be used successfully for the currently consented methodologies and products and future products. The application seeks the use of an AMF to manage the ongoing discharges to air from maintenance activities of the AHB below the proposed threshold values.

# 6. APPENDIX 1: NATURE OF KEY CONTAMINANTS AND THRESHOLDS

- **Particulate Matter (TSP and $PM_{10}$)** – Particulate matter will be discharged to air as fugitive emissions from the dry abrasive blasting and spray painting processes which will include garnet, old paint flakes, the AHB structure and paint overspray. Particles greater than 10µm in diameter are deposited quickly due to gravity and therefore do not travel as far from their source of origin. These particles are termed Total Suspended Particulate (TSP) and are considered more at the nuisance level. As particle size decreases, the greater potential particles have to travel further from their source of origin. Epidemiological research has linked the concentration of particles in the atmosphere with effects on human health and it has been documented that particles less than 10µm in diameter pose the greatest threat to human health as they have the ability to pass through the nose and throat to enter the lungs.

  The current particulate standard was designed to identify those particles likely to be inhaled and penetrate the lower respiratory system. Particulate with a diameter less than 10µm ($PM_{10}$) has become the accepted measure of particulate material in the atmosphere in New Zealand.

  It is proposed that the thresholds used for particulate discharges to air from the maintenance activities carried out on the AHB are:

  - TSP - The Ministry for the Environment has a TSP guideline of 80µg/m$^3$ (averaged over a 24 hour period) in sensitive recieving environments.
  - $PM_{10}$ - The Ministry for the Environment has National Environmental Standard (NES) for $PM_{10}$ of 50µg/m$^3$ (averaged over a 24 hour period).
  - Annual $PM_{10}$ emissions. There is no specific guideline for this value, however, annual $PM_{10}$ emssions were calculated at 130kg/year from abrasive balsting in the current consent. The new methodologies for abrasive blasting submitted as part of the new AEE suggests that there will be an annual reduction in total emissions of 85%. This value is equivalent to reduction from full contaimnment. It is therefore proposed that the threshold for annual emissions of $PM_{10}$ from abrasive blasting will be 31kg/year (note: there is no containment required for the overach section of the bridge and therefore no change in discharges from this area). This will be measured and calculated through the AMF model (by using an emission factor – refer to Section 5.3 below) and will be based on the amount of abrasive material used and the control method utilized.

    There will also be $PM_{10}$ emissions from paint overspray. Research suggests that 50% of the overspray is likely to be $PM_{10}$, however data is limited therefore $PM_{10}$ from spraypainting is not assessed further in this report.

- **Iron –** Iron will be discharged as particulate matter to air from the dry abrasive blasting and spray painting processes. The proposed threshold used for iron is an ESL based on health effects.
  - Iron - 50µg/m$^3$ as a 1 hour average (as $PM_{10}$).

- **Zinc** – Zinc will be discharged as particulate matter to air from the dry abrasive blasting and spray painting processes. Zinc metal is used most commonly as a protective coating of other metals, such as iron and steel. Zinc metal dust is widely used in paint coatings.

  The effects of inhalation exposure to zinc and zinc compounds vary somewhat with the chemical form of the zinc compound, but the majority of the effects seen will occur within the respiratory tract. Following inhalation of zinc oxide, and to a lesser extent zinc metal and many other zinc compounds, the most commonly reported effect is the development of "metal fume fever." Metal fume fever is characterized by chest pain, cough, dyspnea, reduced lung volumes, nausea, chills, malaise, and leukocytosis. Symptoms generally appear a few hours after exposure, and are reversible 1–4 days following cessation of exposure. Exposure levels associated with the development of metal fume fever have not been identified, though are generally in the range of 77–600 mg/m$^3$. Acute experimental exposures of humans to lower concentrations of zinc oxide (14 mg/m$^3$ for 8 hours or 45 mg/m$^3$ for 20 minutes) and occupational exposures to low concentrations of zinc (8–12 mg/m$^3$ for 1–3 hours and 0.034 mg/m$^3$ for 6–8 hours) did not produce symptoms of metal fume fever.[15] The proposed threshold used for zinc is an ESL.

  - Zinc is 20µg/m$^3$ as a 1 hour average (as $PM_{10}$).

- **Lead** – Lead wll be discharged to air from the dry abrsaive blasting process as particulate matter depending on the location on the AHB and the historic coating being removed. Lead affects practically all systems within the body. Lower levels of lead can cause adverse health effects on the central nervous system, kidney, and blood cells. Blood lead levels as low as 10 micrograms per deciliter can impair mental and physical development.[16]

  The effects of lead exposure on fetuses and young children can be severe. They include delays in physical and mental development, lower IQ levels, shortened attention spans, and increased behavioral problems. Fetuses, infants, and children are more vulnerable to lead exposure than adults since lead is more easily absorbed into growing bodies, and the tissues of small children are more sensitive to the damaging effects of lead. Children may have higher exposures since they are more likely to get lead dust on their hands and then put their fingers or other lead-contaminated objects into their mouths.[17]

  The Auckland Council has an Auckland Regional long term air quality target for lead based on 0.2µg/m$^3$ moving average calculated monthly. As the abrasive blasting is a short term activity, it would be difficult to assess the effects against this target. For this activity, it is proposed that a short term threshold be used to assess lead emissions and this will help achieve the air quality

[15] US Department of Health and Human Services - Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Zinc,* August 2005
[16] US Environment Protection Agency – Integrated Risk Information System, *Lead and Compounds (inorganic),* January 2013
[17] US Environmental Protection Agency – *An Introduction* to *Indoor Air Quality, Lead, http://www.epa.gov/iaq/lead.html, Updated 21/06/2012.*

target. The proposed threshold used for lead is based an Ontario Ministry of the Environment Standard.

- Lead – half hour average is 1.5µg/m$^3$.

- **Chromium** - Chromium wll be discharged to air from the dry abrsaive blasting process as particulate matter depending on the location on the AHB and the historic coating being removed. Depending on the original paint used, the chromium may be in present in different compounds. Paint products often contained chromium as chromate (chromium VI) which is one of the more toxic forms. The different types of chromium exhibit different properties, which is important for assessing the risk of potential harm to human health.

  The Auckland Council has an Auckland Regional annual air quality target for chromium VI of 0.0011µg/m$^3$ and chromium III of 0.11µg/m$^3$. For this activity, it is proposed that a short term threshold will be used to assess chromium emissions to help achieve the air quality target.The proposed threshold used for chromium metal and chrome 3 is an ESL

  - Chromium - 3.6µg/m$^3$ as a 1 hour average (as $PM_{10}$).

- **Volatile Organic Compounds**

  - **Aromatic Hydrocarbon Mixture (Naphtha)** – Naphtha is discharged as a gas from the spray painting process. Naphtha is a mixture of paraffins (C5 to C13) that may contain a small amount of aromatic hydrocarbons. Exposure routes include inhalation, ingestion, skin and/or eye contact. Symptoms of exposure include irritation of the eyes, nose, throat; dizziness, drowsiness, headache, nausea; dry cracked skin; chemical pneumonitis (aspiration liquid).[18] Naphtha is a colourless liquid with a petrol or kerosene-like odor. The odour threshold is variable depending on the make up of the naphtha.The proposed threshold used for naphtha is an ESL which is based on odour.

    Naphtha - 1 hour average is 3500µg/m$^3$ or 880ppm.

  - **Xylene** - Xylene is discharged as a gas from the spray painting process. Commercial or mixed xylene usually contains about 40-65% m-xylene and up to 20% each of o-xylene and p-xylene and ethylbenzene. During AHB maintenance xylenes are released into the atmosphere through volatilisation from their use as solvent (in the paint products). Xylene will also be emiited from vehilce exhausts from traffic movements on the AHB.

    Acute (short-term) inhalation exposure to mixed xylenes in humans results in irritation of the eyes, nose, and throat, gastrointestinal effects, eye irritation, and neurological effects.

[18] Centres for Disease Control and Prevention, *National Institute for Occupational Safety and Health – Pocket Guide to Chemical Hazards, Naphtha*, April 2011

EPA has classified mixed xylenes as a Group D, not classifiable as to human carcinogenicity.[19] The threshold proposed for xylene is an odour based ESL.

Xylene – 1 hour average is 350µg/m$^3$ or 80ppm.

- **Trimethylbenzene** – Trimethylbenzene is discharged as a gas from the spray painting process. Trimethylbenzene will be released as fugitive emissions during the painting processes of AHB maintenance. Exposure will be through the inhalation of ambient air. Exposure symptoms include irritation of the eyes, skin, nose, throat, respiratory system. At higher concentrations, bronchitis; hypochromic anemia; headache, drowsiness, lassitude (weakness, exhaustion), dizziness, may occur.[20] The threshold proposed for trimethylbenzene is a health based ESL.

  Trimethylbenzene - 1250µg/m$^3$ over a 1 hour period.

  The odour detection threshold is 1.97µg/m$^3$ or 0.4ppm.

- **Ethylbenzene** - Ethylbenzene is discharged as a gas from the spray painting process. Ethylbenzene will be released as fugitive emissions during the painting processes of AHB maintenance. Exposure will be through the inhalation of ambient air. Acute (short-term) exposure to ethylbenzene in humans results in respiratory effects, such as throat irritation and chest constriction, irritation of the eyes, and neurological effects such as dizziness. The EPA has classified ethylbenzene as Group D, not classifiable as to human carcinogenicity.[21] The threshold proposed for ethylbenzene is an odour based ESL.

  Ethylbenzene - 1 hour for ethylbenzene is 740µg/m$^3$.

  The US EPA states that the odour detection threshold for ethylbenzene is 2.3ppm.

- **Toluene** - Toluene is discharged as a gas from the spray painting process. Toluene will be released as fugitive emissions during the painting processes of AHB maintenance. Exposure will be through the inhalation of ambient air. Acute exposures to toluene can adversely affect the human nervous system, the kidneys, the liver, and the heart. Effects range from unsteadiness and tingling in fingers and toes to unconsciousness and death. These effects are not likely to occur at levels of toluene that are normally found in the environment.

  Toluene can contribute to the formation of photochemical smog when it reacts with other volatile organic carbon substances in air.[22] The threshold proposed for toluene is an odour based ESL.

  Toluene - 1 hour average is 640µg/m$^3$.

[19] US Environmental Protection Agency, Technology Transfer Network, Air Toxics Website, *Xylenes (Mixed Isomers)*, January 2000
[20] Centres for Disease Control and Prevention, *National Institute for Occupational Safety and Health – Pocket Guide to Chemical Hazards, 1,2,4-Trimethylbenzene*, April 2011
[21] US Environment Protection Agency – Integrated Risk Information System, *Ethylbenzene,* September 2012
[22] Office of Pollution Prevention and Toxics, US Environmental Protection Agency, *Chemical Summary for Toluene,* August 1994

- **Heptan-2-one (heptanone, 2-)** – Heptan-2-one is discharged as a gas from the spray painting process. Heptan-2-one will be released as fugitive emissions during the painting processes of AHB maintenance. Exposure will be through the inhalation of ambient air. Acute inhalation efects include eye, nose, and throat irritation; nausea; headache; vertigo; incoordination; CNS depression; narcosis; and cardiorespiratory failure can occur. In most cases, recovery is usually rapid and complete.[23] Heptan-2-one is a colourless liquid with low volatility and a penetrating fruity odour. The threshold used for Heptan-2-one is an odour based ESL.

  Heptan-2-one – 1 hour average is 32ug/m$^3$

- **Methyl isobutyl ketone** – Methyl isobutyl ketone (MIBK) is discharged as a gas from the spray painting process. Methyl isobutyl ketone is used as a solvent for paints and will be released as fugitive emissions during the painting processes of AHB maintenance. Exposure will be through the inhalation of ambient air. Acute (short-term) exposure to methyl isobutyl ketone may irritate the eyes and mucous membranes, and cause weakness, headache, nausea, lightheadedness, vomiting, dizziness, incoordination, narcosis in humans. EPA has classified methyl isobutyl ketone as a Group D, not classifiable as to human carcinogenicity. Methyl isobutyl ketone occurs as a colorless, flammable liquid and has a faint ketonic and camphor odour.[24] The threshold proposed for (MIK) is a health based ESL.

  MBIK – 1 hour average 820µg/m$^3$

- **Isopropylbenzene (cumene) -** Isopropylbenzene is discharged as a gas from the spray painting process. will be released as fugitive emissions during the painting processes of AHB maintenance. Exposure will be through the inhalation of ambient air. Acute exposure symptoms include irritation of the eyes, skin, mucous membrane; dermatitis; headache, narcosis, coma. Isopropylbenzene is a colourless liquid with characteristic petrol like odour.[25] The threshold proposed for cumene is an odour based ESL.

  Cumene – 1 hour average is 230µg/m$^3$ or 48ppb.

- **Isocyanates** – Isocyanates are discharged as a volatile gas from the spray painting process. Isocyanates include compounds classified as potential carcinogens and symptoms of acute exposure include irritation of the eyes, skin, nose and throat. Occupational asthma is associated with acute isocyanate exposure, along with other lung problems. Isocyanates are known sensitizers.

[23] US National Library of Medicine, *Toxicology Data Network*, http://toxnet.nlm.nih.gov/, March 2014
[24] US Environmental Protection Agency, Technology Transfer Network, Air Toxics Website, *Methyl Isobutyl Ketone (Hexone)*, January 2000
[25] Centres for Disease Control and Prevention, *National Institute for Occupational Safety and Health – Pocket Guide to Chemical Hazards, Cumene*, April 2011

The threshold propsoed for methylene bis phenyl diisocyanate (MDI) is a health based ESL. Methylene bis phenyl diisocyanate (MDI) 1 hour average is 0.5µg/m$^3$.

The threshold proposed for toluene diisocyanate monomer (TDI) is a health based ESL. Toluene diisocyanate (TDI) 1 hour average is 0.36µg/m$^3$.

# 7. APPENDIX 2: AHB AIR QUALITY MONITORING REPORT

# TOTAL BRIDGE SERVICES

# AUCKLAND HARBOUR BRIDGE

AIR MATTERS REPORT 13001

Monitoring of particulate and metals from abrasive blasting and total volatile organic compounds and isocyanates from painting during maintenance

Test Date: January-February 2013

Report Date: 16/04/2013

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Report prepared for Total Bridge Services by Air Matters Limited

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| | |
|---|---|
| Air Matters Report: | 13001 |
| Date: | 16/04/2013 |
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Report Checked by:

Carol McSweeney
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# 1. EXECUTIVE SUMMARY

Sampling for dust, metals (specifically iron, lead, chromium and zinc), volatile organic compounds (VOC) and isocyanates was carried out during routine maintenance works on the Auckland Harbour Bridge (AHB). Sampling was carried out under varying meteorological conditions to assess compliance with air discharge consent 38519, and to assess any offsite effects and to better quantify the overall impact that maintenance work is having on the environment in relation to air quality.

Consent conditions have been put in place to ensure that discharges from maintenance operations have no adverse effects offsite particularly on sensitive receptors which include the Westhaven Marina, Sitting Duck Cafe, residential properties and recreational uses of the waterfront on Curran St. One specific condition restricts blasting work south of Pier 5 when the wind is from the NW quarter. Monitoring work was undertaken during abrasive blasting operations between Piers 5 and 6 when the winds varied from the WSW round to N. Results of offsite sampling were as follows:

- The 24 hour total dust sample located at the southern compound of the AHB was below the Auckland Council Dust Trigger Level for Highly Sensitive Receiving Environments.
- $PM_{10}$ measurements taken at offsite locations during abrasive blasting works were equivalent to background concentrations. Where data is extrapolated over a 24 hour average the National Environmental Standard (NES) of 50µg/m$^3$ is not likely to be exceeded.
- Chromium concentrations measured offsite were below the Texas Commission for Environmental Quality Short Term Effects Screening Level (ESL).
- Iron concentrations measured offsite were below the ESL.
- One sample for lead measured offsite (SW of the AHB) was above the Ontario Ministry of the Environment Ontario Regulation 419/05 half hour Standard.

The consent condition restricting abrasive blasting based on wind direction is proving effective with the exception of the sample measured offsite to the SW of the AHB during work on the 29/01/2013 where guidelines were exceeded for lead. This contravenes Condition 32 of Air Discharge Consent 38519. This consent condition focussed more on the sensitive receptors to the SE of the AHB, where all results were below relevant guidelines. Further investigation should be carried out around this and Total Bridge Services (TBS) should look at controlling emissions from blasting for instance by implementing buffer zones, increasing the effectiveness of screens or installing enclosures with filtration/reclaim systems.

A second specific condition relates to the use of screens to prevent overspray from painting activities on the bridge when painting Pier 5 and south. Monitoring work was undertaken during stripe coating on Span 6 and spray painting in Pier 5 when the winds varied from the N round to NE. Results of offsite sampling were as follows:

- No VOCs found in the coating products were detected offsite during stripe coating work on the AHB.
- Levels of Total VOC found offsite during spray painting inside Pier 5 were equivalent to background concentrations.

- No isocyanates were detected offsite during painting work.

Results show that compliance with consent conditions are resulting in minimal effects at offsite locations sampled during this monitoring exercise. Note that no sampling was undertaken when works were carried out south of Pier 6.

Downwind effects of maintenance work have also been assessed in this monitoring exercise. Monitoring data was gathered at the source (or as close as practicable) of work and then at stepped downwind locations from the source. Data allowed for the quantification of contaminant concentrations and the nature of dispersion. Sampling results were as follows:

- Total dust concentrations measured at source during abrasive blasting were considered high but decrease rapidly with distance. At 30m downwind of the source concentrations have more than halved.
- $PM_{10}$ concentrations measured at source during abrasive blasting were considered high but decreases rapidly with distance. At 10m downwind of the source concentrations are below the NES of 50µg/$m^3$.
- Using Advanced Technology Institute Emission Factors and the amount of $PM_{10}$ discharged from abrasive blasting using garnet can be estimated at approximately 0.4kg/hour.
- Elemental concentrations (chromium, iron, lead and zinc) measured at source during abrasive blasting are considered high and are influenced by the elemental makeup of surface coating being removed which appears to vary by location on the AHB.
- When the surface coating being removed by abrasive blasting contains a high percentage of chromium, measured concentrations of this element in the air up to 20m downwind from the blasting source have been found to exceed the ESL.
- An estimated buffer zone for chromium of 183m from land has been calculated from the results. At this point concentrations measured on land will be below the ESL.
- Measured concentrations of iron in the air up to 30m downwind from the blasting source have been found to exceed the ESL.
- An estimated buffer zone for iron of 49m from land has been calculated from the results. At this point concentrations measured on land will be below the ESL.
- When the surface coating being removed by abrasive blasting contains a high percentage of zinc, measured concentrations of this element in the air up to 30m downwind from the blasting source have been found to exceed the ESL.
- An estimated buffer zone for zinc of 216m from land has been calculated from the results. At this point concentrations measured on land will be below the ESL.
- When the surface coating being removed by abrasive blasting contains a high percentage of lead, measured concentrations of this element in the air up to 150m downwind from the blasting source have been found to exceed the Ontario Guideline.
- An estimated buffer zone for lead of 343m from land has been calculated from the results. At this point concentrations measured on land will be below the Ontario Guideline.
- Speciated VOCs measured during stripe coating were not detected in this sampling exercise.
- VOC concentrations measured for ethylbenzene, isopropylbenzene, trimethylbenzene,

toluene, xylene and methyl isobutyl ketone measured at source during spray painting exceed their associated ESL.

- VOC concentrations measured 5-10m downwind of spray painting for ethylbenzene, isopropylbenzene, trimethylbenzene, toluene, and methyl isobutyl ketone are below the ESL.
- Measured xylene concentrations up to 20m downwind from spray painting exceed the ESL. The ESL for xylene is based on odour effects as opposed to health effects.
- An estimated buffer zone for xylene odour effects of 152m from land has been calculated from the results. At this point concentrations measured on land will be below the ESL.
- Isocyanates measured during stripe coating were not detected in this sampling exercise.
- The methylene bisphenyl isocyanate (MDI) concentration measured at source during spray painting exceeded the ESL. The concentration of MDI measured 5-10m downwind was below the ESL.

Monitoring results and applied emission factors show that there is significant particulate (total dust and $PM_{10}$) discharge from the process of abrasive blasting. Monitoring indicates that the coarser particulate fraction measured drops out of the air within distance downwind. $PM_{10}$ follows a similar pattern, however it is assumed that the finer particulate stays suspended for longer and is dispersed as it is transported off site. Overall, monitoring indicates that $PM_{10}$ is unlikely to exceed the NES over a 24 hour period due to the frequency and duration of abrasive blasting activities.

High concentrations of chromium, iron, lead and zinc were measured at source during abrasive blasting. Concentrations decrease with distance downwind; however there were lead levels above the Ontario Guideline measured up to 150m downwind of the blasting source. Buffer zones have been calculated that vary from 49m (iron) up to 343m (lead). Further investigation should be carried out around this and TBS should look at controlling emissions from blasting for instance increasing the effectiveness of screens or installing enclosures with filtration/reclaim systems screens or enclosures with filtration/reclaim systems.

Stripe coating has minimal offsite effects in terms of VOC and isocyanate concentrations. Spray painting will have an odour impact greater than 20m downwind. A buffer of 152m from any sensitive receptors should be put in place when carrying out spray painting in order to minimise offsite odour effects. This will also suitably reduce the isocyanate risk associated with spray painting.

The particulate discharge from spray painting was not assessed in this exercise.

Summary of findings

| | What did the data show | Compliance | Implication | Actions / Next Steps |
|---|---|---|---|---|
| Dust | Total dust concentrations measured at source during abrasive blasting were considered high but concentrations decrease rapidly with distance. At 30m downwind of the source concentrations have more than halved.<br>Total Dust was not measured during spray painting. | One 24 hour total dust sample located at the southern compound of the AHB was below the Auckland Council Dust Trigger Level for Highly Sensitive Receiving Environments. | None | None |
| $PM_{10}$ | $PM_{10}$ concentrations measured at source during abrasive blasting were considered high but decreases rapidly with distance. At 10m downwind of the source concentrations are below the NES of 50µg/m$^3$. Concentrations were affected by the meteorological conditions on the day of sampling.<br>$PM_{10}$ was not measured during spray painting. | Concentrations measured offsite during blasting were below the NES of 50µg/m$^3$.<br>Using Advanced Technology Institute Emission Factors and the amount of $PM_{10}$ discharged from abrasive blasting using garnet can be estimated at approximately 0.4kg/hour. | None | None |
| Chromium | When the surface coating being removed by abrasive blasting contains a high percentage of chromium, measured concentrations of this element in the air up to 20m downwind from the blasting source have been | Concentrations of chromium measured offsite were below the Effects Screening Level. | An estimated buffer zone for chromium of 183m from land has been calculated from the results. At this point there is more certainty that concentrations measured on land will be below the Effects Screening Level. | Implement buffer zone or other form of containment. |

| | What did the data show | Compliance | Implication | Actions / Next Steps |
|---|---|---|---|---|
| | found to exceed the Effects Screening Level. | | | |
| Iron | Measured concentrations of iron in the air up to 30m downwind from the blasting source have been found to exceed the Effects Screening Level. | Concentrations of iron measured offsite were below the Effects Screening Level. | An estimated buffer zone for iron of 49m from land has been calculated from the results. At this point there is more certainty that concentrations measured on land will be below the Effects Screening Level. | Implement buffer zone or other form of containment. |
| Lead | When the surface coating being removed by abrasive blasting contains a high percentage of lead, measured concentrations of this element in the air up to 150m downwind from the blasting source have been found to exceed the Ontario Guideline. | Lead concentrations measured offsite at one downwind location were above the Ontario Guideline. | An estimated buffer zone for lead of 343m from land has been calculated from the results. At this point there is more certainty concentrations measured on land will be below the Ontario Guideline. | Implement buffer zone or other form of containment. |
| Zinc | When the surface coating being removed by abrasive blasting contains a high percentage of zinc, measured concentrations of this element in the air up to 30m downwind from the blasting source have been found to exceed the Effects Screening Level. | Concentrations of zinc measured offsite were below the Effects Screening Level. | An estimated buffer zone for zinc of 216m from land has been calculated from the results. At this point there is more certainty that concentrations measured on land will be below the Effects Screening Level. | Implement buffer zone or other form of containment. |
| Other Metals | Cadmium, Calcium, Cobalt, Magnesium, Manganese, Nickel, and Phosphorus were detected at source above their associated Effects Screening Levels. | Levels of Cadmium, Calcium, Cobalt, Magnesium, Nickel, and Phosphorus drop below their respective Effects Screening Levels | None. | Implementation of buffer zone for other metals (chromium, iron, lead and zinc) will adequately cover the risk associated with these metals |

| | What did the data show | Compliance | Implication | Actions / Next Steps |
|---|---|---|---|---|
| | | 5-10m downwind of the source. Manganese concentrations measured 10-20m downwind are below the Effects Screening Levels. | | |
| VOCs | Speciated VOCs measured during stripe coating were not detected in this sampling exercise. VOC concentrations for ethylbenzene, isopropylbenzene, 1,2,4 trimethylbenzene, 1,2,5 trimethylbenzene, toluene, xylene and methyl isobutyl ketone measured at source during spray painting exceeded their respective Effects Screening Levels. | VOC concentrations measured 5-10m downwind of spray painting for ethylbenzene, isopropylbenzene, trimethylbenzene, toluene, and methyl isobutyl ketone are below the Effects Screening Levels. Measured xylene concentrations up to 20m downwind from spray painting exceed the ESL. The ESL for xylene is based on odour effects as opposed to health effects | An estimated buffer zone for xylene (odour effects) of 152m from land has been calculated. At this point concentrations measured on land will be below the Effects Screening Level for odour. | Implement buffer zone or other form of containment |
| Isocyanates | No isocyanates were detected during stripe coating. High levels of methylene bisphenyl isocyanate (MDI) were measured at source during spray painting | The concentration of MDI measured 5-10m downwind was below the ESL | Any buffer zone implemented for xylene will suitably reduce any isocyanate risk associated with spray painting | None |

## 2. OBJECTIVES

1. To carryout sampling for dust and metals during abrasive blasting. Results are to be compared with the current consent conditions to ensure compliance.

2. To carryout sampling for volatile organic compounds and isocyanates during painting. Results are to be compared with the current consent conditions to ensure compliance.

3. To carryout sampling for dust and metals during abrasive blasting in order to assess the environmental footprint against acute ambient air quality standards and human health effects.

4. To carryout sampling for volatile organic compounds and isocyanates during painting in order to assess the environmental footprint against acute ambient air quality standards and human health effects.

## 3. INTRODUCTION

A resource consent application pertaining to the environmental discharges resulting from maintenance work carried out on the AHB was submitted to the Auckland Council in 2011. The air discharge application was submitted based largely on theoretical data and minimal measured data. Air Discharge Consent 38519 was granted by the Auckland Council on 31 August 2011. Data from this monitoring exercise will be used to verify the consent conditions in place are appropriate. Additionally, this monitoring exercise sits within the requirements of New Zealand Transport Agency (NZTA) project plan "Auckland Harbour Bridge Maintenance Works – State of the Environment" and Air Discharge Consent 38519. The data collected will provide the NZTA with further information on contaminant discharges to air pre containment (2011-2014) when the current consent conditions 30-34 are in place.

> *Condition 33. No dry abrasive blasting shall be undertaken when wind speeds are greater than 7m/s, averaged over 5 minutes, or when;*
>
> *a) undertaking maintenance work north of Pier 1 when the wind is blowing from the southwest or southeast quarters.*
>
> *b) undertaking maintenance work south of Pier 5 when the wind is from the northwest quarter.*
>
> *Condition 34. That in order to minimise the drift of blast debris and paint spray, suitable screens shall be used at all times when undertaking dry abrasive blasting and/or spray painting of the AHB and extensions north of Pier 1 and south of Pier 5.*

The air discharges to be monitored will be: suspended particulate (total dust), $PM_{10}$, metals in particulate, paint solvents including isocyanates. Monitoring results will be assessed against Conditions 30 to 32.

> *Condition 30. Beyond the boundary of the site there shall be no dust or odour caused by discharges from the site, which in the opinion of an enforcement officer, is noxious, offensive or*

*objectionable.*

*Condition 31. No discharges from any activity on site shall give rise to visible emissions, other than water vapour and clean steam, to an extent which, in the opinion of an enforcement officer, is noxious, dangerous, offensive or objectionable.*

*Condition 32. Beyond the boundary of the site, there shall be no discharges to air of any hazardous air pollutant, caused by discharges from the site, which is present at a concentration that causes, or is likely to cause adverse effects to human health, the environment or property.*

Total Bridge Services (TBS) holds the maintenance contract for the AHB. Part of the maintenance involves cleaning and repainting of the Bridge. Some sections of the bridge surface which require repainting are initially prepared by dry abrasive blasting followed by zinc coating and repainting. Only small sections of the bridge are prepared at a time using this technique as exposure of the bare metal to the atmosphere is to be minimised. Garnet is the abrasive material used in the process.

The abrasive blasting process generates particulate from both the garnet used as the abrasive agent and the paint which is removed. Historically the AHB has been coated with paint that is known to contain zinc chromate and certain sections have been coated with lead based paint.

The current painting system includes Wasser MC Zinc Coating, Wasser Mio Mastic, MC Ferrox A Columbia Grey and Wasser Thinner R175. The main components of these coatings are listed in Table 1.

**Table 1: Bridge Surface Coatings and Components**

| | MC Zinc | Wasser Mio Mastic | MC Ferrox A Columbia Grey | Wasser Thinner R175 |
|---|---|---|---|---|
| Iron oxide | | | √ | |
| Zinc Dust | √ | √ | | |
| Aromatic Hydrocarbon Mixture (naphtha) | √ | √ | √ | |
| Xylene | √ | √ | √ | √ |
| 1,2,4 trimethylbenzene | √ | √ | | |
| Ethylbenzene | √ | √ | √ | √ |
| Toluene | | | | √ |
| Heptan-2-one | | | √ | |
| Methyl isobutyl Ketone | | | | √ |
| Methylene Diphenyl Diisocyanate (MDI) | √ | √ | √ | |
| Total Isocyanate | √ | √ | √ | |
| Quartz | | √ | √ | |

Monitoring has been carried out around the abrasive blasting process in 2011 and results can be found in Air Matters Reports 11013-1 and 11013-2 in Appendix 1.

# 4. METHODOLOGY

## Dust

*Total Dust (Inhalable)*

Sampling was carried out in accordance with AS/NZS 3640-2009 for particulates. Samples were collected using an IOM inhalable dust sampler and filter. This was connected to a calibrated sampling pump running at a rate of 2L/min. Samples were set up at various locations in relation to the work, sensitive receptors and wind direction. Samples were collected over various timeframes depending on the abrasive blasting process. Filters were subsequently weighed by Air Matters. The method followed was based on the Australian Standard for inhalable particulate. This method was used as opposed to Total Suspended Particulate (TSP) by other ambient air monitoring equipment due to the nature of the works and the sampling locations making ambient standard method samplers impracticable in this situation.

*$PM_{10}$*

Dust levels were also monitored using a DustTrak™ Aerosol Monitor DRX 8533. The DustTrak™ gives a real-time digital readout of dust concentration by using laser photometer. The DustTrak™ was set up to measure $PM_{10}$. The unit takes a reading every second and was set to data log one minute averages. The unit was shifted to various locations throughout the abrasive blasting process.

## Metals - Chromium, Iron, Lead and Zinc

Metal samples were collected on the same filter as the inhalable dust samples. Analysis was carried out by Hill Laboratories using ICP mass spectrometry in accordance with NIOSH Method 7300.

## Volatile Organic Compounds (VOC)

*Total VOC*

A real time datalogging photo ionisation detector (PID), MultiRae Plus PGM-50 was used to collect data on the concentration of Total Volatile Organic Compounds (TVOC). This monitor was calibrated on the 26/01/2013 using *100ppm of* isobutylene by APC Techsafe in accordance with Calibration Certificate 165499 and 168955. The instrument was set up to log 60 or 30 second averages. The unit was shifted to various locations in relation to the work, sensitive receptors and wind direction.

*Speciated VOC / Solvents*

Sampling was carried out according to 1500. Air samples were collected on charcoal sorbent tubes (SKC 226-01) with the sampling pumps calibrated at a maximum flow of 0.2L/minute. Samples were set up at various locations in relation to the work, sensitive receptors and wind direction. Samples were collected over various timeframes depending on the painting process. Analysis of the tubes was carried out by TestSafe Australia by GC FID analysis according to the NIOSH method.

### Temperature and Wind speed

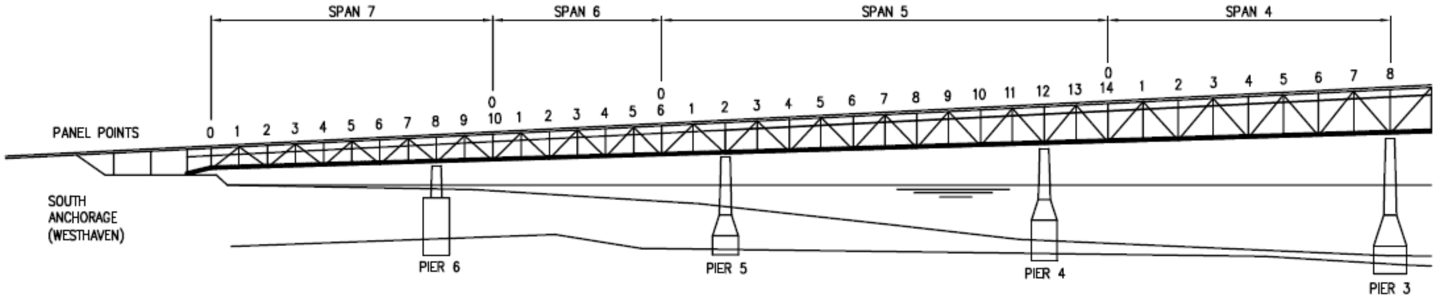
Temperature and wind speed as measured using a handheld anemometer EA-3010.

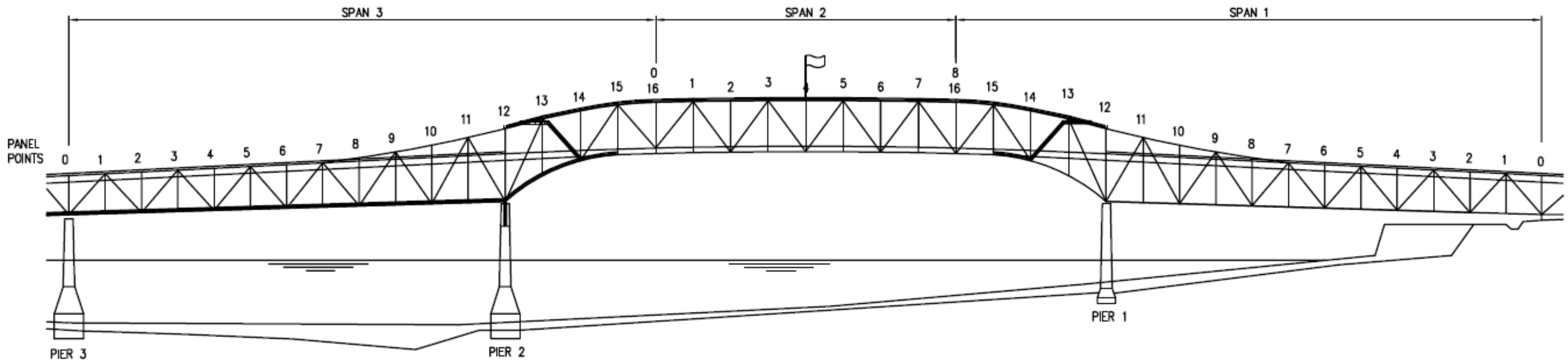
### Field Blank

Field blanks were taken for quality control purposes.

**Offsite Sampling Locations**

**Onsite Sampling Locations**



## 5. RESULTS

### *Total Dust*

Background concentrations measured when no abrasive blasting was taking place on the AHB. Sampling was then undertaken on a number of days when abrasive blasting was being carried out at various locations in Span 7, Span 6 and Pier 5. Results for various sampling locations for total dust are displayed below in Tables 2, 3, 4 and Chart 1.

**Table 2: Background Total Dust Concentrations**

| Date | Works Location | Sampling Location | General Wind Direction & Speed | Measured Concentration |
|---|---|---|---|---|
| 08/02/2013 | No work on Bridge. Background Concentration | Span 7 PP7 Diagonal | WNW Start<br>NNE Finish<br>3km/hr | <20µg/m$^3$ |
| | | SE of Bridge outside Ponsonby Cruising Club | WNW Start<br>NNE Finish<br>1.6km/hr | 140µg/m$^3$ |

**Table 3: Total Dust Concentrations Measured During Abrasive Blasting activities on the AHB**

| Date | Works Location | Sampling Location | General Wind Direction & Speed | Measured Concentration |
|---|---|---|---|---|
| 08/01/2103 | *Span 6*<br>• Panel Point 4-3 (West Diagonal & West Post)<br>• Panel Point 3 (East Diagonal & East Post) | SW of Bridge outside TBS Compound | SW – 20km/hr | 90µg/m$^3$ |
| | | SE of Bridge outside Ponsonby Cruising Club | SSW – 10km/hr | 50µg/m$^3$ |
| | | SE of Bridge outside Sitting Duck Cafe | SSW – 0-5km/hr | <20µg/m$^3$ |
| 09/01/2013 | *Span 6*<br>• Panel Point 4-5 (West Diagonal & West Post)<br>• Panel Point 3-4 (East Diagonal & East Post) | *On Bridge between east and west blasting locations | SW - 5km/hr<br>NE – 3.6km/hr | 660µg/m$^3$ |
| | | SW of Bridge outside TBS Compound | WSW – 5.5km/hr<br>ENE – 2.5km/hr | 240µg/m$^3$ |

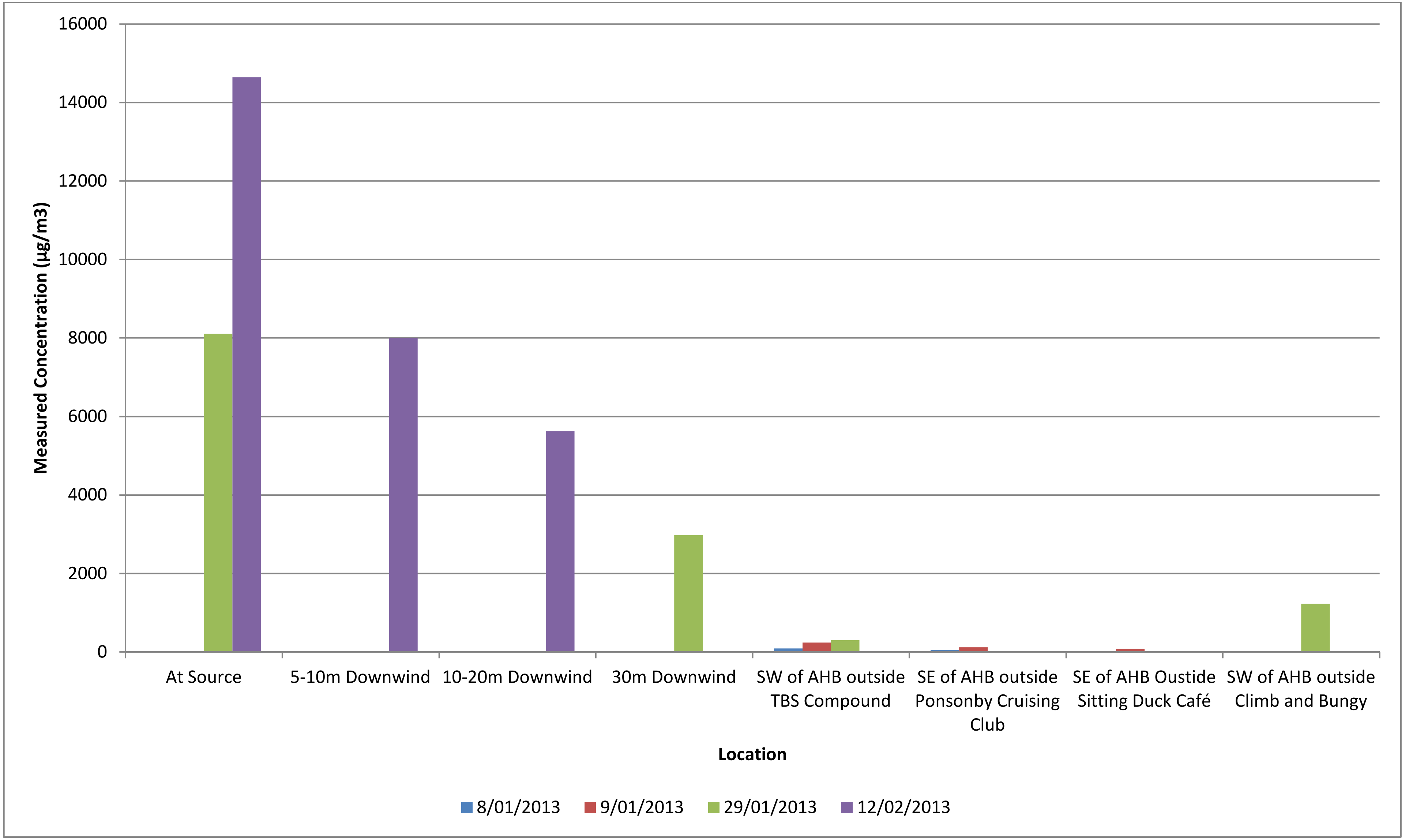
| | | | | |
|---|---|---|---|---|
| | *Top of Pier 6* | SE of Bridge outside Ponsonby Cruising Club | SW – 2.5km/hr<br>NE – 3.6km/hr | 120µg/m$^3$ |
| | | SE of Bridge outside Sitting Duck Cafe | SW - <0.5km/hr<br>NE - <0.5km/hr | 80µg/m$^3$ |
| 29/01/2013 | *Span 7*<br>• Panel Point 9 Apex (East)<br>• Panel Point 9 Diagonal (West) | Panel Point 9 Apex(East) – At Source | NNE - 10km/hr | 8,110µg/m$^3$ |
| | | West walkway 30m Downwind (Span 7 Panel Point 9) | NNE - 5km/hr | 2,980µg/m$^3$ |
| | | SW of Bridge outside TBS Compound | NNE - 5km/hr | 300µg/m$^3$ |
| | | SW of Bridge outside Climb and Bungy | NNE - 11km/hr | 1,230µg/m$^3$ |
| 12/02/2013 | Pier 5 | Inside Pier 5 – At source | None | 14,640µg/m$^3$ |
| | | Span 5 Panel Point 2 Diagonal (east walkway). Approx 5-10m downwind | WSW 0-15km/hr | 8,000µg/m$^3$ |
| | | Pier 5 eastern end (north). Approx 10-20m downwind | WSW 0-15km/hr | 5,630µg/m$^3$ |

*Wind change after samples were set up results therefore not included in the related Charts

**Table 4: Total Dust Concentration Measured over a 24 hour period**

| Date | Works Location | Sampling Location | General Wind Direction & Speed | Measured Concentration | Auckland Council TSP Trigger Level |
|---|---|---|---|---|---|
| 29/01/2013 – 30/01/2013 | Span 7<br>• Panel Point 9 Apex (East)<br>• Panel Point 9 Diagonal (West) | South end of Bridge | NNE/NE - Various | 60µg/m$^3$ | 80µg/m$^3$ |

**Chart 1: Total Dust Concentrations Measured at Various Locations - Onsite and Offsite**



*Fine Particulate $PM_{10}$ (DustTrak™)*

Background concentrations were measured when no abrasive blasting was taking place on the bridge. Sampling was then undertaken on a number of days when abrasive blasting was being carried out at various locations in Span 7, Span 6 and Pier 5. Results for various sampling locations for $PM_{10}$ are displayed in Tables 5, and 6 and Charts 2 and 3.

**Table 5: Background $PM_{10}$ Concentrations Measured on the Bridge and at Offsite Locations**

| Date | Sampling Location | General Wind Direction & Speed | Measured Concentration | National Environmental Standard |
|---|---|---|---|---|
| 08/01/2103 | On bridge next to work location | SW - 15-20km/hr | 1µg/m³ | 50µg/m³ |
| | SW of Bridge outside TBS Compound | SW - 20km/hr | 1µg/m³ | |
| | SE of Bridge outside Ponsonby Cruising Club | SSW - 10km/hr | 1µg/m³ | |
| | SE of Bridge outside Sitting Duck Cafe | SSW - 0-5km/hr | 1µg/m³ | |
| 09/01/2013 | On Bridge between east and west blasting locations | SW - 5km/hr | 2µg/m³ | |
| | On east walkway between Pier 6 and land | SW - 5km/hr | 2µg/m³ | |
| 29/01/2013 | 10m downwind of blasting location | NNE - 10km/hr | 1µg/m³ | |
| | 30m downwind of blasting location | NNE - 5km/hr | 1µg/m³ | |
| | SW of Bridge outside TBS Compound | NNE - 15km/hr | 2µg/m³ | |
| | SW of Bridge outside Climb and Bungy Office | N - 11km/hr | 2µg/m³ | |
| 12/02/2013 | Pier 5 east | WSW - 0-3km/hr | 1µg/m³ | |
| | Pier 5 west | WSW - 8km/hr | <1µg/m³ | |

**Table 6: $PM_{10}$ Concentrations Measured During Sampling**

| Date | Works Location | Sampling Location | General Wind Direction & Speed | Measured Concentration | National Environmental Standard |
|---|---|---|---|---|---|
| 08/01/2013 | *Span 6*<br>• Panel Point 4-3 (West Diagonal & West Post)<br>• Panel Point 3 (East Diagonal & East Post) | 15m Downwind of Blasting on Bridge | SW - 15-20km/hr | 2µg/$m^3$ | 50µg/$m^3$ |
| | | SW of Bridge outside TBS Compound | SW - 18km/hr | 1µg/$m^3$ | |
| | | SE of Bridge outside Ponsonby Cruising Club | SSW - 10km/hr | 1µg/$m^3$ | |
| | | SE of Bridge outside Sitting Duck Cafe | Swirling - 0-5km/hr | 1µg/$m^3$ | |
| 09/01/2013 | *Span 6*<br>• Panel Point 4-5 (West Diagonal & West Post)<br>• Panel Point 3-4 (East Diagonal & East Post)<br>*Top of Pier 6* | 10m downwind (P6 work (west walkway - downwind) | NE - 8km/hr | 9µg/$m^3$ | 50µg/$m^3$ |
| | | SW of Bridge outside TBS Compound | WSW - 5.5km/hr | 1µg/$m^3$ | |
| | | SE of Bridge outside Sitting Duck Cafe | <0.5km/hr | 2µg/$m^3$ | |
| | | SE of Bridge outside Ponsonby Cruising Club | SW - 2.5km/hr | 2µg/$m^3$ | |
| | | SW of Bridge outside TBS Compound | ENE - 2.5km/hr | 2µg/$m^3$ | |
| | | SW of Bridge outside Climb and Bungy Office | NE - 8.5km/hr | 2µg/$m^3$ | |
| | | Inside TBS Compound | <0.5km/hr | 1µg/$m^3$ | |
| 29/01/2013 | *Span 7*<br>• Panel Point 9 (West Diagonal)<br>• Panel Point 9 (East Apex) | 10m Downwind | NNE - 10km/hr | 19µg/$m^3$ | 50µg/$m^3$ |
| | | 15m Downwind | NNE - 10km/hr | 4µg/$m^3$ | |
| | | 30m Downwind | NNE - 10km/hr | 1µg/$m^3$ | |
| | | SW of Bridge outside Climb and Bungy Office | NNE - 10km/hr | 3µg/$m^3$ | |

| | | | | | |
|---|---|---|---|---|---|
| 12/02/2013 | *Pier 5* | 3.5m downwind | WSW - 7.9km/hr | 403µg/$m^3$ | 50µg/$m^3$ |
| | | 6-8m downwind | WSW - 15km/hr | 84µg/$m^3$ | |
| | | 10m downwind | WSW - 7.9km/hr | 35µg/$m^3$ | |
| | | 15m downwind | WSW - 7.9km/hr | 21µg/$m^3$ | |
| | | 20m downwind | WSW - 7.9km/hr | 12µg/$m^3$ | |
| | | 30m downwind | WSW - 7.9km/hr | <0.1µg/$m^3$ | |

**Chart 2: $PM_{10}$ Concentrations Measured During Abrasive Blasting at Various Downwind Locations on the Bridge**

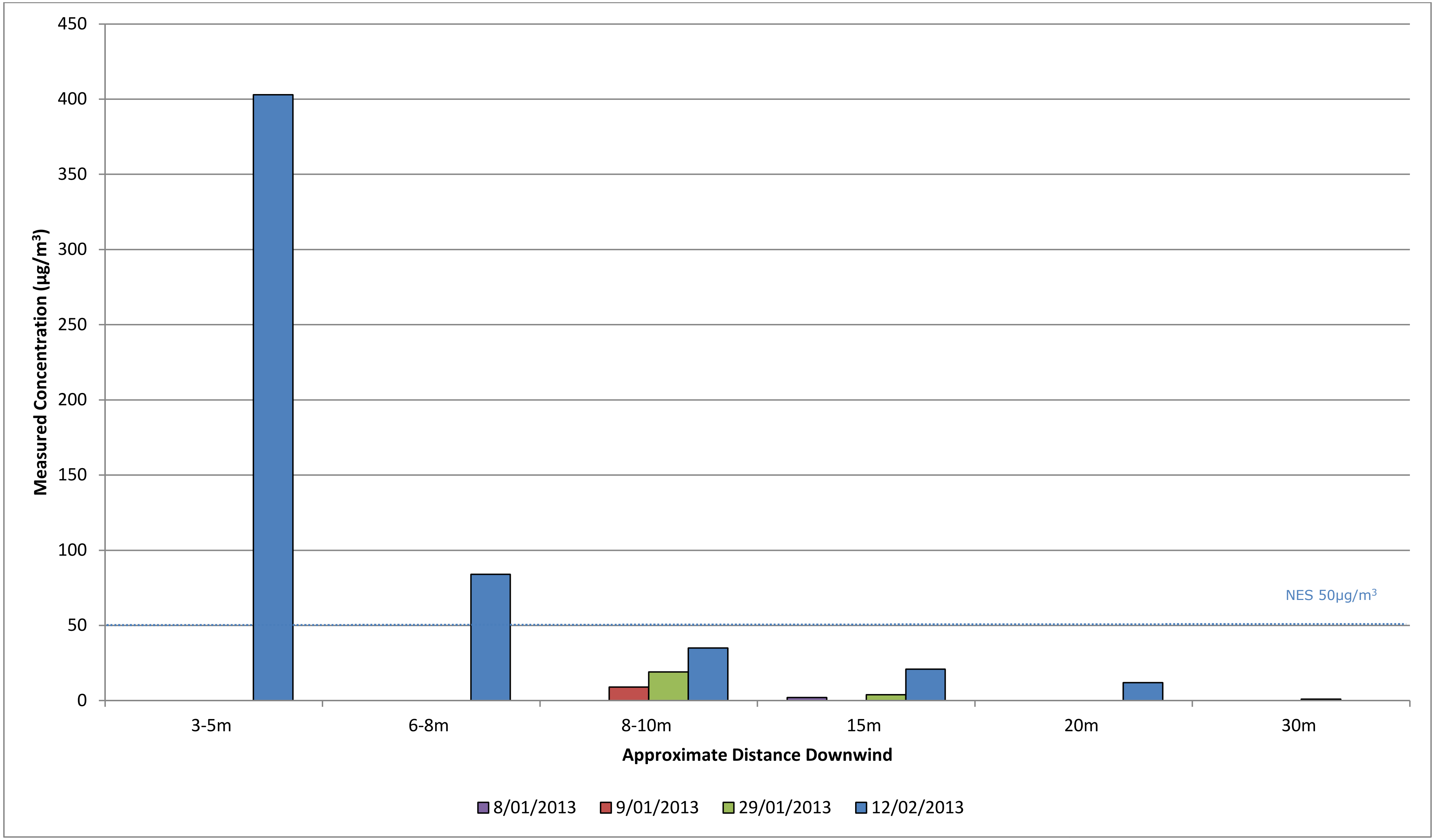
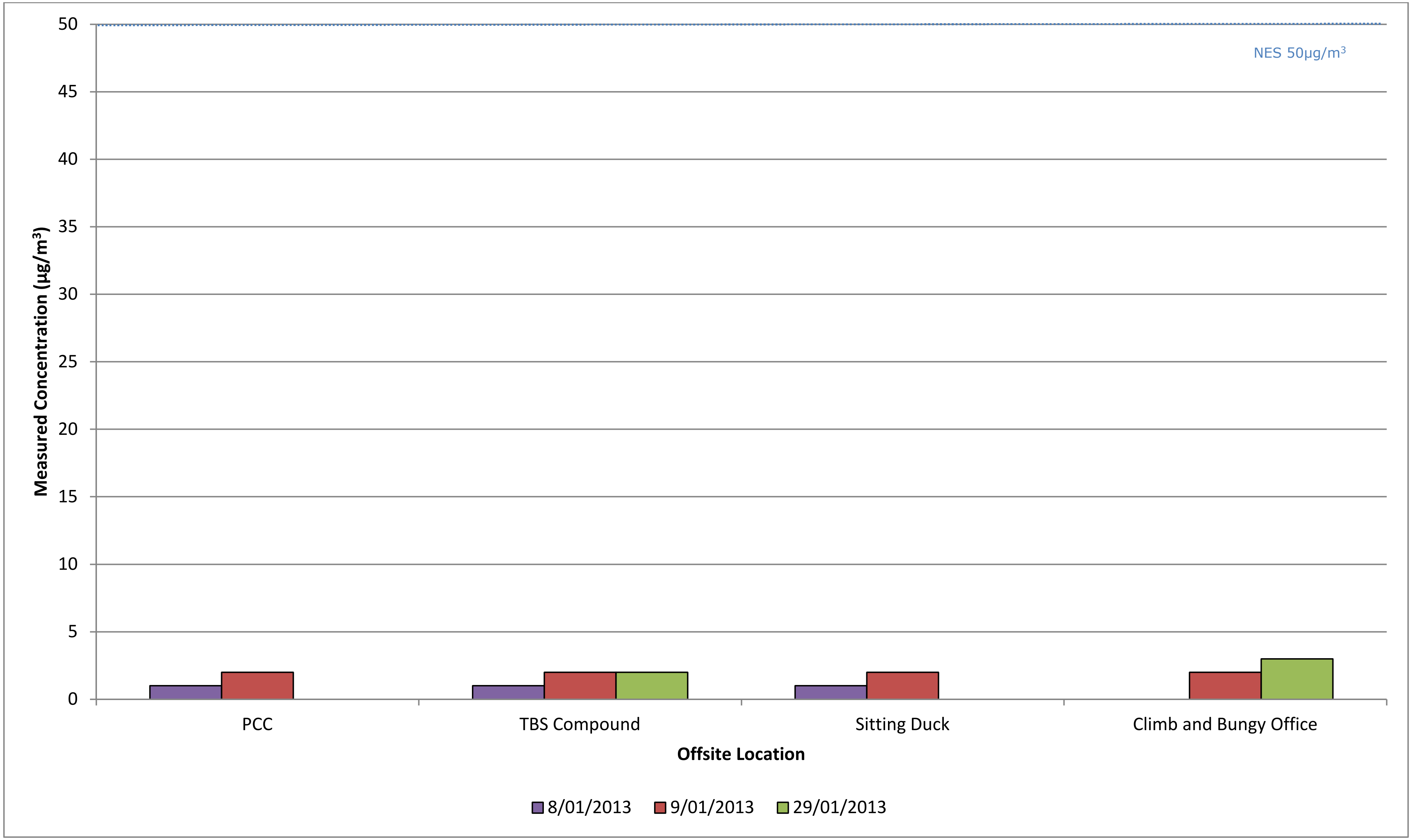


**Chart 3: $PM_{10}$ Concentrations Measured During Abrasive Blasting at Various Offsite Locations**



## *Metals*

Background concentrations were measured when no abrasive blasting was taking place on the bridge. Sampling was then undertaken on a number of days when abrasive blasting was being carried out at various locations in Span 7, Span 6 and Pier 5. Results have been compared with the Texas Commission on Environmental Quality Effects Screening Levels for 1 hour averages. The Effects Screening Levels (ESLs) are used to evaluate the potential for effects to occur as a result of exposure to concentrations of constituents in the air. ESLs are based on data concerning health effects, the potential for odours to be a nuisance, effects on vegetation, and corrosive effects. ESLs are not ambient air standards. If predicted or measured airborne levels of a constituent do not exceed the screening level, adverse health effects are not expected. If ambient levels of constituents in air exceed the screening levels, it does not necessarily indicate a problem but rather triggers a review in more depth.

Lead results have been compared to Ontario Ministry of the Environment 'Ontario Regulation 419/05 – Air Pollution – local Air Quality. These standards and guidelines are based on human health or environmental effects or nuisance effects such as odour

Results for various sampling locations for metals are displayed in Tables 6, 7, 8, 9 10, 11 and Charts 4, 5, 6, 7 below.

**Table 6: Background Metal Concentrations**

| Date | Location | Chromium | Iron | Lead | Zinc |
|---|---|---|---|---|---|
| 08/02/20113 | On AHB - Span 7 PP7 Diagonal | <Blank | 0.3µg/m$^3$ | <Blank | 23.6µg/m$^3$ |
| | SE of Bridge outside Ponsonby Cruising Club | <Blank | <Blank | <Blank | <Blank |

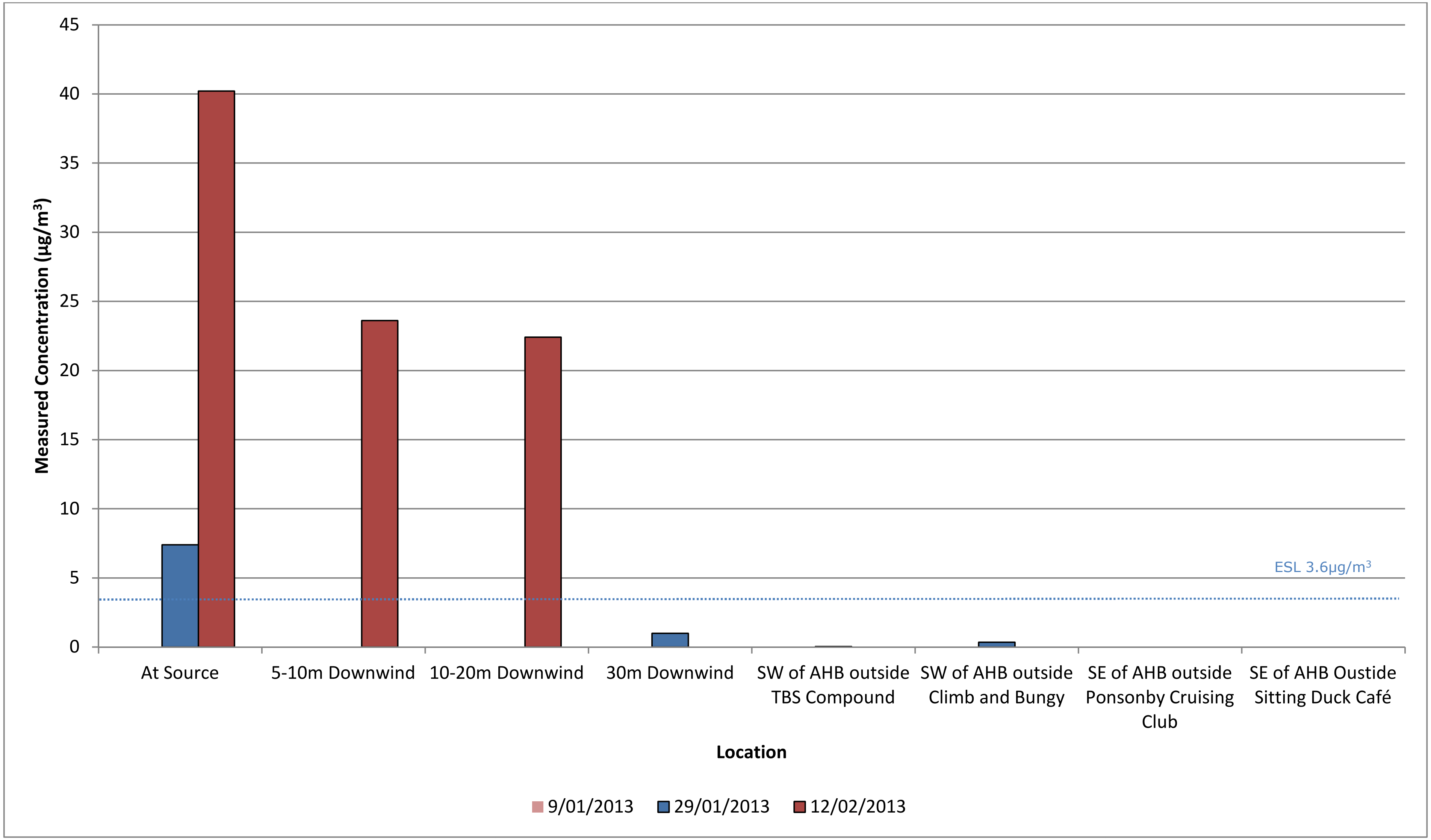
The background concentrations have been blank corrected for sample mass prior to concentrations being calculated.

**Table 7: Chromium Concentrations**

| Date | Works Location | Sampling Location | General Wind Direction & Speed | Measured Concentration | •TCEQ Short Term Effects Screening level – 1 hour average |
|---|---|---|---|---|---|
| 09/01/2013 | *Span 6*<br>• Panel Point 4-5 (West Diagonal & West Post)<br>• Panel Point 3-4 (East Diagonal & East Post)<br>*Top of Pier 6* | *On Bridge between east and west blasting locations | SW - 5km/hr<br>NE – 3.6km/hr | 0.2µg/m$^3$ | 3.6µg/m$^3$ |
| | | SW of Bridge outside TBS Compound | WSW – 5.5km/hr<br>ENE – 2.5km/hr | 0.02µg/m$^3$ | |
| | | SE of Bridge outside Ponsonby Cruising Club | SW – 2.5km/hr<br>NE – 3.6km/hr | < Blank | |
| | | SE of Bridge outside Sitting Duck Cafe | SW - <0.5km/hr<br>NE - <0.5km/hr | 0.04µg/m$^3$ | |
| 29/01/2013 | Span 7<br>• Panel Point 9 Apex (East)<br>• Panel Point 9 Diagonal (West) | At Source - Panel Point 9 Apex (East) | NNE - 10km/hr | 7.4µg/m$^3$ | |
| | | 30m Downwind - West walkway (Span 7 Panel Point 9) | NNE - 5km/hr | 1.0µg/m$^3$ | |
| | | SW of Bridge outside TBS Compound | NNE - 5km/hr | 0.03µg/m$^3$ | |
| | | SW of Bridge outside Climb and Bungy | NNE - 11km/hr | 0.4µg/m$^3$ | |
| | | ◊South end of Bridge | NNE/NE - Various | 0.02µg/m$^3$ | |
| 12/02/2013 | Pier 5 | At source - Inside Pier 5 | None | 40.2µg/m$^3$ | |
| | | Approx 5-10m downwind - Span 5 Panel Point 2 Diagonal (east walkway). | WSW 0-15km/hr | 23.6µg/m$^3$ | |
| | | Approx 10-20m downwind - Pier 5 eastern end (north). | WSW 0-15km/hr | 22.4µg/m$^3$ | |

•Chromium metal and chrome 3
*Wind change after samples were set up results therefore not included in the related Charts
◊24 hour sample therefore not included in the related Charts

**Chart 4: Chromium Concentrations Measured During Abrasive Blasting at Various Locations – Onsite and Offsite**






air matters

**Table 9: Iron Concentrations**

| Date | Works Location | Sampling Location | General Wind Direction & Speed | Measured Concentration | TCEQ Short Term Effects Screening level – 1 hour |
|---|---|---|---|---|---|
| 09/01/2013 | *Span 6*<br>• Panel Point 4-5 (West Diagonal & West Post)<br>• Panel Point 3-4 (East Diagonal & East Post)<br>*Top of Pier 6* | *On Bridge between east and west blasting locations | SW 5km/hr<br>NE 3.6km/hr | 31µg/m$^3$ | 50µg/m$^3$ |
| | | SW of Bridge outside TBS Compound | WSW 5.5km/hr<br>ENE 2.5km/hr | 0.4µg/m$^3$ | |
| | | SE of Bridge outside Ponsonby Cruising Club | SW 2.5km/hr<br>NE 3.6km/hr | 0.8µg/m$^3$ | |
| | | SE of Bridge outside Sitting Duck Cafe | <0.5km/hr | 0.8µg/m$^3$ | |
| 29/01/2013 | Span 7<br>• Panel Point 9 Apex (East)<br>• Panel Point 9 Diagonal (West) | At Source - Panel Point 9 Apex(East) At Source | NNE - 10km/hr | 732.9µg/m$^3$ | |
| | | 30m Downwind - West walkway (Span 7 Panel Point 9) | NNE - 5km/hr | 133.3µg/m$^3$ | |
| | | SW of Bridge outside TBS Compound | NNE - 5km/hr | 6.4µg/m$^3$ | |
| | | SW of Bridge outside Climb and Bungy | NNE - 11km/hr | 39µg/m$^3$ | |
| | | ◊South end of Bridge | NNE/NE - Various | 1.3µg/m$^3$ | |
| 12/02/2013 | Pier 5 | Inside Pier 5 – At source | None | 1035.9µg/m$^3$ | |
| | | Approx 5-10m downwind - Span 5 Panel Point 2 Diagonal (east walkway) | WSW 0-15km/hr | 539.8µg/m$^3$ | |
| | | Approx 10-20m downwind - Pier 5 eastern end (north). | WSW 0-15km/hr | 315µg/m$^3$ | |

•Iron as iron oxide
*Wind change after samples were set up results therefore not included in the related Charts
◊24 hour sample therefore not included in the related Charts

**Chart 5: Iron Concentrations Measured During Abrasive Blasting at Various Locations – Onsite and Offsite**

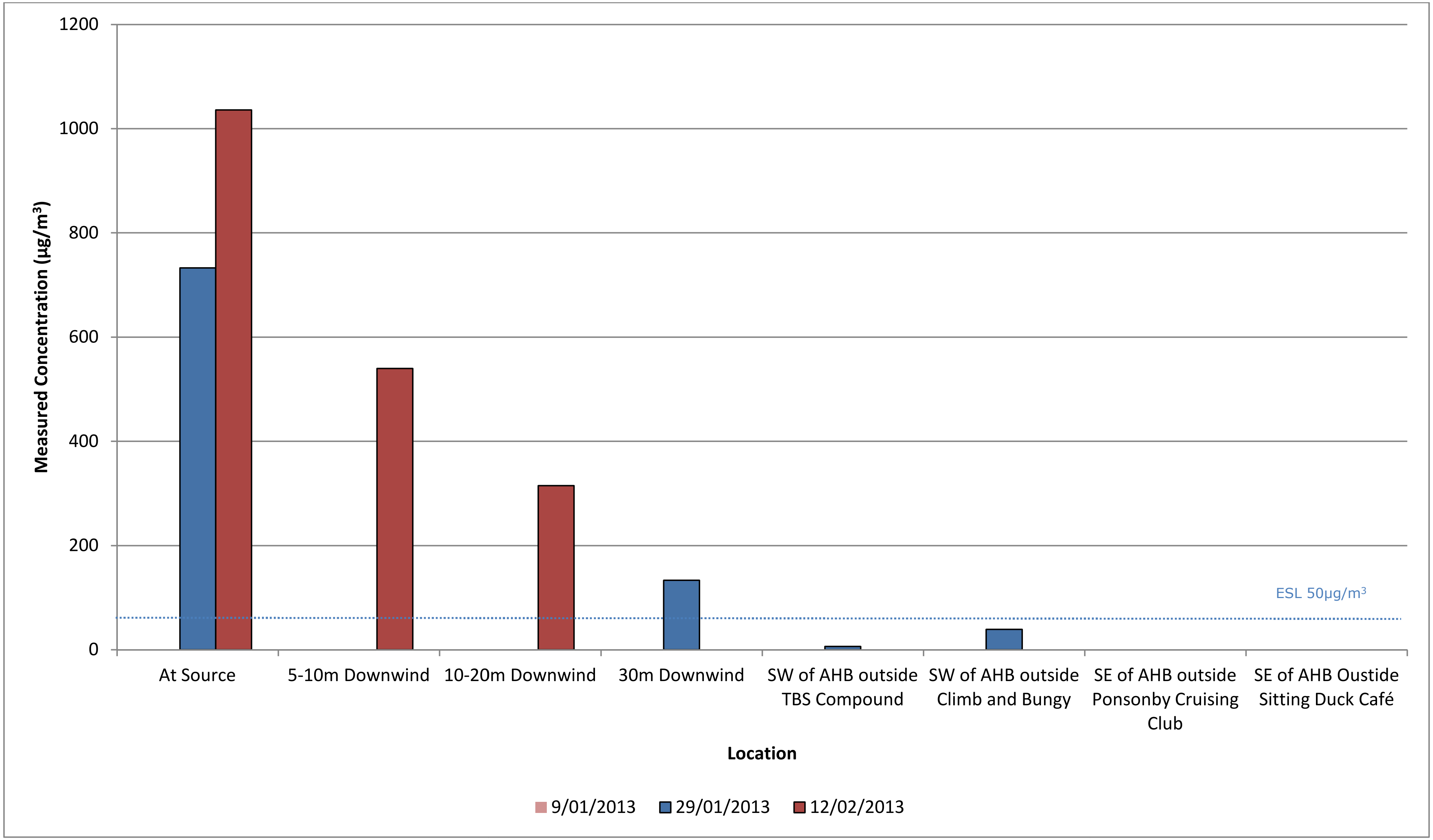


**Table 9: Lead Concentrations**

| Date | Works Location | Sampling Location | General Wind Direction & Speed | Measured Concentration | Ontario Ministry of the Environment Standard – half hour |
|---|---|---|---|---|---|
| 09/01/2013 | *Span 6*<br>• Panel Point 4-5 (West Diagonal & West Post)<br>• Panel Point 3-4 (East Diagonal & East Post)<br>*Top of Pier 6* | *On Bridge between east and west blasting locations | SW 5km/hr<br>NE 3.6km/hr | 1.4µg/$m^3$ | 1.5µg/$m^3$ |
| | | SW of Bridge outside TBS Compound | WSW 5.5km/hr<br>ENE 2.5km/hr | 0.004µg/$m^3$ | |
| | | SE of Bridge outside Ponsonby Cruising Club | SW 2.5km/hr<br>NE 3.6km/hr | 0.01µg/$m^3$ | |
| | | SE of Bridge outside Sitting Duck Cafe | <0.5km/hr | 0.01µg/$m^3$ | |
| 29/01/2013 | Span 7<br>• Panel Point 9 Apex (East)<br>• Panel Point 9 Diagonal (West) | At Source - Panel Point 9 Apex(East) | NNE - 10km/hr | 104.4µg/$m^3$ | |
| | | 30m Downwind - West walkway (Span 7 Panel Point 9) | NNE - 5km/hr | 11.7µg/$m^3$ | |
| | | SW of Bridge outside TBS Compound | NNE - 5km/hr | 0.3µg/$m^3$ | |
| | | SW of Bridge outside Climb and Bungy | NNE - 11km/hr | 2.7µg/$m^3$ | |
| 12/02/2013 | Pier 5 | At source - Inside Pier 5 | None | 7.9µg/$m^3$ | |
| | | Approx 5-10m downwind - Span 5 Panel Point 2 Diagonal (east walkway) | WSW 0-15km/hr | 3.7µg/$m^3$ | |
| | | Approx 10-20m downwind - Pier 5 eastern end (north) | WSW 0-15km/hr | 2.7µg/$m^3$ | |

*Wind change after samples were set up results therefore not included in the related Charts

**Table 10: 24 Hour Lead Concentration**

| Date | Works Location | Sampling Location | General Wind Direction & Speed | Measured Concentration | •Ontario Ministry of the Environment Standard – 24 hour |
|---|---|---|---|---|---|
| 29/01/2013 | Span 7<br>• Panel Point 9 Apex (East)<br>• Panel Point 9 Diagonal (West) | South end of Bridge | NNE/NE - Various | 0.1µg/$m^3$ | 0.5µg/$m^3$ |

24 hour sample therefore not included in the related Charts

**Chart 6: Lead Concentrations Measured During Abrasive Blasting at Various Locations – Onsite and Offsite**

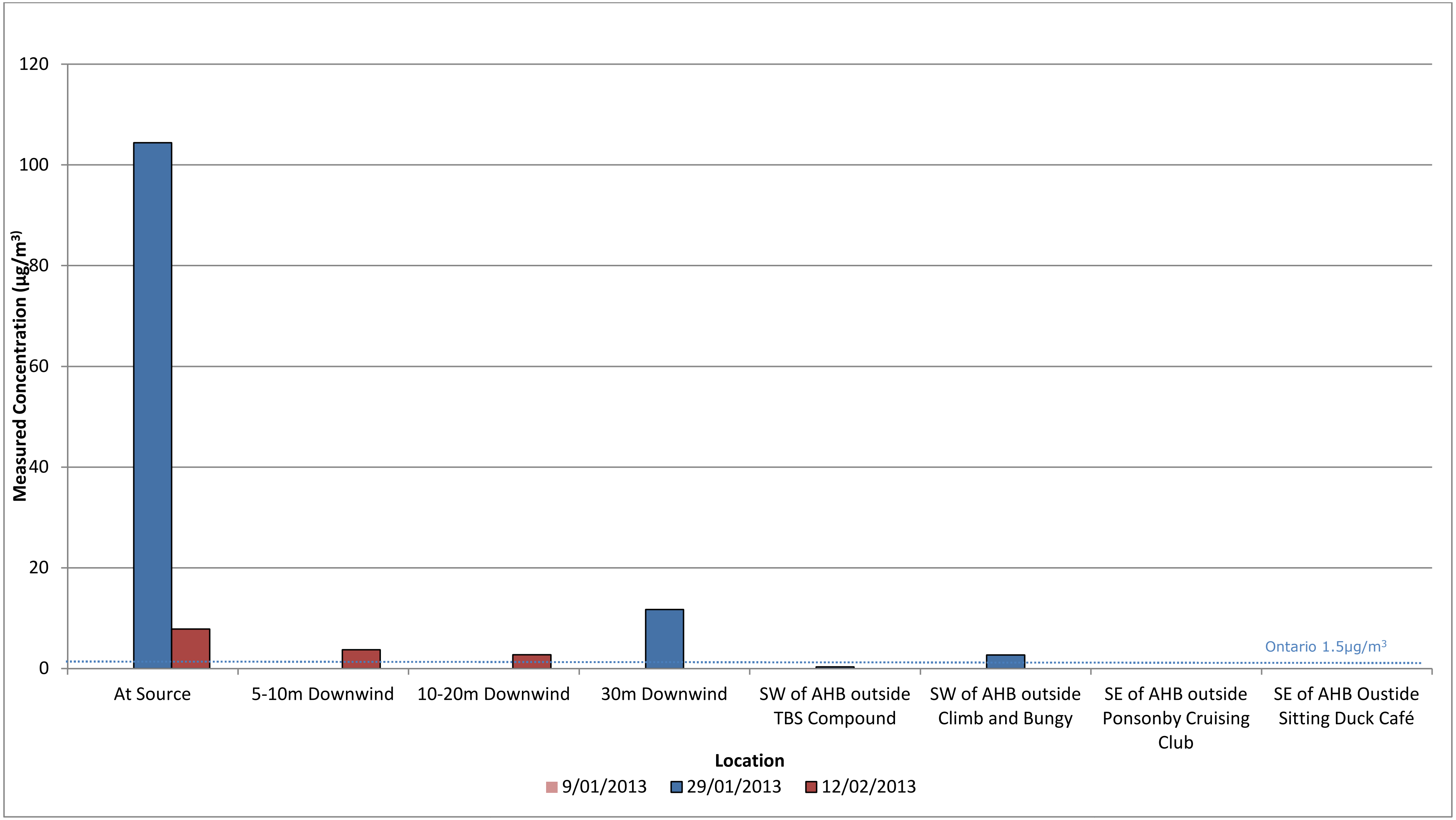
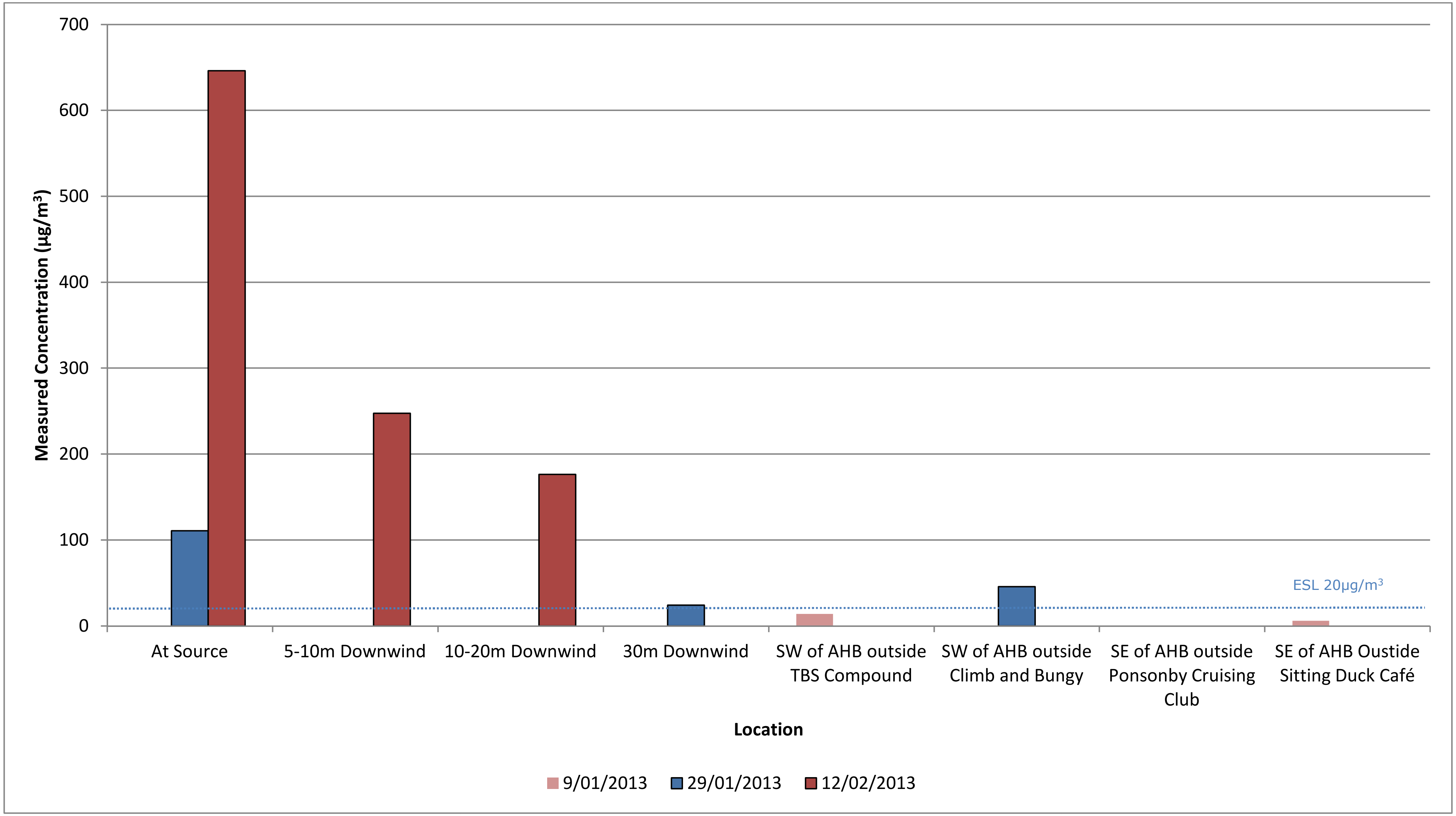


**Table 11: Zinc Concentrations**

| Date | Works Location | Sampling Location | General Wind Direction & Speed | Measured Concentration | •TCEQ Short Term Effects Screening level – 1 hour |
|---|---|---|---|---|---|
| 09/01/2013 | *Span 6*<br>• Panel Point 4-5 (West Diagonal & West Post)<br>• Panel Point 3-4 (East Diagonal & East Post)<br>*Top of Pier 6* | *On Bridge between east and west blasting locations | SW 5km/hr<br>NE 3.6km/hr | 22.1µg/m$^3$ | 20µg/m$^3$ |
| | | SW of Bridge outside TBS Compound | WSW 5.5km/hr<br>ENE 2.5km/hr | 14.1µg/m$^3$ | |
| | | SE of Bridge outside Ponsonby Cruising Club | SW 2.5km/hr<br>NE 3.6km/hr | < Blank | |
| | | SE of Bridge outside Sitting Duck Cafe | <0.5km/hr | 5.9µg/m$^3$ | |
| 29/01/2013 | Span 7<br>• Panel Point 9 Apex (East)<br>• Panel Point 9 Diagonal (West) | At Source - Panel Point 9 Apex (East) | NNE - 10km/hr | 110.6µg/m$^3$ | |
| | | 30m Downwind - West walkway (Span 7 Panel Point 9) | NNE - 5km/hr | 24.2µg/m$^3$ | |
| | | SW of Bridge outside TBS Compound | NNE - 5km/hr | < Blank | |
| | | ˙SW of Bridge outside Climb and Bungy | NNE - 11km/hr | 45.7µg/m$^3$ | |
| | | ◊South end of Bridge | NNE/NE - Various | 2.0µg/m$^3$ | |
| 12/02/2013 | Pier 5 | At source - Inside Pier 5 | None | 646.1µg/m$^3$ | |
| | | Approx 5-10m downwind - Span 5 Panel Point 2 Diagonal (east walkway). | WSW 0-15km/hr | 247.6µg/m$^3$ | |
| | | Approx 10-20m downwind - Pier 5 eastern end (north). | WSW 0-15km/hr | 176.4µg/m$^3$ | |

•Zinc and compounds
*Wind change after samples were set up results therefore not included in the related Charts
◊24 hour sample therefore not included in the related Charts
˙Value discarded from Buffer Zone calculations due to concentration being greater than that measured at 30m downwind. Note: blank glass fibre filter has high zinc concentration.

**Chart 7: Zinc Concentrations Measured During Abrasive Blasting at Various Offsite Locations – Onsite and Offsite**



The samples taken on the 12/02/2013 when abrasive blasting was undertaken in Pier 5 were analysed for a suite of 36 elements. The elements that were detected at a concentration above their respective ESLs at source were:

1. Cadmium
2. Calcium
3. Cobalt
4. Magnesium
5. Manganese
6. Nickel
7. Phosphorus

All of these elements were below the ESL 5-10m downwind with the exception of manganese which was below the ESL at 10-20m downwind from the source of blasting.

## Total Volatile Organic Compounds (TVOC)

Background concentrations were measured when no painting was taking place on the bridge. Sampling was then undertaken on a number of days when painting was being carried out at various locations in Span 7, Span 6 and Pier 5. Results for various sampling locations for TVOC are displayed below.

Sampling was carried out when no work was being undertaken on the Bridge to determine background concentrations. Results for background concentrations are displayed in Table 12 and 13 and Chart 8.

**Table 12: Background TVOC Concentrations**

| Date | Works Location | Sampling Location | Wind Direction | Average Wind speed | Measured Concentration |
|---|---|---|---|---|---|
| 29/01/2013 | *No Painting on Bridge* | Various points around Span 7 | NNE | 10km/hr | <0.1ppm |
| 18/02/2013 | *Pier 5 Spray painting with Mio Mastic* | Pier 5 – west side paint/thinners mixing area | NE | 5.5km/hr | 1.2pmm |
| | | Inside Pier 5 – upper level | NE | 5.5km/hr | 0.9ppm |
| | | West and east walkways (south of Pier 5) | NE | 5.5km/hr | 0.5ppm |
| | | Pier 5 (east side) | NE | 5.5km/hr | 0.3ppm |
| | | East walkway (South of Pier 5) | NE | 5.5km/hr | 0.4ppm |
| | | Ponsonby Cruising Club | NE | 5.5km/hr | 0.5ppm |
| | | Sitting Duck café | NE | 5.5km/hr | 0.4ppm |
| | | Outside TBS Compound | NE | 5.5km/hr | 0.5ppm |
| | | Climb and Bungy | NE | 5.5km/hr | 0.4ppm |
| | | Fishing area | NE | 5.5km/hr | 0.2ppm |

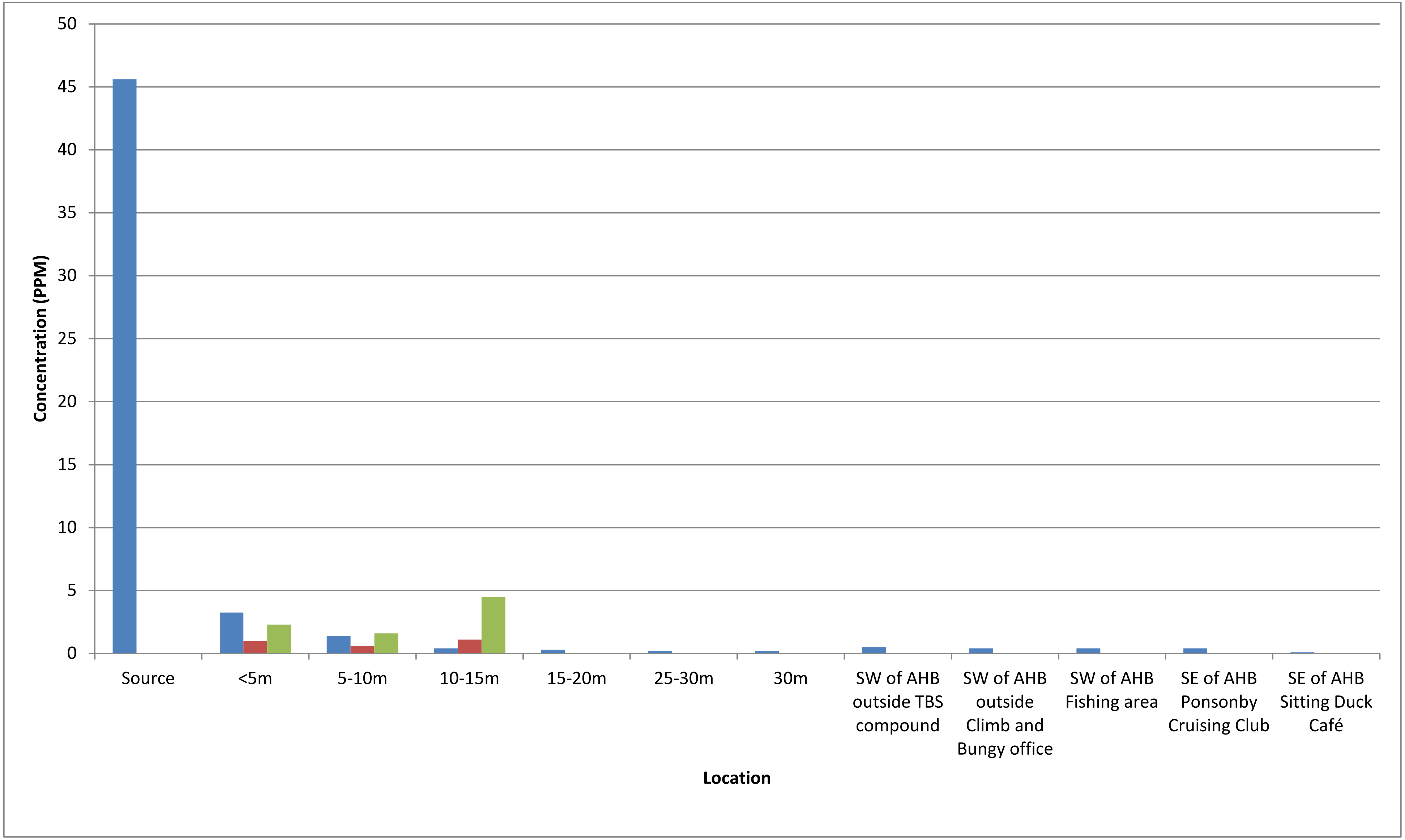
| | | | | | |
|---|---|---|---|---|---|
| 22/02/2013 | *Pier 5<br>Stripe Coating and spray painting with Ferrox* | Outside TBS Compound | ESE | 5.0km/hr | 0.9pmm |
| | | Ponsonby Cruising Club | ESE | 5.0km/hr | 0.8ppm |
| | | West walkway out to Pier 5 | ESE | 5.0km/hr | 0.7ppm |
| | | Inside Pier 5 upper level | ESE | 5.0km/hr | 0.5ppm |
| | | Inside Pier 5 lower level | ESE | 5.0km/hr | 0.4ppm |
| | | Pier 5 west side mixing area – open cans | ESE | 5.0km/hr | 6.9pm |
| | | 5m south of Pier 5 | ESE | 5.0km/hr | 0.4ppm |
| | | 20m south of Pier 5 | ESE | 5.0km/hr | 0.3ppm |
| | | 25-30m south of Pier 5 | ESE | 5.0km/hr | 0.3ppm |
| | | West walkway above Pier 5 | ESE | 5.0km/hr | 0.3ppm |
| | | 5m north of Pier 5 | ESE | 5.0km/hr | 0.2ppm |
| | | 10m north of Pier 5 | ESE | 5.0km/hr | 0.2ppm |

**Table 13: TVOC Concentrations Measured During Sampling**

| Date | Works Location | Sampling Location | Wind Direction | Average Wind speed | Measured Concentration |
|---|---|---|---|---|---|
| 18/02/2013 | *Pier 5 Spray painting with Mio Mastic* | Pier 5 Paint/Thinners mixing area (west) | NE | 5.5km/hr | 2.1pmm |
| | | Pier 5 west side (paint refilling) | NE | 5.5km/hr | 1.1ppm |
| | | Inside Pier 5 during spraying | NE | 5.5km/hr | 22.0ppm |
| | | Entrance to Pier 5 | NE | 5.5km/hr | 3.2ppm |
| | | 5-10m downwind of spraying | NE | 5.5km/hr | 0.3ppm |
| | | 5-10m downwind of spraying | NE | 5.5km/hr | 0.3ppm |
| | | 15m downwind of spraying | NE | 5.5km/hr | 0.1ppm |
| | | 15m downwind of spraying | NE | 5.5km/hr | 0.4ppm |
| | | 20m downwind of spraying | NE | 5.5km/hr | 0.3ppm |
| | | 30m downwind of spraying | NE | 5.5km/hr | 0.4ppm |
| | | 50-60m downwind of spraying | NE | 5.5km/hr | <0.1ppm |
| | | Upwind of spraying | NE | 5.5km/hr | <0.1ppm |
| | | East walkway (upwind) | NE | 5.5km/hr | <0.1ppm |
| 22/02/2013 | *Pier 5 Spray painting with Ferrox* | Inside P5 - 2m from spraying | N/A | <0.1km/hr | 45.6ppm |
| | | 3m from spraying | ENE | 9km/hr | 3.25ppm |
| | | Entrance to P5, 2-3m from spraying | ENE | 9km/hr | 1ppm |
| | | Walkway over P5 (<5m from spraying) | ENE | 2.5km/hr | 2.3ppm |
| | | End of Pier 5 West (5-10m from spraying) | ESE | 5km/hr | 1.4ppm |

| | | | | | |
|---|---|---|---|---|---|
| | | End of Pier 5 West (5-10m from spraying) | ENE | 9km/hr | 0.6ppm |
| | | 5-10m downwind from spraying | ENE | 9km/hr | 1.6ppm |
| | | 10m downwind from spraying | ENE | 9km/hr | 0.4ppm |
| | | 10m from spraying | ENE | 2.5km/hr | 1.1ppm |
| | | 10-15m from spraying | ESE | 5km/hr | 4.5ppm |
| | | 15-20m downwind of spraying | ENE | 5km/hr | 0.3ppm |
| | | 25-30m south of spraying | ENE | 2.5km/hr | 0.2ppm |
| | | 30m downwind of spraying | ENE | 9km/hr | 0.2ppm |
| | | 5-10m upwind | ENE | 2.5km/hr | 0.15ppm |
| | | Outside TBS compound | ENE | 3.5km/hr | 0.5ppm |
| | | Outside Climb and Bungy office | ENE | 3.5km/hr | 0.4ppm |
| | | Fishing area | ENE | 3.5km/hr | 0.4ppm |
| | | Ponsonby Cruising Club | ENE | 3.5km/hr | 0.4ppm |
| | | Sitting Duck Café | N/A | <0.1km/hr | 0.1ppm |
| 22/02/2013 | *Span 7 Panel Point 8 Stripe Coating with Mio Mastic* | 1.5m north of painting | ENE | 4km/hr | 0.1ppm |
| | | 1.5m south of painting (downwind) | ENE | 4km/hr | 0.1ppm |
| | | 5m south of painting (downwind) | ENE | 4km/hr | 0.1ppm |

**Chart 8: TVOC Concentrations Measured During Spray Painting at Various Locations – Onsite and Offsite on 22/02/2013**



*Speciated Volatile Organic Compounds*

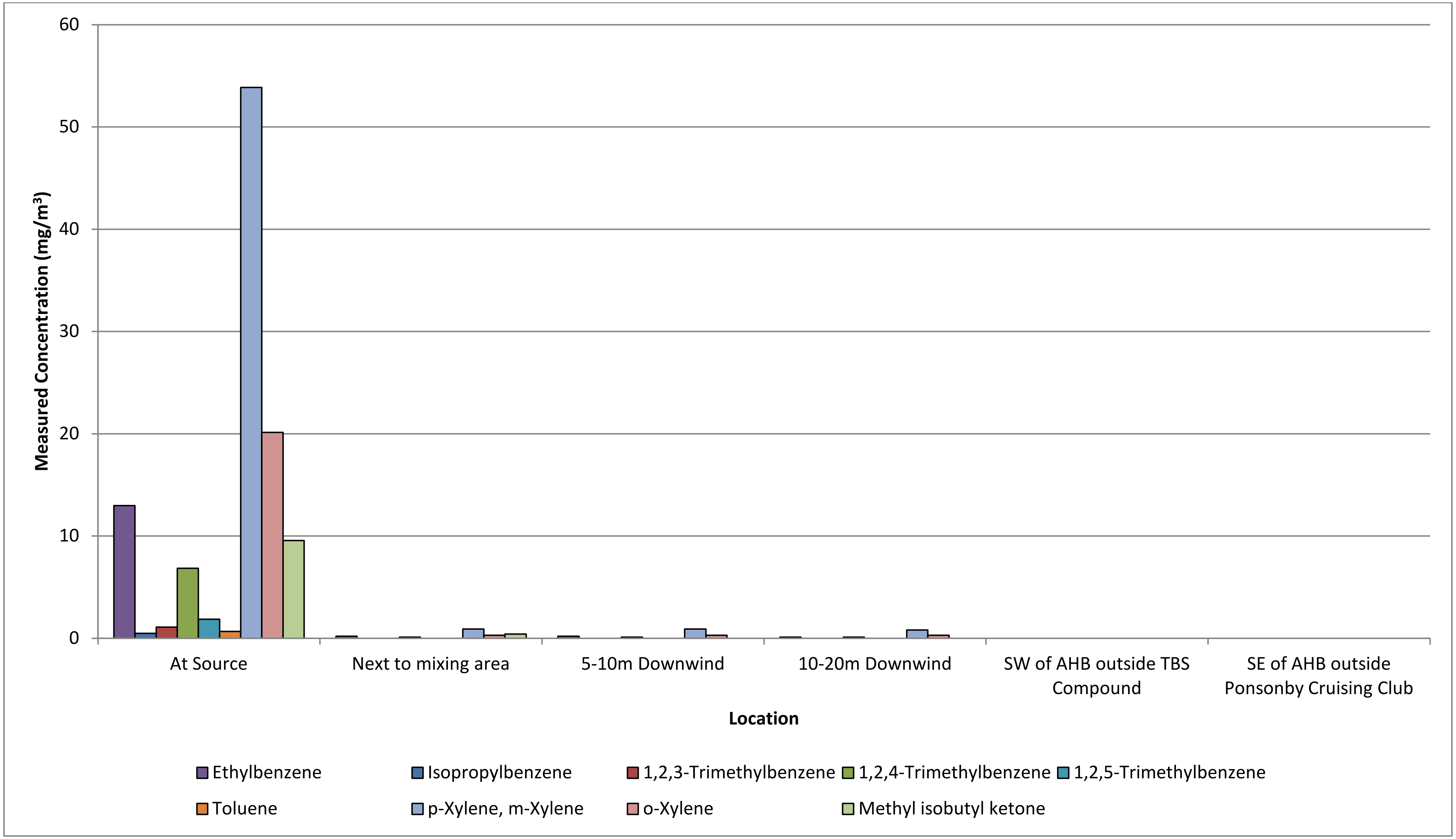
Background concentrations measured when no painting was taking place on the bridge. Sampling was then undertaken on a number of days when painting was being carried out at various locations in Span 6 and Pier 5. Results for various sampling locations for Speciated VOC are displayed below.

Sampling was carried out when no work was being undertaken on the Bridge to determine background concentrations. Results for background concentrations were all below the laboratory level of detection. Results are summarised in Table 14 and displayed in Chart 9.

**Table 14: Speciated VOC Concentrations Measured During Spray Painting**

| Date | Location | Ethylbenzene | Isopropylbenzene | 1,2,3-Trimethylbenzene | 1,2,4-Trimethylbenzene | 1,2,5-Trimethylbenzene | Toluene | p-Xylene, m-Xylene | o-Xylene | Methyl isobutyl ketone |
|---|---|---|---|---|---|---|---|---|---|---|
| 18/02/2013 | At Source | 13000μg/m$^3$ | 500μg/m$^3$ | 1100μg/m$^3$ | 6800μg/m$^3$ | 1900μg/m$^3$ | 700μg/m$^3$ | 53900μg/m$^3$ | 20100μg/m$^3$ | 9500μg/m$^3$ |
| | Next to mixing area | 200μg/m$^3$ | ND | ND | 100μg/m$^3$ | ND | ND | 900μg/m$^3$ | 300μg/m$^3$ | 400μg/m$^3$ |
| | 5-10m Downwind | 200μg/m$^3$ | ND | ND | 100μg/m$^3$ | ND | ND | 900μg/m$^3$ | 300μg/m$^3$ | ND |
| | 10-20m Downwind | 100μg/m$^3$ | ND | ND | 100μg/m$^3$ | ND | ND | 800μg/m$^3$ | 300μg/m$^3$ | ND |
| 10/01/2013 | AHB between painting work | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | SW of AHB outside TBS Compound | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | SE of AHB outside Ponsonby Cruising Club | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| **TCEQ Short Term Effects Screening level – 1 hour** | | **740μg/m$^3$** | **500μg/m$^3$** | **1250μg/m$^3$** | **1250μg/m$^3$** | **1250μg/m$^3$** | **640μg/m$^3$** | **350μg/m$^3$ (Odour)** | **1600μg/m$^3$** | **820μg/m$^3$** |

**Chart 9: Speciated VOC Concentrations Measured During Spray Painting at Various Locations – Onsite and Offsite 18/02/2013**



### *Isocyanates*

Background concentrations were measured when no painting was taking place on the bridge. Sampling was then undertaken on a number of days when painting was being carried out at various locations in Span 6 and Pier 5. Results for various sampling locations for isocyanates are displayed below.

Sampling was carried out when no work was being undertaken on the Bridge to determine background concentrations. Results for background concentrations were all below the laboratory level of detection. Results are summarised in Table 15.

**Table 15: Isocyanate Concentrations Measured During Spray Painting**

| Date | Location | MDI |
|---|---|---|
| 18/02/2013 | At Source | 20µg/m$^3$ |
| | Next to mixing area | <0.2µg/m$^3$ |
| | 5-10m Downwind | 0.2µg/m$^3$ |
| | 10-20m Downwind | 0.2µg/m$^3$ |
| 10/01/2013 | AHB between painting work | <0.2µg/m$^3$ |
| | SW of AHB outside TBS Compound | <0.2µg/m$^3$ |
| | SE of AHB outside Ponsonby Cruising Club | <0.2µg/m$^3$ |
| **TCEQ Short Term Effects Screening level – 1 hour** | | **0.5µg/m$^3$** |

# 6. DISCUSSION

## *Total Dust*

Background concentrations measured when no work was being undertaken varied from below the level of detection on the AHB to an offsite concentration of 140µg/m$^3$ measured at the Ponsonby Cruising Club.

Concentrations measured at the source of abrasive blasting are considered to be high with the maximum recorded concentration of 13,440µg/m$^3$ being measured during blasting works on Pier 5. Blasting was undertaken inside the Pier therefore it was sheltered and represents a worst case scenario. The other at source location (Span 7, Panel Point 9 Apex – East) is more exposed to the atmosphere therefore increased dispersion is expected; this is reflected in the measured concentration being significantly less (8,110µg/m$^3$). Total dust levels decrease considerably with distance from source in a downwind direction. Concentrations measured offsite are significantly lower than those measured on the Bridge with the exception of the sample measured to the SW of the Bridge outside the Climb and Bungy Office.

Environmental Standards for total dust are based on a 24 hour averaging period and the Auckland Council has set out Dust Trigger Levels for the Auckland Region in order to quantify nuisance dust levels. During this monitoring programme one sample was set to run for 24 hours. The sample was located at the south end of the Bridge (Span 7, Panel Point 0) and blasting took place for approximately three hours in that 24 hour period. The concentration measured was below this trigger level for Highly Sensitive Receiving Environments which includes residential areas.

## *Fine Particulate PM$_{10}$*

Background concentrations measured ranged from <1µg/m$^3$ to 2µg/m$^3$. The National Environmental Standard (NES) for PM$_{10}$ is 50µg/m$^3$ averaged over a 24 hour period; therefore, direct comparison to this Standard is not entirely applicable as the data in this report is based on averages less than one hour. For indicative purposes, PM$_{10}$ concentrations measured at source are well above the NES at source but are below 50µg/m$^3$ 10m downwind of the blasting location showing how the concentrations disperse significantly with distance. In addition to this, abrasive blasting work is only undertaken for a part of the working day, therefore levels outside of this time will be significantly lower and therefore the expected concentration over a 24 hour period would be expected to be less than 50µg/m$^3$.
Visual observation on site indicated that measurement of PM$_{10}$ was influenced by wind speed, wind direction, blasting area (i.e. apex or pier), the duration of blasting and the angle of blasting.
The levels of PM$_{10}$ measured at offsite locations were well below the NES.

Emission factors for dry abrasive blasting using Garnet have been used to calculate the mass emission of PM10. These factors were calculated in a controlled environment where painted panels of iron were blasted. The PM10 emission from the AHB is displayed in Table 16.

**Table 16: Particle Size Emission Calculations**

| Particle size (microns) | Cumulative mass (%) | *Garnet use (kg/hr) | Particulate emission rate from AHB operations |
|---|---|---|---|
| 10 | 0.36 | 108 | 0.4 kg/hr |
| 15 | 0.49 | | 0.5 kg/hr |
| 20 | 0.93 | | 1.0 kg/hr |
| 25 | 1.61 | | 1.7 kg/hr |
| 30 | 2.20 | | 2.4 kg/hr |
| 400 | 100.00 | | 108 kg/hr |

*Garnet use calculated from sampling carried out on the 12/02/2013 where 325kg was used over 3 hours

The mass emission of $PM_{10}$ from dry abrasive blasting on the AHB is estimated at 0.4kg/hr.

### *Metals*

The highest metal concentrations were recorded at source, all of which are above relevant Guidelines or Effects Screening Levels. Concentrations decrease with distance downwind from the source. Results are summarised below:

- Chromium concentrations measured 20m downwind of blasting were above the TCEQ Short Term Effects Screening Level
- Chromium concentrations measured offsite were all below the TCEQ Short Term Effects Screening Level.
- Iron concentrations measured 30m downwind of blasting were above the TCEQ Short Term Effects Screening Level.
- Iron concentrations measured offsite were all below the TCEQ Short Term Effects Screening Level.
- Lead levels measured at all locations on the Bridge downwind of blasting were above the Ontario Air Quality Guideline.
- Lead levels measured offsite during work on Span 6 (09/01/2013) were below the Ontario Air Quality Guideline.
- The lead level measured at one offsite location (SW of AHB Climb and Bungy) during work on Span 7 (29/01/2013) was above the Ontario Air Quality Guideline.
- The 24 hour lead level measured at the southern end was below the Ontario Air Quality Guideline.
- Zinc levels measured at all locations on the Bridge downwind of blasting were above the TCEQ Short Term Effects Screening Level.
- Zinc levels measured offsite were below the TCEQ Short Term Effects Screening Level.

Offsite concentrations of metals are dependent on meteorological conditions and the surface coating being blasted. Iron levels measured in the dust are more consistent between locations, but some areas contain a greater proportion of lead, chromium and zinc.

Buffer zones have been calculated by extrapolating data using the most conservative distances measured. Results are displayed in Table 17.

**Table 17: Metals Buffer Zone Calculations**

| Metal | Environmental Standard/Guideline ($\mu g/m^3$) | Maximum concentration Measured ($\mu g/m^3$) | *Calculated decrease in concentration with distance ($\mu g/m^3$ per m) | Required buffer zone (m) |
|---|---|---|---|---|
| Chromium | 3.6 | 40.2 | 0.2 | 183 |
| Iron | 50 | 1035.9 | 20 | 49 |
| Lead | 1.5 | 104.4 | 0.3 | 343 |
| Zinc | 20 | 646.1 | 0.4 | 216 |

*Calculated using the most conservative decrease in concentration measured downwind of the source

Buffer distances are illustrated in Appendix 3.

### *Total Volatile Organic Compounds (TVOC)*

TVOC concentrations are high at source and disperse according to the varying atmospheric conditions which are present on the Bridge. This is evident with varying TVOC concentrations measured at the same locations on the same day. Data indicates that TVOC concentrations decrease rapidly with distance from source. Results are summarised as follows:

- TVOC concentrations resulting from stripe coating are just above background levels
- TVOC concentrations measured from spray painting are high but disperse quickly
- Both strip and spray painting monitored in this exercise resulted in no effect at offsite locations

### *Speciated Volatile Organic Compounds*

Speciated VOC concentrations are high at source and disperse according to the varying atmospheric conditions which are present on the Bridge. Results are summarised as follows:

- Speciated VOCs on the target list were not detected during stripe coating
- The following VOCs on the target list were detected during spray painting:
    - Ethylbenzene
    - Isopropylbenzene
    - 1,2,3-Trimethylbenzene
    - 1,2,4-Trimethylbenzene
    - 1,2,5-Trimethylbenzene
    - Toluene
    - p-Xylene, m-Xylene
    - o-Xylene
    - Methyl isobutyl ketone

Concentrations measured at source were high and above the TCEQ Short Term Effects Screening Levels. Concentrations disperse quickly and are below the TCEQ Short Term Effects Screening Level 5-10m from spray painting with the exception of p-Xylene & m-Xylene which above the ESL 10-20m downwind. This screening level is odour based.

A buffer zone has been calculated for xylene using TVOC results and assuming that all TVOC measured was xylene. Details can be viewed in Table 18.

**Table 18: Xylene Buffer Zone Calculations for Spray Painting**

| VOC | Environmental Standard/Guideline (μg/m$^3$) | Maximum concentration Measured (μg/m$^3$) | *Calculated decrease in concentration with distance (μg/m$^3$ per m) | Required buffer zone (m) |
|---|---|---|---|---|
| Xylenes | 350 | 198,000 | 1,300 | 152 |

Buffer distances are illustrated in Appendix 3.

## *Isocyanates*

Isocyanate concentrations are high at source and disperse according to the varying atmospheric conditions which are present on the Bridge. Results are summarised as follows:

- No isocyanates were detected during stripe coating either on the Bridge or offsite.
- Isocyanate levels detected at source during spray painting were 40 times above the TCEQ Short Term Effects Screening Level.
- Isocyanate levels were detected at 10-20m downwind of spray painting but levels were below the TCEQ Short Term Effects Screening Level

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# APPENDIX 1: DATA SHEETS

## *DUST - INHALABLE*

Industry: AHB

Project Number: 13001

Contaminant: Dust

| Date | Sample number | Location of test point | Time | | Sampling Details | | | Sample mass (mg) | Blank corrected sample mass (mg) | Contaminant Concentration (mg/m$^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | | | |
| 8/01/2013 | 13001 AA1 | SW of AHB outside TBS Compound | 10:19 | 15:13 | 294 | 1.987 | 0.5842 | 0.16 | 0.05 | 0.09 |
| | 13001 AA2 | SE of AHB outside Ponsonby Cruising Club | 10:21 | 15:17 | 296 | 2.001 | 0.5923 | 0.14 | 0.03 | 0.05 |
| | 13001 AA3 | Outside Sitting Duck Café | 10:22 | 15:19 | 297 | 1.991 | 0.5913 | 0.11 | 0.00 | 0.00 |
| | 13001 AA4 | Blank | - | - | - | - | - | 0.11 | - | - |

Industry: AHB
Project Number: 13001
Contaminant: Dust

| Date | Sample number | Location of test point | Time | | Sampling Details | | | Sample mass (mg) | Blank corrected sample mass (mg) | Contaminant Concentration (mg/m$^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | | | |
| 9/01/2013 | 13001 AB1 | SW of AHB outside TBS Compound | 8:22 | 12:31 | 249 | 1.992 | 0.4960 | 0.02 | 0.12 | 0.24 |
| | 13001 AB2 | SE of AHB outside Ponsonby Cruising Club | 8:20 | 12:34 | 254 | 1.993 | 0.5062 | -0.04 | 0.06 | 0.12 |
| | 13001 AA3 | Outside Sitting Duck Café | 8:21 | 12:36 | 255 | 1.998 | 0.5095 | -0.06 | 0.04 | 0.08 |
| | 13001 AA4 | On AHB between blasting locations | 8:17 | 12:43 | 266 | 2.038 | 0.5421 | 0.26 | 0.36 | 0.66 |
| | 13001 AB5 | Blank | - | - | - | - | - | -0.1 | - | - |

Industry: AHB

Project Number: 13001

Contaminant: Dust

| Date | Sample number | Location of test point | Time | | Sampling Details | | | Sample mass (mg) | Blank corrected sample mass (mg) | Contaminant Concentration (mg/m$^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | | | |
| 29/01/2013 | 13001 AC2 | 30m Downwind of Blasting - W (S7 PP5) | 15:38 | 18:01 | 143 | 2.019 | 0.2887 | 0.77 | 0.86 | 2.98 |
| | 13001 AC3 | At Source - Blasting location East Apex S7 PP9 | 15:28 | 18:06 | 158 | 2.06 | 0.3255 | 2.55 | 2.64 | 8.11 |
| | 13001 AC4 | SW of AHB outside TBS Compound | 15:43 | 18:09 | 146 | 2.034 | 0.2970 | 0 | 0.09 | 0.30 |
| | 13001 AC5 | SW of AHB outside Climb and Bungy | 15:47 | 18:10 | 143 | 1.99 | 0.2846 | 0.26 | 0.35 | 1.23 |
| | 13001 AC6 | Southend of Bridge - 24 hour sample | 15:56 | 16:20 | 1464 | 2.012 | 2.9456 | 0.09 | 0.18 | 0.06 |
| | 13001 AC7 | Blank | - | - | - | - | - | -0.09 | - | - |

Industry: AHB

Project Number: 13001

Contaminant: Dust

| Date | Sample number | Location of test point | Time | | Sampling Details | | | Sample mass (mg) | Blank corrected sample mass (mg) | Contaminant Concentration (mg/m$^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | | | |
| 12/02/2013 | 13001 AE1 | Inside Pier 5 - East end on portal | 12:29 | 17:32 | 224 | 1.976 | 0.4426 | 6.49 | 6.48 | 14.64 |
| | 13001 AE2 | Span 5 PP2 North Diagonal - East side. 5-10m Downwind | 15:13 | 17:23 | 183 | 1.878 | 0.3437 | 2.76 | 2.75 | 8.00 |
| | 13001 AE3 | Pier 5 outer arm - East side. 10-20m Downwind | 15:13 | 17:25 | 179 | 1.995 | 0.3571 | 1.93 | 2.01 | 5.63 |
| | 13001 AE4 | Blank | - | - | - | - | - | -0.08 | - | - |
| | | Lab Blank - Button Samplers (AE1 and AE2) | - | - | - | - | - | 0.01 | - | - |

## *ELEMENTS - METALS*

| **Measured Blank Values** | | | |
|---|---|---|---|
| Sample 13001 AE04 | Chromium | 0.1 | µg/sample |
| | Iron | 1.5 | µg/sample |
| | Lead | 0.021 | µg/sample |
| | Zinc | 124 | µg/sample |

**Location: TBS Compound**

| Date | Sample number | Contaminant | Time | | Sampling Details | | | Sample mass (µg) | Blank corrected Sample mass (µg) | Contaminant Concentration (µg.m$^{-3}$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | | | |
| 9/01/2013 | 13001 AB1 | Chromium | 8:22 | 12:31 | 249 | 1.992 | 0.4960 | 0.11 | 0.01 | 0.02 |
| | | Iron | | | | | | 1.7 | 0.2 | 0.4 |
| | | Lead | | | | | | 0.023 | 0.002 | 0.004 |
| | | Zinc | | | | | | 131 | 7 | 14.1 |

**Location: Ponsonby Cruising Club**

| Date | Sample number | Contaminant | Time | | Sampling Details | | | Sample mass (µg) | Blank corrected Sample mass (µg) | Contaminant Concentration (µg.m$^{-3}$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | | | |
| 9/01/2013 | 13001 AB2 | Chromium | 8:20 | 12:34 | 254 | 1.993 | 0.5062 | 0.1 | - | <BLK |
| | | Iron | | | | | | 1.9 | 0.4 | 0.8 |
| | | Lead | | | | | | 0.027 | 0.006 | 0.01 |
| | | Zinc | | | | | | 121 | - | <BLK |

**Location: Sitting Duck Café**

| Date | Sample number | Contaminant | Time | | Sampling Details | | | Sample mass (µg) | Blank corrected Sample mass (µg) | Contaminant Concentration (µg.m$^{-3}$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | | | |
| 9/01/2013 | 13001 AB3 | Chromium | 8:21 | 12:36 | 255 | 1.998 | 0.5095 | 0.12 | 0.02 | 0.04 |
| | | Iron | | | | | | 1.9 | 0.4 | 0.8 |
| | | Lead | | | | | | 0.026 | 0.005 | 0.01 |
| | | Zinc | | | | | | 127 | 3 | 5.9 |

**Location: AHB Between Blasting Locations**

| Date | Sample number | Contaminant | Time | | Sampling Details | | | Sample mass (µg) | Blank corrected Sample mass (µg) | Contaminant Concentration (µg.m$^{-3}$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | | | |
| 9/01/2013 | 13001 AB4 | Chromium | 8:17 | 12:43 | 266 | 2.038 | 0.5421 | 0.21 | 0.11 | 0.2 |
| | | Iron | | | | | | 18.3 | 16.8 | 31.0 |
| | | Lead | | | | | | 0.79 | 0.769 | 1.4 |
| | | Zinc | | | | | | 136 | 12 | 22.1 |

**Location: 30m Downwind**

| Date | Sample number | Contaminant | Time | | Sampling Details | | | Sample mass (µg) | Blank corrected Sample mass (µg) | Contaminant Concentration (µg.m$^{-3}$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | | | |
| 29/01/2013 | 13001 AC2 | Chromium | 15:38 | 18:01 | 143 | 2.019 | 0.2887 | 0.38 | 0.28 | 1.0 |
| | | Iron | | | | | | 40 | 38.5 | 133.3 |
| | | Lead | | | | | | 3.4 | 3.379 | 11.7 |
| | | Zinc | | | | | | 131 | 7 | 24.2 |

**Location: At Source**

| Date | Sample number | Contaminant | Time | | Sampling Details | | | Sample mass (µg) | Blank corrected Sample mass (µg) | Contaminant Concentration (µg.m$^{-3}$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | | | |
| 29/01/2013 | 13001 AC3 | Chromium | 15:28 | 18:06 | 158 | 2.0595 | 0.3254 | 2.5 | 2.4 | 7.4 |
| | | Iron | | | | | | 240 | 238.5 | 732.9 |
| | | Lead | | | | | | 34 | 33.979 | 104.4 |
| | | Zinc | | | | | | 160 | 36.00 | 110.6 |

**Location TBS Compound**

| Date | Sample number | Contaminant | Time | | Sampling Details | | | Sample mass (µg) | Blank corrected Sample mass (µg) | Contaminant Concentration (µg.m$^{-3}$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | | | |
| 29/01/2013 | 13001 AC4 | Chromium | 15:43 | 18:09 | 146 | 2.034 | 0.2970 | 0.11 | 0.01 | 0.03 |
| | | Iron | | | | | | 3.4 | 1.9 | 6.4 |
| | | Lead | | | | | | 0.118 | 0.097 | 0.3 |
| | | Zinc | | | | | | 112 | -12 | <BLK |

**Location: Climb and Bungy**

| Date | Sample number | Contaminant | Time | | Sampling Details | | | Sample mass (µg) | Blank corrected Sample mass (µg) | Contaminant Concentration (µg.m$^{-3}$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | | | |
| 29/01/2013 | 13001 AC5 | Chromium | 15:47 | 18:10 | 143 | 1.99 | 0.2846 | 0.2 | 0.1 | 0.4 |
| | | Iron | | | | | | 12.6 | 11.1 | 39.0 |
| | | Lead | | | | | | 0.79 | 0.769 | 2.7 |
| | | Zinc | | | | | | 137 | 13 | 45.7 |

**Location: South End of Bridge 24 hour sample**

| Date | Sample number | Contaminant | Time | | Sampling Details | | | Sample mass (µg) | Blank corrected Sample mass (µg) | Contaminant Concentration (µg.m$^{-3}$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | | | |
| 29/01/2013 | 13001 AC6 | Chromium | 15:56 | 16:20 | 1464 | 2.012 | 2.9456 | 0.15 | 0.05 | 0.02 |
| | | Iron | | | | | | 5.3 | 3.8 | 1.3 |
| | | Lead | | | | | | 0.181 | 0.16 | 0.05 |
| | | Zinc | | | | | | 130 | 6 | 2.0 |

**Location:** **AHB Background**

| Date | Sample number | Contaminant | Time | | Sampling Details | | | Sample mass (µg) | Blank corrected Sample mass (µg) | Contaminant Concentration (µg.m$^{-3}$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | | | |
| 9/02/2013 | 13001 AD1 | Aluminium | 13:09 | 15:34 | 145 | 2.046 | 0.2967 | 77 | 2 | 6.7 |
| | | Antimony | | | | | | <0.010 | <LOD | <LOD |
| | | Arsenic | | | | | | <0.05 | <LOD | <LOD |
| | | Barium | | | | | | 164 | 7 | 23.6 |
| | | Berylium | | | | | | <0.005 | <LOD | <LOD |
| | | Bismuth | | | | | | <0.005 | <LOD | <LOD |
| | | Boron | | | | | | 132 | 3 | 10.1 |
| | | Bromine | | | | | | <0.3 | <LOD | <LOD |
| | | Cadmium | | | | | | <0.003 | <LOD | <LOD |
| | | Caesium | | | | | | <0.005 | <LOD | <LOD |
| | | Calcium | | | | | | 55 | 9 | 30.3 |
| | | Chromium | | | | | | 0.09 | <BLK | <BLK |
| | | Cobalt | | | | | | <0.010 | <LOD | <LOD |
| | | Copper | | | | | | 0.07 | 0.01 | 0.03 |
| | | Iron | | | | | | 1.6 | 0.1 | 0.3 |
| | | Lanthanum | | | | | | 0.006 | 0.001 | 0.003 |
| | | Lead | | | | | | 0.019 | <BLK | <BLK |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Lithium | | | | | | 0.023 | <BLK | <BLK |
| | | Magnesium | | | | | | 6.9 | 0.6 | 2.0 |
| | | Manganese | | | | | | 0.04 | <BLK | <BLK |
| | | Mercury | | | | | | <0.005 | <LOD | <LOD |
| | | Molybdenum | | | | | | <0.010 | <LOD | <LOD |
| | | Nickel | | | | | | <0.05 | <LOD | <LOD |
| | | Phosphorus | | | | | | <1.0 | <LOD | <LOD |
| | | Potassium | | | | | | 118 | 4 | 13.5 |
| | | Rubidium | | | | | | 0.071 | 0.003 | 0.01 |
| | | Selenium | | | | | | <0.05 | <LOD | <LOD |
| | | Silver | | | | | | <0.005 | <LOD | <LOD |
| | | Sodium | | | | | | 290 | <BLK | <BLK |
| | | Strontium | | | | | | 3.3 | 0.1 | 0.3 |
| | | Sulphur | | | | | | <500 | <LOD | <LOD |
| | | Thallium | | | | | | <0.003 | <LOD | <LOD |
| | | Tin | | | | | | <0.03 | <LOD | <LOD |
| | | Uranium | | | | | | 0.0028 | 0.0009 | 0.003 |
| | | Vanadium | | | | | | <0.3 | <LOD | <LOD |
| | | Zinc | | | | | | 131 | 7 | 23.6 |

**Location: Ponsonby Cruising Club Background**

| Date | Sample number | Contaminant | Time | | Sampling Details | | | Sample mass (µg) | Blank corrected Sample mass (µg) | Contaminant Concentration (µg.m$^{-3}$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | | | |
| 9/02/2013 | 13001 AD2 | Aluminium | 13:14 | 15:39 | 145 | 1.973 | 0.2861 | 61 | <BLK | <BLK |
| | | Antimony | | | | | | <0.010 | <LOD | <LOD |
| | | Arsenic | | | | | | <0.05 | <LOD | <LOD |
| | | Barium | | | | | | 135 | <BLK | <BLK |
| | | Berylium | | | | | | <0.005 | <LOD | <LOD |
| | | Bismuth | | | | | | <0.005 | <LOD | <LOD |
| | | Boron | | | | | | 107 | <BLK | <BLK |
| | | Bromine | | | | | | <0.3 | <LOD | <LOD |
| | | Cadmium | | | | | | <0.003 | <LOD | <LOD |
| | | Caesium | | | | | | <0.005 | <LOD | <LOD |
| | | Calcium | | | | | | 41 | <BLK | <BLK |
| | | Chromium | | | | | | 0.08 | <BLK | <BLK |
| | | Cobalt | | | | | | <0.010 | <LOD | <LOD |
| | | Copper | | | | | | 0.07 | 0.01 | 0.03 |
| | | Iron | | | | | | 1.3 | <BLK | <BLK |
| | | Lanthanum | | | | | | <0.005 | <LOD | <LOD |
| | | Lead | | | | | | 0.017 | <BLK | <BLK |
| | | Lithium | | | | | | 0.017 | <BLK | <BLK |
| | | Magnesium | | | | | | 5.5 | <BLK | <BLK |
| | | Manganese | | | | | | 0.03 | <BLK | <BLK |
| | | Mercury | | | | | | <0.005 | <LOD | <LOD |
| | | Molybdenum | | | | | | <0.010 | <LOD | <LOD |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Nickel | | | | | | <0.05 | <LOD | <LOD |
| | | Phosphorus | | | | | | <1.0 | <LOD | <LOD |
| | | Potassium | | | | | | 96 | <BLK | <BLK |
| | | Rubidium | | | | | | 0.058 | <BLK | <BLK |
| | | Selenium | | | | | | <0.05 | <LOD | <LOD |
| | | Silver | | | | | | <0.005 | <LOD | <LOD |
| | | Sodium | | | | | | 260 | <BLK | <BLK |
| | | Strontium | | | | | | 2.7 | <BLK | <BLK |
| | | Sulphur | | | | | | <500 | <LOD | <LOD |
| | | Thallium | | | | | | <0.003 | <LOD | <LOD |
| | | Tin | | | | | | <0.03 | <LOD | <LOD |
| | | Uranium | | | | | | 0.0016 | <LOD | <LOD |
| | | Vanadium | | | | | | <0.3 | <LOD | <LOD |
| | | Zinc | | | | | | 104 | <BLK | <BLK |

**Location:** **At Source P5**

| Date | Sample number | Contaminant | Time | | Sampling Details | | | Sample mass (µg) | Blank corrected Sample mass (µg) | Contaminant Concentration (µ.m$^{-3}$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | | | |
| 12/02/2013 | 13001 AE1 | Aluminium | 12:29 | 17:32 | 224 | 1.976 | 0.4426 | 96 | 21 | 47.4 |
| | | Antimony | | | | | | 0.02 | 0.01 | 0.02 |
| | | Arsenic | | | | | | 0.18 | 0.13 | 0.3 |
| | | Barium | | | | | | 57 | <BLK | <BLK |
| | | Berylium | | | | | | <0.005 | <LOD | <LOD |
| | | Bismuth | | | | | | <0.005 | <LOD | <LOD |
| | | Boron | | | | | | 44 | <BLK | <BLK |
| | | Bromine | | | | | | <0.3 | <LOD | <LOD |
| | | Cadmium | | | | | | 0.092 | 0.089 | 0.2 |
| | | Caesium | | | | | | <0.005 | <LOD | <LOD |
| | | Calcium | | | | | | 88 | 42 | 94.9 |
| | | Chromium | | | | | | 17.9 | 17.8 | 40.2 |
| | | Cobalt | | | | | | 0.33 | 0.32 | 0.7 |
| | | Copper | | | | | | 1 | 0.94 | 2.1 |
| | | Iron | | | | | | 460 | 458.5 | 1035.9 |
| | | Lanthanum | | | | | | 0.154 | 0.149 | 0.3 |
| | | Lead | | | | | | 3.5 | 3.479 | 7.9 |
| | | Lithium | | | | | | 0.036 | 0.012 | 0.03 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Magnesium | | | | | | 34 | 27.7 | 62.6 |
| | | Manganese | | | | | | 6.2 | 6.16 | 13.9 |
| | | Mercury | | | | | | 0.01 | 0.005 | 0.01 |
| | | Molybdenum | | | | | | 0.12 | 0.11 | 0.2 |
| | | Nickel | | | | | | 0.48 | 0.43 | 1.0 |
| | | Phosphorus | | | | | | 3 | 2 | 4.5 |
| | | Potassium | | | | | | 64 | <BLK | <BLK |
| | | Rubidium | | | | | | 0.088 | 0.02 | 0.05 |
| | | Selenium | | | | | | 0.05 | <BLK | <BLK |
| | | Silver | | | | | | 0.008 | 0.003 | 0.007 |
| | | Sodium | | | | | | 151 | <BLK | <BLK |
| | | Strontium | | | | | | 1.41 | <BLK | <BLK |
| | | Sulphur | | | | | | <500 | <LOD | <LOD |
| | | Thallium | | | | | | <0.003 | <LOD | <LOD |
| | | Tin | | | | | | 0.14 | 0.11 | 0.2 |
| | | Uranium | | | | | | 0.0052 | 0.0033 | 0.007 |
| | | Vanadium | | | | | | <0.3 | <LOD | <LOD |
| | | Zinc | | | | | | 410 | 286 | 646.1 |

**Location: 5-10m Downwind**

| Date | Sample number | Contaminant | Time On | Time Off | Sampling Details: Minutes on | Sampling Details: Flow rate (L/min) | Sampling Details: Volume ($m^3$) | Sample mass (µg) | Blank corrected Sample mass (µg) | Contaminant Concentration ($\mu g.m^{-3}$) |
|---|---|---|---|---|---|---|---|---|---|---|
| 12/02/2013 | 13001 AE2 | Aluminium | 12:47 | 17:23 | 183 | 1.898 | 0.3473 | 64 | <BLK | <BLK |
| | | Antimony | | | | | | <0.010 | <LOD | <LOD |
| | | Arsenic | | | | | | <0.05 | <LOD | <LOD |
| | | Barium | | | | | | 92 | <BLK | <BLK |
| | | Berylium | | | | | | <0.005 | <LOD | <LOD |
| | | Bismuth | | | | | | <0.005 | <LOD | <LOD |
| | | Boron | | | | | | 74 | <BLK | <BLK |
| | | Bromine | | | | | | <0.3 | <LOD | <LOD |
| | | Cadmium | | | | | | 0.038 | 0.035 | 0.1 |
| | | Caesium | | | | | | <0.005 | <LOD | <LOD |
| | | Calcium | | | | | | 56 | 10 | 28.8 |
| | | Chromium | | | | | | 8.3 | 8.2 | 23.6 |
| | | Cobalt | | | | | | 0.126 | 0.026 | 0.07 |
| | | Copper | | | | | | 0.35 | 0.29 | 1.0 |
| | | Iron | | | | | | 189 | 187.5 | 539.8 |
| | | Lanthanum | | | | | | 0.065 | 0.06 | 0.2 |
| | | Lead | | | | | | 1.31 | 1.289 | 3.7 |
| | | Lithium | | | | | | 0.025 | 0.001 | 0.003 |
| | | Magnesium | | | | | | 16.6 | 10.3 | 29.7 |
| | | Manganese | | | | | | 2.2 | 2.16 | 6.2 |
| | | Mercury | | | | | | <0.005 | <LOD | <LOD |
| | | Molybdenum | | | | | | 0.035 | 0.025 | 0.07 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Nickel | | | | | 0.15 | 0.1 | 0.3 |
| | | Phosphorus | | | | | <1.0 | <LOD | <LOD |
| | | Potassium | | | | | 80 | <BLK | <BLK |
| | | Rubidium | | | | | 0.072 | 0.004 | 0.01 |
| | | Selenium | | | | | <0.05 | <LOD | <LOD |
| | | Silver | | | | | 0.007 | 0.002 | 0.006 |
| | | Sodium | | | | | 210 | <BLK | <BLK |
| | | Strontium | | | | | 1.94 | <BLK | <BLK |
| | | Sulphur | | | | | <500 | <LOD | <LOD |
| | | Thallium | | | | | <0.003 | <LOD | <LOD |
| | | Tin | | | | | 0.05 | 0.02 | 0.06 |
| | | Uranium | | | | | 0.0026 | 0.0007 | 0.002 |
| | | Vanadium | | | | | <0.3 | <LOD | <LOD |
| | | Zinc | | | | | 210 | 86 | 247.6 |

**Location: 20-30m Downwind**

| Date | Sample number | Contaminant | Time | | Sampling Details | | | Sample mass (µg) | Blank corrected Sample mass (µg) | Contaminant Concentration (µg.m$^{-3}$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | | | |
| 12/02/2013 | 13001 AE3 | Aluminium | 12:53 | 17:25 | 179 | 1.995 | 0.3571 | 66 | <BLK | 0.2 |
| | | Antimony | | | | | | <0.010 | <LOD | <LOD |
| | | Arsenic | | | | | | <0.05 | <LOD | <LOD |
| | | Barium | | | | | | 114 | <BLK | <BLK |
| | | Berylium | | | | | | <0.005 | <LOD | <LOD |
| | | Bismuth | | | | | | <0.005 | <LOD | <LOD |
| | | Boron | | | | | | 87 | <BLK | <BLK |
| | | Bromine | | | | | | <0.3 | <LOD | <LOD |
| | | Cadmium | | | | | | 0.027 | 0.024 | 0.07 |
| | | Caesium | | | | | | <0.005 | <LOD | <LOD |
| | | Calcium | | | | | | 57 | 11 | 30.8 |
| | | Chromium | | | | | | 8.1 | 8 | 22.4 |
| | | Cobalt | | | | | | 0.099 | 0.089 | 0.2 |
| | | Copper | | | | | | 0.27 | 0.21 | 0.8 |
| | | Iron | | | | | | 114 | 112.5 | 315.0 |
| | | Lanthanum | | | | | | 0.041 | 0.036 | 0.1 |
| | | Lead | | | | | | 1 | 0.979 | 2.7 |
| | | Lithium | | | | | | 0.022 | <BLK | <BLK |
| | | Magnesium | | | | | | 11.8 | 5.5 | 15.4 |
| | | Manganese | | | | | | 1.27 | 1.23 | 3.4 |
| | | Mercury | | | | | | <0.005 | <LOD | <LOD |
| | | Molybdenum | | | | | | 0.024 | 0.014 | 0.04 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Nickel | | | | | | 0.09 | 0.04 | 0.1 |
| | | Phosphorus | | | | | | <1.0 | <LOD | <LOD |
| | | Potassium | | | | | | 89 | <BLK | <BLK |
| | | Rubidium | | | | | | 0.064 | <BLK | <BLK |
| | | Selenium | | | | | | <0.05 | <LOD | <LOD |
| | | Silver | | | | | | <0.005 | <LOD | <LOD |
| | | Sodium | | | | | | 230 | <BLK | <BLK |
| | | Strontium | | | | | | 2.4 | <BLK | <BLK |
| | | Sulphur | | | | | | <500 | <LOD | <LOD |
| | | Thallium | | | | | | <0.003 | <LOD | <LOD |
| | | Tin | | | | | | 0.03 | <BLK | <BLK |
| | | Uranium | | | | | | 0.0024 | 0.0005 | 0.001 |
| | | Vanadium | | | | | | <0.3 | <BLK | <BLK |
| | | Zinc | | | | | | 187 | 63 | 176.4 |

***SPECIATED VOC***

All results corrected to 25ºC and 1 atmosphere pressure

18/02/2013 Pm = 1023 HPa

Pm = 767 mmHg

**Location: At Source**

| Date | Sample number | | Contaminant | Time | | Sampling Details | | | | Sample mass (µg) | Contaminant Concentration ($mg/m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | On | Off | Minutes on | Flow rate (L/min) | Volume ($m^3$) | Ambient temp (°K) | | |
| 18/02/2013 | 13001 | CC1 | Ethylbenzene | 13:40 | 15:02 | 82 | 0.1984 | 0.0163 | 294 | 216 | 13.0 |
| | | | Isopropylbenzene | | | | | | | 8 | 0.5 |
| | | | 1,2,3-Trimethylbenzene | | | | | | | 18 | 1.1 |
| | | | 1,2,4-Trimethylbenzene | | | | | | | 114 | 6.8 |
| | | | 1,2,5-Trimethylbenzene | | | | | | | 31 | 1.9 |
| | | | Toluene | | | | | | | 11 | 0.7 |
| | | | p-Xylene, m-Xylene | | | | | | | 897 | 53.9 |
| | | | o-Xylene | | | | | | | 335 | 20.1 |
| | | | Methyl isobutyl ketone | | | | | | | 159 | 9.5 |

**Location:** **Pier 5 - Mixing Area (7m from source)**

| Date | Sample number | | Contaminant | Time | | Sampling Details | | | | Sample mass (μg) | Contaminant Concentration (mg/m$^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | Ambient temp (°K) | | |
| 18/02/2013 | 13001 | CC2 | Ethylbenzene | 13:47 | 15:04 | 77 | 0.2223 | 0.0171 | 294 | 3 | 0.2 |
| | | | 1,2,4-Trimethylbenzene | | | | | | | 1 | 0.1 |
| | | | p-Xylene, m-Xylene | | | | | | | 16 | 0.9 |
| | | | o-Xylene | | | | | | | 6 | 0.3 |
| | | | Methyl isobutyl ketone | | | | | | | 7 | 0.4 |

**Location:** **5-10m Downwind**

| Date | Sample number | | Contaminant | Time | | Sampling Details | | | | Sample mass (μg) | Contaminant Concentration (mg/m$^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | Ambient temp (°K) | | |
| 18/02/2013 | 13001 | CC3 | Ethylbenzene | 13:47 | 15:15 | 88 | 0.1997 | 0.0176 | 294 | 3 | 0.2 |
| | | | 1,2,4-Trimethylbenzene | | | | | | | 1 | 0.1 |
| | | | p-Xylene, m-Xylene | | | | | | | 16 | 0.9 |
| | | | o-Xylene | | | | | | | 6 | 0.3 |
| | | | 2-Methylbutane | | | | | | | 44 | 2.4 |

**Location:** **20m Downwind**

| Date | Sample number | | Contaminant | Time | | Sampling Details | | | | Sample mass (µg) | Contaminant Concentration (mg/m$^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | Ambient temp (°K) | | |
| 18/02/2013 | 13001 | CC4 | Ethylbenzene | 13:47 | 15:20 | 93 | 0.198 | 0.0184 | 294 | 2 | 0.1 |
| | | | 1,2,4-Trimethylbenzene | | | | | | | 1 | 0.1 |
| | | | p-Xylene, m-Xylene | | | | | | | 15 | 0.8 |
| | | | o-Xylene | | | | | | | 5 | 0.3 |

**Location:** **30m Downwind**

| Date | Sample number | | Contaminant | Time | | Sampling Details | | | | Sample mass (µg) | Contaminant Concentration (mg/m$^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | Ambient temp (°K) | | |
| 18/02/2013 | 13001 | CC5 | Ethylbenzene | 13:47 | 15:30 | 103 | 0.2075 | 0.0214 | 294 | 2 | 0.1 |
| | | | 1,2,4-Trimethylbenzene | | | | | | | 1 | 0.0 |
| | | | p-Xylene, m-Xylene | | | | | | | 15 | 0.7 |
| | | | o-Xylene | | | | | | | 5 | 0.2 |

***ISOCYANATES***

| Date | Sample number | Location of test point | Time | | Sampling Details | | | | Sample mass (µg) | Blank/Spike corrected Sample mass (µg) | Contaminant Concentration (mg/m$^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | Ambient temp (°K) | | | |
| 18/02/2013 | 13001 BC1 | At source - inside Pier 5 | 13:40 | 15:02 | 82 | 1.031 | 0.0845 | 294 | 1.74 | 1.74 | 0.0201 |
| | 13001 BC2 | West end of Pier 5 - near mixing area/work station | 13:47 | 15:04 | 77 | 1.054 | 0.0812 | 294 | <0.02 | <0.02 | <0.0002 |
| | 13001 BC3 | 5-10m downwind (west walkway) | 13:47 | 15:15 | 88 | 1.068 | 0.0940 | 294 | 0.02 | 0.02 | 0.0002 |
| | 13001 BC4 | 20m downwind (west walkway) | 13:47 | 15:20 | 93 | 1.047 | 0.0974 | 294 | 0.02 | 0.02 | 0.0002 |

## APPENDIX 2: ANALYTICAL REPORTS

### *DUST - INHALABLE*

Sampling Date: 08/01/2013

| Sample Type: IOM sampler containing filter and foam insert - Inhalable Dust | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sample Number | 13001AA1 | 13001AA2 | 13001AA3 | 13001AA4 | | | | |
| Initial weight of filter prior to collection (g) | 1.15878 | 1.15895 | 1.15627 | 1.15909 | | | | |
| Final weight of filter after collection (g) | 1.15894 | 1.15909 | 1.15638 | 1.1592 | | | | |
| Net weight gain due to particulate matter (g) | 0.00016 | 0.00014 | 0.00011 | 0.00011 | | | | |
| Conversion to milligrams (mg) | 0.16 | 0.14 | 0.11 | 0.11 | | | | |

Pre Weigh Filters: HET
Date: 14/12/2012

Post Weigh Filters: RJM
Date: 11/01/2013

Sampling Date: 09/01/2013

| Sample Type: IOM sampler containing filter and foam insert - Inhalable Dust | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sample Number | 13001AB1 | 13001AB2 | 13001AB3 | 13001AB4 | 13001AB5 | | | |
| Initial weight of filter prior to collection (g) | 1.16491 | 1.167 | 1.16599 | 1.16375 | 1.16558 | | | |
| Final weight of filter after collection (g) | 1.16493 | 1.16696 | 1.16593 | 1.16401 | 1.16548 | | | |
| Net weight gain due to particulate matter (g) | 0.00002 | -0.00004 | -0.00006 | 0.00026 | -0.00010 | | | |
| Conversion to milligrams (mg) | 0.02 | -0.04 | -0.06 | 0.26 | -0.1 | | | |

Pre Weigh Filters: RJM
Date: 21/12/2012

Post Weigh Filters: RJM
Date: 11/01/2013

| Sampling Date: 29/01/2013 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sample Type: IOM sampler containing filter and foam insert - Inhalable Dust | | | | | | | | |
| Sample Number | 13001AC1 | 13001AC2 | 13001AC3 | 13001AC4 | 13001AC5 | 13001AC6 | 13001AC7 | |
| Initial weight of filter prior to collection (g) | 1.16097 | 1.16881 | 0.0317 | 1.15933 | 1.15982 | 1.15925 | 1.16193 | |
| Final weight of filter after collection (g) | 1.16916 | 1.16958 | 0.03425 | 1.15933 | 1.16008 | 1.15934 | 1.16184 | |
| Net weight gain due to particulate matter (g) | 0.00819 | 0.00077 | 0.00255 | 0.00000 | 0.00026 | 0.00009 | -0.00009 | |
| Conversion to milligrams (mg) | 8.19 | 0.77 | 2.55 | 0.00 | 0.26 | 0.09 | -0.09 | |

Pre Weigh Filters: RJM
Date: 21/12/2012, 22/01/2013, 23/01/2013

Post Weigh Filters: RJM
Date: 11/01/2013

Sampling Date: 08/02/2013

| Sample Type: IOM sampler containing filter and foam insert - Inhalable Dust | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sample Number | 13001AD1 | 13001AD2 | 13001AD3 | | | | |
| Initial weight of filter prior to collection (g) | 1.15847 | 1.16136 | 1.15841 | | | | |
| Final weight of filter after collection (g) | 1.15837 | 1.16143 | 1.15844 | | | | |
| Net weight gain due to particulate matter (g) | -0.00010 | 0.00007 | 0.00003 | | | | |
| Conversion to milligrams (mg) | -0.1 | 0.07 | 0.03 | | | | |

Pre Weigh Filters: RJM
Date: 22/01/2013

Post Weigh Filters: RJM
Date: 11/01/2013

Sampling Date: 12/02/2013

| Sample Type: IOM sampler containing filter and foam insert - Inhalable Dust | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sample Number | 13001AE1 | 13001AE2 | 13001AE3 | 13001AE4 | B BLANK | | |
| Initial weight of filter prior to collection (g) | 0.03196 | 0.03216 | 1.16028 | 1.15851 | 0.03176 | | |
| Final weight of filter after collection (g) | 0.03845 | 0.03492 | 1.16221 | 1.15843 | 0.03177 | | |
| Net weight gain due to particulate matter (g) | 0.00649 | 0.00276 | 0.00193 | -0.00008 | 0.00001 | | |
| Conversion to milligrams (mg) | 6.49 | 2.76 | 1.93 | -0.08 | 0.01 | | |

Pre Weigh Filters: RJM
Date: 23/01/2013

Post Weigh Filters: RJM
Date: 14/02/2013

## ELEMENTS - METALS

**Hill Laboratories**
BETTER TESTING **BETTER RESULTS**

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Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

# ANALYSIS REPORT



| | | | |
|---|---|---|---|
| **Client:** | Air Matters Limited | **Lab No:** | 1103531 SPv1 |
| **Contact:** | Robert Murray | **Date Registered:** | 23-Feb-2013 |
| | C/- Air Matters Limited | **Date Reported:** | 12-Mar-2013 |
| | PO Box 96 256 | **Quote No:** | |
| | Balmoral | **Order No:** | |
| | AUCKLAND 1342 | **Client Reference:** | |
| | | **Submitted By:** | Robert Murray |

**Sample Type: Miscellaneous filter type less than 50 mm diameter**

| | **Sample Name:** | 13001 AB1 | 13001 AB2 | 13001 AB3 | 13001 AB4 | 13001 AC2 29-Jan-2013 |
|---|---|---|---|---|---|---|
| | **Lab Number:** | 1103531.1 | 1103531.2 | 1103531.3 | 1103531.4 | 1103531.5 |
| Chromium | µg/sample | 0.11 | 0.10 | 0.12 | 0.21 | 0.38 |
| Iron | µg/sample | 1.7 | 1.9 | 1.9 | 18.3 | 40 |
| Lead | µg/sample | 0.023 | 0.027 | 0.026 | 0.79 | 3.4 |
| Zinc | µg/sample | 131 | 121 | 127 | 136 | 131 |

| | **Sample Name:** | 13001 AC3 29-Jan-2013 | 13001 AC4 29-Jan-2013 | 13001 AC5 29-Jan-2013 | 13001 AC6 29-Jan-2013 | 13001 AD1 08-Feb-2013 |
|---|---|---|---|---|---|---|
| | **Lab Number:** | 1103531.6 | 1103531.7 | 1103531.8 | 1103531.9 | 1103531.10 |
| Aluminium | µg/sample | - | - | - | - | 77 |
| Antimony | µg/sample | - | - | - | - | < 0.010 |
| Arsenic | µg/sample | - | - | - | - | < 0.05 |
| Barium | µg/sample | - | - | - | - | 164 |
| Beryllium | µg/sample | - | - | - | - | < 0.005 |
| Bismuth | µg/sample | - | - | - | - | < 0.005 |
| Boron | µg/sample | - | - | - | - | 132 |
| Bromine | µg/sample | - | - | - | - | < 0.3 |
| Cadmium | µg/sample | - | - | - | - | < 0.003 |
| Caesium | µg/sample | - | - | - | - | < 0.005 |
| Calcium | µg/sample | - | - | - | - | 55 |
| Chromium | µg/sample | 2.5 | 0.11 | 0.20 | 0.15 | 0.09 |
| Cobalt | µg/sample | - | - | - | - | < 0.010 |
| Copper | µg/sample | - | - | - | - | 0.07 |
| Iron | µg/sample | 240 | 3.4 | 12.6 | 5.3 | 1.6 |
| Lanthanum | µg/sample | - | - | - | - | 0.006 |
| Lead | µg/sample | 34 | 0.118 | 0.79 | 0.181 | 0.019 |
| Lithium | µg/sample | - | - | - | - | 0.023 |
| Magnesium | µg/sample | - | - | - | - | 6.9 |
| Manganese | µg/sample | - | - | - | - | 0.04 |
| Mercury | µg/sample | - | - | - | - | < 0.005 |
| Molybdenum | µg/sample | - | - | - | - | < 0.010 |
| Nickel | µg/sample | - | - | - | - | < 0.05 |
| Phosphorus | µg/sample | - | - | - | - | < 1.0 |
| Potassium | µg/sample | - | - | - | - | 118 |
| Rubidium | µg/sample | - | - | - | - | 0.071 |
| Selenium | µg/sample | - | - | - | - | < 0.05 |
| Silver | µg/sample | - | - | - | - | < 0.005 |
| Sodium | µg/sample | - | - | - | - | 290 |
| Strontium | µg/sample | - | - | - | - | 3.3 |
| Sulphur | µg/sample | - | - | - | - | < 500 |
| Thallium | µg/sample | - | - | - | - | < 0.003 |
| Tin | µg/sample | - | - | - | - | < 0.03 |
| Uranium | µg/sample | - | - | - | - | 0.0028 |

| Sample Type: Miscellaneous filter type less than 50 mm diameter | | | | | | |
|---|---|---|---|---|---|---|
| | **Sample Name:** | 13001 AC3 29-Jan-2013 | 13001 AC4 29-Jan-2013 | 13001 AC5 29-Jan-2013 | 13001 AC6 29-Jan-2013 | 13001 AD1 08-Feb-2013 |
| | **Lab Number:** | 1103531.6 | 1103531.7 | 1103531.8 | 1103531.9 | 1103531.10 |
| Vanadium | µg/sample | - | - | - | - | < 0.3 |
| Zinc | µg/sample | 160 | 112 | 137 | 130 | 131 |

| | **Sample Name:** | 13001 AD2 08-Feb-2013 | 13001 AE01 12-Feb-2013 | 13001 AE02 12-Feb-2013 | 13001 AE03 12-Feb-2013 | 13001 AE04 Blank 12-Feb-2013 |
|---|---|---|---|---|---|---|
| | **Lab Number:** | 1103531.11 | 1103531.12 | 1103531.13 | 1103531.14 | 1103531.15 |
| Aluminium | µg/sample | 61 | 96 | 64 | 66 | 75 |
| Antimony | µg/sample | < 0.010 | 0.020 | < 0.010 | < 0.010 | < 0.010 |
| Arsenic | µg/sample | < 0.05 | 0.18 | < 0.05 | < 0.05 | < 0.05 |
| Barium | µg/sample | 135 | 57 | 92 | 114 | 157 |
| Beryllium | µg/sample | < 0.005 | < 0.005 | < 0.005 | < 0.005 | < 0.005 |
| Bismuth | µg/sample | < 0.005 | < 0.005 | < 0.005 | < 0.005 | < 0.005 |
| Boron | µg/sample | 107 | 44 | 74 | 87 | 129 |
| Bromine | µg/sample | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 |
| Cadmium | µg/sample | < 0.003 | 0.092 | 0.038 | 0.027 | < 0.003 |
| Caesium | µg/sample | < 0.005 | < 0.005 | < 0.005 | < 0.005 | < 0.005 |
| Calcium | µg/sample | 41 | 88 | 56 | 57 | 46 |
| Chromium | µg/sample | 0.08 | 17.9 | 8.3 | 8.1 | 0.10 |
| Cobalt | µg/sample | < 0.010 | 0.33 | 0.126 | 0.099 | < 0.010 |
| Copper | µg/sample | 0.07 | 1.00 | 0.35 | 0.27 | 0.06 |
| Iron | µg/sample | 1.3 | 460 | 189 | 114 | 1.5 |
| Lanthanum | µg/sample | < 0.005 | 0.154 | 0.065 | 0.041 | 0.005 |
| Lead | µg/sample | 0.017 | 3.5 | 1.31 | 1.00 | 0.021 |
| Lithium | µg/sample | 0.017 | 0.036 | 0.025 | 0.022 | 0.024 |
| Magnesium | µg/sample | 5.5 | 34 | 16.6 | 11.8 | 6.3 |
| Manganese | µg/sample | 0.03 | 6.2 | 2.2 | 1.27 | 0.04 |
| Mercury | µg/sample | < 0.005 | 0.010 | < 0.005 | < 0.005 | < 0.005 |
| Molybdenum | µg/sample | < 0.010 | 0.120 | 0.035 | 0.024 | < 0.010 |
| Nickel | µg/sample | < 0.05 | 0.48 | 0.15 | 0.09 | < 0.05 |
| Phosphorus | µg/sample | < 1.0 | 3.0 | < 1.0 | < 1.0 | < 1.0 |
| Potassium | µg/sample | 96 | 64 | 80 | 89 | 114 |
| Rubidium | µg/sample | 0.058 | 0.088 | 0.072 | 0.064 | 0.068 |
| Selenium | µg/sample | < 0.05 | 0.05 | < 0.05 | < 0.05 | < 0.05 |
| Silver | µg/sample | < 0.005 | 0.008 | 0.007 | < 0.005 | < 0.005 |
| Sodium | µg/sample | 260 | 151 | 210 | 230 | 290 |
| Strontium | µg/sample | 2.7 | 1.41 | 1.94 | 2.4 | 3.2 |
| Sulphur | µg/sample | < 500 | < 500 | < 500 | < 500 | < 500 |
| Thallium | µg/sample | < 0.003 | < 0.003 | < 0.003 | < 0.003 | < 0.003 |
| Tin | µg/sample | < 0.03 | 0.14 | 0.05 | 0.03 | < 0.03 |
| Uranium | µg/sample | 0.0016 | 0.0052 | 0.0026 | 0.0024 | 0.0019 |
| Vanadium | µg/sample | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 |
| Zinc | µg/sample | 104 | 410 | 210 | 187 | 124 |

# SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

**Sample Type: Miscellaneous filter type less than 50 mm diameter**

| Test | Method Description | Default Detection Limit | Samples |
|---|---|---|---|
| Aluminium | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 0.2 µg/sample | 10-15 |
| Antimony | Modified aqua regia digestion of client filter, analysis by ICP-MS (see NIOSH 7303). In-house based on NIOSH Method 7303, issue 1 (modified). | 0.010 µg/sample | 10-15 |
| Arsenic | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 0.05 µg/sample | 10-15 |
| Barium | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 0.005 µg/sample | 10-15 |
| Beryllium | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 0.005 µg/sample | 10-15 |

| Sample Type: Miscellaneous filter type less than 50 mm diameter | | | |
|---|---|---|---|
| **Test** | **Method Description** | **Default Detection Limit** | **Samples** |
| Bismuth | Modified aqua regia digestion of client filter, analysis by ICP-MS (see NIOSH 7303). In-house based on NIOSH Method 7303, issue 1 (modified). | 0.005 µg/sample | 10-15 |
| Boron | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 0.3 µg/sample | 10-15 |
| Bromine | Modified aqua regia digestion of client filter, analysis by ICP-MS (not listed by NIOSH 7303). In-house based on NIOSH Method 7303, issue 1 (modified). | 0 µg/sample | 10-15 |
| Cadmium | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 0.0010 µg/sample | 10-15 |
| Caesium | Modified aqua regia digestion of client filter, analysis by ICP-MS (not listed by NIOSH 7303). In-house based on NIOSH Method 7303, issue 1 (modified). | 0.005 µg/sample | 10-15 |
| Calcium | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 3 µg/sample | 10-15 |
| Chromium | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 0.05 µg/sample | 1-15 |
| Cobalt | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 0.010 µg/sample | 10-15 |
| Copper | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 0.03 µg/sample | 10-15 |
| Iron | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 1.0 µg/sample | 1-15 |
| Lanthanum | Modified aqua regia digestion of client filter, analysis by ICP-MS (not listed by NIOSH 7303). In-house based on NIOSH Method 7303, issue 1 (modified). | 0.005 µg/sample | 10-15 |
| Lead | Modified aqua regia digestion of client filter, analysis by ICP-MS (see NIOSH 7303). In-house based on NIOSH Method 7303, issue 1 (modified). | 0.005 µg/sample | 1-15 |
| Lithium | Modified aqua regia digestion of client filter, analysis by ICP-MS (not listed by NIOSH 7303). In-house based on NIOSH Method 7303, issue 1 (modified). | 0.010 µg/sample | 10-15 |
| Magnesium | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 1.0 µg/sample | 10-15 |
| Manganese | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 0.010 µg/sample | 10-15 |
| Mercury | Modified aqua regia digestion of client filter, analysis by ICP-MS (not listed by NIOSH 7303). In-house based on NIOSH Method 7303, issue 1 (modified). | 0.005 µg/sample | 10-15 |
| Molybdenum | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 0.010 µg/sample | 10-15 |
| Nickel | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 0.05 µg/sample | 10-15 |
| Phosphorus | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 1.0 µg/sample | 10-15 |
| Potassium | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 3 µg/sample | 10-15 |
| Rubidium | Modified aqua regia digestion of client filter, analysis by ICP-MS (not listed by NIOSH 7303). In-house based on NIOSH Method 7303, issue 1 (modified). | 0.005 µg/sample | 10-15 |
| Selenium | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 0.010 µg/sample | 10-15 |
| Silver | Modified aqua regia digestion of client filter, analysis by ICP-MS (not listed by NIOSH 7303). In-house based on NIOSH Method 7303, issue 1 (modified). | 0.005 µg/sample | 10-15 |
| Sodium | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 1.0 µg/sample | 10-15 |
| Strontium | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 0.03 µg/sample | 10-15 |
| Sulphur | Modified aqua regia digestion of client filter, analysis by ICP-MS (not listed by NIOSH 7303). In-house based on NIOSH Method 7303, issue 1 (modified). | 0 µg/sample | 10-15 |
| Thallium | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 0.003 µg/sample | 10-15 |
| Tin | Modified aqua regia digestion of client filter, analysis by ICP-MS (see NIOSH 7303). In-house based on NIOSH Method 7303, issue 1 (modified). | 0.03 µg/sample | 10-15 |
| Uranium | Modified aqua regia digestion of client filter, analysis by ICP-MS (not listed by NIOSH 7303). In-house based on NIOSH Method 7303, issue 1 (modified). | 0.0010 µg/sample | 10-15 |

| Sample Type: Miscellaneous filter type less than 50 mm diameter | | | |
|---|---|---|---|
| **Test** | **Method Description** | **Default Detection Limit** | **Samples** |
| Vanadium | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 0.3 µg/sample | 10-15 |
| Zinc | Modified aqua regia digestion of client filter, analysis by ICP-MS. In-house based on NIOSH Method 7303, issue 1 (modified). | 0.05 µg/sample | 1-15 |

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.



Graham Corban MSc Tech (Hons)
Client Services Manager - Environmental Division

## *SPECIATED VOC*

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CHEMICAL ANALYSIS BRANCH

WORKCOVER NEW SOUTH WALES

Robert Murray
Air Matters Ltd
PO Box 96-256 BALMORAL
AUCKLAND 1342

**Lab. Reference:** 2013-0356

**SAMPLE ORIGIN:** Air Matters Ltd

**DATE OF INVESTIGATION:** 10/01/2013 **DATE RECEIVED:** 25/02/13

**ANALYSIS REQUIRED:** Volatile Organic Compounds

**REPORT OF ANALYSIS**

See attached sheet(s) for sample description and test results.

The results of this report have been approved by the NATA signatory whose signature appears below.

For all administrative or account details please contact Sue Northover or Jeanine Wells.

M Mazereeuw

Martin Mazereeuw
Manager

**Date:** 14/03/13

**TestSafe Australia** – *Chemical Analysis Branch*
ABN 77 682 742 966 5A Pioneer Avenue Thornleigh NSW 2120 AUSTRALIA
Telephone: 61 2 9473 4000 Facsimile: 61 2 9980 6849 Email: lab@workcover.nsw.gov.au
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## *Analysis of Volatile Organic Compounds in Workplace Air by GC/MS*

**Client : Robert Murray** — **Date Sampled : 10-Jan-2013**

**Sample ID : 13001 CA1** — **Reference Number : 2013-0356-1F**

| No | Compounds | CAS No | Front (µg/section) | Back (µg/section) | No | Compounds | CAS No | Front (µg/section) | Back (µg/section) |
|---|---|---|---|---|---|---|---|---|---|
| | **Aliphatic hydrocarbons** (LOD = 5µg/compound/section) | | | | | **Aromatic hydrocarbons** (LOD = 1µg/compound/section) | | | |
| 1 | 2-Methylbutane | 78-78-4 | ND | ND | 39 | Benzene | 71-43-2 | ND | ND |
| 2 | n-Pentane | 109-66-0 | ND | ND | 40 | Ethylbenzene | 100-41-4 | ND | ND |
| 3 | 2-Methylpentane | 107-83-5 | ND | ND | 41 | Isopropylbenzene | 98-82-8 | ND | ND |
| 4 | 3-Methylpentane | 96-14-0 | ND | ND | 42 | 1,2,3-Trimethylbenzene | 526-73-8 | ND | ND |
| 5 | Cyclopentane | 287-92-3 | ND | ND | 43 | 1,2,4-Trimethylbenzene | 95-63-6 | ND | ND |
| 6 | Methylcyclopentane | 96-37-7 | ND | ND | 44 | 1,3,5-Trimethylbenzene | 108-67-8 | ND | ND |
| 7 | 2,3-Dimethylpentane | 565-59-3 | ND | ND | 45 | Styrene | 100-42-5 | ND | ND |
| 8 | n-Hexane | 110-54-3 | ND | ND | 46 | Toluene | 108-88-3 | ND | ND |
| 9 | 3-Methylhexane | 589-34-4 | ND | ND | 47 | p-Xylene &/or m-Xylene | 106-42-3 & 108-38-3 | ND | ND |
| 10 | Cyclohexane | 110-8-27 | ND | ND | 48 | o-Xylene | 95-47-6 | ND | ND |
| 11 | Methylcyclohexane | 108-87-2 | ND | ND | | **Ketones** (LOD #49, #54 & #55 =5µg/c/s; #50, #51, #52 & #53 =25µg/c/s) | | | |
| 12 | 2,2,4-Trimethylpentane | 540-84-1 | ND | ND | 49 | Acetone | 67-64-1 | ND | ND |
| 13 | n-Heptane | 142-82-5 | ND | ND | 50 | Acetoin | 513-86-0 | ND | ND |
| 14 | n-Octane | 111-65-9 | ND | ND | 51 | Diacetone alcohol | 123-42-2 | ND | ND |
| 15 | n-Nonane | 111-84-2 | ND | ND | 52 | Cyclohexanone | 108-94-1 | ND | ND |
| 16 | n-Decane | 124-18-5 | ND | ND | 53 | Isophorone | 78-59-1 | ND | ND |
| 17 | n-Undecane | 1120-21-4 | ND | ND | 54 | Methyl ethyl ketone (MEK) | 78-93-3 | ND | ND |
| 18 | n-Dodecane | 112-40-3 | ND | ND | 55 | Methyl isobutyl ketone (MIBK) | 108-10-1 | ND | ND |
| 19 | n-Tridecane | 629-50-5 | ND | ND | | **Alcohols** (LOD = 25µg/compound/section) | | | |
| 20 | n-Tetradecane | 629-59-4 | ND | ND | 56 | Ethyl alcohol | 64-17-5 | ND | ND |
| 21 | α-Pinene | 80-56-8 | ND | ND | 57 | n-Butyl alcohol | 71-36-3 | ND | ND |
| 22 | β-Pinene | 127-91-3 | ND | ND | 58 | Isobutyl alcohol | 78-83-1 | ND | ND |
| 23 | D-Limonene | 138-86-3 | ND | ND | 59 | Isopropyl alcohol | 67-63-0 | ND | ND |
| | **Chlorinated hydrocarbons** (LOD = 5µg/compound/section) | | | | 60 | 2-Ethyl hexanol | 104-76-7 | ND | ND |
| 24 | Dichloromethane | 75-09-2 | ND | ND | 61 | Cyclohexanol | 108-93-0 | ND | ND |
| 25 | 1,1-Dichloroethane | 75-34-3 | ND | ND | | **Acetates** (LOD = 25µg/compound/section) | | | |
| 26 | 1,2-Dichloroethane | 107-06-2 | ND | ND | 62 | Ethyl acetate | 141-78-6 | ND | ND |
| 27 | Chloroform | 67-66-3 | ND | ND | 63 | n-Propyl acetate | 109-60-4 | ND | ND |
| 28 | 1,1,1-Trichloroethane | 71-55-6 | ND | ND | 64 | n-Butyl acetate | 123-86-4 | ND | ND |
| 29 | 1,1,2-Trichloroethane | 79-00-5 | ND | ND | 65 | Isobutyl acetate | 110-19-0 | ND | ND |
| 30 | Trichloroethylene | 79-01-6 | ND | ND | | **Ethers** (LOD = 25µg/compound/section) | | | |
| 31 | Carbon tetrachloride | 56-23-5 | ND | ND | 66 | Ethyl ether | 60-29-7 | ND | ND |
| 32 | Perchloroethylene | 127-18-4 | ND | ND | 67 | *tert*-Butyl methyl ether (MTBE) | 1634-04-4 | ND | ND |
| 33 | 1,1,2,2-Tetrachloroethane | 79-34-5 | ND | ND | 68 | Tetrahydrofuran (THF) | 109-99-9 | ND | ND |
| 34 | Chlorobenzene | 108-90-7 | ND | ND | | **Glycols** (LOD = 25µg/compound/section) | | | |
| 35 | 1,2-Dichlorobenzene | 95-50-1 | ND | ND | 69 | PGME | 107-98-2 | ND | ND |
| 36 | 1,4-Dichlorobenzene | 106-46-7 | ND | ND | 70 | Ethylene glycol diethyl ether | 629-14-1 | ND | ND |
| | **Miscellaneous** (LOD #37= 5µg & #38=25µg/compound/section) | | | | 71 | PGMEA | 108-65-6 | ND | ND |
| 37 | Acetonitrile | 75-05-8 | ND | ND | 72 | Cellosolve acetate | 111-15-9 | ND | ND |
| 38 | n-Vinyl-2-pyrrolidinone | 88-12-0 | ND | ND | 73 | DGMEA | 112-15-2 | ND | ND |
| | **Total VOCs** (LOD =50µg/compound/section) | | ND | ND | | Worksheet check | | YES | YES |



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# Analysis of Volatile Organic Compounds in Workplace Air by GC/MS

Client : Robert Murray
Sample ID : 13001 CA2

Date Sampled : 10-Jan-2013
Reference Number : 2013-0356-2F

| No | Compounds | CAS No | Front (µg/section) | Back (µg/section) |
|---|---|---|---|---|
| | **Aliphatic hydrocarbons** (LOD = 5µg/compound/section) | | | |
| 1 | 2-Methylbutane | 78-78-4 | ND | ND |
| 2 | n-Pentane | 109-66-0 | ND | ND |
| 3 | 2-Methylpentane | 107-83-5 | ND | ND |
| 4 | 3-Methylpentane | 96-14-0 | ND | ND |
| 5 | Cyclopentane | 287-92-3 | ND | ND |
| 6 | Methylcyclopentane | 96-37-7 | ND | ND |
| 7 | 2,3-Dimethylpentane | 565-59-3 | ND | ND |
| 8 | n-Hexane | 110-54-3 | ND | ND |
| 9 | 3-Methylhexane | 589-34-4 | ND | ND |
| 10 | Cyclohexane | 110-8-27 | ND | ND |
| 11 | Methylcyclohexane | 108-87-2 | ND | ND |
| 12 | 2,2,4-Trimethylpentane | 540-84-1 | ND | ND |
| 13 | n-Heptane | 142-82-5 | ND | ND |
| 14 | n-Octane | 111-65-9 | ND | ND |
| 15 | n-Nonane | 111-84-2 | ND | ND |
| 16 | n-Decane | 124-18-5 | ND | ND |
| 17 | n-Undecane | 1120-21-4 | ND | ND |
| 18 | n-Dodecane | 112-40-3 | ND | ND |
| 19 | n-Tridecane | 629-50-5 | ND | ND |
| 20 | n-Tetradecane | 629-59-4 | ND | ND |
| 21 | α-Pinene | 80-56-8 | ND | ND |
| 22 | β-Pinene | 127-91-3 | ND | ND |
| 23 | D-Limonene | 138-86-3 | ND | ND |
| | **Chlorinated hydrocarbons** (LOD = 5µg/compound/section) | | | |
| 24 | Dichloromethane | 75-09-2 | ND | ND |
| 25 | 1,1-Dichloroethane | 75-34-3 | ND | ND |
| 26 | 1,2-Dichloroethane | 107-06-2 | ND | ND |
| 27 | Chloroform | 67-66-3 | ND | ND |
| 28 | 1,1,1-Trichloroethane | 71-55-6 | ND | ND |
| 29 | 1,1,2-Trichloroethane | 79-00-5 | ND | ND |
| 30 | Trichloroethylene | 79-01-6 | ND | ND |
| 31 | Carbon tetrachloride | 56-23-5 | ND | ND |
| 32 | Perchloroethylene | 127-18-4 | ND | ND |
| 33 | 1,1,2,2-Tetrachloroethane | 79-34-5 | ND | ND |
| 34 | Chlorobenzene | 108-90-7 | ND | ND |
| 35 | 1,2-Dichlorobenzene | 95-50-1 | ND | ND |
| 36 | 1,4-Dichlorobenzene | 106-46-7 | ND | ND |
| | **Miscellaneous** (LOD #37= 5µg & #38=25µg/compound/section) | | | |
| 37 | Acetonitrile | 75-05-8 | ND | ND |
| 38 | n-Vinyl-2-pyrrolidinone | 88-12-0 | ND | ND |
| | Total VOCs (LOD =50µg/compound/section) | | ND | ND |

| No | Compounds | CAS No | Front (µg/section) | Back (µg/section) |
|---|---|---|---|---|
| | **Aromatic hydrocarbons** (LOD = 1µg/compound/section) | | | |
| 39 | Benzene | 71-43-2 | ND | ND |
| 40 | Ethylbenzene | 100-41-4 | ND | ND |
| 41 | Isopropylbenzene | 98-82-8 | ND | ND |
| 42 | 1,2,3-Trimethylbenzene | 526-73-8 | ND | ND |
| 43 | 1,2,4-Trimethylbenzene | 95-63-6 | ND | ND |
| 44 | 1,3,5-Trimethylbenzene | 108-67-8 | ND | ND |
| 45 | Styrene | 100-42-5 | ND | ND |
| 46 | Toluene | 108-88-3 | ND | ND |
| 47 | p-Xylene &/or m-Xylene | 106-42-3 & 108-38-3 | ND | ND |
| 48 | o-Xylene | 95-47-6 | ND | ND |
| | **Ketones** (LOD #49, #54 & #55 =5µg/c/s; #50, #51, #52 & #53 =25µg/c/s) | | | |
| 49 | Acetone | 67-64-1 | ND | ND |
| 50 | Acetoin | 513-86-0 | ND | ND |
| 51 | Diacetone alcohol | 123-42-2 | ND | ND |
| 52 | Cyclohexanone | 108-94-1 | ND | ND |
| 53 | Isophorone | 78-59-1 | ND | ND |
| 54 | Methyl ethyl ketone (MEK) | 78-93-3 | ND | ND |
| 55 | Methyl isobutyl ketone (MIBK) | 108-10-1 | ND | ND |
| | **Alcohols** (LOD = 25µg/compound/section) | | | |
| 56 | Ethyl alcohol | 64-17-5 | ND | ND |
| 57 | n-Butyl alcohol | 71-36-3 | ND | ND |
| 58 | Isobutyl alcohol | 78-83-1 | ND | ND |
| 59 | Isopropyl alcohol | 67-63-0 | ND | ND |
| 60 | 2-Ethyl hexanol | 104-76-7 | ND | ND |
| 61 | Cyclohexanol | 108-93-0 | ND | ND |
| | **Acetates** (LOD = 25µg/compound/section) | | | |
| 62 | Ethyl acetate | 141-78-6 | ND | ND |
| 63 | n-Propyl acetate | 109-60-4 | ND | ND |
| 64 | n-Butyl acetate | 123-86-4 | ND | ND |
| 65 | Isobutyl acetate | 110-19-0 | ND | ND |
| | **Ethers** (LOD = 25µg/compound/section) | | | |
| 66 | Ethyl ether | 60-29-7 | ND | ND |
| 67 | *tert*-Butyl methyl ether (MTBE) | 1634-04-4 | ND | ND |
| 68 | Tetrahydrofuran (THF) | 109-99-9 | ND | ND |
| | **Glycols** (LOD = 25µg/compound/section) | | | |
| 69 | PGME | 107-98-2 | ND | ND |
| 70 | Ethylene glycol diethyl ether | 629-14-1 | ND | ND |
| 71 | PGMEA | 108-65-6 | ND | ND |
| 72 | Cellosolve acetate | 111-15-9 | ND | ND |
| 73 | DGMEA | 112-15-2 | ND | ND |
| | Worksheet check | | YES | YES |



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WC03147 0412



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## *Analysis of Volatile Organic Compounds in Workplace Air by GC/MS*

Client : Robert Murray

Sample ID : 13001 CA3

Date Sampled : 10-Jan-2013

Reference Number : 2013-0356-3F

| No | Compounds | CAS No | Front | Back |
|---|---|---|---|---|
| | | | µg/section | |
| | **Aliphatic hydrocarbons** (LOD = 5µg/compound/section) | | | |
| 1 | 2-Methylbutane | 78-78-4 | ND | ND |
| 2 | n-Pentane | 109-66-0 | ND | ND |
| 3 | 2-Methylpentane | 107-83-5 | ND | ND |
| 4 | 3-Methylpentane | 96-14-0 | ND | ND |
| 5 | Cyclopentane | 287-92-3 | ND | ND |
| 6 | Methylcyclopentane | 96-37-7 | ND | ND |
| 7 | 2,3-Dimethylpentane | 565-59-3 | ND | ND |
| 8 | n-Hexane | 110-54-3 | ND | ND |
| 9 | 3-Methylhexane | 589-34-4 | ND | ND |
| 10 | Cyclohexane | 110-8-27 | ND | ND |
| 11 | Methylcyclohexane | 108-87-2 | ND | ND |
| 12 | 2,2,4-Trimethylpentane | 540-84-1 | ND | ND |
| 13 | n-Heptane | 142-82-5 | ND | ND |
| 14 | n-Octane | 111-65-9 | ND | ND |
| 15 | n-Nonane | 111-84-2 | ND | ND |
| 16 | n-Decane | 124-18-5 | ND | ND |
| 17 | n-Undecane | 1120-21-4 | ND | ND |
| 18 | n-Dodecane | 112-40-3 | ND | ND |
| 19 | n-Tridecane | 629-50-5 | ND | ND |
| 20 | n-Tetradecane | 629-59-4 | ND | ND |
| 21 | α-Pinene | 80-56-8 | ND | ND |
| 22 | β-Pinene | 127-91-3 | ND | ND |
| 23 | D-Limonene | 138-86-3 | ND | ND |
| | **Chlorinated hydrocarbons** (LOD = 5µg/compound/section) | | | |
| 24 | Dichloromethane | 75-09-2 | ND | ND |
| 25 | 1,1-Dichloroethane | 75-34-3 | ND | ND |
| 26 | 1,2-Dichloroethane | 107-06-2 | ND | ND |
| 27 | Chloroform | 67-66-3 | ND | ND |
| 28 | 1,1,1-Trichloroethane | 71-55-6 | ND | ND |
| 29 | 1,1,2-Trichloroethane | 79-00-5 | ND | ND |
| 30 | Trichloroethylene | 79-01-6 | ND | ND |
| 31 | Carbon tetrachloride | 56-23-5 | ND | ND |
| 32 | Perchloroethylene | 127-18-4 | ND | ND |
| 33 | 1,1,2,2-Tetrachloroethane | 79-34-5 | ND | ND |
| 34 | Chlorobenzene | 108-90-7 | ND | ND |
| 35 | 1,2-Dichlorobenzene | 95-50-1 | ND | ND |
| 36 | 1,4-Dichlorobenzene | 106-46-7 | ND | ND |
| | **Miscellaneous** (LOD #37= 5µg & #38=25µg/compound/section) | | | |
| 37 | Acetonitrile | 75-05-8 | ND | ND |
| 38 | n-Vinyl-2-pyrrolidinone | 88-12-0 | ND | ND |
| | Total VOCs (LOD =50µg/compound/section) | | ND | ND |

| No | Compounds | CAS No | Front | Back |
|---|---|---|---|---|
| | | | µg/section | |
| | **Aromatic hydrocarbons** (LOD = 1µg/compound/section) | | | |
| 39 | Benzene | 71-43-2 | ND | ND |
| 40 | Ethylbenzene | 100-41-4 | ND | ND |
| 41 | Isopropylbenzene | 98-82-8 | ND | ND |
| 42 | 1,2,3-Trimethylbenzene | 526-73-8 | ND | ND |
| 43 | 1,2,4-Trimethylbenzene | 95-63-6 | ND | ND |
| 44 | 1,3,5-Trimethylbenzene | 108-67-8 | ND | ND |
| 45 | Styrene | 100-42-5 | ND | ND |
| 46 | Toluene | 108-88-3 | ND | ND |
| 47 | p-Xylene &/or m-Xylene | 106-42-3 & 108-38-3 | ND | ND |
| 48 | o-Xylene | 95-47-6 | ND | ND |
| | **Ketones** (LOD #49, #54 & #55 =5µg/c/s; #50, #51, #52 & #53 =25µg/c/s) | | | |
| 49 | Acetone | 67-64-1 | ND | ND |
| 50 | Acetoin | 513-86-0 | ND | ND |
| 51 | Diacetone alcohol | 123-42-2 | ND | ND |
| 52 | Cyclohexanone | 108-94-1 | ND | ND |
| 53 | Isophorone | 78-59-1 | ND | ND |
| 54 | Methyl ethyl ketone (MEK) | 78-93-3 | ND | ND |
| 55 | Methyl isobutyl ketone (MIBK) | 108-10-1 | ND | ND |
| | **Alcohols** (LOD = 25µg/compound/section) | | | |
| 56 | Ethyl alcohol | 64-17-5 | ND | ND |
| 57 | n-Butyl alcohol | 71-36-3 | ND | ND |
| 58 | Isobutyl alcohol | 78-83-1 | ND | ND |
| 59 | Isopropyl alcohol | 67-63-0 | ND | ND |
| 60 | 2-Ethyl hexanol | 104-76-7 | ND | ND |
| 61 | Cyclohexanol | 108-93-0 | ND | ND |
| | **Acetates** (LOD = 25µg/compound/section) | | | |
| 62 | Ethyl acetate | 141-78-6 | ND | ND |
| 63 | n-Propyl acetate | 109-60-4 | ND | ND |
| 64 | n-Butyl acetate | 123-86-4 | ND | ND |
| 65 | Isobutyl acetate | 110-19-0 | ND | ND |
| | **Ethers** (LOD = 25µg/compound/section) | | | |
| 66 | Ethyl ether | 60-29-7 | ND | ND |
| 67 | *tert*-Butyl methyl ether (MTBE) | 1634-04-4 | ND | ND |
| 68 | Tetrahydrofuran (THF) | 109-99-9 | ND | ND |
| | **Glycols** (LOD = 25µg/compound/section) | | | |
| 69 | PGME | 107-98-2 | ND | ND |
| 70 | Ethylene glycol diethyl ether | 629-14-1 | ND | ND |
| 71 | PGMEA | 108-65-6 | ND | ND |
| 72 | Cellosolve acetate | 111-15-9 | ND | ND |
| 73 | DGMEA | 112-15-2 | ND | ND |
| | Worksheet check | | YES | YES |



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## *Analysis of Volatile Organic Compounds in Workplace Air by GC/MS*

Client : Robert Murray
Sample ID : 13001 CA4

Date Sampled : 10-Jan-2013
Reference Number : 2013-0356-4F

| No | Compounds | CAS No | Front µg/section | Back µg/section | No | Compounds | CAS No | Front µg/section | Back µg/section |
|---|---|---|---|---|---|---|---|---|---|
| | **Aliphatic hydrocarbons** (LOD = 5µg/compound/section) | | | | | **Aromatic hydrocarbons** (LOD = 1µg/compound/section) | | | |
| 1 | 2-Methylbutane | *78-78-4* | ND | ND | 39 | Benzene | *71-43-2* | ND | ND |
| 2 | n-Pentane | *109-66-0* | ND | ND | 40 | Ethylbenzene | *100-41-4* | ND | ND |
| 3 | 2-Methylpentane | *107-83-5* | ND | ND | 41 | Isopropylbenzene | *98-82-8* | ND | ND |
| 4 | 3-Methylpentane | *96-14-0* | ND | ND | 42 | 1,2,3-Trimethylbenzene | *526-73-8* | ND | ND |
| 5 | Cyclopentane | *287-92-3* | ND | ND | 43 | 1,2,4-Trimethylbenzene | *95-63-6* | ND | ND |
| 6 | Methylcyclopentane | *96-37-7* | ND | ND | 44 | 1,3,5-Trimethylbenzene | *108-67-8* | ND | ND |
| 7 | 2,3-Dimethylpentane | *565-59-3* | ND | ND | 45 | Styrene | *100-42-5* | ND | ND |
| 8 | n-Hexane | *110-54-3* | ND | ND | 46 | Toluene | *108-88-3* | ND | ND |
| 9 | 3-Methylhexane | *589-34-4* | ND | ND | 47 | p-Xylene &/or m-Xylene | *106-42-3 & 108-38-3* | ND | ND |
| 10 | Cyclohexane | *110-8-27* | ND | ND | 48 | o-Xylene | *95-47-6* | ND | ND |
| 11 | Methylcyclohexane | *108-87-2* | ND | ND | | **Ketones** (LOD #49, #54 & #55 =5µg/c/s; #50, #51, #52 & #53 =25µg/c/s) | | | |
| 12 | 2,2,4-Trimethylpentane | *540-84-1* | ND | ND | 49 | Acetone | *67-64-1* | ND | ND |
| 13 | n-Heptane | *142-82-5* | ND | ND | 50 | Acetoin | *513-86-0* | ND | ND |
| 14 | n-Octane | *111-65-9* | ND | ND | 51 | Diacetone alcohol | *123-42-2* | ND | ND |
| 15 | n-Nonane | *111-84-2* | ND | ND | 52 | Cyclohexanone | *108-94-1* | ND | ND |
| 16 | n-Decane | *124-18-5* | ND | ND | 53 | Isophorone | *78-59-1* | ND | ND |
| 17 | n-Undecane | *1120-21-4* | ND | ND | 54 | Methyl ethyl ketone (MEK) | *78-93-3* | ND | ND |
| 18 | n-Dodecane | *112-40-3* | ND | ND | 55 | Methyl isobutyl ketone (MIBK) | *108-10-1* | ND | ND |
| 19 | n-Tridecane | *629-50-5* | ND | ND | | **Alcohols** (LOD = 25µg/compound/section) | | | |
| 20 | n-Tetradecane | *629-59-4* | ND | ND | 56 | Ethyl alcohol | *64-17-5* | ND | ND |
| 21 | α-Pinene | *80-56-8* | ND | ND | 57 | n-Butyl alcohol | *71-36-3* | ND | ND |
| 22 | β-Pinene | *127-91-3* | ND | ND | 58 | Isobutyl alcohol | *78-83-1* | ND | ND |
| 23 | D-Limonene | *138-86-3* | ND | ND | 59 | Isopropyl alcohol | *67-63-0* | ND | ND |
| | **Chlorinated hydrocarbons** (LOD = 5µg/compound/section) | | | | 60 | 2-Ethyl hexanol | *104-76-7* | ND | ND |
| 24 | Dichloromethane | *75-09-2* | ND | ND | 61 | Cyclohexanol | *108-93-0* | ND | ND |
| 25 | 1,1-Dichloroethane | *75-34-3* | ND | ND | | **Acetates** (LOD = 25µg/compound/section) | | | |
| 26 | 1,2-Dichloroethane | *107-06-2* | ND | ND | 62 | Ethyl acetate | *141-78-6* | ND | ND |
| 27 | Chloroform | *67-66-3* | ND | ND | 63 | n-Propyl acetate | *109-60-4* | ND | ND |
| 28 | 1,1,1-Trichloroethane | *71-55-6* | ND | ND | 64 | n-Butyl acetate | *123-86-4* | ND | ND |
| 29 | 1,1,2-Trichloroethane | *79-00-5* | ND | ND | 65 | Isobutyl acetate | *110-19-0* | ND | ND |
| 30 | Trichloroethylene | *79-01-6* | ND | ND | | **Ethers** (LOD = 25µg/compound/section) | | | |
| 31 | Carbon tetrachloride | *56-23-5* | ND | ND | 66 | Ethyl ether | *60-29-7* | ND | ND |
| 32 | Perchloroethylene | *127-18-4* | ND | ND | 67 | *tert*-Butyl methyl ether (MTBE) | *1634-04-4* | ND | ND |
| 33 | 1,1,2,2-Tetrachloroethane | *79-34-5* | ND | ND | 68 | Tetrahydrofuran (THF) | *109-99-9* | ND | ND |
| 34 | Chlorobenzene | *108-90-7* | ND | ND | | **Glycols** (LOD = 25µg/compound/section) | | | |
| 35 | 1,2-Dichlorobenzene | *95-50-1* | ND | ND | 69 | PGME | *107-98-2* | ND | ND |
| 36 | 1,4-Dichlorobenzene | *106-46-7* | ND | ND | 70 | Ethylene glycol diethyl ether | *629-14-1* | ND | ND |
| | **Miscellaneous** (LOD #37= 5µg & #38=25µg/compound/section) | | | | 71 | PGMEA | *108-65-6* | ND | ND |
| 37 | Acetonitrile | *75-05-8* | ND | ND | 72 | Cellosolve acetate | *111-15-9* | ND | ND |
| 38 | n-Vinyl-2-pyrrolidinone | *88-12-0* | ND | ND | 73 | DGMEA | *112-15-2* | ND | ND |
| | Total VOCs (LOD =50µg/compound/section) | | ND | ND | | Worksheet check | | YES | YES |



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TestSafe Australia – WorkCover NSW *Chemical Analysis Branch*
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## *Analysis of Volatile Organic Compounds in Workplace Air by GC/MS*

Client : Robert Murray
Sample ID : 13001 CB1

Date Sampled : 11-Feb-2013
Reference Number : 2013-0356-5F

| No | Compounds | CAS No | Front | Back |
|---|---|---|---|---|
| | | | µg/section | |
| | **Aliphatic hydrocarbons** (LOD = 5µg/compound/section) | | | |
| 1 | 2-Methylbutane | *78-78-4* | ND | ND |
| 2 | n-Pentane | *109-66-0* | ND | ND |
| 3 | 2-Methylpentane | *107-83-5* | ND | ND |
| 4 | 3-Methylpentane | *96-14-0* | ND | ND |
| 5 | Cyclopentane | *287-92-3* | ND | ND |
| 6 | Methylcyclopentane | *96-37-7* | ND | ND |
| 7 | 2,3-Dimethylpentane | *565-59-3* | ND | ND |
| 8 | n-Hexane | *110-54-3* | ND | ND |
| 9 | 3-Methylhexane | *589-34-4* | ND | ND |
| 10 | Cyclohexane | *110-8-27* | ND | ND |
| 11 | Methylcyclohexane | *108-87-2* | ND | ND |
| 12 | 2,2,4-Trimethylpentane | *540-84-1* | ND | ND |
| 13 | n-Heptane | *142-82-5* | ND | ND |
| 14 | n-Octane | *111-65-9* | ND | ND |
| 15 | n-Nonane | *111-84-2* | ND | ND |
| 16 | n-Decane | *124-18-5* | ND | ND |
| 17 | n-Undecane | *1120-21-4* | ND | ND |
| 18 | n-Dodecane | *112-40-3* | ND | ND |
| 19 | n-Tridecane | *629-50-5* | ND | ND |
| 20 | n-Tetradecane | *629-59-4* | ND | ND |
| 21 | α-Pinene | *80-56-8* | ND | ND |
| 22 | β-Pinene | *127-91-3* | ND | ND |
| 23 | D-Limonene | *138-86-3* | ND | ND |
| | **Chlorinated hydrocarbons** (LOD = 5µg/compound/section) | | | |
| 24 | Dichloromethane | *75-09-2* | ND | ND |
| 25 | 1,1-Dichloroethane | *75-34-3* | ND | ND |
| 26 | 1,2-Dichloroethane | *107-06-2* | ND | ND |
| 27 | Chloroform | *67-66-3* | ND | ND |
| 28 | 1,1,1-Trichloroethane | *71-55-6* | ND | ND |
| 29 | 1,1,2-Trichloroethane | *79-00-5* | ND | ND |
| 30 | Trichloroethylene | *79-01-6* | ND | ND |
| 31 | Carbon tetrachloride | *56-23-5* | ND | ND |
| 32 | Perchloroethylene | *127-18-4* | ND | ND |
| 33 | 1,1,2,2-Tetrachloroethane | *79-34-5* | ND | ND |
| 34 | Chlorobenzene | *108-90-7* | ND | ND |
| 35 | 1,2-Dichlorobenzene | *95-50-1* | ND | ND |
| 36 | 1,4-Dichlorobenzene | *106-46-7* | ND | ND |
| | **Miscellaneous** (LOD #37= 5µg & #38=25µg/compound/section) | | | |
| 37 | Acetonitrile | *75-05-8* | ND | ND |
| 38 | n-Vinyl-2-pyrrolidinone | *88-12-0* | ND | ND |
| | Total VOCs (LOD =50µg/compound/section) | | ND | ND |

| No | Compounds | CAS No | Front | Back |
|---|---|---|---|---|
| | | | µg/section | |
| | **Aromatic hydrocarbons** (LOD = 1µg/compound/section) | | | |
| 39 | Benzene | *71-43-2* | ND | ND |
| 40 | Ethylbenzene | *100-41-4* | ND | ND |
| 41 | Isopropylbenzene | *98-82-8* | ND | ND |
| 42 | 1,2,3-Trimethylbenzene | *526-73-8* | ND | ND |
| 43 | 1,2,4-Trimethylbenzene | *95-63-6* | ND | ND |
| 44 | 1,3,5-Trimethylbenzene | *108-67-8* | ND | ND |
| 45 | Styrene | *100-42-5* | ND | ND |
| 46 | Toluene | *108-88-3* | ND | ND |
| 47 | p-Xylene &/or m-Xylene | *106-42-3 & 108-38-3* | ND | ND |
| 48 | o-Xylene | *95-47-6* | ND | ND |
| | **Ketones** (LOD #49, #54 & #55 =5µg/c/s; #50, #51, #52 & #53 =25µg/c/s) | | | |
| 49 | Acetone | *67-64-1* | ND | ND |
| 50 | Acetoin | *513-86-0* | ND | ND |
| 51 | Diacetone alcohol | *123-42-2* | ND | ND |
| 52 | Cyclohexanone | *108-94-1* | ND | ND |
| 53 | Isophorone | *78-59-1* | ND | ND |
| 54 | Methyl ethyl ketone (MEK) | *78-93-3* | ND | ND |
| 55 | Methyl isobutyl ketone (MIBK) | *108-10-1* | ND | ND |
| | **Alcohols** (LOD = 25µg/compound/section) | | | |
| 56 | Ethyl alcohol | *64-17-5* | ND | ND |
| 57 | n-Butyl alcohol | *71-36-3* | ND | ND |
| 58 | Isobutyl alcohol | *78-83-1* | ND | ND |
| 59 | Isopropyl alcohol | *67-63-0* | ND | ND |
| 60 | 2-Ethyl hexanol | *104-76-7* | ND | ND |
| 61 | Cyclohexanol | *108-93-0* | ND | ND |
| | **Acetates** (LOD = 25µg/compound/section) | | | |
| 62 | Ethyl acetate | *141-78-6* | ND | ND |
| 63 | n-Propyl acetate | *109-60-4* | ND | ND |
| 64 | n-Butyl acetate | *123-86-4* | ND | ND |
| 65 | Isobutyl acetate | *110-19-0* | ND | ND |
| | **Ethers** (LOD = 25µg/compound/section) | | | |
| 66 | Ethyl ether | *60-29-7* | ND | ND |
| 67 | *tert*-Butyl methyl ether (MTBE) | *1634-04-4* | ND | ND |
| 68 | Tetrahydrofuran (THF) | *109-99-9* | ND | ND |
| | **Glycols** (LOD = 25µg/compound/section) | | | |
| 69 | PGME | *107-98-2* | ND | ND |
| 70 | Ethylene glycol diethyl ether | *629-14-1* | ND | ND |
| 71 | PGMEA | *108-65-6* | ND | ND |
| 72 | Cellosolve acetate | *111-15-9* | ND | ND |
| 73 | DGMEA | *112-15-2* | ND | ND |
| | Worksheet check | | YES | YES |



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## *Analysis of Volatile Organic Compounds in Workplace Air by GC/MS*

Client : Robert Murray
Sample ID : 13001 CB2

Date Sampled : 11-Feb-2013
Reference Number : 2013-0356-6F

| No | Compounds | CAS No | Front | Back | No | Compounds | CAS No | Front | Back |
|---|---|---|---|---|---|---|---|---|---|
| | | | μg/section | | | | | μg/section | |
| | **Aliphatic hydrocarbons** (LOD = 5μg/compound/section) | | | | | **Aromatic hydrocarbons** (LOD = 1μg/compound/section) | | | |
| 1 | 2-Methylbutane | 78-78-4 | ND | ND | 39 | Benzene | 71-43-2 | ND | ND |
| 2 | n-Pentane | 109-66-0 | ND | ND | 40 | Ethylbenzene | 100-41-4 | ND | ND |
| 3 | 2-Methylpentane | 107-83-5 | ND | ND | 41 | Isopropylbenzene | 98-82-8 | ND | ND |
| 4 | 3-Methylpentane | 96-14-0 | ND | ND | 42 | 1,2,3-Trimethylbenzene | 526-73-8 | ND | ND |
| 5 | Cyclopentane | 287-92-3 | ND | ND | 43 | 1,2,4-Trimethylbenzene | 95-63-6 | ND | ND |
| 6 | Methylcyclopentane | 96-37-7 | ND | ND | 44 | 1,3,5-Trimethylbenzene | 108-67-8 | ND | ND |
| 7 | 2,3-Dimethylpentane | 565-59-3 | ND | ND | 45 | Styrene | 100-42-5 | ND | ND |
| 8 | n-Hexane | 110-54-3 | ND | ND | 46 | Toluene | 108-88-3 | ND | ND |
| 9 | 3-Methylhexane | 589-34-4 | ND | ND | 47 | p-Xylene &/or m-Xylene | 106-42-3 & 108-38-3 | ND | ND |
| 10 | Cyclohexane | 110-8-27 | ND | ND | 48 | o-Xylene | 95-47-6 | ND | ND |
| 11 | Methylcyclohexane | 108-87-2 | ND | ND | | **Ketones** (LOD #49, #54 & #55 =5μg/c/s; #50, #51, #52 & #53 =25μg/c/s) | | | |
| 12 | 2,2,4-Trimethylpentane | 540-84-1 | ND | ND | 49 | Acetone | 67-64-1 | ND | ND |
| 13 | n-Heptane | 142-82-5 | ND | ND | 50 | Acetoin | 513-86-0 | ND | ND |
| 14 | n-Octane | 111-65-9 | ND | ND | 51 | Diacetone alcohol | 123-42-2 | ND | ND |
| 15 | n-Nonane | 111-84-2 | ND | ND | 52 | Cyclohexanone | 108-94-1 | ND | ND |
| 16 | n-Decane | 124-18-5 | ND | ND | 53 | Isophorone | 78-59-1 | ND | ND |
| 17 | n-Undecane | 1120-21-4 | ND | ND | 54 | Methyl ethyl ketone (MEK) | 78-93-3 | ND | ND |
| 18 | n-Dodecane | 112-40-3 | ND | ND | 55 | Methyl isobutyl ketone (MIBK) | 108-10-1 | ND | ND |
| 19 | n-Tridecane | 629-50-5 | ND | ND | | **Alcohols** (LOD = 25μg/compound/section) | | | |
| 20 | n-Tetradecane | 629-59-4 | ND | ND | 56 | Ethyl alcohol | 64-17-5 | ND | ND |
| 21 | α-Pinene | 80-56-8 | ND | ND | 57 | n-Butyl alcohol | 71-36-3 | ND | ND |
| 22 | β-Pinene | 127-91-3 | ND | ND | 58 | Isobutyl alcohol | 78-83-1 | ND | ND |
| 23 | D-Limonene | 138-86-3 | ND | ND | 59 | Isopropyl alcohol | 67-63-0 | ND | ND |
| | **Chlorinated hydrocarbons** (LOD = 5μg/compound/section) | | | | 60 | 2-Ethyl hexanol | 104-76-7 | ND | ND |
| 24 | Dichloromethane | 75-09-2 | ND | ND | 61 | Cyclohexanol | 108-93-0 | ND | ND |
| 25 | 1,1-Dichloroethane | 75-34-3 | ND | ND | | **Acetates** (LOD = 25μg/compound/section) | | | |
| 26 | 1,2-Dichloroethane | 107-06-2 | ND | ND | 62 | Ethyl acetate | 141-78-6 | ND | ND |
| 27 | Chloroform | 67-66-3 | ND | ND | 63 | n-Propyl acetate | 109-60-4 | ND | ND |
| 28 | 1,1,1-Trichloroethane | 71-55-6 | ND | ND | 64 | n-Butyl acetate | 123-86-4 | ND | ND |
| 29 | 1,1,2-Trichloroethane | 79-00-5 | ND | ND | 65 | Isobutyl acetate | 110-19-0 | ND | ND |
| 30 | Trichloroethylene | 79-01-6 | ND | ND | | **Ethers** (LOD = 25μg/compound/section) | | | |
| 31 | Carbon tetrachloride | 56-23-5 | ND | ND | 66 | Ethyl ether | 60-29-7 | ND | ND |
| 32 | Perchloroethylene | 127-18-4 | ND | ND | 67 | *tert*-Butyl methyl ether (MTBE) | 1634-04-4 | ND | ND |
| 33 | 1,1,2,2-Tetrachloroethane | 79-34-5 | ND | ND | 68 | Tetrahydrofuran (THF) | 109-99-9 | ND | ND |
| 34 | Chlorobenzene | 108-90-7 | ND | ND | | **Glycols** (LOD = 25μg/compound/section) | | | |
| 35 | 1,2-Dichlorobenzene | 95-50-1 | ND | ND | 69 | PGME | 107-98-2 | ND | ND |
| 36 | 1,4-Dichlorobenzene | 106-46-7 | ND | ND | 70 | Ethylene glycol diethyl ether | 629-14-1 | ND | ND |
| | **Miscellaneous** (LOD #37= 5μg & #38=25μg/compound/section) | | | | 71 | PGMEA | 108-65-6 | ND | ND |
| 37 | Acetonitrile | 75-05-8 | ND | ND | 72 | Cellosolve acetate | 111-15-9 | ND | ND |
| 38 | n-Vinyl-2-pyrrolidinone | 88-12-0 | ND | ND | 73 | DGMEA | 112-15-2 | ND | ND |
| | Total VOCs (LOD =50μg/compound/section) | | ND | ND | | Worksheet check | | YES | YES |

2013-0356



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Website: testsafe.com.au/chemical.asp WorkCover Assistance Service: 13 10 50

WC03147 0412

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# *Analysis of Volatile Organic Compounds in Workplace Air by GC/MS*

Client : Robert Murray
Sample ID : 13001 CC1

Date Sampled : 18-Feb-2013
Reference Number : 2013-0356-7F

| No | Compounds | CAS No | Front (µg/section) | Back (µg/section) |
|---|---|---|---|---|
| | **Aliphatic hydrocarbons** (LOD = 5µg/compound/section) | | | |
| 1 | 2-Methylbutane | 78-78-4 | ND | ND |
| 2 | n-Pentane | 109-66-0 | ND | ND |
| 3 | 2-Methylpentane | 107-83-5 | ND | ND |
| 4 | 3-Methylpentane | 96-14-0 | ND | ND |
| 5 | Cyclopentane | 287-92-3 | ND | ND |
| 6 | Methylcyclopentane | 96-37-7 | ND | ND |
| 7 | 2,3-Dimethylpentane | 565-59-3 | ND | ND |
| 8 | n-Hexane | 110-54-3 | ND | ND |
| 9 | 3-Methylhexane | 589-34-4 | ND | ND |
| 10 | Cyclohexane | 110-8-27 | ND | ND |
| 11 | Methylcyclohexane | 108-87-2 | ND | ND |
| 12 | 2,2,4-Trimethylpentane | 540-84-1 | ND | ND |
| 13 | n-Heptane | 142-82-5 | ND | ND |
| 14 | n-Octane | 111-65-9 | ND | ND |
| 15 | n-Nonane | 111-84-2 | ND | ND |
| 16 | n-Decane | 124-18-5 | ND | ND |
| 17 | n-Undecane | 1120-21-4 | ND | ND |
| 18 | n-Dodecane | 112-40-3 | ND | ND |
| 19 | n-Tridecane | 629-50-5 | ND | ND |
| 20 | n-Tetradecane | 629-59-4 | ND | ND |
| 21 | α-Pinene | 80-56-8 | ND | ND |
| 22 | β-Pinene | 127-91-3 | ND | ND |
| 23 | D-Limonene | 138-86-3 | ND | ND |
| | **Chlorinated hydrocarbons** (LOD = 5µg/compound/section) | | | |
| 24 | Dichloromethane | 75-09-2 | ND | ND |
| 25 | 1,1-Dichloroethane | 75-34-3 | ND | ND |
| 26 | 1,2-Dichloroethane | 107-06-2 | ND | ND |
| 27 | Chloroform | 67-66-3 | ND | ND |
| 28 | 1,1,1-Trichloroethane | 71-55-6 | ND | ND |
| 29 | 1,1,2-Trichloroethane | 79-00-5 | ND | ND |
| 30 | Trichloroethylene | 79-01-6 | ND | ND |
| 31 | Carbon tetrachloride | 56-23-5 | ND | ND |
| 32 | Perchloroethylene | 127-18-4 | ND | ND |
| 33 | 1,1,2,2-Tetrachloroethane | 79-34-5 | ND | ND |
| 34 | Chlorobenzene | 108-90-7 | ND | ND |
| 35 | 1,2-Dichlorobenzene | 95-50-1 | ND | ND |
| 36 | 1,4-Dichlorobenzene | 106-46-7 | ND | ND |
| | **Miscellaneous** (LOD #37= 5µg & #38=25µg/compound/section) | | | |
| 37 | Acetonitrile | 75-05-8 | ND | ND |
| 38 | n-Vinyl-2-pyrrolidinone | 88-12-0 | ND | ND |
| | Total VOCs (LOD =50µg/compound/section) | | 3293 | ND |

| No | Compounds | CAS No | Front (µg/section) | Back (µg/section) |
|---|---|---|---|---|
| | **Aromatic hydrocarbons** (LOD = 1µg/compound/section) | | | |
| 39 | Benzene | 71-43-2 | ND | ND |
| 40 | Ethylbenzene | 100-41-4 | **216** | ND |
| 41 | Isopropylbenzene | 98-82-8 | **8** | ND |
| 42 | 1,2,3-Trimethylbenzene | 526-73-8 | **18** | ND |
| 43 | 1,2,4-Trimethylbenzene | 95-63-6 | **114** | ND |
| 44 | 1,3,5-Trimethylbenzene | 108-67-8 | **31** | ND |
| 45 | Styrene | 100-42-5 | ND | ND |
| 46 | Toluene | 108-88-3 | **11** | ND |
| 47 | p-Xylene &/or m-Xylene | 106-42-3 & 108-38-3 | **897** | ND |
| 48 | o-Xylene | 95-47-6 | **335** | ND |
| | **Ketones** (LOD #49, #54 & #55 =5µg/c/s; #50, #51, #52 & #53 =25µg/c/s) | | | |
| 49 | Acetone | 67-64-1 | ND | ND |
| 50 | Acetoin | 513-86-0 | ND | ND |
| 51 | Diacetone alcohol | 123-42-2 | ND | ND |
| 52 | Cyclohexanone | 108-94-1 | ND | ND |
| 53 | Isophorone | 78-59-1 | ND | ND |
| 54 | Methyl ethyl ketone (MEK) | 78-93-3 | ND | ND |
| 55 | Methyl isobutyl ketone (MIBK) | 108-10-1 | **159** | ND |
| | **Alcohols** (LOD = 25µg/compound/section) | | | |
| 56 | Ethyl alcohol | 64-17-5 | ND | ND |
| 57 | n-Butyl alcohol | 71-36-3 | ND | ND |
| 58 | Isobutyl alcohol | 78-83-1 | ND | ND |
| 59 | Isopropyl alcohol | 67-63-0 | ND | ND |
| 60 | 2-Ethyl hexanol | 104-76-7 | ND | ND |
| 61 | Cyclohexanol | 108-93-0 | ND | ND |
| | **Acetates** (LOD = 25µg/compound/section) | | | |
| 62 | Ethyl acetate | 141-78-6 | ND | ND |
| 63 | n-Propyl acetate | 109-60-4 | ND | ND |
| 64 | n-Butyl acetate | 123-86-4 | ND | ND |
| 65 | Isobutyl acetate | 110-19-0 | ND | ND |
| | **Ethers** (LOD = 25µg/compound/section) | | | |
| 66 | Ethyl ether | 60-29-7 | ND | ND |
| 67 | *tert*-Butyl methyl ether (MTBE) | 1634-04-4 | ND | ND |
| 68 | Tetrahydrofuran (THF) | 109-99-9 | ND | ND |
| | **Glycols** (LOD = 25µg/compound/section) | | | |
| 69 | PGME | 107-98-2 | ND | ND |
| 70 | Ethylene glycol diethyl ether | 629-14-1 | ND | ND |
| 71 | PGMEA | 108-65-6 | ND | ND |
| 72 | Cellosolve acetate | 111-15-9 | ND | ND |
| 73 | DGMEA | 112-15-2 | ND | ND |
| | Worksheet check | | YES | YES |



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TestSafe Australia – WorkCover NSW *Chemical Analysis Branch*
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Telephone: 61 2 9473 4000 Facsimile: 61 2 9980 6849 Email: lab@workcover.nsw.gov.au
Website: testsafe.com.au/chemical.asp WorkCover Assistance Service: 13 10 50

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## *Analysis of Volatile Organic Compounds in Workplace Air by GC/MS*

Client : Robert Murray
Sample ID : 13001 CC2

Date Sampled : 18-Feb-2013
Reference Number : 2013-0356-8F

| No | Compounds | CAS No | Front (µg/section) | Back (µg/section) | No | Compounds | CAS No | Front (µg/section) | Back (µg/section) |
|---|---|---|---|---|---|---|---|---|---|
| | **Aliphatic hydrocarbons** (LOD = 5µg/compound/section) | | | | | **Aromatic hydrocarbons** (LOD = 1µg/compound/section) | | | |
| 1 | 2-Methylbutane | 78-78-4 | ND | ND | 39 | Benzene | 71-43-2 | ND | ND |
| 2 | n-Pentane | 109-66-0 | ND | ND | 40 | Ethylbenzene | 100-41-4 | 3 | ND |
| 3 | 2-Methylpentane | 107-83-5 | ND | ND | 41 | Isopropylbenzene | 98-82-8 | ND | ND |
| 4 | 3-Methylpentane | 96-14-0 | ND | ND | 42 | 1,2,3-Trimethylbenzene | 526-73-8 | ND | ND |
| 5 | Cyclopentane | 287-92-3 | ND | ND | 43 | 1,2,4-Trimethylbenzene | 95-63-6 | 1 | ND |
| 6 | Methylcyclopentane | 96-37-7 | ND | ND | 44 | 1,3,5-Trimethylbenzene | 108-67-8 | ND | ND |
| 7 | 2,3-Dimethylpentane | 565-59-3 | ND | ND | 45 | Styrene | 100-42-5 | ND | ND |
| 8 | n-Hexane | 110-54-3 | ND | ND | 46 | Toluene | 108-88-3 | ND | ND |
| 9 | 3-Methylhexane | 589-34-4 | ND | ND | 47 | p-Xylene &/or m-Xylene | 106-42-3 & 108-38-3 | 16 | ND |
| 10 | Cyclohexane | 110-8-27 | ND | ND | 48 | o-Xylene | 95-47-6 | 6 | ND |
| 11 | Methylcyclohexane | 108-87-2 | ND | ND | | **Ketones** (LOD #49, #54 & #55 =5µg/c/s; #50, #51, #52 & #53 =25µg/c/s) | | | |
| 12 | 2,2,4-Trimethylpentane | 540-84-1 | ND | ND | 49 | Acetone | 67-64-1 | ND | ND |
| 13 | n-Heptane | 142-82-5 | ND | ND | 50 | Acetoin | 513-86-0 | ND | ND |
| 14 | n-Octane | 111-65-9 | ND | ND | 51 | Diacetone alcohol | 123-42-2 | ND | ND |
| 15 | n-Nonane | 111-84-2 | ND | ND | 52 | Cyclohexanone | 108-94-1 | ND | ND |
| 16 | n-Decane | 124-18-5 | ND | ND | 53 | Isophorone | 78-59-1 | ND | ND |
| 17 | n-Undecane | 1120-21-4 | ND | ND | 54 | Methyl ethyl ketone (MEK) | 78-93-3 | ND | ND |
| 18 | n-Dodecane | 112-40-3 | ND | ND | 55 | Methyl isobutyl ketone (MIBK) | 108-10-1 | 7 | ND |
| 19 | n-Tridecane | 629-50-5 | ND | ND | | **Alcohols** (LOD = 25µg/compound/section) | | | |
| 20 | n-Tetradecane | 629-59-4 | ND | ND | 56 | Ethyl alcohol | 64-17-5 | ND | ND |
| 21 | α-Pinene | 80-56-8 | ND | ND | 57 | n-Butyl alcohol | 71-36-3 | ND | ND |
| 22 | β-Pinene | 127-91-3 | ND | ND | 58 | Isobutyl alcohol | 78-83-1 | ND | ND |
| 23 | D-Limonene | 138-86-3 | ND | ND | 59 | Isopropyl alcohol | 67-63-0 | ND | ND |
| | **Chlorinated hydrocarbons** (LOD = 5µg/compound/section) | | | | 60 | 2-Ethyl hexanol | 104-76-7 | ND | ND |
| 24 | Dichloromethane | 75-09-2 | ND | ND | 61 | Cyclohexanol | 108-93-0 | ND | ND |
| 25 | 1,1-Dichloroethane | 75-34-3 | ND | ND | | **Acetates** (LOD = 25µg/compound/section) | | | |
| 26 | 1,2-Dichloroethane | 107-06-2 | ND | ND | 62 | Ethyl acetate | 141-78-6 | ND | ND |
| 27 | Chloroform | 67-66-3 | ND | ND | 63 | n-Propyl acetate | 109-60-4 | ND | ND |
| 28 | 1,1,1-Trichloroethane | 71-55-6 | ND | ND | 64 | n-Butyl acetate | 123-86-4 | ND | ND |
| 29 | 1,1,2-Trichloroethane | 79-00-5 | ND | ND | 65 | Isobutyl acetate | 110-19-0 | ND | ND |
| 30 | Trichloroethylene | 79-01-6 | ND | ND | | **Ethers** (LOD = 25µg/compound/section) | | | |
| 31 | Carbon tetrachloride | 56-23-5 | ND | ND | 66 | Ethyl ether | 60-29-7 | ND | ND |
| 32 | Perchloroethylene | 127-18-4 | ND | ND | 67 | *tert*-Butyl methyl ether (MTBE) | 1634-04-4 | ND | ND |
| 33 | 1,1,2,2-Tetrachloroethane | 79-34-5 | ND | ND | 68 | Tetrahydrofuran (THF) | 109-99-9 | ND | ND |
| 34 | Chlorobenzene | 108-90-7 | ND | ND | | **Glycols** (LOD = 25µg/compound/section) | | | |
| 35 | 1,2-Dichlorobenzene | 95-50-1 | ND | ND | 69 | PGME | 107-98-2 | ND | ND |
| 36 | 1,4-Dichlorobenzene | 106-46-7 | ND | ND | 70 | Ethylene glycol diethyl ether | 629-14-1 | ND | ND |
| | **Miscellaneous** (LOD #37= 5µg & #38=25µg/compound/section) | | | | 71 | PGMEA | 108-65-6 | ND | ND |
| 37 | Acetonitrile | 75-05-8 | ND | ND | 72 | Cellosolve acetate | 111-15-9 | ND | ND |
| 38 | n-Vinyl-2-pyrrolidinone | 88-12-0 | ND | ND | 73 | DGMEA | 112-15-2 | ND | ND |
| | Total VOCs (LOD =50µg/compound/section) | | 123 | ND | | Worksheet check | | YES | YES |

2013-0356



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TestSafe Australia – WorkCover NSW *Chemical Analysis Branch*
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Website: testsafe.com.au/chemical.asp WorkCover Assistance Service: 13 10 50

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## *Analysis of Volatile Organic Compounds in Workplace Air by GC/MS*

Client : Robert Murray
Sample ID : 13001 CC3

Date Sampled : 18-Feb-2013
Reference Number : 2013-0356-9F

| No | Compounds | CAS No | Front | Back | No | Compounds | CAS No | Front | Back |
|---|---|---|---|---|---|---|---|---|---|
| | | | µg/section | | | | | µg/section | |
| | **Aliphatic hydrocarbons** (LOD = 5µg/compound/section) | | | | | **Aromatic hydrocarbons** (LOD = 1µg/compound/section) | | | |
| 1 | 2-Methylbutane | *78-78-4* | ND | **44** | 39 | Benzene | *71-43-2* | ND | ND |
| 2 | n-Pentane | *109-66-0* | ND | ND | 40 | Ethylbenzene | *100-41-4* | **3** | ND |
| 3 | 2-Methylpentane | *107-83-5* | ND | ND | 41 | Isopropylbenzene | *98-82-8* | ND | ND |
| 4 | 3-Methylpentane | *96-14-0* | ND | ND | 42 | 1,2,3-Trimethylbenzene | *526-73-8* | ND | ND |
| 5 | Cyclopentane | *287-92-3* | ND | ND | 43 | 1,2,4-Trimethylbenzene | *95-63-6* | **1** | ND |
| 6 | Methylcyclopentane | *96-37-7* | ND | ND | 44 | 1,3,5-Trimethylbenzene | *108-67-8* | ND | ND |
| 7 | 2,3-Dimethylpentane | *565-59-3* | ND | ND | 45 | Styrene | *100-42-5* | ND | ND |
| 8 | n-Hexane | *110-54-3* | ND | ND | 46 | Toluene | *108-88-3* | ND | ND |
| 9 | 3-Methylhexane | *589-34-4* | ND | ND | 47 | p-Xylene &/or m-Xylene | *106-42-3 & 108-38-3* | **16** | ND |
| 10 | Cyclohexane | *110-8-27* | ND | ND | 48 | o-Xylene | *95-47-6* | **6** | ND |
| 11 | Methylcyclohexane | *108-87-2* | ND | ND | | **Ketones** (LOD #49, #54 & #55 =5µg/c/s; #50, #51, #52 & #53 =25µg/c/s) | | | |
| 12 | 2,2,4-Trimethylpentane | *540-84-1* | ND | ND | 49 | Acetone | *67-64-1* | ND | ND |
| 13 | n-Heptane | *142-82-5* | ND | ND | 50 | Acetoin | *513-86-0* | ND | ND |
| 14 | n-Octane | *111-65-9* | ND | ND | 51 | Diacetone alcohol | *123-42-2* | ND | ND |
| 15 | n-Nonane | *111-84-2* | ND | ND | 52 | Cyclohexanone | *108-94-1* | ND | ND |
| 16 | n-Decane | *124-18-5* | ND | ND | 53 | Isophorone | *78-59-1* | ND | ND |
| 17 | n-Undecane | *1120-21-4* | ND | ND | 54 | Methyl ethyl ketone (MEK) | *78-93-3* | ND | ND |
| 18 | n-Dodecane | *112-40-3* | ND | ND | 55 | Methyl isobutyl ketone (MIBK) | *108-10-1* | ND | ND |
| 19 | n-Tridecane | *629-50-5* | ND | ND | | **Alcohols** (LOD = 25µg/compound/section) | | | |
| 20 | n-Tetradecane | *629-59-4* | ND | ND | 56 | Ethyl alcohol | *64-17-5* | ND | **33** |
| 21 | α-Pinene | *80-56-8* | ND | ND | 57 | n-Butyl alcohol | *71-36-3* | ND | ND |
| 22 | β-Pinene | *127-91-3* | ND | ND | 58 | Isobutyl alcohol | *78-83-1* | ND | ND |
| 23 | D-Limonene | *138-86-3* | ND | ND | 59 | Isopropyl alcohol | *67-63-0* | ND | ND |
| | **Chlorinated hydrocarbons** (LOD = 5µg/compound/section) | | | | 60 | 2-Ethyl hexanol | *104-76-7* | ND | ND |
| 24 | Dichloromethane | *75-09-2* | ND | ND | 61 | Cyclohexanol | *108-93-0* | ND | ND |
| 25 | 1,1-Dichloroethane | *75-34-3* | ND | ND | | **Acetates** (LOD = 25µg/compound/section) | | | |
| 26 | 1,2-Dichloroethane | *107-06-2* | ND | ND | 62 | Ethyl acetate | *141-78-6* | ND | ND |
| 27 | Chloroform | *67-66-3* | ND | ND | 63 | n-Propyl acetate | *109-60-4* | ND | ND |
| 28 | 1,1,1-Trichloroethane | *71-55-6* | ND | ND | 64 | n-Butyl acetate | *123-86-4* | ND | ND |
| 29 | 1,1,2-Trichloroethane | *79-00-5* | ND | ND | 65 | Isobutyl acetate | *110-19-0* | ND | ND |
| 30 | Trichloroethylene | *79-01-6* | ND | ND | | **Ethers** (LOD = 25µg/compound/section) | | | |
| 31 | Carbon tetrachloride | *56-23-5* | ND | ND | 66 | Ethyl ether | *60-29-7* | ND | ND |
| 32 | Perchloroethylene | *127-18-4* | ND | ND | 67 | *tert*-Butyl methyl ether (MTBE) | *1634-04-4* | ND | ND |
| 33 | 1,1,2,2-Tetrachloroethane | *79-34-5* | ND | ND | 68 | Tetrahydrofuran (THF) | *109-99-9* | ND | ND |
| 34 | Chlorobenzene | *108-90-7* | ND | ND | | **Glycols** (LOD = 25µg/compound/section) | | | |
| 35 | 1,2-Dichlorobenzene | *95-50-1* | ND | ND | 69 | PGME | *107-98-2* | ND | ND |
| 36 | 1,4-Dichlorobenzene | *106-46-7* | ND | ND | 70 | Ethylene glycol diethyl ether | *629-14-1* | ND | ND |
| | **Miscellaneous** (LOD #37= 5µg & #38=25µg/compound/section) | | | | 71 | PGMEA | *108-65-6* | ND | ND |
| 37 | Acetonitrile | *75-05-8* | ND | ND | 72 | Cellosolve acetate | *111-15-9* | ND | ND |
| 38 | n-Vinyl-2-pyrrolidinone | *88-12-0* | ND | ND | 73 | DGMEA | *112-15-2* | ND | ND |
| | Total VOCs (LOD =50µg/compound/section) | | ND | **111** | | Worksheet check | | YES | YES |

2013-0356



TestSafe Australia – WorkCover NSW *Chemical Analysis Branch*
WorkCover NSW ABN 77 682 742 966 5A Pioneer Avenue, Thornleigh, NSW 2120, Australia
Telephone: **61 2 9473 4000** Facsimile: **61 2 9980 6849** Email: **lab@workcover.nsw.gov.au**
Website: **testsafe.com.au/chemical.asp** WorkCover Assistance Service: **13 10 50**

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## *Analysis of Volatile Organic Compounds in Workplace Air by GC/MS*

Client : Robert Murray | Date Sampled : 18-Feb-2013

Sample ID : 13001 CC4 | Reference Number : 2013-0356-10F

| No | Compounds | CAS No | Front | Back | No | Compounds | CAS No | Front | Back |
|---|---|---|---|---|---|---|---|---|---|
| | | | µg/section | | | | | µg/section | |
| | **Aliphatic hydrocarbons** (LOD = 5µg/compound/section) | | | | | **Aromatic hydrocarbons** (LOD = 1µg/compound/section) | | | |
| 1 | 2-Methylbutane | *78-78-4* | ND | ND | 39 | Benzene | *71-43-2* | ND | ND |
| 2 | n-Pentane | *109-66-0* | ND | ND | 40 | Ethylbenzene | *100-41-4* | 2 | ND |
| 3 | 2-Methylpentane | *107-83-5* | ND | ND | 41 | Isopropylbenzene | *98-82-8* | ND | ND |
| 4 | 3-Methylpentane | *96-14-0* | ND | ND | 42 | 1,2,3-Trimethylbenzene | *526-73-8* | ND | ND |
| 5 | Cyclopentane | *287-92-3* | ND | ND | 43 | 1,2,4-Trimethylbenzene | *95-63-6* | 1 | ND |
| 6 | Methylcyclopentane | *96-37-7* | ND | ND | 44 | 1,3,5-Trimethylbenzene | *108-67-8* | ND | ND |
| 7 | 2,3-Dimethylpentane | *565-59-3* | ND | ND | 45 | Styrene | *100-42-5* | ND | ND |
| 8 | n-Hexane | *110-54-3* | ND | ND | 46 | Toluene | *108-88-3* | ND | ND |
| 9 | 3-Methylhexane | *589-34-4* | ND | ND | 47 | p-Xylene &/or m-Xylene | *106-42-3 & 108-38-3* | 15 | ND |
| 10 | Cyclohexane | *110-8-27* | ND | ND | 48 | o-Xylene | *95-47-6* | 5 | ND |
| 11 | Methylcyclohexane | *108-87-2* | ND | ND | | **Ketones** (LOD #49, #54 & #55 =5µg/c/s; #50, #51, #52 & #53 =25µg/c/s) | | | |
| 12 | 2,2,4-Trimethylpentane | *540-84-1* | ND | ND | 49 | Acetone | *67-64-1* | ND | ND |
| 13 | n-Heptane | *142-82-5* | ND | ND | 50 | Acetoin | *513-86-0* | ND | ND |
| 14 | n-Octane | *111-65-9* | ND | ND | 51 | Diacetone alcohol | *123-42-2* | ND | ND |
| 15 | n-Nonane | *111-84-2* | ND | ND | 52 | Cyclohexanone | *108-94-1* | ND | ND |
| 16 | n-Decane | *124-18-5* | ND | ND | 53 | Isophorone | *78-59-1* | ND | ND |
| 17 | n-Undecane | *1120-21-4* | ND | ND | 54 | Methyl ethyl ketone (MEK) | *78-93-3* | ND | ND |
| 18 | n-Dodecane | *112-40-3* | ND | ND | 55 | Methyl isobutyl ketone (MIBK) | *108-10-1* | ND | ND |
| 19 | n-Tridecane | *629-50-5* | ND | ND | | **Alcohols** (LOD = 25µg/compound/section) | | | |
| 20 | n-Tetradecane | *629-59-4* | ND | ND | 56 | Ethyl alcohol | *64-17-5* | ND | ND |
| 21 | α-Pinene | *80-56-8* | ND | ND | 57 | n-Butyl alcohol | *71-36-3* | ND | ND |
| 22 | β-Pinene | *127-91-3* | ND | ND | 58 | Isobutyl alcohol | *78-83-1* | ND | ND |
| 23 | D-Limonene | *138-86-3* | ND | ND | 59 | Isopropyl alcohol | *67-63-0* | ND | ND |
| | **Chlorinated hydrocarbons** (LOD = 5µg/compound/section) | | | | 60 | 2-Ethyl hexanol | *104-76-7* | ND | ND |
| 24 | Dichloromethane | *75-09-2* | ND | ND | 61 | Cyclohexanol | *108-93-0* | ND | ND |
| 25 | 1,1-Dichloroethane | *75-34-3* | ND | ND | | **Acetates** (LOD = 25µg/compound/section) | | | |
| 26 | 1,2-Dichloroethane | *107-06-2* | ND | ND | 62 | Ethyl acetate | *141-78-6* | ND | ND |
| 27 | Chloroform | *67-66-3* | ND | ND | 63 | n-Propyl acetate | *109-60-4* | ND | ND |
| 28 | 1,1,1-Trichloroethane | *71-55-6* | ND | ND | 64 | n-Butyl acetate | *123-86-4* | ND | ND |
| 29 | 1,1,2-Trichloroethane | *79-00-5* | ND | ND | 65 | Isobutyl acetate | *110-19-0* | ND | ND |
| 30 | Trichloroethylene | *79-01-6* | ND | ND | | **Ethers** (LOD = 25µg/compound/section) | | | |
| 31 | Carbon tetrachloride | *56-23-5* | ND | ND | 66 | Ethyl ether | *60-29-7* | ND | ND |
| 32 | Perchloroethylene | *127-18-4* | ND | ND | 67 | *tert*-Butyl methyl ether (MTBE) | *1634-04-4* | ND | ND |
| 33 | 1,1,2,2-Tetrachloroethane | *79-34-5* | ND | ND | 68 | Tetrahydrofuran (THF) | *109-99-9* | ND | ND |
| 34 | Chlorobenzene | *108-90-7* | ND | ND | | **Glycols** (LOD = 25µg/compound/section) | | | |
| 35 | 1,2-Dichlorobenzene | *95-50-1* | ND | ND | 69 | PGME | *107-98-2* | ND | ND |
| 36 | 1,4-Dichlorobenzene | *106-46-7* | ND | ND | 70 | Ethylene glycol diethyl ether | *629-14-1* | ND | ND |
| | **Miscellaneous** (LOD #37= 5µg & #38=25µg/compound/section) | | | | 71 | PGMEA | *108-65-6* | ND | ND |
| 37 | Acetonitrile | *75-05-8* | ND | ND | 72 | Cellosolve acetate | *111-15-9* | ND | ND |
| 38 | n-Vinyl-2-pyrrolidinone | *88-12-0* | ND | ND | 73 | DGMEA | *112-15-2* | ND | ND |
| | Total VOCs (LOD =50µg/compound/section) | | 107 | ND | | Worksheet check | | YES | YES |



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Accreditation No. 3726

Accredited for compliance with ISO/IEC 17025

TestSafe Australia – WorkCover NSW *Chemical Analysis Branch*
WorkCover NSW ABN 77 682 742 966 5A Pioneer Avenue, Thornleigh, NSW 2120, Australia
Telephone: 61 2 9473 4000 Facsimile: 61 2 9980 6849 Email: lab@workcover.nsw.gov.au
Website: testsafe.com.au/chemical.asp WorkCover Assistance Service: 13 10 50

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## Analysis of Volatile Organic Compounds in Workplace Air by GC/MS

Client : Robert Murray | Date Sampled : 18-Feb-2013

Sample ID : 13001 CC5 | Reference Number : 2013-0356-11F

| No | Compounds | CAS No | Front | Back | No | Compounds | CAS No | Front | Back |
|---|---|---|---|---|---|---|---|---|---|
| | | | µg/section | | | | | µg/section | |
| | **Aliphatic hydrocarbons** (LOD = 5µg/compound/section) | | | | | **Aromatic hydrocarbons** (LOD = 1µg/compound/section) | | | |
| 1 | 2-Methylbutane | *78-78-4* | ND | ND | 39 | Benzene | *71-43-2* | ND | ND |
| 2 | n-Pentane | *109-66-0* | ND | ND | 40 | Ethylbenzene | *100-41-4* | **2** | ND |
| 3 | 2-Methylpentane | *107-83-5* | ND | ND | 41 | Isopropylbenzene | *98-82-8* | ND | ND |
| 4 | 3-Methylpentane | *96-14-0* | ND | ND | 42 | 1,2,3-Trimethylbenzene | *526-73-8* | ND | ND |
| 5 | Cyclopentane | *287-92-3* | ND | ND | 43 | 1,2,4-Trimethylbenzene | *95-63-6* | **1** | ND |
| 6 | Methylcyclopentane | *96-37-7* | ND | ND | 44 | 1,3,5-Trimethylbenzene | *108-67-8* | ND | ND |
| 7 | 2,3-Dimethylpentane | *565-59-3* | ND | ND | 45 | Styrene | *100-42-5* | ND | ND |
| 8 | n-Hexane | *110-54-3* | ND | ND | 46 | Toluene | *108-88-3* | ND | ND |
| 9 | 3-Methylhexane | *589-34-4* | ND | ND | 47 | p-Xylene &/or m-Xylene | *106-42-3 & 108-38-3* | **15** | ND |
| 10 | Cyclohexane | *110-8-27* | ND | ND | 48 | o-Xylene | *95-47-6* | **5** | ND |
| 11 | Methylcyclohexane | *108-87-2* | ND | ND | | **Ketones** (LOD #49, #54 & #55 =5µg/c/s; #50, #51, #52 & #53 =25µg/c/s) | | | |
| 12 | 2,2,4-Trimethylpentane | *540-84-1* | ND | ND | 49 | Acetone | *67-64-1* | ND | ND |
| 13 | n-Heptane | *142-82-5* | ND | ND | 50 | Acetoin | *513-86-0* | ND | ND |
| 14 | n-Octane | *111-65-9* | ND | ND | 51 | Diacetone alcohol | *123-42-2* | ND | ND |
| 15 | n-Nonane | *111-84-2* | ND | ND | 52 | Cyclohexanone | *108-94-1* | ND | ND |
| 16 | n-Decane | *124-18-5* | ND | ND | 53 | Isophorone | *78-59-1* | ND | ND |
| 17 | n-Undecane | *1120-21-4* | ND | ND | 54 | Methyl ethyl ketone (MEK) | *78-93-3* | ND | ND |
| 18 | n-Dodecane | *112-40-3* | ND | ND | 55 | Methyl isobutyl ketone (MIBK) | *108-10-1* | ND | ND |
| 19 | n-Tridecane | *629-50-5* | ND | ND | | **Alcohols** (LOD = 25µg/compound/section) | | | |
| 20 | n-Tetradecane | *629-59-4* | ND | ND | 56 | Ethyl alcohol | *64-17-5* | ND | ND |
| 21 | α-Pinene | *80-56-8* | ND | ND | 57 | n-Butyl alcohol | *71-36-3* | ND | ND |
| 22 | β-Pinene | *127-91-3* | ND | ND | 58 | Isobutyl alcohol | *78-83-1* | ND | ND |
| 23 | D-Limonene | *138-86-3* | ND | ND | 59 | Isopropyl alcohol | *67-63-0* | ND | ND |
| | **Chlorinated hydrocarbons** (LOD = 5µg/compound/section) | | | | 60 | 2-Ethyl hexanol | *104-76-7* | ND | ND |
| 24 | Dichloromethane | *75-09-2* | ND | ND | 61 | Cyclohexanol | *108-93-0* | ND | ND |
| 25 | 1,1-Dichloroethane | *75-34-3* | ND | ND | | **Acetates** (LOD = 25µg/compound/section) | | | |
| 26 | 1,2-Dichloroethane | *107-06-2* | ND | ND | 62 | Ethyl acetate | *141-78-6* | ND | ND |
| 27 | Chloroform | *67-66-3* | ND | ND | 63 | n-Propyl acetate | *109-60-4* | ND | ND |
| 28 | 1,1,1-Trichloroethane | *71-55-6* | ND | ND | 64 | n-Butyl acetate | *123-86-4* | ND | ND |
| 29 | 1,1,2-Trichloroethane | *79-00-5* | ND | ND | 65 | Isobutyl acetate | *110-19-0* | ND | ND |
| 30 | Trichloroethylene | *79-01-6* | ND | ND | | **Ethers** (LOD = 25µg/compound/section) | | | |
| 31 | Carbon tetrachloride | *56-23-5* | ND | ND | 66 | Ethyl ether | *60-29-7* | ND | ND |
| 32 | Perchloroethylene | *127-18-4* | ND | ND | 67 | *tert*-Butyl methyl ether (MTBE) | *1634-04-4* | ND | ND |
| 33 | 1,1,2,2-Tetrachloroethane | *79-34-5* | ND | ND | 68 | Tetrahydrofuran (THF) | *109-99-9* | ND | ND |
| 34 | Chlorobenzene | *108-90-7* | ND | ND | | **Glycols** (LOD = 25µg/compound/section) | | | |
| 35 | 1,2-Dichlorobenzene | *95-50-1* | ND | ND | 69 | PGME | *107-98-2* | ND | ND |
| 36 | 1,4-Dichlorobenzene | *106-46-7* | ND | ND | 70 | Ethylene glycol diethyl ether | *629-14-1* | ND | ND |
| | **Miscellaneous** (LOD #37= 5µg & #38=25µg/compound/section) | | | | 71 | PGMEA | *108-65-6* | ND | ND |
| 37 | Acetonitrile | *75-05-8* | ND | ND | 72 | Cellosolve acetate | *111-15-9* | ND | ND |
| 38 | n-Vinyl-2-pyrrolidinone | *88-12-0* | ND | ND | 73 | DGMEA | *112-15-2* | ND | ND |
| | Total VOCs (LOD =50µg/compound/section) | | **107** | ND | | Worksheet check | | YES | YES |

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TestSafe Australia – WorkCover NSW *Chemical Analysis Branch*
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WC03147 0412

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Accredited for compliance with ISO/IEC 17025



air matters

NSW GOVERNMENT | WorkCover

Test Safe AUSTRALIA

## *Analysis of Volatile Organic Compounds in Workplace Air by GC/MS*

Air Matters

ND = Not Detected
VOCs = Volatile Organic Compounds
Method : Analysis of Volatile Organic Compounds in Workplace Air by Gas Chromatography/Mass Spectrometry
Method Number : WCA.207
Detection Limit : 5µg/section; 25µg/section for oxygenated hydrocarbons except acetone, MEK and MIBK at 5µg/section and aromatic hydrocarbon at 1µg/section.
Brief Description : Volatile organic compounds are trapped from the workplace air onto charcoal tubes by the use of a personal air monitoring pump. The volatile organic compounds are then desorbed from the charcoal in the laboratory with $CS_2$. An aliquot of the desorbant is analysed by capillary gas chromatography with mass spectrometry detection.

Total Volatile Organic Compounds (TVOC) test result in µg/section is calculated by comparison to the average mass detector response of the 73 quantified compounds. The response of a mass detector is dependent on the fragmentation of the molecule. Therefore, the TVOC test result should be interpreted as a semi-quantitative guide to the amount of VOCs present. If the TVOC test result is less than the addition of the total amount of the 73 quantified compounds then the TVOC result is of little value other than for comparative purposes. If the TVOC test result is greater than the addition of all the compounds quantified then this can indicate that there are additional compounds present other than the 73 quantified compounds reported.

PGME : Propylene Glycol Monomethyl Ether
PGMEA : Propylene Glycol Monomethyl Ether Acetate
DGMEA : Diethylene Glycol Monoethyl Ether Acetate

Measurement Uncertainty
The measurement uncertainty is an estimate that characterises the range of values within which the true value is asserted to lie. The uncertainty estimate is an expanded uncertainty using a coverage factor of 2, which gives a level of confidence of approximately 95%. The estimate is compliant with the "ISO Guide to the Expression of Uncertainty in Measurement" and is a full estimate based on in-house method validation and quality control data.

Quality Assurance
In order to ensure the highest degree of accuracy and precision in our analytical results, we undertake extensive intra- and inter-laboratory quality assurance (QA) activities. Within our own laboratory, we analyse laboratory and field blanks and perform duplicate and repeat analysis of samples. Spiked QA samples are also included routinely in each run to ensure the accuracy of the analyses. WorkCover Laboratory Services has participated for many years in several national and international inter-laboratory comparison programs listed below:-

- Workplace Analysis Scheme for Proficiency (WASP) conducted by the Health & Safety Executive UK;
- Quality Management in Occupational and Environmental Medicine QA Program, conducted by the Institute for Occupational, Social and Environmental Medicine, University of Erlangen – Nuremberg, Germany;
- Quality Control Technologies QA Program, Australia;
- Royal College of Pathologists QA Program, Australia.



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**Hill Laboratories**
BETTER TESTING **BETTER RESULTS**

# ANALYSIS REPORT

Page 1 of 1

| | | | |
|---|---|---|---|
| **Client:** | Air Matters Limited | **Lab No:** | 1103546 SPv1 |
| **Contact:** | Robert Murray | **Date Registered:** | 23-Feb-2013 |
| | C/- Air Matters Limited | **Date Reported:** | 08-Mar-2013 |
| | PO Box 96 256 | **Quote No:** | |
| | Balmoral | **Order No:** | |
| | AUCKLAND 1342 | **Client Reference:** | |
| | | **Submitted By:** | Robert Murray |

**Sample Type: 1-(2-Pyridyl)piperazine (1-2PP) coated glass fiber filters <50mm**

| | | | | | | |
|---|---|---|---|---|---|---|
| | **Sample Name:** | 13001 BB1 | 13001 BB2 | 13001 BC1 | 13001 BC2 | 13001 BC3 |
| | **Lab Number:** | 1103546.1 | 1103546.2 | 1103546.3 | 1103546.4 | 1103546.5 |
| HDI (1,6-hexamethylene diisocyanate) | µg/sample | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| 2,4-TDI (2,4-Toluene diisocyanate) | µg/sample | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| 2,6-TDI (2,6-Toluene diisocyanate) | µg/sample | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| MDI (Methylene bisphenyl isocyanate) | µg/sample | < 0.02 | < 0.02 | 1.74 | < 0.02 | 0.02 |
| | **Sample Name:** | 13001 BC4 | | | | |
| | **Lab Number:** | 1103546.6 | | | | |
| HDI (1,6-hexamethylene diisocyanate) | µg/sample | < 0.02 | - | - | - | - |
| 2,4-TDI (2,4-Toluene diisocyanate) | µg/sample | < 0.02 | - | - | - | - |
| 2,6-TDI (2,6-Toluene diisocyanate) | µg/sample | < 0.02 | - | - | - | - |
| MDI (Methylene bisphenyl isocyanate) | µg/sample | 0.02 | - | - | - | - |

# SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

**Sample Type: 1-(2-Pyridyl)piperazine (1-2PP) coated glass fiber filters <50mm**

| Test | Method Description | Default Detection Limit | Samples |
|---|---|---|---|
| Isocyanates from treated Filters <50mm | 1-2PP coated filters extracted with ACN/DMSO 90/10, LC-MS analysis based on OSHA methods 42/47. | - | 1-6 |

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

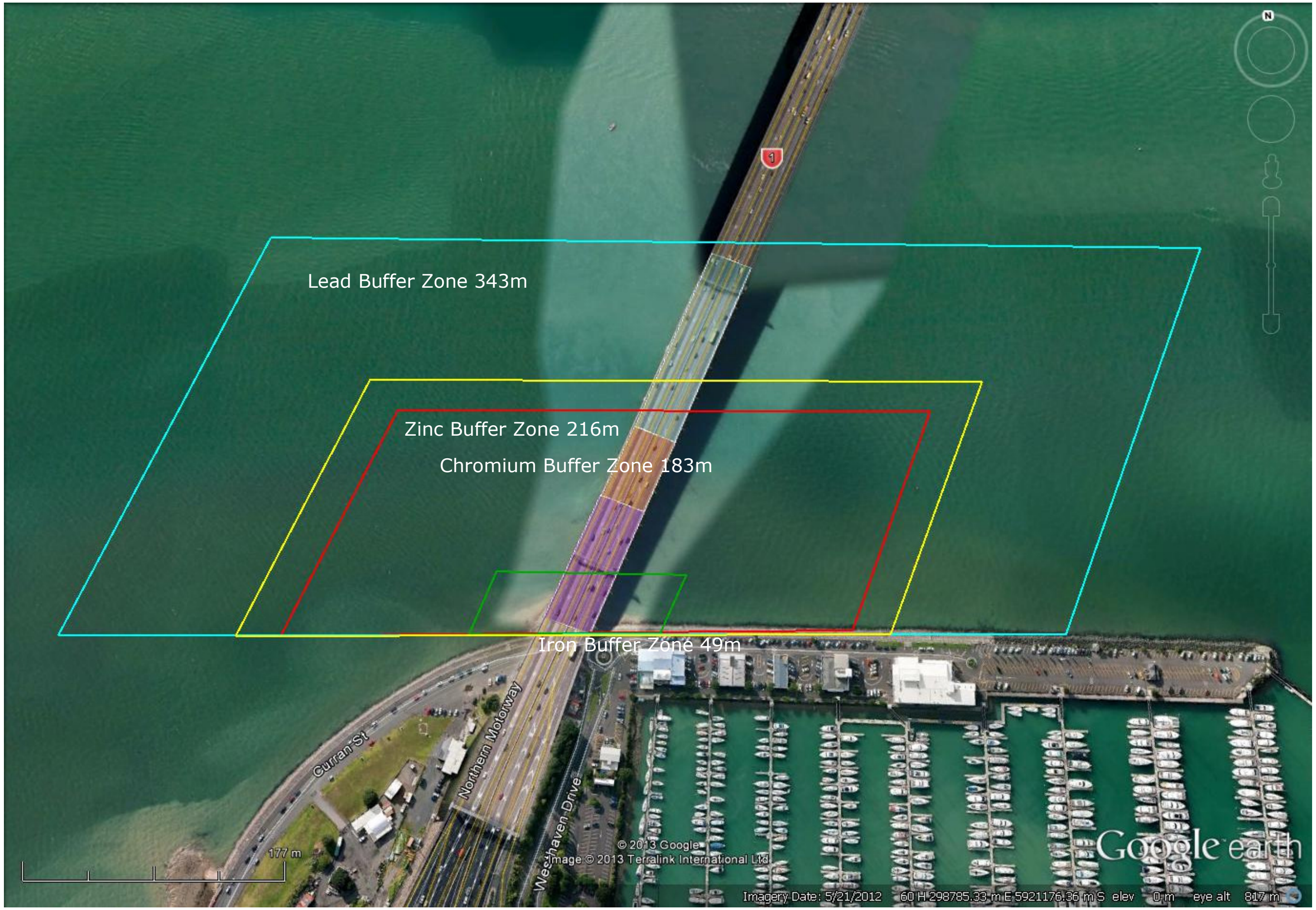
Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.



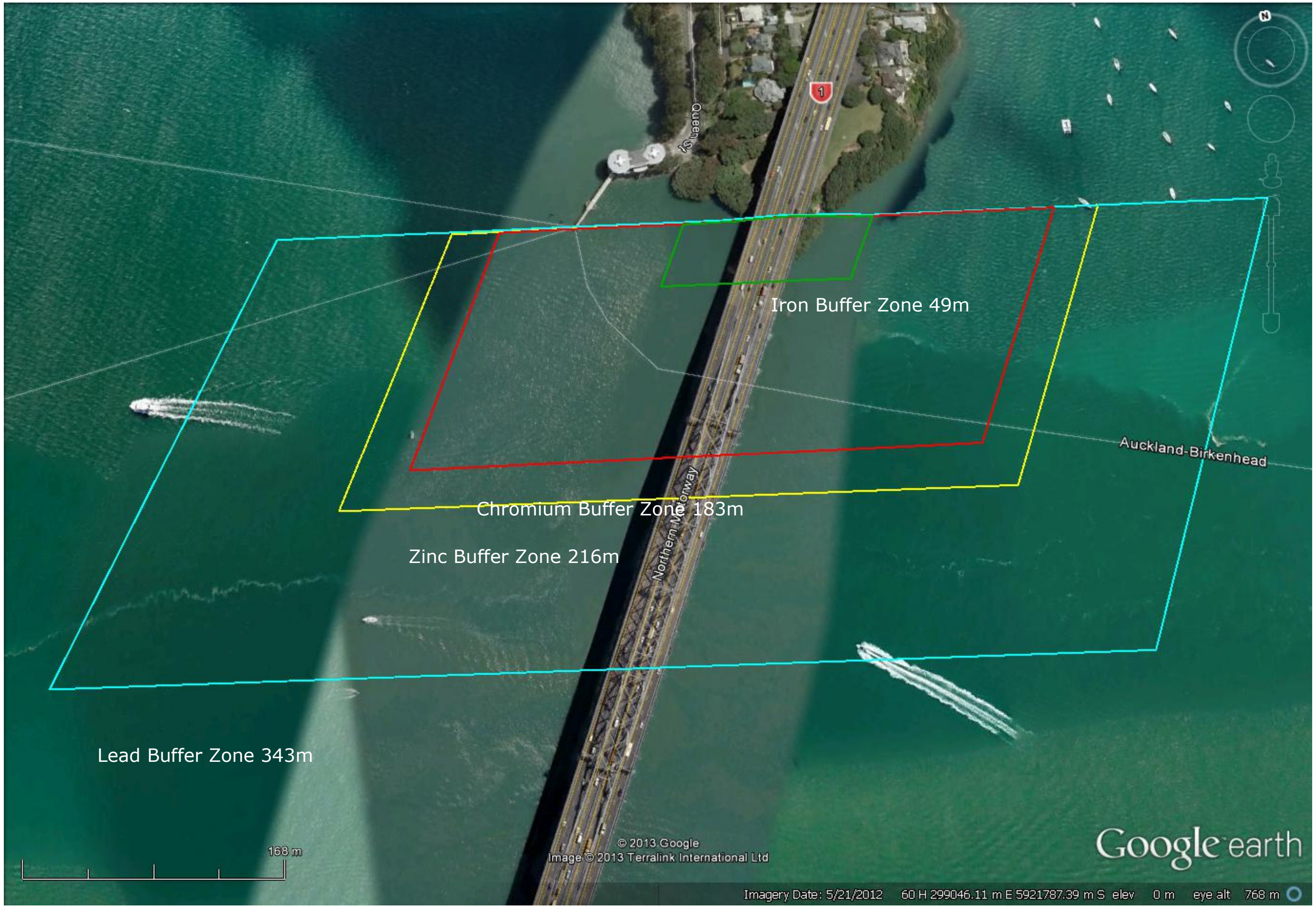
Graham Corban MSc Tech (Hons)
Client Services Manager - Environmental Division

## APPENDIX 3: BUFFER ZONES

SOUTHERN END METALS



NORTHERN END METALS



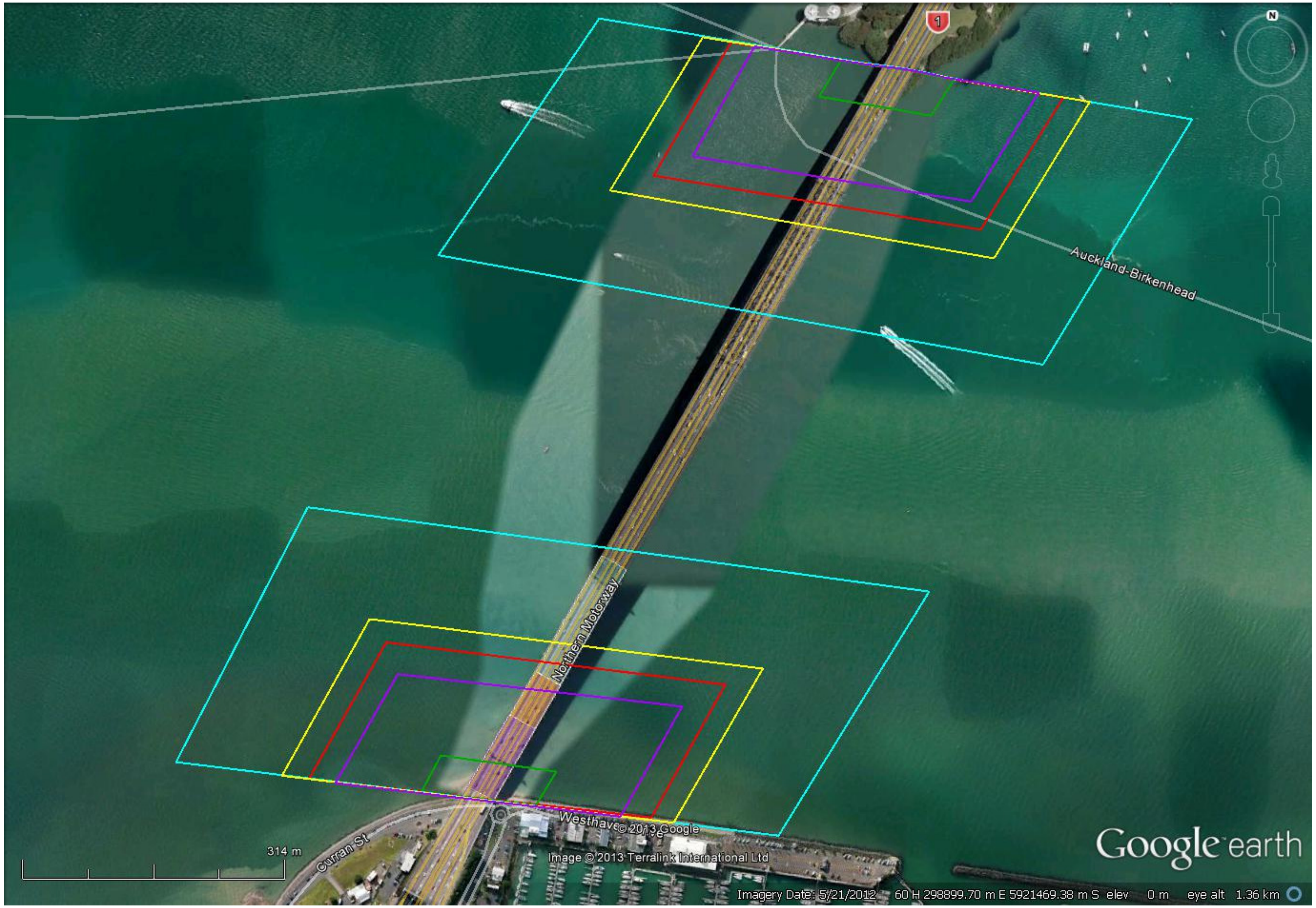



air matters

SOUTHERN END XYLENE

NORTHERN END XYLENE

NORTHERN AND SOUTHERN BUFFER ZONES



# 8. APPENDIX 3: BUFFER ZONES

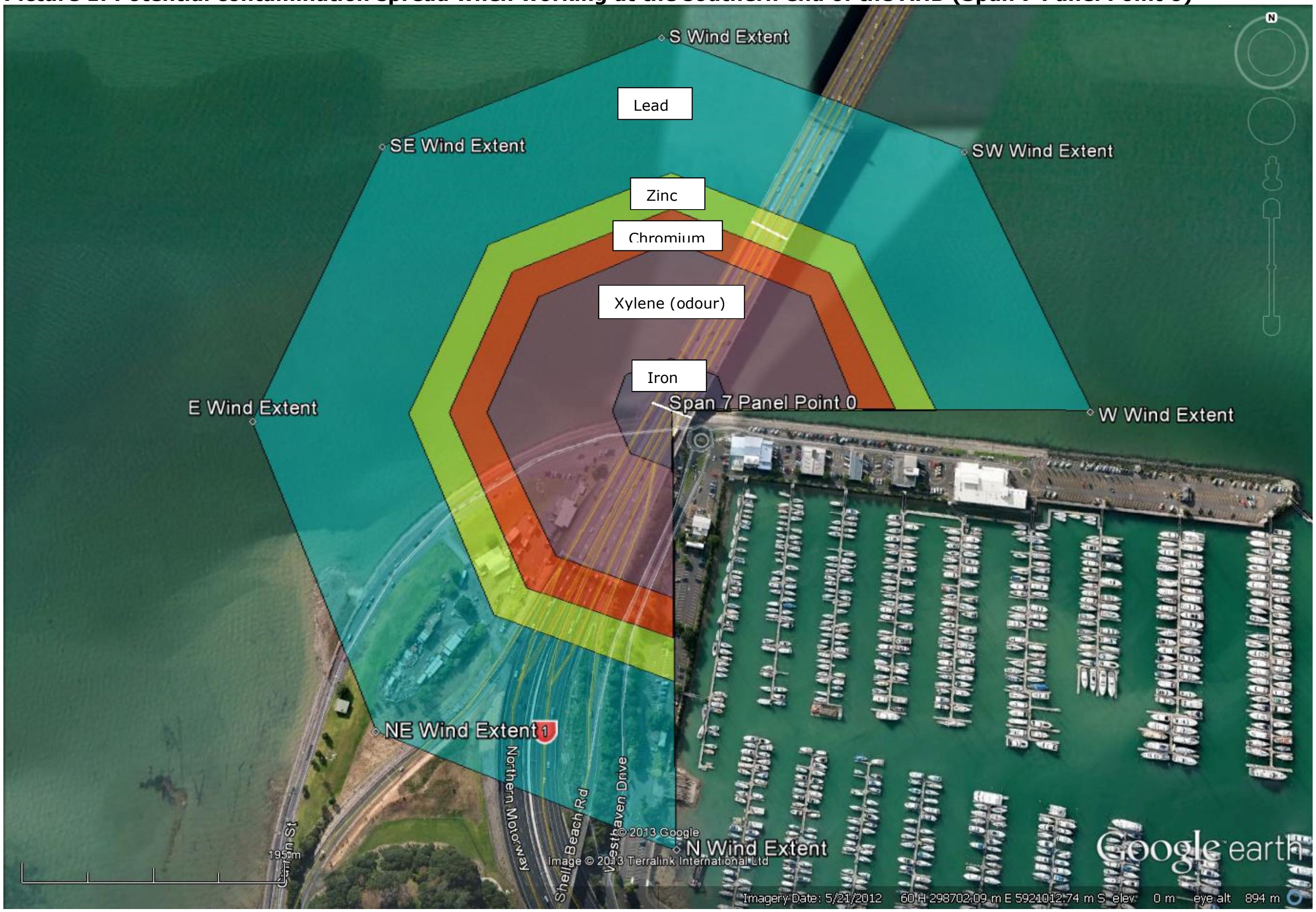
Monitoring of particulate and various metals was carried out at source (or as close as practicable to source) and then at stepped locations as close as possible to being down wind (e.g. 5m, 10m, 15m, 20m, 30m, 150m etc.). Sampling for each contaminant was carried out over a few days with varying environmental conditions. A value for the decrease in concentration per meter was then calculated by using measured concentrations at various locations downwind. The potential spread of contamination was then calculated by using the maximum at source concentration and the most conservative concentration decrease per meter. From this buffer zones were created which indicate the location on the AHB where maintenance activities can be undertaken without any specific controls required. These buffer zones are considered conservative.

The concentrations can be viewed below.

| | **Chromium** | **Iron** | **Lead** | **Zinc** | **Xylene (conversion from TVOC ppm data)** |
|---|---|---|---|---|---|
| **Maximum Concentration Measured at Source (µg/m³)** | 40.2 | 1035.9 | 104.4 | 646.1 | 198 |
| **Worst Case Decrease per meter (µg/m³)** | 0.2 | 20 | 0.3 | 2.9 | 1.3 |
| **Environmental Standard (µg/m³)** | 3.6 | 50 | 1.5 | 20 | 0.35 |
| **Projected distance as buffer zone (m)** | 183 | 49 | 343 | 216 | 152 |

From this data the potential contaminant spread has been calculated and illustrated. This information is detailed below. The colour coding is labelled in Picture 1 and is the same for pictures 2, and 3.

**Picture 1: Potential contamination spread when working at the southern end of the AHB (Span 7 Panel Point 0)**





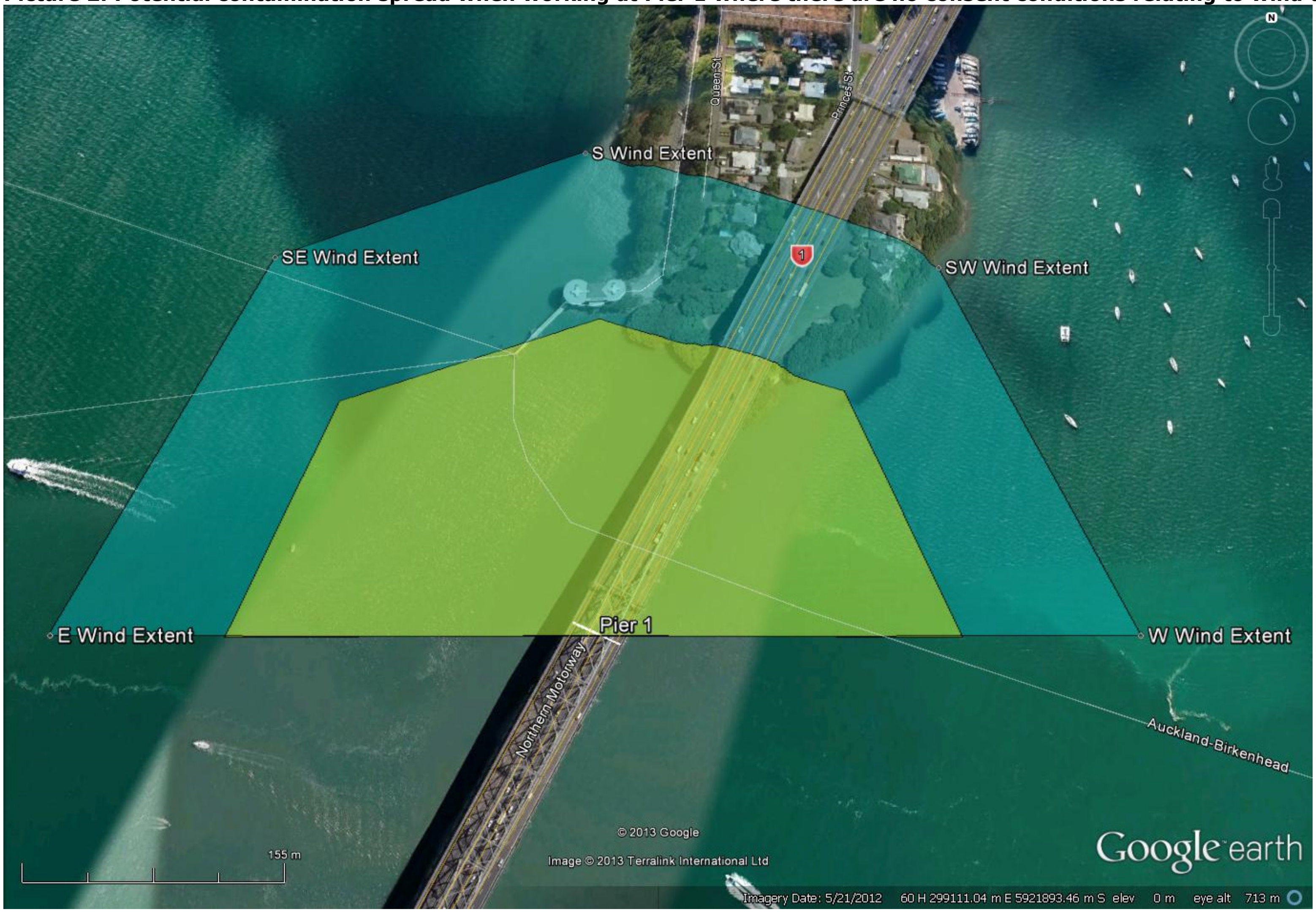

air matters

Picture 1 visually displays the potential spread of various contaminants when working at the most landward point of the AHB (Span 7 Panel Point 0). At this point (and any point south of Pier 5) there are specific resource consent conditions around wind direction (i.e. no work to be undertaken when the wind is from the NW quarter).

The picture shows that the consent condition is adequately protecting the area to the SE of the AHB (Westhaven Marina); however there are areas (used by people for work or recreation) that are affected by concentrations above environmental guidelines from the S round to the SW of the AHB. Potential ways to mitigate this include containment, exclusion zones, working when people are not present in the affected areas.

*Note: Xylene is an odour based standard.*

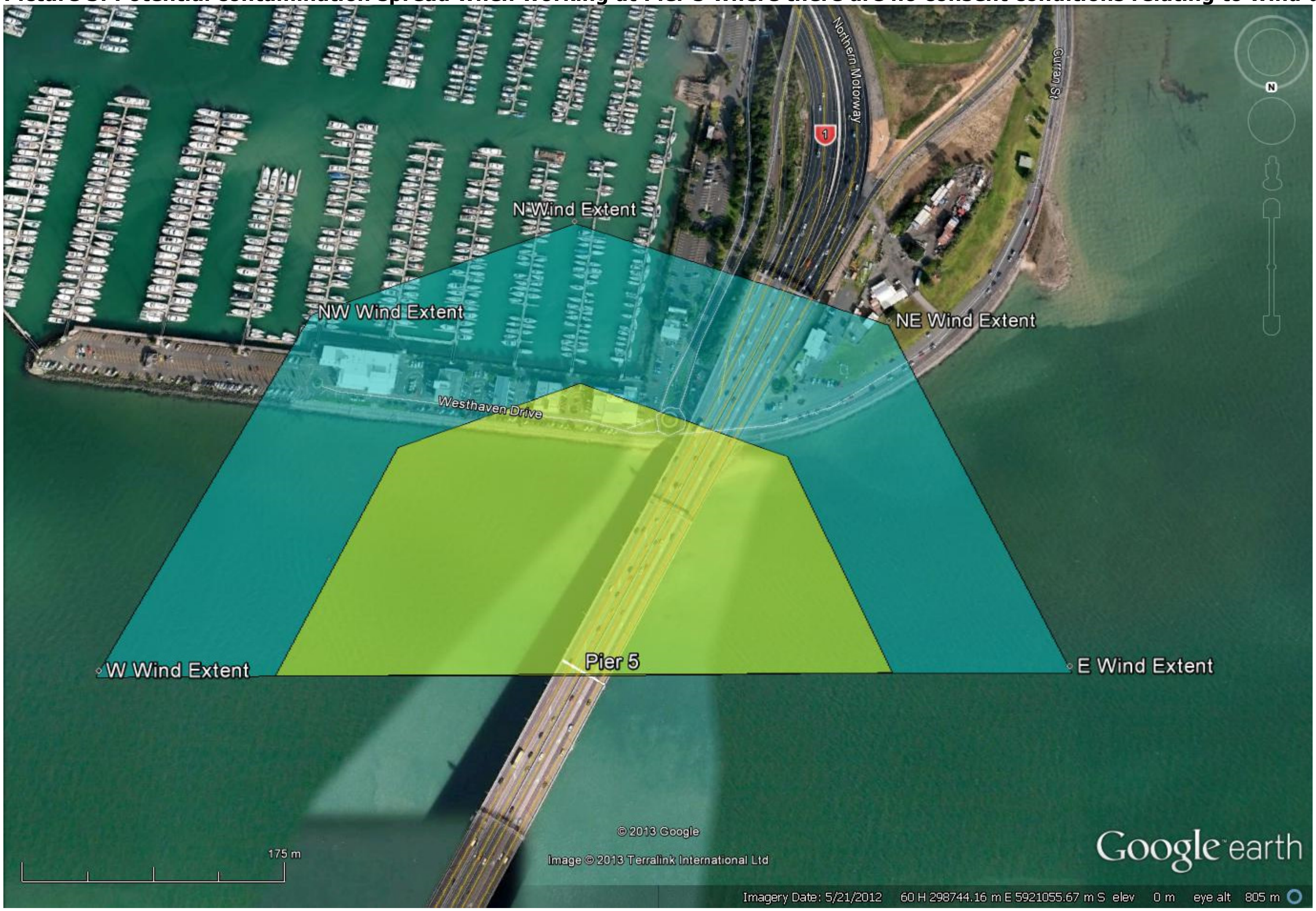
**Picture 2: Potential contamination spread when working at Pier 1 where there are no consent conditions relating to wind direction**



Picture 2 is based on work being undertaken on Pier 1. At this point there are no consent conditions restricting work under certain wind directions. The picture indicates that lead and zinc concentrations may be above environmental guidelines on land when the wind is from the S round to the SW.

Lead is the main issue and is determined by the concentration of lead in the surface coating being removed. Potential ways to mitigate this include containment and wind direction restrictions i.e. blasting in this area may occur when wind is not from the S-SW. A better understanding of the lead content in the surface coating prior to removal may also be used to estimate potential buffer zones (i.e. if no or very low levels are lead found restrictions may not apply). Based on current data when blasting work is located more than 340m away from land there are no restrictions required, this would be approximately Span 2 Panel Point 3.

**Picture 3: Potential contamination spread when working at Pier 5 where there are no consent conditions relating to wind direction**



Picture 3 is based on work being undertaken on Pier 5. At this point there are no consent conditions restricting work under certain wind directions. The picture indicates that lead and zinc concentrations may be above environmental guidelines on land when the wind is from the NW round to the NE. Lead is the main issue and is determined by the concentration of lead in the surface coating being removed. Potential ways to mitigate this include containment and wind direction restrictions i.e. blasting in this area may occur when wind is not from the NW-NE. A better understanding of the lead content in the surface coating prior to removal may also be used to estimate potential buffer zones (i.e. if no or very low levels are lead found restrictions may not apply). Based on current data when blasting work is located more than 340m away from land there are no restrictions required, this would be approximately Span 4 Panel Point 2.

Buffer Zones were then calculated which indicate areas of the AHB where dry abrasive blasting work and spray painting using the current product can be used without the requirement of mitigation measures (e.g. containment, wind direction controls). Note: the 7m/s wind speed control still applies at all locations on the bridge when dry abrasive blasting.

Buffer Zones for the north and south ends of the AHB are displayed below.

**Picture 4: Buffer Zones for Applicable to Dry Abrasive Blasting**

**Picture 5: Buffer Zones for Applicable to Spray Painting (Currently Consented Products)**

# 9. APPENDIX 4: AMF APPLICATION - TERMARUST

# TOTAL BRIDGE SERVICES

# AUCKLAND HARBOUR BRIDGE

Assessment of a new coating product, Termarust, using the Adaptive Management Framework process

AIR MATTERS REPORT 14051

Test Date: 15/4/2014
Report Date: 10/07/2014

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Unit K, 383 Khyber Pass Rd, Newmarket / PO Box 96 256, Balmoral 1342
Auckland, New Zealand / **W:** airmatters.co.nz

Report prepared for Total Bridge Services by Air Matters Limited

| | |
|---|---|
| Air Matters Report: | 14051 |
| Date: | 10/07/2014 |
| Status: | FINAL |

Report written by:

Carol McSweeney
Director

Report peer reviewed by:

Robert Murray
Environmental Scientist

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## 1. OBJECTIVES

1. To carry out sampling for overspray, volatile organic compounds and odour during the trial of a new coating product (Termarust).
2. To assess results in terms of the Adaptive Management Framework which has been developed as part of the new maintenance consent applications to manage discharges from the Auckland Harbour Bridge maintenance process throughout the term of the consent.

## 2. INTRODUCTION

The Termarust system is based on a proprietary formulation of high-ratio calcium sulfonate alkyd (HRCSA) that consists of a penetrating sealer (TR2200LV) for use on crevices and a high-build coating product (TR2100) that is used as caulking or stripe coat on crevices or fasteners, and as a self-priming topcoat.

The Termarust can be applied over various levels of surface preparation ranging from a hot water wash at 6,000 psi to remove loosely adherent material and salt contamination when used as an encapsulation coating, through to abrasive blast cleaning to a SSPC SP7 (Brush off) or SP14 (Industrial) finish. It has a "volume solids" of 63% and is thinned or cleaned with mineral spirits. It is usually applied as two "wet on wet" coats (i.e. caulk and stripe coat immediately followed by a full coat)

Termarust is particularly suitable for use on riveted steel work with crevices and has been used to successfully treat many bridges where de-icing salt has been used and the bridge structure has developed pack rust. It has also been used as an encapsulating coating to avoid the costs associated with the removal of lead-based paint.

Its principal disadvantage is that it may take several days to harden enough to walk on and even when fully cured has low abrasion resistance, so is not recommended on surfaces subject to impact or that are accessible to the public.

It is envisaged that Termarust could be a useful option to coat the inside of lattice posts and diagonals of the original bridge, and similar elements where it is difficult to access for abrasive blasting or painting, and to treat any joints with rust bleed. It could also be used in enclosed spaces where the elimination of odour and hazards from conventional solvents may be desirable. Its main benefit could be from extending the life of the existing coating system without the use dry abrasive blasting and negative pressure containment of chromate dust.

# 3. METHODOLOGY FOR ADAPTIVE MANAGEMENT FRAMEWORK ASSESSMENT

Termarust will be assessed based on the protocol developed as part of the Adaptive Management Framework (AMF) for new products and methods utilised for bridge maintenance. The procedure methodology is:

1. Request and review Material Safety Data Sheet for the product;
2. Identify components of the product;
3. Research air quality guidelines associated with components and create a list of thresholds (if not already covered);
4. Check usage and product against the Auckland Council Regional Plan: Air Land and Water Plan (ALWP) or the Proposed Unitary Plan rules or the statutory requirements of the consent;
5. Define mitigation measures to be used with new products e.g. preparation method, application method, wind restrictions, screens, buffer zones, containment;
6. Carry out trial of product which may require ambient air quality monitoring and/or ambient air quality modelling;
7. Compare results with the thresholds presented in the consent application and against the environmental guidelines and or standards as appropriate. Assess effectiveness of mitigation measures. Implement more mitigation where required to meet thresholds, guideline concentrations or environmental standards;
8. If product meets thresholds (ambient air quality guidelines) update EMP to include new product and associated mitigations; and
9. Introduce product to maintenance.

# 4. REVIEW OF TERMARUST BASED ON THE METHODOLOGY OF THE AMF

## 4.1 REQUEST FOR INFORMATION

The Termarust Series Organic Coating 2100/2200 and Termarust thinner (TRT01) safety data sheets have been provided. (See Appendix 3).

## 4.2 IDENTIFY THE COMPONENTS IN THE SAFETY DATA SHEET.

The Material Safety Datasheet for Termarust Series Organic Coating 2100/2200 and Termarust thinner (TRT01) identifies mineral spirits (CAS# 64742-88-7) at 10-30% in the coating and 60-100% in the thinner. Mineral spirits is also known as solvent naptha and is identified as a general petroleum solvent with a boiling range of 130°C to 220°C. The mineral spirits used in Termarust has a boiling point of 150°C.

Mineral spirits is a complex mixture of saturated aliphatic and aromatic $C_7$ to $C_{13}$ hydrocarbons. The literature defines mineral spirits as having 80-86% aliphatic (straight chain) hydrocarbons and 14-20% aromatic hydrocarbons which includes such things as xylene and ethylbenzene. However, it will contain only very low levels of the more toxic aromatics such as benzene and naphthalene.

Mineral spirits is known to have a solvent odour which will need to be assessed for the use of this product.

The above assessment indicates that Termarust should be assessed under the AMF for odour from both the aliphatic and aromatic hydrocarbons and health effects from aromatic hydrocarbons.

The product can be applied in various ways; strip coated by hand or sprayed coated. From assessments of other coating products used on the bridge, spray painting is the only application method that contributes significant solvents and particulate to the air. Total suspended particulate (TSP) in the form of overspray is identified as a contaminant of concern where spray painting is carried out. Spray painting also produces a certain amount of fine particulate $PM_{10}$ (up to 50% depending on nozzle size etc).

## 4.3 DETERMINE THRESHOLD VALUES FOR THE KEY CONTAMINANTS OF TERMARUST

Key contaminants discharged from the maintenance of the Auckland Harbour Bridge (AHB) have been assessed as recommended by the Good Practice Guide for Assessing Discharges to Air from Industry. TP152 also provides guidance on air quality criteria, but as a national and more recent document, the Good Practice Guide for Assessing Discharges to Air from Industry takes precedent.

According to this document, assessments are to be compared to air quality criteria in the following order of priority depending on what is provided in the various documents:

a. National Environmental Standards for Air Quality (NESAQ)
b. National Ambient Air Quality Guidelines (AAQG)
c. Regional objectives (unless more stringent than above criteria). The Auckland Regional Air Quality Targets are the same as the AAQG
d. World Health Organisation Air Quality Guidelines (WHO)
e. California Office of Environmental Health Hazard Assessment Reference Exposure Levels (OEHHA acute, 8 hr and chronic) and unit risk factors
f. US EPA inhalation reference concentrations (USEPA RfC) and unit risk factors
g. Other standards and guidelines. The Texas Commission on Environmental Quality (TCEQ) Effects Screening Levels (ESL) have been used as these are recommended in TP152.

Each standard/guideline was referred to for each contaminant in turn and based on the above order of priority. However, as the processes involved in the maintenance of the AHB are short term, appropriate short term guidelines have generally been used.

Key contaminants identified in Termarust and their associated thresholds are outlined below.

*Table 1: Threshold values for the key environmental contaminants of the product*

| | Short term acute odour values | | | Short term acute toxicity values | | |
|---|---|---|---|---|---|---|
| **Contaminant** | **Concentration $\mu g.m^{-3}$** | **Averaging period** | **Authority** | **Concentration $\mu g.m^{-3}$** | **Averaging period** | **Authority** |
| Naphtha | 3500 | 1 hour | TCEQ ESL | 18,000 | 30 min | Ontario |
| Xylene | 350 | 1 hour | TCEQ ESL | 22000 | 1 hour | OEHHA |
| Trimethylbenzene | No data* | No data | No data | 1250 | 1 hour | TCEQ ESL |
| Ethylbenzene | 740 | 1 hour | TCEQ ESL | 1100 | 1 hour | ATSDR |
| Methyl Isobutyl ketone (MIBK) | 820 | 1 hour | TCEQ ESL | No data** | No data | No data |

* See reference 14 (odour threshold 1700µg/m³) ** See reference 13 (No peer reviewed dose response data)

*Table 2: Threshold values for particulate overspray from spray painting of the product*

| Contaminant | Concentration µg.m$^{-3}$ | Averaging period | Authority |
|---|---|---|---|
| Total Suspended Particulate (Nuisance) | 80 | 24 hour | MfE Recommended Trigger |
| $PM_{10}$ (Health) Applies to outdoor location where the public might be exposed. | 50 | 24 hour | MfE NES |

## 4.4 THE PROPOSED USAGE OF TERMARUST AND REVIEW AGAINST THE CURRENT CONSENT REQUIREMENTS

The use of Termarust does not trigger any new rule in the Auckland Council Regional Plan, Air Land and Water. Solvent use is provided for by the consent and there are no new contaminants, therefore no new effects. The discharges from the proposed Termarust usage must therefore meet the threshold values identified in Table 1 above in order to ensure that there are no effects from this product.

## 4.5 MITIGATION FOR TRIAL

For the purpose of the Temarust trial, partial containment was used in the form of polythene sheeting set up on either side of the panel point to be sprayed. The area painted by the trial was 25m$^2$. 2 litres of Termarust was used for spotting (hand application) and 16 litres for spray painting which consisted of 10% Termarust thinner.

## 4.6 METHODOLOGY FOR AIR TESTING FOR TERMARUST

Measurement of airborne contaminants was carried out during the trial as required by the AMF. The methodology for testing and assessing new components under the AMF will be decided based on the above assessment and may differ for various application methods or products. For the Termarust trial the method and results are reported below.

### *4.6.1 TOTAL SUSPENDED PARTICULATE AND $PM_{10}$*

Sampling for total suspended particulate (measured as inhalable dust less than 100 microns in diameter) was carried out in accordance with AS/NZS 3640-2009 for particulates. Samples were collected using an IOM inhalable dust sampler and filter. This was connected to a calibrated sampling pump running at a rate of 2L/min. Samples were set up at various locations in relation to the work, sensitive receptors and wind direction. Filters were subsequently weighed by Air Matters. The method followed was based on the Australian Standard for inhalable particulate. This method was used as opposed to Total Suspended Particulate (TSP) by high volume ambient air monitoring equipment due to the short term nature of the works and the sampling locations making ambient standard method samplers impracticable in this situation.

The literature suggests that up to 50% of overspray particles may be $PM_{10}$. Based on this assumption, $PM_{10}$ concentration in the overspray could be calculated. However, this is not considered appropriate and the overspray is viewed as a nuisance deposit.

### 4.6.2 VOLATILE ORGANIC COMPOUNDS (VOC)

Total VOC (TVOC)

A real time datalogging photo ionisation detector (PID), MultiRae Plus PGM-50, was used to collect data on the concentration of Total Volatile Organic Compounds (TVOC). This monitor was calibrated by Air Matters on the 15/4/2014 using 10ppm of isobutylene. The instrument was set up to log 60 or 30 second averages. The unit was shifted to various locations in relation to the work, sensitive receptors and wind direction. Calculations from parts per million to milligrams per cubic meter have been made to compare values with the Threshold levels. (Based on an average molecular weight of 150.)

Speciated VOC / Solvents

Sampling was carried out according to NIOSH method 1550. Air samples were collected on charcoal sorbent tubes (SKC 226-01) with the sampling pumps calibrated at a maximum flow of 0.2L/minute. Samples were set up at various locations in relation to the work, sensitive receptors and wind direction. Analysis of the tubes was carried out by Hill Laboratories by GC FID analysis according to the NIOSH method.

### 4.6.3 ODOUR

As odour has been identified as an issue in the MDS for the product, an odour survey was planned as part of the Termarust trial. This took the form of an "odour scout" (a technician with a calibrated nose) and was carried out by Watercare Services Ltd. Odour was assessed every 5 metres from a starting distance of 50 meters from the spray painting. The characteristic odour was recorded along with intensity, offensiveness and frequency of the odour. A full report from Watercare is to be found in Appendix 2.

## 4.7 RESULTS OF AIR TESTING DURING TERMARUST TRIAL

### 4.7.1 TOTAL SUSPENDED PARTICULATE AND $PM_{10}$

Total Suspended Particulate Concentrations from Overspray

*Table 3: Total Suspended Particulate Concentrations Measured During Spray Painting on 15/04/2014 (Termarust Trial)*

| General Wind Direction & Speed | Sampling Location | Measured Concentration of TSP over 2 hour period $mg.m^{-3}$ | Calculated Concentration of TSP over 24 hour period $mg.m^{-3}$ | Threshold value for sensitive areas over 24 hour period $mg.m^{-3}$ |
|---|---|---|---|---|
| North East Average wind speed 1.1m/s, gusting to 1.9m/s | 1m **downwind** of Termarust Trial partial containment | 6.13 | 0.5 | **0.08** |
| | 5m **downwind** of Termarust Trial partial containment | 0.78 | 0.07 | |
| | 5m **upwind** of Termarust Trial partial containment | 0.55 | 0.05 | |
| | 5m **above** Termarust Trial partial containment | 2.43 | 0.2 | |

The nature of paint overspray means that the nuisance effect on property (cars and buildings) is different from a dry dust particle.

TSP measured one metre from the works and above the works exceeded the threshold value for a 24 hour period. However, by 5 meters downwind, the concentration was below the threshold value.

$PM_{10}$ Concentration Calculation from Overspray

At 5 meters downwind from the works, the calculated $PM_{10}$ concentration across a 24 hour period would be 32.5µg/$m^3$ based on 50% of the overspray being $PM_{10}$. This is considered a conservative calculation as the particles will still likely have some acceleration from the spray nozzle resulting in increased dispersion.

### *4.7.2 VOLATILE ORGANIC COMPOUNDS*

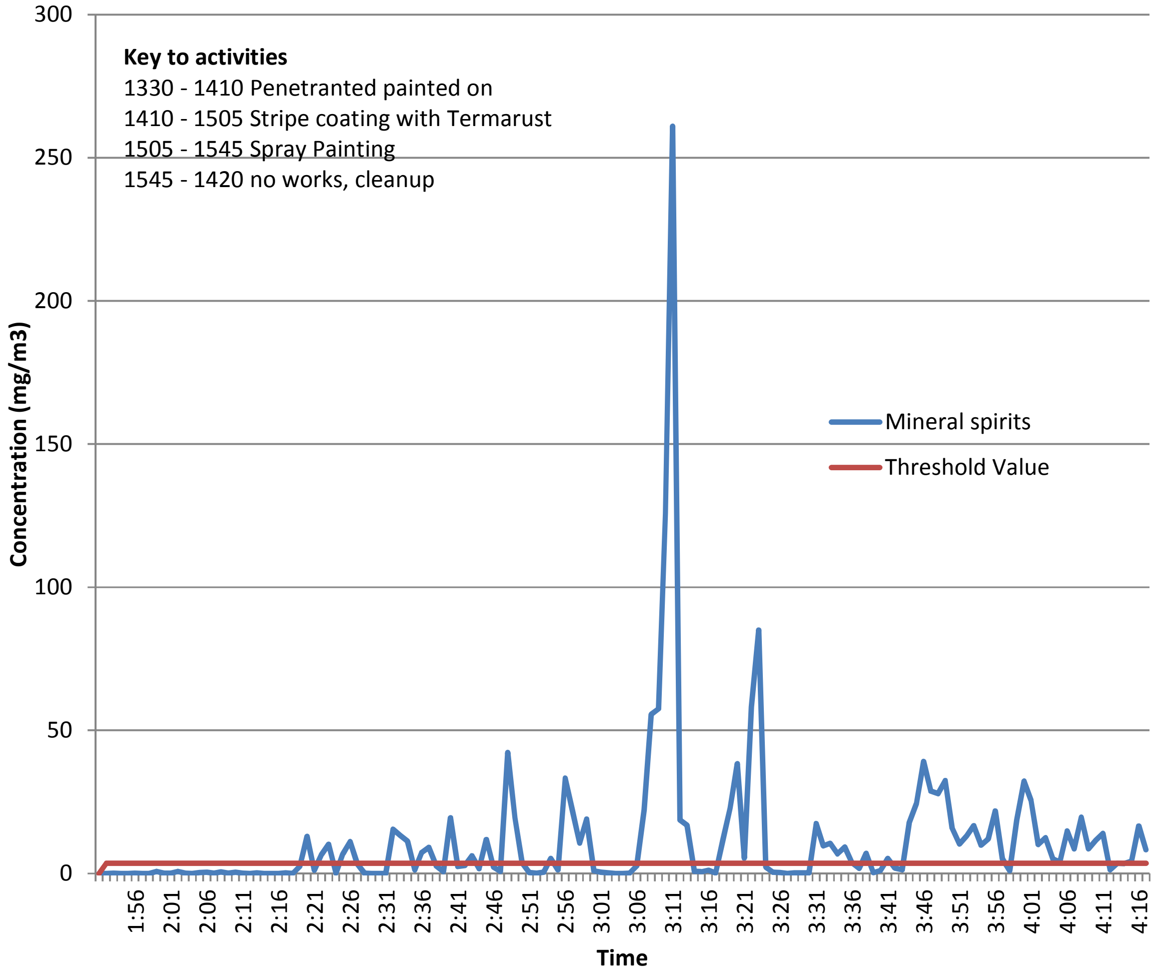
Total Volatile Organic Compounds (TVOC)

Background concentrations were measured when no Termarust spray painting was taking place on the bridge. Sampling was then undertaken at various stages and locations during the trial. All measurements have been converted to $mg.m^{-3}$ based on an average molecular weight for mineral spirits. This allows a comparison against the threshold value for odour and toxicity. Overall measurements for the process are shown in Chart 1.

*Table 4: TVOC Concentrations Measured During Sampling on 15/04/2014*

| Time | Activity | Sampling Location | Measured Concentration $mg.m^{-3}$ |
|---|---|---|---|
| 13:52 | Preworks | Downwind of contained area | 0 |
| 13:58 | Penetrant applied | Downwind 1m from containment | 7 |
| 14:10 | Strip coating with Termarust | Downwind edge of containment | 68 |
| 15:05 | Spray coating starts | Downwind edge of containment | 264 |
| 15:30 | Spray coating continues | Gate entrance to compound | 509 |
| 15:50-15:40 | Spray coating continues | Centre of the yard | 98 |
| 15:45 | Spray coating finishes | Spray finishes - sample at gate entrance to compound | 86 |
| 15:45 - 6:17 | Clean-up | Sample still at compound gate | 3-32 |

*Chart 1: Average 1 minute concentration of mineral spirits throughout the spray painting*




Note: the above measurements were taken 1 metre downwind from the containment area.

Speciated Volatile Organic Compounds (VOC)

Analysis was carried out for a wide range of VOCs as a time weighted average over the trial period. Only the compounds reported below were identified above the detection limit.

*Table 5: Speciated VOC Concentrations Measured During Spray Painting (mg.m$^{-3}$)*

| Location | Ethylbenzene | Xylene | Propyl benzene | Tri-methylbenzene | MIBK | Aliphatic hydrocarbon |
|---|---|---|---|---|---|---|
| 1 metre downwind from containment | 2.6 | 1.9 | 0.03 | 0.02 | <0.02 | 5.6 |
| 5 metre downwind from containment | 0.6 | 0.5 | 0.01 | <0.02 | 0.03 | 1.5 |
| 5 metre upwind from containment | 0.2 | 0.2 | <0.02 | <0.02 | 0.03 | 0.8 |
| 1 metre above the spray painting (on bridge) | 0.8 | 2 | 0.04 | 0.02 | 0.04 | 6.9 |
| **Threshold value for odour** | **0.74** | **0.35** | **0.23** | **No data** | **0.7** | **3.5** |
| **Threshold value for toxicity/ human health** | **1.1** | **22** | **No data** | **1.25** | **No data** | **18** |

### *4.7.3 ODOUR*

The full odour results and report from the Watercare Odour Scout are presented in Appendix 2. Table 1 from that report is included here for reference.

*Table 6: Results from Watercare Odour Monitoring Report, April 2014*

| Distance from source of spray-painting (m) | Time | Wind Speed (m/s) | Wind Direction | Character | Intensity | Frequency | Offensiveness |
|---|---|---|---|---|---|---|---|
| 5 | 15:56 | 0.9 | NE | Paint | 5 | 3 | 4 |
| 10 | 15:55 | 0.9 | NE | Paint | 5 | 3 | 4 |
| 15 | 15:48 | 1.2 | NE | Paint | 3 | 3 | 3 |
| 20 | 15:47 | 1.6 | NE | Paint | 2 | 3 | 3 |
| 25 | 15:39 | 1.8 | NE | Paint | 2 | 1 | 2 |
| 30 | 15:36 | 1.9 | NE | NDO | 0 | 0 | 0 |
| 35 | 15:29 | 1.9 | NE | Paint | 1 | 1 | 1 |
| 40 | 15:26 | 1.7 | NE | NDO | 0 | 0 | 0 |
| 45 | 15:21 | 2.9 | NE | NDO | 0 | 0 | 0 |
| 50 | 15:20 | 3.1 | NE | NDO | 0 | 0 | 0 |
| 55 | 15:12 | 2.4 | NE | NDO | 0 | 0 | 0 |

| Odour Scoring Guide | | | | | |
|---|---|---|---|---|---|
| **Intensity score /6** | | **Frequency score /3** | | **Offensiveness /4** | |
| 0 / blank | NDO | 0 / blank | NDO | 0 | NDO |
| 1 | Very Slight | 1 | Once-off | 1 | Not offensive |
| 2 | Slight | 2 | Intermittent | 2 | Slightly offensive |
| 3 | Distinct | 3 | Constant | 3 | Moderately offensive |
| 4 | Strong | | | 4 | Highly offensive |
| 5 | Very Strong | | | | |
| 6 | Extremely Strong | | | | |

NDO = No detectable odour

The above table shows intensity, frequency and offensiveness of odour from 5 to 55 metres downwind of the Termarust trial. (Full report in Appendix 2)

## 4.8 DISCUSSION OF RESULTS FOR UPDATE OF ENVIRONMENTAL MANAGEMENT PLAN (EMP)

### *4.8.1 TOTAL SUSPENDED PARTICULATE AND $PM_{10}$*

$PM_{10}$ emissions were low and will not contribute significantly to the airshed. The effects are considered over a 24 hour period where the public may be exposed. The effect of PM10 from the use of the new product does not require any change in the EMP.

TSP is considered a nuisance particulate and paint overspray would be thus considered. It is important that spray paint particulate does not settle on property in the area.

Particulate in the form of overspray was high at 1 metre downwind of the partial containment. However, by 5 metres downwind the level had dropped considerably and was just below the 0.08mg/$m^3$ value used as a guideline value for TSP in a sensitive area (MfE) over a 24 hour period.

The nature of the containment for this trial (only the sides of the area protected with polythene) meant that the level of TSP was elevated on the bridge above the work site as well.

The sample set up 5 metres upwind of the works showed the presence of overspray, although it was below 0.08mg/$m^3$. Once again the partial containment (side screens only) may have led to the overspray and the solvents swirling above the plastic and moving upwind.

In summary, the overspray has an effect close to the works. It will be essential that overspray does not impact on property if this is close to the spray area. The effect from overspray will need to be considered when working close to land or close to traffic on the roadway. Overspray can be controlled by various methods:

1. Use of a buffer zone of 30m downwind from the works
2. Wind direction controls to prevent overspray being carried onto sensitive areas.
3. Screening /containment of the works to prevent upwind movement of the particulate.

The EMP will need to reflect the appropriate controls to achieve threshold values and ensure no nuisance effect.

### *4.8.2 VOLATILE ORGANIC COMPOUNDS*

Total Volatile Organic Compounds (TVOC)

Total volatile organic compounds in the form of mineral spirits were identified in concentrations above the odour threshold close to the works. The concentrations spiked during the spray painting activity but remained elevated after the spray painting was completed. The full trial was approximately 2 hours long.

Odour will need to be managed to maintain odour below the threshold values in sensitive receiving environments, over houses at the north end and over cafes and restaurants at the south end. Spray painting in areas of sensitive receptors will have to be controlled and these controls will be identified in the EMP. Controls may include:

1. A buffer zone of 30m from sensitive receptors to the works.
2. Wind direction controls to prevent odour being carried onto sensitive areas.
3. Hand painting to prevent the release of VOCs in overspray.

<u>Speciated Volatile Organic Compounds</u>

The samples collected over the full time of the trial gave a time weighted average result and identified the volatile components of the product. The health related thresholds for the speciated hydrocarbons were not exceeded at any location.

### *4.8.3 ODOUR*

The odour threshold value was exceeded close to the works for ethylbenzene, xylene and aliphatic hydrocarbons (see above details for TVOC). By 5 metres downwind of the works, the individual odour threshold values for individual contaminants were not exceeded. However, the odour survey using the odour scout defined the odour as distinct and moderately offensive out to 20 metres and slightly offensive out to 25 metres. It is likely that the combined effect of the odorous chemicals may have had a synergistic effect on the human detection of odour. Termarust has therefore been identified has having an odour effect close to the works and extending downwind of the works. There will be an effect on sensitive receptors which will need to be managed. Odour controls will be required when working in sensitive areas. As for particulate overspray, controls may include;

1. A buffer zone of 30m from the works
2. Wind direction controls to prevent overspray being carried onto sensitive areas.
3. Hand painting when close to sensitive receptors.

## 4.9 ASSESSMENT SUMMARY FOR INTRODUCTION OF PRODUCT TO MAINTENANCE

In summary, Termarust is considered a low effect product in terms of air discharges. When used on most areas of the Auckland Harbour Bridge it will not be necessary to make any changes to the EMP to meet the threshold levels for the contaminants of concern.

Odour and paint overspray from spray painting will have effects when used close to properties and other sensitive receptors overland. The odour scout sampling suggested a buffer zone of 20-30 meters downwind be required of any works in sensitive areas to reduce the odour to less than "distinct" and "moderatley offensive". Other controls relating to wind direction and/or hand painting will need to be used in conjunction with buffer controls to manage odour effects.

Overspray particulate will have a nuisance effect in sensitive areas. Overspray can be controlled effectively in sensitive areas with screens or containment and wind direction limitations. If this method of control is not achievable, hand painting will eliminate the effect from overspray. The EMP will be updated to reflect these controls.

The chemical testing indicated the concentrations of individual species were below the health effect level at 5 metres downwind of the works (as measured on the day of testing). Consideration will have to be given to the amount of product used and the duration of the works. The controls put in place for managing odour and overspray will be effective in maintaining levels below the hydrocarbon health threshold values.

Once the EMP is updated to reflect the above controls for Termarust, assessment suggests that this product can be used for bridge maintenance in accordance with the AMF.

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## APPENDIX 1A: DATA SHEETS - TSP AS INHALABLE PARTICULATE

Industry: Auckland Harbour Bridge

Project Number: 14051

Contaminant: Overspray particulate from Termarust Trial

| Date | Sample number | Location of test point | Time | | Sampling Details | | | Sample mass (mg) | Blank corrected (mg) | Contaminant Concentration (mg/$m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume ($m^3$) | | | |
| 15/04/2014 | 14051B B | Above spray paint, attached to fence on walkway | 13:42 | 16:00 | 138 | 2.03 | 0.280 | 0.65 | 0.68 | 2.43 |
| | 14051B C | 5m upwind of painting, above mixing area | 13:34 | 16:03 | 149 | 2.061 | 0.307 | 0.14 | 0.17 | 0.55 |
| | 14051B D | 5m downwind of painting, on Stokes Pt yard fence | 14:05 | 15:55 | 110 | 1.989 | 0.219 | 0.14 | 0.17 | 0.78 |
| | 14051B E | 1m downwind of painting, on fence | 14:02 | 15:55 | 113 | 2.037 | 0.230 | 1.38 | 1.41 | 6.13 |
| | 14051B F | Lab blank | - | - | - | - | - | -0.03 | - | - |

## APPENDIX 1B DATA SHEETS – HYDROCARBONS

Industry: Auckland Harbour Bridge Termarust Trial    Date: 15/04/2014
Project Number: 14051

Location: One metre downwind on fence

Contaminant: VOCs

| Location | Sample number | Location of test point | Sampling Details | | | | | | Sample mass (ug) | Blank/Spike corrected mass (ug) | Contaminant Concentration ($mg/m^3$) | Acute guideline value mg/m3 | Avg time | Jurisdiction | Effect |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume ($m^3$) | Ambient temp (ºK) | | | | | | | |
| 1 m downwind from works | 14051 AA | Ethylbenzene | 14:05 | 15:55 | 110 | 0.217 | 0.024 | 291 | 62 | 62 | 2.6 | 11 | 1 hour | ATSDR | Toxicity |
| | | Xylene | 14:05 | 15:55 | 110 | 0.217 | 0.024 | 291 | 47.3 | 47.3 | 1.9 | 22 | 1hour | OEHHA | Toxicity |
| | | Propylbenzene | 14:05 | 15:55 | 110 | 0.217 | 0.024 | 291 | 0.84 | 0.84 | 0.03 | | | | |
| | | Trimethylbenzene | 14:05 | 15:55 | 110 | 0.217 | 0.024 | 291 | 0.39 | 0.39 | 0.02 | 0.5 | 30 minute | Ontario | Odour |
| | | MIBK | 14:05 | 15:55 | 110 | 0.217 | 0.024 | 292 | 0 | 0 | 0.00 | 0.86 | 30 minute | | Odour |
| | | Naptha/other hydrocarbons | 14:05 | 15:55 | 110 | 0.217 | 0.024 | 293 | 134.5 | 134.5 | 5.6 | 3.5 | | | |
| | | Decane | | | | | | | | | | 180 | 30 minute | Ontario | Health |
| | | Octane | | | | | | | | | | 454 | 30 minute | Ontario | Odour |

All results corrected to 25ºC and 1 atmosphere pressure    15/04/2014    1006 HPa
755 mmHg

Industry: Auckland Harbour Bridge. Termarust Trial Date: 15/04/2014
Project Number: 14051

Location Five metres downwind

Contaminant: VOCs

| Location | Sample number | Location of test point | Time | | Sampling Details | | | | Sample mass (ug) | Blank/Spike corrected mass (ug) | Contaminant Concentration ($mg/m^3$) | Acute guideline value mg/m3 | Avg time | Jurisdiction | Effect |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume ($m^3$) | Ambient temp (°K) | | | | | | | |
| 5m downwind from works | 14051 AB | Ethylbenzene | 14:05 | 15:53 | 108 | 0.366 | 0.040 | 291 | 24 | 24 | 0.6 | 11 | 1 hour | ATSDR | Toxicity |
| | | Xylene | 14:05 | 15:53 | 108 | 0.366 | 0.040 | 291 | 18.2 | 18.2 | 0.5 | 22 | 1hour | OEHHA | Toxicity |
| | | Propylbenzene | 14:05 | 15:53 | 108 | 0.366 | 0.040 | 291 | 0.35 | 0.35 | 0.01 | | | | |
| | | Trimethylbenzene | 14:05 | 15:53 | 108 | 0.366 | 0.040 | 291 | 0.1 | 0.1 | 0.002 | 0.5 | 30 minute | Ontario | Odour |
| | | MIBK | 14:05 | 15:53 | 108 | 0.366 | 0.040 | 291 | 1.3 | 1.3 | 0.03 | 0.86 | 30 minute | | Odour |
| | | Other hydrocarbons | 14:05 | 15:53 | 108 | 0.366 | 0.040 | 291 | 60.6 | 60.6 | 1.5 | | | | |
| | | Decane | | | | | | | | | | 180 | 30 minute | Ontario | Health |
| | | Octane | | | | | | | | | | 454 | 30 minute | Ontario | Odour |

All results corrected to 25ºC and 1 atmosphere pressure

1006 HPa
755 mmHg

Industry: Auckland Harbour Bridge Termarust Trial Date: 15/04/2014
Project Number: 14051

Location: Five metres upwind above mixing area

Contaminant: VOCs

| Location | Sample number | Location of test point | Time | | Sampling Details | | | | Sample mass (ug) | Blank/Spike corrected mass (ug) | Contaminant Concentration (mg/m$^3$) | Acute guideline value mg/m3 | Avg time | Jurisdiction | Effect |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | Ambient temp (°K) | | | | | | | |
| 5m from spray painting upwind above mixing area | 14051 AD | Ethylbenzene | 13:34 | 16:05 | 151 | 0.28 | 0.042 | 291 | 10 | 10 | 0.2 | 11 | 1 hour | ATSDR | Toxicity |
| | | Xylene | 13:34 | 16:05 | 151 | 0.28 | 0.042 | 291 | 8.3 | 8.3 | 0.2 | 22 | 1hour | OEHHA | Toxicity |
| | | Propylbenzene | 13:34 | 16:05 | 151 | 0.28 | 0.042 | 291 | 0 | 0 | 0.00 | | | | |
| | | Trimethylbenzene | 13:34 | 16:05 | 151 | 0.28 | 0.042 | 291 | 0.12 | 0.12 | 0.00 | 0.5 | 30 minute | Ontario | Odour |
| | | MIBK | 13:34 | 16:05 | 151 | 0.28 | 0.042 | 291 | 1.1 | 1.1 | 0.03 | 0.86 | 30 minute | | Odour |
| | | Other hydrocarbons | 13:34 | 16:05 | 151 | 0.28 | 0.042 | 291 | 34.5 | 34.5 | 0.8 | | | | |
| | | Decane | | | | | | | | | | 180 | 30 minute | Ontario | Health |
| | | Octane | | | | | | | | | | 454 | 30 minute | Ontario | Odour |

All results corrected to 25ºC and 1 atmosphere pressure

1006 HPa
755 mmHg

Industry: Auckland Harbour Bridge. Termarust Trial Date: 15/04/2014
Project Number: 14051

Location: On bridge above spray painting

Contaminant: VOCs

| Location | Sample number | Location of test point | Time | | Sampling Details | | | | Sample mass (ug) | Blank /Spike corrected mass (ug) | Contaminant Concentration (mg/m$^3$) | Acute guideline value mg/m3 | Avg time | Jurisdiction | Effect |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | On | Off | Minutes on | Flow rate (L/min) | Volume (m$^3$) | Ambient temp (°K) | | | | | | | |
| On bridge above spray painting | 14051 AC | Ethylbenzene | 13:43 | 16:00 | 137 | 0.26 | 0.036 | 291 | 29 | 29 | 0.8 | 11 | 1 hour | ATSDR | Toxicity |
| | | Xylene | 13:43 | 16:00 | 137 | 0.26 | 0.036 | 291 | 73 | 73 | 2.0 | 22 | 1hour | OEHHA | Toxicity |
| | | Propylbenzene | 13:43 | 16:00 | 137 | 0.26 | 0.036 | 291 | 1.37 | 1.37 | 0.04 | ND | | | |
| | | Trimethylbenzene | 13:43 | 16:00 | 137 | 0.26 | 0.036 | 291 | 0.79 | 0.79 | 0.02 | 0.5 | 30 minute | Ontario | Odour |
| | | MIBK | 13:43 | 16:00 | 137 | 0.26 | 0.036 | 291 | 1.5 | 1.5 | 0.04 | 0.86 | 30 minute | Ontario | Odour |
| | | Other hydrocarbons | 13:43 | 16:00 | 137 | 0.26 | 0.036 | 291 | 251 | 251 | 6.9 | | | | |
| | | Decane | | | | | | | | | | 180 | 30 minute | Ontario | Health |
| | | Octane | | | | | | | | | | 454 | 30 minute | Ontario | Odour |

All results corrected to 25ºC and 1 atmosphere pressure — 15/04/2014 — 1006 HPa, 755 mmHg

## APPENDIX 2: WATERCARE REPORT FOR ODOUR SCOUT

# Air Matters

# Auckland Harbour Bridge

# Odour Monitoring Report

# April 2014

Prepared for

Air Matters

By

Watercare Laboratory Services – Air Quality Group

O-2022733

IANZ

ACCREDITED LABORATORY

# Auckland Harbour Bridge
# Odour Monitoring Report
# April 2014

A report for:

Air Matters

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28 April 2014

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# I INTRODUCTION

## 1.1 Purpose

Air Matters asked Watercare Laboratory Services to carry out odour monitoring at Auckland's Harbour Bridge. Odour monitoring was undertaken at the northern end of the Harbour Bridge on 15 April 2014. A Termarust coating was being spray-painted onto the underside of the bridge during monitoring.

In this report we will:

- Outline the methodology used
- Present a summary of results from the odour scout undertaken on 15 April 2014.

## 1.2 Methodology

On the 15 April 2014 odour monitoring was undertaken at the northern end of the Auckland Harbour Bridge. Spray-painting of a Termarust coating was being applied to the underside of the bridge during odour monitoring. An odour scout was undertaken with odour measurements recorded from a distance of approximately 55m away from the spray-painting source, and taken at increasing 5m intervals back towards the source. The characteristic odour was recorded, with the intensity, frequency and offensiveness of the odour observed.

# 2 Summary of monitoring results

The results of odour scout monitoring undertaken on 15 April 2014 are summarised below.

## 2.1 15 April 2014

Monitoring was undertaken between 15:12hrs and 15:56hrs.

Weather conditions were as follows:

- Temperature was 20.5°C
- Wind speed ranged from 0.9 to 2.9 m/s
- Wind direction was from the North East
- Relative humidity was 72.5%
- Overcast skies throughout the day. No precipitation.

Results of the odour scout monitoring during spray-painting of Termarust on 15 April 2014 are presented in Table 1, and Figure 1.

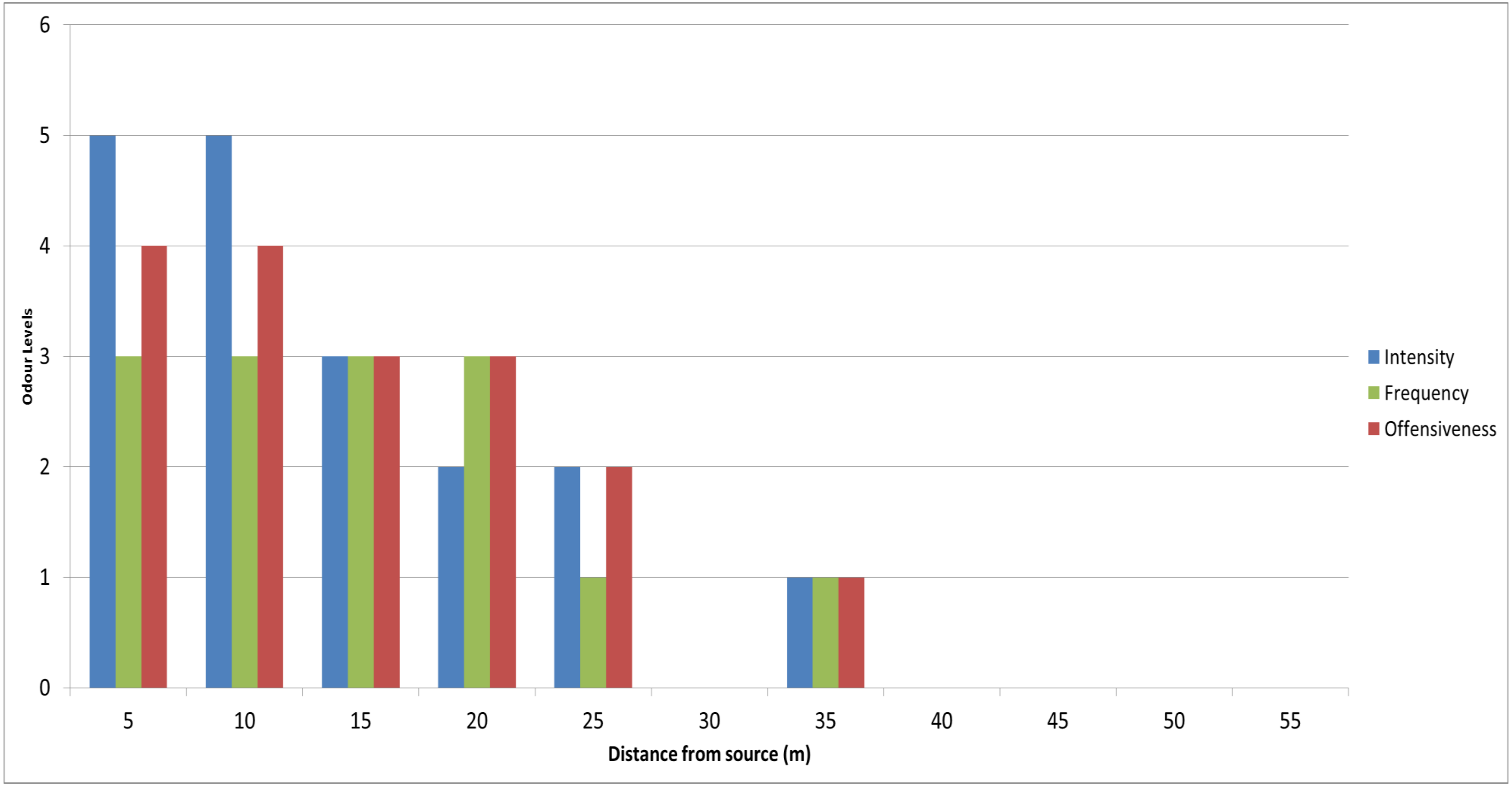
As measurements were taken closer to the spray-painting source, the odour detected from the Termarust coating increased in intensity, frequency and offensiveness. Within 10 metres of the source the characteristic paint odour was very strong in intensity, and a continuous frequency. Offensiveness within 10 metres of the source was considered highly offensive. There were no odours detected from 40 metres away from the source.

**Table 1: Harbour Bridge Odour Scout Monitoring Results, 15 April 2014.**

| Distance from source of spray-painting (m) | Time | Wind Speed (m/s) | Wind Direction | Character | Intensity | Frequency | Offensiveness |
|---|---|---|---|---|---|---|---|
| 5 | 15:56 | 0.9 | NE | Paint | 5 | 3 | 4 |
| 10 | 15:55 | 0.9 | NE | Paint | 5 | 3 | 4 |
| 15 | 15:48 | 1.2 | NE | Paint | 3 | 3 | 3 |
| 20 | 15:47 | 1.6 | NE | Paint | 2 | 3 | 3 |
| 25 | 15:39 | 1.8 | NE | Paint | 2 | 1 | 2 |
| 30 | 15:36 | 1.9 | NE | NDO | 0 | 0 | 0 |
| 35 | 15:29 | 1.9 | NE | Paint | 1 | 1 | 1 |
| 40 | 15:26 | 1.7 | NE | NDO | 0 | 0 | 0 |
| 45 | 15:21 | 2.9 | NE | NDO | 0 | 0 | 0 |
| 50 | 15:20 | 3.1 | NE | NDO | 0 | 0 | 0 |
| 55 | 15:12 | 2.4 | NE | NDO | 0 | 0 | 0 |
| **Odour Scoring Guide** | | | | | | | |
| **Intensity score /6** | | **Frequency score /3** | | **Offensiveness /4** | | | |
| 0 / blank | NDO | 0 / blank | NDO | 0 | NDO | | |
| 1 | Very Slight | 1 | Once-off | 1 | Not offensive | | |
| 2 | Slight | 2 | Intermittent | 2 | Slightly offensive | | |
| 3 | Distinct | 3 | Constant | 3 | Moderately offensive | | |
| 4 | Strong | | | 4 | Highly offensive | | |
| 5 | Very Strong | | | | | | |
| 6 | Extremely Strong | | | | | | |

NDO = No detectable odour

**Figure 1: Harbour Bridge Termarust Coating Odour Levels, 15 April 2014.**



## APPENDIX 3: MSD SHEETS FOR TERMARUST

## TERMARUST SERIES 2100

Please note that there are three options: [Stealth Grey] [Grey] [Green]

### MATERIAL SAFETY DATA SHEET

#### *Section I - Material identification and use*

| | | | | | |
|---|---|---|---|---|---|
| Product code : | 032TR2100 | Health : | Moderate | Whmis Class : | B3 D2B |
| Product name : | Termarust Stealth Grey | Fire : | Moderate | TDG Class : | 3 |
| Chemical family : | Organic coating | Reactivity : | Minimal | TDG UN : | 1263 |
| Product use : | Protective coating | | | | |

#### *Section II - Hazardous ingredients of material*

| Hazardous ingredients | Concentration % | C.A.S. Num. | LD50 Oral rat & dermal rabbit | LC50 Inhalation rate PPM/H |
|---|---|---|---|---|
| Mineral spirits | 10.0 - 30.0 | 64742-88-7 | 5600 mg/kg 3160 mg/kg | 51000/4 |

#### *Section III - Physical data for material*

| | | | | | |
|---|---|---|---|---|---|
| Physical state : | Liquid | Specific gravity : | 1.118-1.168 | Vapor pressure (mm): | 7.00 Boiling point (℃) : 150.00 |
| Odor : | Hydrocarbon | Solubility in water : | 0.09/20℃ | Vapor density : | 4.80 Freezing point (℃) : N/A |
| | | % Volatile/Volume | 30.0 - 60.0 | Heavier than air : | PH : N/A |

Coefficient of water/oil distribution : N/A
Evaporation rate (nBu Ac=1) : 0.10

#### *Section IV - Fire and explosion hazard of material*

***Flammability :*** Yes, by open flame, sparks, excessive heat, smoking and other sources of ignition.
***Note*** : Vapor may travel some distance to a source of ignition and flash back along the vapor trail.
***Means of extinction :*** Dry chemical, carbon dioxide, foam, water fog.
***Special procedures :*** Do not enter confined fire space without adequate protective clothing and an approved positive self contained breathing apparatus. Exclude air. Do not use water except as a fog. Use water to cool fire exposed containers.
***Explosion :*** Vapor forms explosive mixture with air between upper and lower flammable limits.
**Flash point :** (c) and method : 42.00
**Auto-ignition** (c) : N/A
**Sensitivity to mechanical impact :** None
**Upper explosion limit (% by volume) :** 5.00
**Lower explosion limit (% by volume) :** 0.80
**Sensitivity to static discharge :** Yes

#### *Section V - Toxicological properties of material*

**Exposure limits (TVL ppm) :** 100.00
**Irritancy of material :** Slight to moderate skin irritant
CARINOGENICITY, REPRODUCTIE EFFECTS, TERATOGENICITY and MULTAGENICITY
No adverse affects are anticipated.

Emergency telephone number: Canutec (613) 996-6666, Termarust technical department (514) 351-7600

### *Section VI - Toxicological properties of material (cont'd)*

**Route of entry :** Skin contact, skin absorption, inhalation acute, ingestion
**Effects of acute exposure to material :** Direct contact with skin may cause drying and cracking. Contact with eyes may cause conjunctivitis, irritation, and inflammation of mucous membranes. Inhaled, may cause irritation of eyes, nose, throat, and respiratory tract. Ingestion may cause irritation of mucous membranes of mouth and throat.
**Effects of chronic exposure to material :** Prolonged or repeated skin contact may cause drying resulting in irritation and possible dermatitis. Prolonged exposure to high vapor concentration can cause headache, dizziness, nausea, depression and narcosis. Ingestion may cause nausea, vomiting and/or diarrhea.

### *Section VII - Reactivity data*

**Chemical stability :** Yes
**Incompatibility with other substances :** Yes, with strong Oxidizing agents, mineral acids
**Reactivity and under what conditions :** Avoid excessive heat, open flame, spark and all ignition sources
**Hazardous decomposition products :** Carbon monoxide and Carbon dioxide when heated

### *Section VIII - Preventive measures, Personal protective equipment*

**Gloves :** Impervious (Nitrile, PVC) **Eyes :** Chemical safety goggles of full face shield
**Respiratory :** Wear a CSA approved respirator
**Other :** Where the risk of skin exposure is higher, impervious clothing should be worn. A positive demand, self-contained or airline breathing apparatus for extremely high concentrations.
**Engineering controls :** Local and mechanical ventilation to maintain below LEL and TLV values
**Leak and spill procedure :** Eliminate all sources of ignition. Prevent from entering water sources or sewers. Ventilate enclosed spaces. **Large spills:** Warn public of potential down wind explosion hazard due to flash back of flammable vapors. Contain by dyking. Recover product and collect contaminated soil or water for treatment and/or disposal. **Small spills :** Contain by applying absorbent. Collect waste absorbent and contaminated soil for disposal. Notify appropriate environmental agency.
**Waste disposal :** Reclaim or dispose of waste material in an approved incinerator or waste treatment disposal facility in accordance with applicable regulations by the environmental authority.
**Handling procedures and equipment :** Flammable. Avoid breathing vapors and prolonged or repeated contact with skin. Launder contaminated clothing. Use good personal hygiene. Ground equipment. Use sparks resistant tools. Avoid splash filling.
**Storage requirement :** Keep container closed. Store in a cool, dry, well-ventilated area, from heat and ignition sources.
**Special shipping information :** Handle as flammable liquid.

### *Section IX - First aid measures*

**Inhaled :** Remove to fresh air. If not breathing give artificial respiration. Obtain medical attention immediately
**Skin contact :** Flush affected areas with mild soap and water. Remove contaminated clothing
**Eye contact :** Flush eyes with water for at least 15 minutes holding eyelids open. Obtain medical attention immediately.
**Ingestion :** Do not induce vomiting. Obtain medical attention immediately.
**Additional information :** If accidentally ingested or inhaled, liquid can produce chemical pneumonia. Cardiac arrhythmia has been reported with solvent exposure.

### *Section X - Preparation of M.S.D.S.*

**Additional notes or references :**
**N/A =** not or none available
**OSHA =** Occupational Safety and Health Administration
**IARC =** International Agency for Research on Cancer
**ACGIH =** American Conference of Governmental Industrial Hygienists

We believe that the information contained herein is current as of the date of this Material Safety Data Sheet. Since the use of this information and the conditions of the use of the product are beyond the control of the company, it is the user's responsibility to establish conditions for safe use of the product.

**MATERIAL SAFETY DATA SHEET**

***Section I – Material identification and use***

| | | | | | |
|---|---|---|---|---|---|
| Product code : | 200TR2100 | Health : | Moderate | Whmis Class : | B3 D2B |
| Product name : | Termarust 501-212 Grey | Fire : | Moderate | TDG Class : | 3 |
| Chemical family : | Organic coating | Reactivity : | Minimal | TDG UN : | 1263 |
| Product use : | Protective coating | | | | |

***Section II – Hazardous ingredients of material***

| Hazardous ingredients | Concentration % | C.A.S. Num. | LD50 Oral rat & dermal rabbit | LC50 Inhalation rate PPM/H |
|---|---|---|---|---|
| Mineral spirits | 10.0 - 30.0 | 64742-88-7 | 5600 mg/kg 3160 mg/kg | 51000/4 |

***Section III – Physical data for material***

| | | | | | |
|---|---|---|---|---|---|
| Physical state : | Liquid | Specific gravity : | 1.114-1.164 | Vapor pressure (mm): | 7.00 Boiling point (℃) : 150.00 |
| Odor : | Hydrocarbon | Solubility in water : | 0.05/20℃ | Vapor density : | 4.80 Freezing point (℃) : N/A |
| | | % Volatile/Volume | 30.0 - 60.0 | Heavier than air : | PH : N/A |

Coefficient of water/oil distribution : N/A
Evaporation rate (nBu Ac=1) : 0.10

***Section IV – Fire and explosion hazard of material***

***Flammability :*** Yes, by open flame, sparks, excessive heat, smoking and other sources of ignition.
***Note*** : Vapor may travel some distance to a source of ignition and flash back along the vapor trail.
***Means of extinction :*** Dry chemical, carbon dioxide, foam, water fog.
***Special procedures :*** Do not enter confined fire space without adequate protective clothing and an approved positive self contained breathing apparatus. Exclude air. Do not use water except as a fog. Use water to cool fire exposed containers.
***Explosion :*** Vapor forms explosive mixture with air between upper and lower flammable limits.
**Flash point :** (℃) and method : 42.00 **Upper explosion limit (% by volume) :** 5.00
**Auto-ignition** (℃) : N/A **Lower explosion limit (% by volume) :** 0.80
**Sensitivity to mechanical impact :** None **Sensitivity to static discharge :** Yes

## *Section V – Toxicological properties of material*

**Exposure limits (TVL ppm) :** 100.00 **Irritancy of material :** Slight to moderate skin irritant
CARINOGENICITY, REPRODUCTIE EFFECTS, TERATOGENICITY and MULTAGENICITY
No adverse affects are anticipated.

Emergency telephone number: Canutec (613) 996-6666, Termarust technical department (514) 351-7600

## *Section VI – Toxicological properties of material (cont'd)*

**Route of entry :** Skin contact, skin absorption, inhalation acute, ingestion
**Effects of acute exposure to material :** Direct contact with skin may cause drying and cracking. Contact with eyes may cause conjunctivitis, irritation, and inflammation of mucous membranes. Inhaled, may cause irritation of eyes, nose, throat, and respiratory tract. Ingestion may cause irritation of mucous membranes of mouth and throat.
**Effects of chronic exposure to material :** Prolonged or repeated skin contact may cause drying resulting in irritation and possible dermatitis. Prolonged exposure to high vapor concentration can cause headache, dizziness, nausea, depression and narcosis. Ingestion may cause nausea, vomiting and/or diarrhea.

## *Section VII – Reactivity data*

**Chemical stability :** Yes
**Incompatibility with other substances :** Yes, with strong Oxidizing agents, mineral acids
**Reactivity and under what conditions :** Avoid excessive heat, open flame, spark and all ignition sources
**Hazardous decomposition products :** Carbon monoxide and Carbon dioxide when heated

## *Section VIII – Preventive measures, Personal protective equipment*

**Gloves :** Impervious (Nitrile, PVC) **Eyes :** Chemical safety goggles of full face shield
**Respiratory :** Wear a CSA approved respirator
**Other :** Where the risk of skin exposure is higher, impervious clothing should be worn. A positive demand, self-contained or airline breathing apparatus for extremely high concentrations.
**Engineering controls :** Local and mechanical ventilation to maintain below LEL and TLV values
**Leak and spill procedure :** Eliminate all sources of ignition. Prevent from entering water sources or sewers. Ventilate enclosed spaces. **Large spills:** Warn public of potential down wind explosion hazard due to flash back of flammable vapors. Contain by dyking. Recover product and collect contaminated soil or water for treatment and/or disposal. **Small spills :** Contain by applying absorbent. Collect waste absorbent and contaminated soil for disposal. Notify appropriate environmental agency.
**Waste disposal :** Reclaim or dispose of waste material in an approved incinerator or waste treatment disposal facility in accordance with applicable regulations by the environmental authority.
**Handling procedures and equipment :** Flammable. Avoid breathing vapors and prolonged or repeated contact with skin. Launder contaminated clothing. Use good personal hygiene. Ground equipment. Use sparks resistant tools. Avoid splash filling.
**Storage requirement :** Keep container closed. Store in a cool, dry, well-ventilated area, from heat and ignition sources.
**Special shipping information :** Handle as flammable liquid.

## *Section IX – First aid measures*

**Inhaled :** Remove to fresh air. If not breathing give artificial respiration. Obtain medical attention immediately

**Skin contact :** Flush affected areas with mild soap and water. Remove contaminated clothing
**Eye contact :** Flush eyes with water for at least 15 minutes holding eyelids open. Obtain medical attention immediately.
**Ingestion :** Do not induce vomiting. Obtain medical attention immediately.
**Additional information :** If accidentally ingested or inhaled, liquid can produce chemical pneumonia. Cardiac arrhythmia has been reported with solvent exposure.

***Section X – Preparation of M.S.D.S.***

**Additional notes or references :**
**N/A =** not or none available
**OSHA =** Occupational Safety and Health Administration
**IARC =** International Agency for Research on Cancer
**ACGIH =** American Conference of Governmental Industrial Hygienists

We believe that the information contained herein is current as of the date of this Material Safety Data Sheet. Since the use of this information and the conditions of the use of the product are beyond the control of the company, it is the user's responsibility to establish conditions for safe use of the product.

**MATERIAL SAFETY DATA SHEET**

***Section I – Material identification and use***

| | | | | | |
|---|---|---|---|---|---|
| Product code : | 003TR2100 | Health : | Moderate | Whmis Class : | B3 D2B |
| Product name : | TR100-NS. DOT Green | Fire : | Moderate | TDG Class : | 3 |
| Chemical family : | Organic coating | Reactivity : | Minimal | TDG UN : | 1263 |
| Product use : | Protective coating | | | | |

***Section II – Hazardous ingredients of material***

| Hazardous ingredients | Concentration % | C.A.S. Num. | LD50 Oral rat & dermal rabbit | LC50 Inhalation rate PPM/H |
|---|---|---|---|---|
| Mineral spirits | 10.0 - 30.0 | 64742-88-7 | 5600 mg/kg 3160 mg/kg | 51000/4 |

***Section III – Physical data for material***

| | | | | | |
|---|---|---|---|---|---|
| Physical state : | Liquid | Specific gravity : | 1.090-1.140 | Vapor pressure (mm): | 7.00 Boiling point (℃) : 150.00 |
| Odor : | Hydrocarbon | Solubility in water : | 0.05/20c | Vapor density : | 4.80 Freezing point (℃) : N/A |
| | | % Volatile/Volume | 30.0 - 60.0 | Heavier than air : | PH : N/A |

Coefficient of water/oil distribution : N/A
Evaporation rate (nBu Ac=1) : 0.10

***Section IV – Fire and explosion hazard of material***

***Flammability :*** Yes, by open flame, sparks, excessive heat, smoking and other sources of ignition.
***Note*** : Vapor may travel some distance to a source of ignition and flash back along the vapor trail.
***Means of extinction :*** Dry chemical, carbon dioxide, foam, water fog.

***Special procedures :*** Do not enter confined fire space without adequate protective clothing and an approved positive self contained breathing apparatus. Exclude air. Do not use water except as a fog. Use water to cool fire exposed containers.
***Explosion :*** Vapor forms explosive mixture with air between upper and lower flammable limits.
**Flash point :** (℃) and method : 42.00 **Upper explosion limit (% by volume) :** 5.00
**Auto-ignition** (℃) : N/A **Lower explosion limit (% by volume) :** 0.80
**Sensitivity to mechanical impact :** None **Sensitivity to static discharge :** Yes

## *Section V – Toxicological properties of material*

**Exposure limits (TVL ppm) :** 100.00 **Irritancy of material :** Slight to moderate skin irritant
** CARINOGENICITY, REPRODUCTIE EFFECTS, TERATOGENICITY and MULTAGENICITY **
No adverse affects are anticipated.

Emergency telephone number: Canutec (613) 996-6666, Termarust technical department (514) 351-7600

## *Section VI – Toxicological properties of material (cont'd)*

**Route of entry :** Skin contact, skin absorption, inhalation acute, ingestion
**Effects of acute exposure to material :** Direct contact with skin may cause drying and cracking. Contact with eyes may cause conjunctivitis, irritation, and inflammation of mucous membranes. Inhaled, may cause irritation of eyes, nose, throat, and respiratory tract. Ingestion may cause irritation of mucous membranes of mouth and throat.
**Effects of chronic exposure to material :** Prolonged or repeated skin contact may cause drying resulting in irritation and possible dermatitis. Prolonged exposure to high vapor concentration can cause headache, dizziness, nausea, depression and narcosis. Ingestion may cause nausea, vomiting and/or diarrhea.

## *Section VII – Reactivity data*

**Chemical stability :** Yes
**Incompatibility with other substances :** Yes, with strong Oxidizing agents, mineral acids
**Reactivity and under what conditions :** Avoid excessive heat, open flame, spark and all ignition sources
**Hazardous decomposition products :** Carbon monoxide and Carbon dioxide when heated

## *Section VIII – Preventive measures, Personal protective equipment*

**Gloves :** Impervious (Nitrile, PVC) **Eyes :** Chemical safety goggles of full face shield
**Respiratory :** Wear a CSA approved respirator
**Other :** Where the risk of skin exposure is higher, impervious clothing should be worn. A positive demand, self-contained or airline breathing apparatus for extremely high concentrations.
**Engineering controls :** Local and mechanical ventilation to maintain below LEL and TLV values
**Leak and spill procedure :** Eliminate all sources of ignition. Prevent from entering water sources or sewers. Ventilate enclosed spaces. **Large spills:** Warn public of potential down wind explosion hazard due to flash back of flammable vapors. Contain by dyking. Recover product and collect contaminated soil or water for treatment and/or disposal. **Small spills :** Contain by applying absorbent. Collect waste absorbent and contaminated soil for disposal. Notify appropriate environmental agency.
**Waste disposal :** Reclaim or dispose of waste material in an approved incinerator or waste treatment disposal facility in accordance with applicable regulations by the environmental authority.
**Handling procedures and equipment :** Flammable. Avoid breathing vapors and prolonged or repeated contact with skin. Launder contaminated clothing. Use good personal hygiene. Ground equipment. Use sparks resistant tools. Avoid splash filling.

**Storage requirement :** Keep container closed. Store in a cool, dry, well-ventilated area, from heat and ignition sources.
**Special shipping information :** Handle as flammable liquid.

## *Section IX – First aid measures*

**Inhaled :** Remove to fresh air. If not breathing give artificial respiration. Obtain medical attention immediately
**Skin contact :** Flush affected areas with mild soap and water. Remove contaminated clothing
**Eye contact :** Flush eyes with water for at least 15 minutes holding eyelids open. Obtain medical attention immediately.
**Ingestion :** Do not induce vomiting. Obtain medical attention immediately.
**Additional information :** If accidentally ingested or inhaled, liquid can produce chemical pneumonia. Cardiac arrhythmia has been reported with solvent exposure.

## *Section X – Preparation of M.S.D.S.*

**Additional notes or references :**
**N/A =** not or none available
**OSHA =** Occupational Safety and Health Administration
**IARC =** International Agency for Research on Cancer
**ACGIH =** American Conference of Governmental Industrial Hygienists

We believe that the information contained herein is current as of the date of this Material Safety Data Sheet. Since the use of this information and the conditions of the use of the product are beyond the control of the company, it is the user's responsibility to establish conditions for safe use of the product.

TERMARUST SERIES 2200

# MATERIAL SAFETY DATA SHEET

# Section I – Material identification and use

| | | | | | |
|---|---|---|---|---|---|
| Product code: | 1TR2200HS HRCSA | Health: | Moderate | Whims' Class: | Non regulated |
| Product name: | Termarust (100% Solids)<br><br>0 VOC Penetrant/Sealer | Fire: | Minimal | TDG Class: | Non regulated |
| Chemical family: | Organic coating | Reactivity: | Minimal | TDG UN: | Non regulated |
| Product use: | Protective coating | | | Revision Date | 04/01/2013 |

# Section II – Hazardous ingredients of material

| Hazardous ingredients | Concentration % | C.A.S. Num. | LD50 Oral rat & dermal rabbit | LC50 Inhalation rate PPM/H |
|---|---|---|---|---|
| none | | | | |

# Section III – Physical data for material

| | | | | | |
|---|---|---|---|---|---|
| Physical state: | Liquid | Specific gravity: | N/A | Vapor pressure (mm): | N/A |
| Odor: Light | Odor | Solubility in water: | no | Vapor density: 20˚ C | environ |
| PH: N/A | | % Volatile/Volume | none | Heavier than air | |

Coefficient of water/oil distribution: N/A

Boiling point (°C): > 300˚ C

Evaporation rate (nBu Ac=1): N/A

Freezing point (°C): N/A

# Section IV – Fire and explosion hazard of material

***Flammability:*** Yes, by open flame, sparks, excessive heat, smoking and other sources of ignition.

***Means of extinction:*** Dry chemical, carbon dioxide, foam, water fog.

***Special procedures:*** Do not enter confined fire space without adequate protective clothing and an approved positive

self-contained breathing apparatus. Exclude air. Do not use water except as a fog. Use water to cool fire exposed containers.

***Explosion:*** N/A

***Flash point:*** (°C) and method: > 120 ˚ C

***Upper explosion limit (% by volume):*** N/A

***Spontaneous Combustion*** (°C): N/A

***Lower explosion limit (% by volume):*** N/A

***Sensitivity to mechanical impact:*** None

***Sensitivity to static discharge:*** Yes

# Section V – Toxicological properties of material

***Exposure limits (TVL ppm):*** 100.00

***Irritancy of material:*** Slight to moderate skin irritant

CARCINOGENIC, POSSIBLE FOETUS MALFORMATION AND MUTATION

No adverse affects are anticipated.

Emergency telephone number: Canutec (613) 996-6666, Termarust Technical Department (514) 351-7600

# Section VI – Toxicological properties of material

**Route of entry:** Skin contact, skin absorption, inhalation acute, ingestion

# Section VI – Toxicological properties of material (cont'd)

**Effects of acute exposure to material:** Direct contact with skin may cause drying and cracking. Contact with eyes may cause conjunctivitis, irritation, and inflammation of mucous membranes. Inhaled, may cause irritation of eyes, nose, throat, and respiratory tract. Ingestion may cause irritation of mucous membranes of mouth and throat.

**Effects of chronic exposure to material:** Prolonged or repeated skin contact may cause drying resulting in irritation and possible dermatitis. Prolonged exposure to high vapor concentration can cause headache, dizziness, nausea, depression and narcosis. Ingestion may cause nausea, vomiting and/or diarrhea.

# Section VII – Reactivity data

**Chemical stability:** Yes

**Incompatibility with other substances:** Yes, with strong Oxidizing agents, mineral acids

**Reactivity and under what conditions:** Avoid excessive heat, open flame, spark and all ignition sources

**Hazardous decomposition products:** Carbon monoxide and Carbon dioxide when heated

# Section VIII – Preventive measures, Personal protective equipment

**Gloves:** Impervious (Nitrile, PVC) **Eyes:** Chemical safety goggles of full face shield

**Respiratory:** Wear a CSA approved respirator

**Other:** Where the risk of skin exposure is higher, impervious clothing should be worn. A positive demand, self-contained or airline breathing apparatus for extremely high concentrations.

**Engineering controls:** Local and mechanical ventilation to maintain below LEL and TLV values

**Leak and spill procedure:** Eliminate all sources of ignition. Prevent from entering water sources or sewers. Ventilate enclosed spaces. **Large spills:** Warn public of potential down wind explosion hazard due to flash back of flammable vapors. Contain by diking. Recover product and collect contaminated soil or water for treatment and/or disposal. **Small spills:** Contain by applying absorbent. Collect waste absorbent and contaminated soil for disposal. Notify appropriate environmental agency.

**Waste disposal:** Reclaim or dispose of waste material in an approved incinerator or waste treatment disposal facility in accordance with applicable regulations by the environmental authority.

**Handling procedures and equipment:** Flammable. Avoid breathing vapors and prolonged or repeated contact with skin. Launder contaminated clothing. Use good personal hygiene. Ground equipment. Use sparks resistant tools. Avoid splash filling.

**Storage requirement:** Keep container closed. Store in a cool, dry, well-ventilated area, from heat and ignition sources.

**Special shipping information:** Handle as flammable liquid.

# Section IX – First aid measures

**Inhaled:** Remove to fresh air. If not breathing give artificial respiration. Obtain medical attention immediately

**Skin contact:** Flush affected areas with mild soap and water. Remove contaminated clothing

**Eye contact:** Flush eyes with water for at least 15 minutes holding eyelids open. Obtain medical attention immediately.

**Ingestion:** Do not induce vomiting. Obtain medical attention immediately.

**Additional information:** If accidentally ingested or inhaled, liquid can produce chemical pneumonia. Cardiac arrhythmia has been reported with solvent exposure.

# Section X – Preparation of M.S.D.S.

**Additional notes or references:**

**N/A =** not or none available

**OSHA =** Occupational Safety and Health Administration

**IARC =** International Agency for Research on Cancer

**ACGIH =** American Conference of Governmental Industrial Hygienists

We believe that the information contained herein is current as of the date of this Material Safety Data Sheet. Since the use of this information and the conditions of the use of the product are beyond the control of the company, it is the user's responsibility to establish conditions for safe use of the product.

THE BEST CORROSION CONTROL PERFORMANCE, GUARANTEED!

# MATERIAL SAFETY DATA SHEET

## *Section I – Material identification and use*

| | | | | | |
|---|---|---|---|---|---|
| Product code: | TRT01 | Health: | Moderate | Whmis Class: | B3 D2B |
| Product name: | Termarust Thinner | Fire: | Moderate | TDG Class: | 3 |
| Chemical family: | Organic solvent | Reactivity: | Minimal | TDG UN: | 1263 |
| Product use: | Thinner and cleaning solvent | | | Revision Date | 07/01/2007 |

## *Section II – Hazardous ingredients of material*

| Hazardous ingredients | Concentration % | C.A.S. Num. | LD50 Oral rat & dermal rabbit | LC50 Inhalation rate PPM/H |
|---|---|---|---|---|
| Mineral spirits | 60.0 -100% | 64742-88-7 | 5600 mg/kg 3160 mg/kg | 51000/4 |

## *Section III – Physical data for material*

| | | | | | |
|---|---|---|---|---|---|
| Physical state: | Liquid | Specific gravity: | | Vapor pressure (mm): | 7.00 |
| Odor: | light | Relative Density | .763 - .813 | Vapor density: | 4.80 |
| PH: | 0 | % Volatile/Volume | 60.0 – 100% | Heavier than air | |

Coefficient of water/oil distribution: N/A
Boiling point (°C): 150.00
Evaporation rate (nBu Ac=1): 0.10
Freezing point (°C): N/A

## *Section IV – Fire and explosion hazard of material*

***Flammability:*** Yes, by open flame, sparks, excessive heat, smoking and other sources of ignition.
***Note***: Vapor may travel some distance to a source of ignition and flash back along the vapor trail.
***Means of extinction:*** Dry chemical, carbon dioxide, foam, water fog.
***Special procedures:*** Do not enter confined fire space without adequate protective clothing and an approved positive self-contained breathing apparatus. Exclude air. Do not use water except as a fog. Use water to cool fire exposed containers.
***Explosion:*** Vapor forms explosive mixture with air between upper and lower flammable limits.
***Flash point:*** (°C) and method: 42.00
***Upper explosion limit (% by volume):*** 5.00
***Spontaneous Combustion***(°C): N/A
***Lower explosion limit (% by volume):*** 0.80
***Sensitivity to mechanical impact:*** None
***Sensitivity to static discharge:*** Yes

## *Section V – Toxicological properties of material*

***Exposure limits (TVL ppm) :*** 100.00
***Irritancy of material :*** Slight to moderate skin irritant
CARCINOGENIC, POSSIBLE FOETUS MALFORMATION AND MUTATION
No adverse affects are anticipated.
Emergency telephone number: Canutec (613) 996-6666, Termarust Technical Department (514) 351-7600

## *Section VI – Toxicological properties of material*

**Route of entry :** Skin contact, skin absorption, inhalation acute, ingestion

## *Section VI – Toxicological properties of material (cont'd)*

**Effects of acute exposure to material :** Direct contact with skin may cause drying and cracking. Contact with eyes may cause conjunctivitis, irritation, and inflammation of mucous membranes. Inhaled, may cause irritation of eyes, nose, throat, and respiratory tract. Ingestion may cause irritation of mucous membranes of mouth and throat.
**Effects of chronic exposure to material :** Prolonged or repeated skin contact may cause drying resulting in irritation and possible dermatitis. Prolonged exposure to high vapor concentration can cause headache, dizziness, nausea, depression and narcosis. Ingestion may cause nausea, vomiting and/or diarrhea.

## *Section VII – Reactivity data*

**Chemical stability :** Yes
**Incompatibility with other substances :** Yes, with strong Oxidizing agents, mineral acids
**Reactivity and under what conditions :** Avoid excessive heat, open flame, spark and all ignition sources
**Hazardous decomposition products :** Carbon monoxide and Carbon dioxide when heated

## *Section VIII – Preventive measures, Personal protective equipment*

**Gloves :** Impervious (Nitrile, PVC) **Eyes :** Chemical safety goggles of full face shield
**Respiratory :** Wear a CSA approved respirator
**Other :** Where the risk of skin exposure is higher, impervious clothing should be worn. A positive demand, self-contained or airline breathing apparatus for extremely high concentrations.
**Engineering controls :** Local and mechanical ventilation to maintain below LEL and TLV values
**Leak and spill procedure :** Eliminate all sources of ignition. Prevent from entering water sources or sewers. Ventilate enclosed spaces. **Large spills:** Warn public of potential down wind explosion hazard due to flash back of flammable vapors. Contain by dyking. Recover product and collect contaminated soil or water for treatment and/or disposal. **Small spills :** Contain by applying absorbent. Collect waste absorbent and contaminated soil for disposal. Notify appropriate environmental agency.
**Waste disposal :** Reclaim or dispose of waste material in an approved incinerator or waste treatment disposal facility in accordance with applicable regulations by the environmental authority.
**Handling procedures and equipment :** Flammable. Avoid breathing vapors and prolonged or repeated contact with skin. Launder contaminated clothing. Use good personal hygiene. Ground equipment. Use sparks resistant tools. Avoid splash filling.
**Storage requirement :** Keep container closed. Store in a cool, dry, well-ventilated area, from heat and ignition sources.
**Special shipping information :** Handle as flammable liquid.

## *Section IX – First aid measures*

**Inhaled :** Remove to fresh air. If not breathing give artificial respiration. Obtain medical attention immediately
**Skin contact :** Flush affected areas with mild soap and water. Remove contaminated clothing
**Eye contact :** Flush eyes with water for at least 15 minutes holding eyelids open. Obtain medical attention immediately.
**Ingestion :** Do not induce vomiting. Obtain medical attention immediately.
**Additional information :** If accidentally ingested or inhaled, liquid can produce chemical pneumonia. Cardiac arrhythmia has been reported with solvent exposure.

## *Section X – Preparation of M.S.D.S.*

**Additional notes or references :**
**N/A =** not or none available
**OSHA =** Occupational Safety and Health Administration
**IARC =** International Agency for Research on Cancer
**ACGIH =** American Conference of Governmental Industrial Hygienists
We believe that the information contained herein is current as of the date of this Material Safety Data Sheet. Since the use of this information and the conditions of the use of the product are beyond the control of the company, it is the user's responsibility to establish conditions for safe use of the product.

## Appendix E

## Washwater Sampling Report (Opus, September 2014)

| | |
|---|---|
| To | AHB Maintenance Discharge Consent Project Team |
| FROM | Liz Coombes (Total Bridge Services), Sharon De Luca (Boffa Miskell) |
| DATE | 19 September 2014 |
| SUBJECT | Contaminants in Waterblasting Washwater |

# 1. Introduction

Waterblasting is carried out on the Auckland Harbour Bridge (AHB) to remove salt deposits and prepare the surface prior to abrasive blasting and painting. Contaminants in the waterblasting washwater are predominantly derived from weathering of surface coatings and traffic residues deposited on the bridge, and include metals, hydrocarbons and particulate.

The current AHB maintenance consent (Permit 38836, granted in 2011) required the containment of all washwater to prevent any discharge to the coast. However, since the consent was granted it has been determined that such containment is not practicable, because of the difficulties and high cost of implementing the system over the coastal area (for example strengthening of the bridge structure would be required to hold the weight of the washwater in a containment system). Consequently, a new consent is now being sought that allows a more flexible approach to the management of contaminants from maintenance discharges to achieve the same or better environmental outcomes as under the current consent.

To determine the best practicable option for disposal of washwater, Total Bridge Services (TBS) undertook washwater sampling in May 2013 to investigate the level of contaminants generated through waterblasting the bridge. The results of the investigation are summarised in this memo, with a discussion of these in the wider context of the proposed new AHB maintenance discharge consent.

## 1.1 Washwater Sampling

The washwater sampling was designed to capture a 'worst case' scenario in terms of level of contaminants in the washwater, through sampling from structures where contaminants have built up over time because of the presence of multiple joints, rivets and semi-enclosed structures. Washwater was sampled during the waterblasting carried out on three separate structures (two diagonals and one post) on the lower truss bridge. Two composite samples were collected from each structure, one at the start of the waterblasting and one towards the end (six samples in total).

The samples were analysed for total and dissolved metals (arsenic, cadmium, chromium, copper, lead, nickel and zinc), hexavalent chromium (chromium VI), total petroleum hydrocarbons (TPH) and total suspended solids (TSS).

# 2. Discussion of Washwater Sampling Results

The concentrations of contaminants in the waterblasting washwater varied considerably between structures and between the initial and end samples. In order to account for this variation, assessment has been undertaken on the average value (arithmetic mean) to represent the average concentration in the water discharged to the harbour.

Results for dissolved metals have been assessed in relation to the ANZECC (2000) guidelines for 95% protection of marine ecosystems. Total metals and TSS have been assessed with respect to the mass load of contaminants that would be discharged into the harbour from waterblasting. These are discussed in the sections below.

All results for chromium VI and TPH were below the laboratory detection limit, so these are not discussed further in this memo.

## 2.1 Washwater Characteristics

The characteristics of the washwater samples observed during the sampling are summarised in Table 1.

**Table 1: Characteristics of waterblasting washwater**

| Sample | Description |
|---|---|
| East diagonal – initial sample | Very dirty, dark brown, organic matter evident (twigs, leaves, silt), no odour. pH 7.4 |
| East diagonal – end sample | Clean, no colour, clear, no odour. pH 7.6 |
| West diagonal – initial sample | Light brown, not cloudy, no odour, some particulate. pH 7.1 |
| West diagonal – end sample | Slight brown colour, cloudy, no odour, slight particulate. pH 7.2 |
| West post – initial sample | Very slight cloudy colour, quite clear, no odour, very little particulate. pH 7.3 |
| West post – end sample | Clear, no colour, no odour. pH 7.7 |

Most of the samples were clear or only slightly cloudy or discoloured. However, the initial discharge from the East diagonal appeared very dirty. This appearance would be due to the presence of particulates in the water. Particulates in the washwater were measured at the laboratory as TSS, and results of this sampling are discussed below in Section2.3.

No films, scums or foams were observed on the surface of the washwater. None of the samples exhibited any odour.

The temperature of the washwater was not recorded. However, washwater is not heated or chilled prior to use, therefore it is unlikely to be significantly different in temperature to seawater at the time of discharge, and would not cause a 3˚C rise in water temperature in the harbour. In the future it is proposed that hot water (~75˚C) may be used for waterblasting (due to its ability to remove salt residues more easily), however trials indicate that the temperature of such water decreases very rapidly after discharge and would be expected to have reached (or be close to) ambient temperature by the time it reaches the harbour.

The pH of the washwater was between 7.1 and 7.7. It is considered unlikely that discharge of water with pH 7.1-7.7 to the harbour would have an effect on the pH of the ambient seawater. This is primarily because of the small volume of washwater relative to the much larger volume of the harbour, but also because the pH of the washwater is similar to that of natural seawater[1] and because of the natural capacity of seawater to buffer pH.

## 2.2 Comparison of Dissolved Metals with ANZECC Guidelines

Where washwater is discharged directly to the CMA it is necessary to consider the effects of dissolved contaminants on marine ecological values. A summary of the dissolved metals results from the washwater sampling is given in Table 2, along with the ANZECC trigger levels for 95% protection of marine ecosystems. It should be noted, however, that the ANZECC guidelines apply after reasonable mixing, while these samples were taken 'at source'. Consequently, where the average concentration of a contaminant in the washwater exceeds the ANZECC 95% trigger level, the level of dilution that is required to meet the trigger level has been calculated. These values are also included in Table 2.

[1] Seawater typically has a pH of around 8

**Table 2: Summary of dissolved metals results and comparison to ANZECC marine trigger levels**

| Dissolved metal | Sampling results summary: Maximum value (mg/L) | Minimum value (mg/L) | Average (mean) value[1] (mg/L) | Standard Error (mg/L) | 95% ANZECC marine ecosystem protection trigger levels[2] (mg/L) | Dilution factors to meet 95 % ANZECC marine trigger levels[3] |
|---|---|---|---|---|---|---|
| Arsenic | 0.0021 | <0.001 | 0.0019 | 0.00077 | ID | n/a |
| Cadmium | 0.0010 | 0.00035 | 0.00054 | 0.00010 | 0.0055 | n/a |
| Chromium (total) | **0.096** | 0.0014 | 0.025 | 0.0143 | 0.0274 | n/a |
| Copper | **0.079** | **0.0029** | **0.021** | 0.0118 | 0.0013 | 19 |
| Lead | **0.28** | 0.0022 | **0.053** | 0.0454 | 0.0044 | 12 |
| Nickel | 0.011 | 0.0005 | 0.0028 | 0.00158 | 0.07 | n/a |
| Zinc | **5.6** | **0.54** | **3.48** | 0.84 | 0.015 | 242 |

Notes:

1. Where a result was below the laboratory detection limit a value of half the detection limit has been used in the calculation of the mean.
2. Australian and New Zealand Environment and Conservation Council (ANZECC), 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality guidelines*.
3. Dilution based on background concentrations in the Manukau Harbour in the absence of data for the Waitemata Harbour: Purakau Channel: Cu: <0.0005 mg/L, Pb: <0.0001 mg/L, Zn: 0.00064 mg/L, and Mangere Inlet: Cr: 0.000035 mg/L(midrange) (Auckland Council, 2008)
4. **Bold** indicates exceedance of marine trigger level.

The average concentrations of copper, lead and zinc in undiluted washwater exceeded the ANZECC 95% marine and trigger levels. The dilution required for the (average) dissolved metals in the washwater to meet the ANZECC 95% marine trigger levels has been calculated as being 242 times the discharged volume (based on the dilution required to achieve the zinc trigger level).

The typical volume of washwater that would be discharged on a daily basis is approximately 850L, with a daily maximum of 4230L. Given a neap tidal prism of 108,000,000m$^3$ in the Central Waitemata Harbour, which is 1.08 x 10$^{13}$ L. The tidal prism provides a dilution of 25,531,915 times for the maximum daily discharge. If a smaller area of harbour water is considered (e.g. 10,000m$^3$ of seawater around the bridge) the dilution factor provided for the maximum daily washwater discharge is approximately 4230. Therefore ample dilution is provided by the receiving environment, which ensures that ecotoxicological effects are highly unlikely to occur due to contaminants contained in washwater discharges.

Where maintenance works occurs over land washwater discharges are primarily to the stormwater network. Stormwater is discharged directly into the CMA on the eastern and western side of the northern abutments, and directly underneath the bridge at the southern end. The dissolved metals in washwater are unlikely to remain in dilution after discharge to coastal waters because they sorb to fine organic particles and settle out into sediment. Consequently, the washwater was also sampled for total metals, the results of which are discussed below.

## 2.3 Total Metals and TSS

A summary of the sampling results for total metals and TSS is provided in Table 3. Based on the laboratory results for total metals, the average (mean) annual mass loads of these contaminants have been calculated (assuming that 10% of the bridge is waterblasted annually), these are also presented in Table 3.

**Table 3: Summary of results for total metals and TSS, and estimated annual mass loads**

| Contaminant | Sampling results summary | | | | Mean annual mass load[1] (kg/annum) |
|---|---|---|---|---|---|
| | Maximum value (mg/L) | Minimum value (mg/L) | Mean value (mg/L) | Standard Error (mg/L) | |
| **Total Metals** | | | | | |
| Arsenic | 0.039 | 0.0016 | 0.012 | 0.0057 | 0.0019 |
| Cadmium | 0.0041 | 0.00047 | 0.0012 | 0.00058 | 0.00021 |
| Chromium (total) | 0.49 | 0.011 | 0.20 | 0.070 | 0.033 |
| Copper | 0.37 | 0.0077 | 0.091 | 0.056 | 0.014 |
| Lead | 0.92 | 0.047 | 0.26 | 0.14 | 0.041 |
| Nickel | 0.047 | 0.0024 | 0.013 | 0.0070 | 0.0020 |
| Zinc | 26 | 1.7 | 13 | 3.6 | 2.4 |
| **Particulate** | | | | | |
| TSS | 2600 | 18 | 498 | 421 | 77 |

Notes:

1. Annual load based on maintenance of 10% of the bridge per annum

Stormwater contaminant source modelling work carried out by Dr Malcolm Green for Auckland Council (unpublished[2]) estimates the total zinc and total copper inputs to the Central Waitemata Harbour from a variety of land use activities (including runoff from roads, roofs, paved areas, erodible stream channels, grasslands and bare earth) to be 18,623 kg/annum and 1,111.47 kg/annum respectively. Based on the mean annual mass loads above, the percentage of contaminants from washwater compared to the loads from other sources is 0.013% and 0.0013% respectively. On that basis, it can be concluded that the load of contaminants from washwater is negligible in the context of the load discharged from other sources in the Central Waitemata Harbour (CWH). It is expected that contaminants other than zinc and copper in washwater form a similarly small percentage of the total catchment discharges. However these contaminants are not priority contaminants of concern for Auckland Council and therefore have not been modelled in the same way as copper and zinc.

It is estimated that of the 2.4 kg/annum of zinc discharged, 0.58 kg/annum may be discharged (via existing stormwater system) to the CMA from washwater from the areas of AHB over land. This additional load, whilst a point source discharge, is negligible in terms of the load discharged to the CMA directly from maintenance works (0.26%) and from other sources within the CWH (0.003%). For example comparing the maximum washwater contaminant load that may be discharged to stormwater at the northern end of the bridge, if we assume 50% is discharged to western side[3] and 50% to the eastern side[4] of the peninsula, the load forms 0.4% and 0.6% of the annual zinc load discharged from the sub catchments as modelled by Green (2008).

Under the current maintenance consent, the discharge of zinc and particulate (garnet) from other maintenance activities on the bridge such as abrasive blasting and spray painting is managed through consent conditions that require a proportion of the discharges to be contained. The annual mass loads of these discharges that can be discharged under the current consent have been calculated according to the current consent conditions, and represent permitted 'thresholds' of up to 223 kg/annum of zinc and 14679 kg/annum of particulate (garnet). The estimated annual mass loads of zinc and particulate from washwater represent approximately 1% and 0.005% of these thresholds respectively.

Consequently, even though the effects of the discharges of zinc and particulate from washwater are expected to have a negligible environmental effect on the Waitemata Harbour, it is considered appropriate to include this discharge in the accounting for total zinc and total particulate discharged from all consented maintenance activities to ensure that the total discharge of these contaminants remains equal to or less than that allowed under the current consent.

# 3. Conclusions

The concentrations of dissolved metals are able to comply with the ANZECC 95% trigger levels for protection of marine ecosystems after reasonable mixing. The environmental effects of disposal of the waterblasting washwater is considered unlikely to have more than a negligible environmental effect on the Waitemata Harbour.

Given high cost to implement the previously proposed containment system for washwater and the low environmental effect relative to other consented maintenance

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[2] Approved for use for this assessment provided by Judy Anson at Auckland Council.
[3] Auckland Council Stormwater Management Unit 29.
[4] Auckland Council Stormwater Management Unit 39.

activities, it is considered that the best practicable option to manage the washwater generated through waterblasting on the AHB is direct discharge into the coast with the extent of the discharge limited to ensure that the total discharge of contaminants remains within acceptable limits (i.e. the limits allowed by the current consent).

Consequently it is recommended that discharges from this washwater be managed within the key contaminant thresholds to be used for the wider maintenance discharges, so that the total discharges of zinc and particulate to the coast from all consented maintenance activities do not exceed the calculated thresholds: Zinc: 223kg/annum, Particulate (garnet): 14679 kg/annum.

Other contaminants in washwater are not key contaminants of concern for Auckland Council and/or they form a small proportion of the total annual contaminant load discharged to the CWH. On that basis it is considered that the effects of the other contaminants on marine ecological values are at worst negligible and it is not considered necessary to include these as key contaminants under the AHB maintenance consent.

# 4. References

Auckland Council (2008). *The Impacts of Urban Stormwater in Auckland's Aquatic Receiving Environment: A Review of Information 1995 to 2005*. Technical Report TR2008/029.

Green M, 2008. *Central Waitemata Harbour Contaminant Study. Predictions of Sediment, Zinc and Copper Accumulation under Future Development Scenario 1*, prepared by NIWA for Auckland Regional Council, Technical Report 2008/043.

## Appendix F

### Records of Iwi Consultation

Withheld in full under section 9(2)(ba)(i)

s9(2)(a)

[redacted]

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