AHB Alliance

Historic Coatings Characterisation Study Outcomes Report

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NZ TRANSPORT AGENCY
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PART OF THE AUCKLAND MOTORWAY ALLIANCE

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Executive Summary

The paint systems used on the Auckland Harbour Bridge (AHB) in the past are known to have contained lead and chromium (zinc chromate), both of which are known to be hazardous to human health. However, the exact location and extent of these metals is unknown, due to changes in painting systems over the years.

The scope of the study was to review existing information on the presence of contaminants of concern (predominantly lead and chromium) in historic coatings on the bridge, undertake paint sampling in key areas to evaluate the level and variability of these contaminants, and to review the assumptions that current environmental controls are based on to determine whether further work is required to confirm that controls are adequate.

The study showed that Span 7 has the highest lead concentration and remains a hotspot for historic lead paints, which was expected from prior studies. Outside of Span 7, concentrations of lead were still found in some areas at levels that would be considered hazardous under the AS/NZS guide for projects removing >250kg of paint. Chromium is present across all areas of the bridge tested at levels that are considered hazardous according to the AS/NZS guide for projects removing <50kg of paint (i.e. projects of any size). Arsenic and cadmium were not found at levels of concern.

Based on the results, we recommend the following:

- Evaluate the feasibility of using maintenance techniques that avoid the use of dry abrasive blasting (such as MC Ferrox overcoating), or if it cannot be avoided, continue to use spot-blasting to reduce the area blasted to a minimum.
- The requirements of the AS/NZS Guide to Hazardous Paint Removal should be reviewed to determine which aspects of it should be adopted during AHB maintenance.
- Take paint samples prior to blasting and undertake further air testing during abrasive blasting if high chromium levels are found. Air Matters should be requested to review buffer zones after testing and confirm whether they are acceptable.
- Further research should be undertaken into the implications of the dust wipe results, especially in relation to current and future uses on the bridge (public access areas), and further surface wipe sampling should be undertaken in some areas (such as inside the bungee pod), to determine whether additional clean-up work is required following abrasive blasting to protect the health of workers and members of the public in these areas.
- Any future paint sample analysis carried out to further our knowledge of the issues described in this report should be undertaken in accordance with the methodologies described in the AS/NZS Guide to Hazardous Paint Removal. The use of portable XRF should be considered.
- Based on the findings of this study, no changes are required to the operational discharge model.

1 Introduction

1.1 Background

The paint systems used on the Auckland Harbour Bridge (AHB) in the past are known to have contained lead and chromate, both of which are known to cause severe health effects (AS/NZS, 2017). However, the exact location and extent of these metals is unknown, due to changes in painting systems over the years. Surface preparation maintenance activities release historic coatings into the air (and coast and potentially land). These discharges are currently permitted under discharge consents from the Auckland Council.

The assessment of effects for the current consents were based on a semi-quantitative assessment of the composition of the historic coatings on the bridge carried out in 2011, and air testing during maintenance works carried out in 2013. At the time of the semi-quantitative assessment, lead-based paint was known to be present in Span 7 of the AHB, and the assessment assumed that no additional sources of lead were present in other areas of the bridge. However, subsequent paint sampling from various locations on the bridge indicated that lead was present in other spans (Flinders Cook, 2011). A review by coating specialists concluded that the results probably indicated lower levels of lead being present in the historic paints rather than a lead-based paint layer (lead-based paint contains >5000ppm lead). Air sampling further verified these findings; lead was detected in dry abrasive blasting discharges in areas of the bridge outside Span 7, such as Span 3 (Air Matters, 2013).

A Standards New Zealand guideline (AS/NZS 4361.1:2017) has recently been released. This guideline deals with hazardous paint management in industrial applications, and has requirements for identifying hazardous metallic pigment (that contain concentrations of lead, zinc chromate, arsenic and/or cadmium) and managing discharges during removal.

A pilot study was undertaken in 2016 to increase our understanding of the distribution of key contaminants in the historic coatings on the AHB, and the relationship between source contaminants (particularly lead) in bridge coatings and the levels in dry abrasive blasting discharge. The pilot study was intended to determine the usefulness of the results and provide recommendations before further phases of sampling.

A second phase of sampling was undertaken in 2017 to expand on the pilot study and investigate the likely ranges of key contaminants in historic coatings on the bridge. This report presents the findings and provides recommendations from the second phase of sampling.

1.2 Purpose and Scope

The purpose of the historic coatings characterisation study was to increase our understanding of the distribution of key contaminants in the historic coatings across the bridge, and to identify whether there is a need to undertake further sampling to confirm that H&S and environmental controls are adequate.

The scope of the study was:

- To review existing information on the presence of contaminants of concern (predominantly lead and chromium) in historic coatings on the bridge;
- To undertake paint sampling in key areas to evaluate the level and variability of these contaminants (the sampling and results are described in AHBA Technical Report "Historic Coating Characterisation Study" prepared by Hanieh Ghominejad and Raed El Sarraf); and
- To review the assumptions that current environmental controls are based on to determine whether further work is required to confirm that controls are adequate.

2 Information Review

2.1 AS/NZS Guide to Hazardous Paint Management

The recently released *Guide to hazardous paint management Part 1: Lead and other hazardous metallic pigments in industrial applications* (AS/NZS 4361.1:2017) contains advice for managing the following hazardous metallic pigments in paints:

- Lead: used extensively in paints until the early 1980s. Lead-based paint has greater than 5000ppm, but lead may also be present at lower levels in paints as it was historically used as a filler or drying agent.
- Chromium: widely used in the latter part of the 20th Century in the form of zinc chromate primer (hexavalent chromium)[1].
- Arsenic and cadmium: used in coloured pigments mainly in greens and yellows. Their presence is rare on industrial structures or infrastructure (AS/NZS, 2017).

The guidelines apply where the total mass of paint to be removed from the structure exceeds the thresholds in Table 1.

Table 1: AS/NZS 4361.1:2017 Threshold concentration criteria for hazardous paint projects (% by weight)

	Total Mass of Paint		
Hazard	>250kg paint	50-250kg paint	<50kg paint
Lead	0.1%	0.25%	1%
Zinc Chromate (as Cr)	0.05%	0.1%	0.25%
Arsenic	0.05%	0.1%	0.25%
Cadmium	0.05%	0.1%	0.25%

2.2 Historic Coatings Systems on the AHB

A desktop review was undertaken of the coatings systems used on the bridge to determine the potential presence of the key contaminants identified in AS/NZS 4361.1:2017. The findings are summarised in Table 2.

Table 2: Summary of information found on historic coatings Mandeno (1996)

Date/Phase	Coatings	Potential Key Contaminants Present	Location
1954-1955 Original specification used initially during construction	• Red lead primer • Micaceous iron oxide enamel	Lead >5000ppm (lead-based paint)	Span 7 Potentially Span 1[2]

[1] Hexavalent chromium is the most toxic form of chromium, estimated at 100 to 1000 times more toxic than trivalent chromium (Bodle & Salome, 2008).

[2] Mandeno (2011).

Date/Phase	Coatings	Potential Key Contaminants Present	Location
1956-1959 Construction	• Metallise with zinc spray • Zinc chromate primer • Two coats of ferrodor paint	Zinc chromate	Truss
1963-1969 Clip-ons construction	• Internal: 2x coats of red lead • External: zinc spray or zinc silicate, sealed with vinyl butyral etch primer, MIO/phenolic topcoat	Lead >5000ppm (lead-based paint)	Box Girders – internal
1963-1969 Truss maintenance	• Phenolic zinc chromate primer • Micaceous iron oxide pigmented topcoats	Zinc chromate	Truss
1969-1989 Maintenance	• Oil/phenolic zinc chromate primer • Phenolic chromate primer (AS K211 Type 4 but with 50%zinc chromate pigment) • MIO/phenolic topcoat	Zinc chromate	Everywhere
1989-1994 Maintenance	• Type 1 primer (an alkyd/oil binder) with pigment composition of 50% by weight of basic zinc potassium chromate, with a minimum pigment level in the paint of 53%	Zinc chromate	Everywhere
1994-Present	• Following a request by the bridge maintenance contractor, a proprietary chromate-free primer was substituted • Termarust has been added to the specification	None	

It has been reported that the maintenance regime over the years should have resulted in the majority of the lead-based paint in Span 7 being removed (with the exception of PP5-7), as records show that contractors were historically engaged to strip and repaint entire sections of the bridge at a time. However, observations on site indicate that the lead-based primer still remains in areas where it was expected to have been removed. It appears that historically the contractors may have made the decision to overcoat areas where the paint underneath was sound, rather than removing it entirely.

In summary, the review found that lead-based paint is likely to only have been used in Span 7 and inside the Box Girders (clip-ons), although there is potential for it to be present in Span 1. Zinc chromate was used extensively across the bridge between 1956 and 1994. No evidence was found that indicates paints containing arsenic or cadmium have been used on the bridge.

Due to maintenance regime and paint system changes over the years, it is likely that the concentrations of lead and zinc chromate are variable in the historic coatings across the bridge.

2.3 Previous Sampling

2.3.1 Air Sampling 10 March 2011

Air Matters (March 2011). *Measurement of Ambient Levels of Chromium, Zinc, Lead and Iron during Abrasive Blasting*.

Air sampling was carried out during abrasive blasting in Span 3 (pp5/6). The results indicated that both chromium and lead were present in the area being blasted. The concentration of these contaminants in the historic coatings was not measured before abrasive blasting was carried out.

2.3.2 Paint Sampling April-May 2011

Flinders Cook (April 2011). Lab report 76376.
Flinders Cook (May 2011). Lab report 76533.

Paint flake samples were taken (back to bare steel) in several locations, and tested for lead. Lead was found in every span and the inner and outer boxes (~500-600ppm). A review by coating specialists suggested that the results were likely to indicate lower levels of lead being present in the historic paints rather than a lead-based paint layer.

2.3.3 Air Sampling January-February 2013

Air Matters (April 2013). *Monitoring of particulate and metals from abrasive blasting and total volatile organic compounds and isocyanates from painting during maintenance.*

Sampling was carried out during abrasive blasting in Span 6, Span 7, and Pier 5. Chromium and lead were both detected in the air samples taken for each location. The concentration of these contaminants in the historic coatings was not measured before abrasive blasting was carried out.

Arsenic and cadmium were both detected at low concentrations (an order of magnitude below TCEQ short-term effects screening levels[3] at source) in air samples during abrasive blasting.

2.3.4 Historic Coatings Study Pilot June 2016

AHB Alliance (2016). *Historic Coatings Study Pilot*.

In 2016 a pilot study was undertaken to try to improve our understanding of the distribution of key contaminants in the historic coatings and the relationship to concentrations measured in the air during abrasive blasting.

Paint samples from four locations were sampled across one post (Span 7, Post 10). Lead concentrations varied from 160ppm to 1160ppm, and chromium varied from 1730ppm to 8790ppm across the post sampled.

The concentrations of lead and hexavalent chromium measured in the air during the abrasive blasting of this post were found to be below the relevant environmental guidelines. The study confirmed that the buffer zones established for compliance with the maintenance discharge consent

[3] TCEQ short term ESL: Cd: 5.4μm/m^3. As: 3μm/m^3.

are adequate to meet the required thresholds for lead and chromium (and iron and zinc) where concentrations of these key contaminants are within the range found in the paint samples. It also confirmed that, for the abrasive blasting set up on the day of sampling, occupational exposure to key contaminants was below the workplace exposure standard.

No arsenic or cadmium was detected in any of the paint samples, however the laboratory that undertook the paint sample analysis has reported that they are not able to determine detection limits for the analysis method used. This means that although neither of these metals was detected in the paint samples, it may still be present at low levels, and we are unable to report on what those levels may be.

Both arsenic and cadmium were detected in samples of washwater taken during waterblasting, with higher concentrations being found in the sample from the start of the waterblasting, and lower concentrations in the end sample. This may indicate that the source of these contaminants is surface deposition (e.g. from traffic fumes).

Arsenic and cadmium were not tested in the air samples during the pilot study.

2.3.5 Summary

Lead has been found in most areas of the bridge, though only at high concentrations in Span 7 and inside the box girders. This indicates lead may have been used as a filler or drying agent outside of Span 7, but Span 7 is the only place where levels are high enough to indicate a lead-based paint layer.

Chromium and/or hexavalent chromium have been found in all parts of the bridge where it has been tested for.

Arsenic and cadmium have not been detected in any paint samples, however have been detected at low levels during air sampling. The results of the pilot study suggest surface contamination may be the source.

2.4 Semi-Quantitative Assessment

A semi-quantitative assessment for paint debris from dry abrasive blasting was developed in December 2010. Initially this was intended to inform the assessment of environmental effects for the 2011 discharge consent and development of controls under the consent (level of containment of discharges required during works). The historic coating types considered in the assessment were:

- ‘Lead-based paint’
- Zinc chromate
- Micaceous iron oxide
- Zinc phosphate

The assessment estimated the potential worst-case and best-case scenarios for the total volume of each coating type released in paint debris into land or water from dry abrasive blasting of the AHB. The coating thickness and average surface area being blasted were multiplied to give the total potential volume that could be released, which was then adjusted using a more realistic discharge scenario based on information from the AHB site team and a number of assumptions. The potential total volume released was multiplied by the density (soil density was used as a proxy for density of paint flakes, which was unknown) to give the annual average mass discharged of each of the coatings types. The total mass of the zinc components of relevant coatings was then calculated.

The semi-quantitative assessment was used as the basis for a contaminant discharge model developed to inform the 2014 coastal discharge consenting process. The contaminant thresholds determined at that time were then used for the current consent conditions for the coastal discharge. There were several assumptions made in the semi-quantitative assessment and contaminant discharge model for determining contaminant thresholds, and it has never been comprehensively tested through field sampling.

3 Approach

Paint sampling was undertaken to increase our knowledge of the distribution and presence of key contaminants in the historic coatings on the bridge. The assumptions made about historic coatings when calculating environmental discharges from the maintenance works were then reviewed to determine whether they can still be considered accurate in the light of the new knowledge gained from this sampling round.

3.1 Paint Sampling Strategy

3.1.1 Key Contaminants of Concern

Lead and hexavalent chromate are the key contaminants of concern in the paint testing undertaken. The information review did not identify arsenic or cadmium as likely to be present in the historic coatings, however these were also tested for in paint samples to confirm this (because the AS/NZS Guideline to Hazardous Paint Removal also deals with these metals). The proportion of zinc was tested to allow the calculations from the semi-quantitative assessment to be tested.

Determination of chromium in paints is a relatively straight forward procedure but determining the proportion of chromium present as hexavalent chromium (chromate) presents a challenge due to the efficacy of extraction procedures in the laboratory. Given these difficulties, it is recommended that analysis of paint samples should determine the total chromium content of the paint with the assumption that all the chromium present is in the form of chromate (Bodle & Salome 2008).

3.1.2 Samples

Full depth paint samples and surface dust wipes of the AHB coatings were collected at 15 sites on the bridge. All sampling was carried out on 31 March 2017. The sampling plan for coating analysis of the AHB is presented in Table 3. Further information about these sites and the sample collection and analysis process is described in the technical report by Ghominejad & El Sarraf (2018).

Table 3 Sampling plan for the historic coating survey, March 2017.

Site Number	Sampling Location	No. of Samples	Description of Sites
1	**Span 1 Panel Point 0**	1	Top of the stairs
2	**Span 1 Panel Point 7/8 Diagonal at Western Bottom Chord**	2	One site on each of the top and bottom faces of the diagonal
3	**Span 1 PP 14 Eastern Green Mile**	2	Both sites located at the beginning of the Eastern Green Mile, with one site close to the road and the other on the underside of the orthotropic deck
4	**Span 2 Panel Point 5**	6	One site at the top of the western side of the Overarch, one site on adjacent members of the Green Mile, and two sites on either face (interior/exterior) of the Extension

Site Number	Sampling Location	No. of Samples	Description of Sites
6	**Span 2**	1	At Southern walkway, vertical surface adjacent to the road surface
5	**Span 7 Panel Point 6**	2	One each on a Vertical and Diagonal where red lead was known to be present to demonstrate the difference between red lead primer and other historic coating
7	**Span 7 Panel Point 7/8 Diagonal at Western Bottom Chord**	1	At the top face of the diagonal after abrasive blasting, which is a known location with red lead primer

The paint thickness was tested at each sample site, and paint samples were taken and sent to CRL Laboratories for testing for a suite of metals using X-ray fluorescence analyser (XRF).

Dust wipe samples were also taken at locations 2-7 and tested for lead, hexavalent chromium and other heavy metal elements. These samples were intended to provide information on the level of key contaminants that may have been deposited on the surface of the bridge, e.g. from traffic fumes.

3.2 Confirmation of Semi-Quantitative Assessment Assumptions

The key assumptions used in the semi-quantitative assessment were reviewed in light of the findings from the coatings sampling. This was to determine whether the conclusions made as a result of the semi-quantitative assessment are still valid now that our knowledge of the paints on the bridge has increased. These assumptions include:

- The thickness of the historic coatings on the bridge were assumed to be between 675 µm and 1875 µm.
- Average zinc discharge from 10% of bridge maintained[4] is between 379kg and 610kg.

[4] Based on blasting back to bare steel 10% of the time, and 25% of the depth of the coatings 90% of the time.

4 Paint Sampling Results

The paint sampling and dust sampling results are summarised in Table 4. The dry film thickness (DFT) of paint coatings, where detectable, ranged from 370 to 1740µm, with an average of 1067µm.

4.1.1 Lead

Lead was recorded in paint chips from all spans tested. The lead detected in paint chips ranged from 0.036 to 5.04% by weight. Span 7 had the highest lead concentration and remains a hotspot for historic lead, which was expected from prior studies.

Lead was detected in all dust wipe samples, with the concentration ranging from 0.41 to 12.1µg/sample. The greatest concentration of surface lead was at Span 2 at the southern walkway, just below the road surface. Other parts of Span 2 had relatively low surface lead concentrations. Generally, surface lead concentrations in dust wipe samples were higher at sites close to the roadway which suggests that sources of surface lead may be from carbon soot emissions from vehicles, the road itself, or traffic paints used in road markings. The concentration of lead in dust wipes from Span 7 was close to the mean concentration for all samples, which confirms that most of the lead contaminants from Span 7 are from historic paint coatings.

4.1.2 Chromium

Chromium was detected in all but one of the paint chip samples and the concentration ranged from 0.010 to 0.864% by weight. These levels of chromium are attributed to historic use of zinc chromate primer. Chromium was also detected in all dust wipe samples, with concentrations ranging from 0.5 to 17.5µm/sample. The highest concentrations of chromium were detected near the roadway, therefore potential sources come from road activities, as noted for lead above.

Hexavalent chromium was also assessed using dust wipes, with concentrations ranging from <0.01 to 0.7µm/sample. The highest level of hexavalent chromium in surface dust was found at Span 7 where abrasive blasting had been carried out. The presence of hexavalent chromium is related to zinc chromate primers being exposed during paint removal. Sources of hexavalent chromate are also associated with roadway activities, including traffic marking paints, chrome plating on vehicles, and vehicle fumes.

4.1.3 Arsenic and Cadmium

Arsenic and cadmium were both below the method detection limit in the paint samples. In the dust wipes, cadmium was below or very close to the detection limit in all samples, and arsenic was detected in several samples at up to four times the detection limit.

4.1.4 Zinc

The concentration of zinc in paint chip samples ranged from 2.78 to 34.4% by weight. The variation in zinc concentrations is attributed to the primer coating system that was likely applied in variable thicknesses throughout the bridge. The concentration of zinc in dust wipe samples ranged from 70 to 2,300µm/sample. The highest levels of surface zinc were collected from Spans 1 and 7 from surfaces that were near where blasting operations were being undertaken. High levels of zinc were found in two samples, Samples S3B and S7, on surfaces which were later identified to have been near areas where abrasive blasting operations were being undertaken; either earlier that day, or the day before. This indicates that airborne paint dust is being deposited onto these surfaces. It should be noted that these surfaces also included high levels of lead and hexavalent chromium levels.

Paint Sampling Results

Table 4: Paint sampling and dust sampling results

Location	Sample Site	Sample Name	Average DFT (µm)	Paint samples (% by weight)					Dust samples (µm/sample)					
				Pb	Cr	As	Cd	Zn	Pb	Cr (total)	Cr (VI)	As	Cd	Zn
Span 1 PP 0	Top of the stairs	S1A	1,740	0.104	0.26	nd	nd	3.32	nt	nt	nt	nt	nt	nt
Span 1 PP 7/8	Western Bottom Chord Top Diagonal	S2A	1,370	0.139	0.864	nd	nd	22.1	5.6	3.4	0.4	2.0	<0.03	320
	Western Bottom Chord Bottom Diagonal	S2B	nr	nt	nt	nt	nt	nt	3.1	0.8	<0.1	0.6	<0.03	70
Span 1 PP 14	Eastern Green Mile close to the road	S3A	1,415	0.036	0.174	nd	nd	18.1	6.3	10.5	0.2	0.8	0.04	250
	Eastern Green Mile underside of the orthotropic deck	S3B	740	0.046	0.669	nd	nd	34.4	4.1	17.5	0.3	1.1	0.04	1,230
Span 2 PP 5	Western side of the Overarch	S4A	1,190	0.091	0.724	nd	nd	16.5	0.97	1.9	0.2	<0.5	<0.03	81
	Adjacent members on the Green Mile	S4D	370	ND	0.01	nd	nd	12.4	nt	nt	nt	nt	nt	nt
	Interior face of the Extension	S4E	415	ND	ND	nd	nd	28.8	0.41	1.7	<0.1	<0.5	<0.03	480
	Exterior face of the Extension	S4F	831	0.054	0.086	nd	nd	11.2	1.01	0.6	<0.1	0.5	<0.03	105
Span 2	At Southern walkway, vertical surface adjacent to the road surface	S6	nr	nt	nt	nt	nt	nt	12.1	4.5	0.4	0.6	0.03	240
Span 7 PP 6	Vertical	S5A	1,530	5.04	0.29	nd	nd	2.78	2.7	0.5	<0.1	<0.5	<0.03	774
	Diagonal	S5B	nr	nt	nt	nt	nt	nt	3.8	1.2	<0.1	<0.5	<0.03	230
Span 7 PP 7/8	After blasting	S7	nr	nt	nt	nt	nt	nt	3.8	15.3	0.7	1.1	0.07	2,300

Notes:
- nr = not recorded
- nd = not detected
- nt = not tested

5 Discussion

5.1 Verifying Semi-Quantitative Assessment

There were several assumptions made in the semi-quantitative assessment process for determining contaminant thresholds. We have re-examined these assumptions in light of the findings from the coatings sampling.

Table 5 presents the relevant key assumptions made for the semi-quantitative assessment and comments on their applicability based on the sampling results.

Table 5 Test of key assumptions used in the semi-quantitative assessment.

Assumption	Comment	Test
Coating thickness for each coating type was based on the product specifications. Total paint thickness was assumed to be 1000-1875 µm for the worst-case scenario and 675 µm for the best-case scenario.	Average DFT was 1067 µm, which is within the worst-case scenario range. All DFT measurements were less than the upper range of the worst-case scenario assumption. Only two of the sites were below the best-case scenario coating thickness. Therefore, the worst-case scenario is assumed to be correct for paint layers over most of the bridge.	✓
Composition of historic coatings calculated by the semi-quantitative assessment is similar to the composition of historic coatings indicted by sample results. Zinc discharge was calculated to be between 379-610 kg per year (10% of the bridge maintained)	Calculations for zinc based on paint samples are consistent with the calculations for zinc discharge in the semi-quantitative assessment. Based on the paint sample results, the amount of zinc discharged as a result of maintaining 10% of the bridge would be 274-411kg on average (range of 77-871kg)	✓

The key assumptions made during the semi-quantitative assessment and development of the contaminant discharge model remain correct considering the results of historic coatings findings. The worst-case scenario calculations are assumed to be correct for paint layers over most of the bridge.

5.2 Reviewing Environmental Controls (Buffer Zones)

Air controls for abrasive blasting were based on air testing in 2013 during blasting carried out at Span 6, Span 7 and Pier 5. The composition of the historic coatings being blasted was unknown. The pilot study indicated that the abrasive blasting air controls were appropriate for the level of key contaminants in the coatings at the location tested.

Table 6 shows a comparison of the results of the paint samples from this study against the paint sample results from the pilot study (collected from Span 7, Post 10).

Table 6: Paint sample results from the 2017 testing compared to the paint samples from the 2016 pilot study.

	Chromium			Lead			Zinc		
	min	max	mean	min	max	mean	min	max	mean
Pilot study range*	0.173	0.879	0.57	0.016	0.116	0.060	9.26	23.60	16.95
Sample location 1	0.26	0.26	0.26	0.104	0.104	0.104	3.3	3.3	3.3
Sample location 2	0.864	0.864	0.86	0.139	0.139	0.139	22.1	22.1	22.1
Sample location 3	0.174	0.669	0.42	0.036	0.046	0.041	18.1	34.4	26.25
Sample location 4	0.01	0.724	0.27	0.054	0.091	0.0725	11.2	28.8	17.22
Sample location 5 (Span 7)	0.29	0.29	0.29	5.04	5.04	5.04	2.78	2.78	2.78

22.1 Result exceeds mean result from the pilot study

34.4 Result exceeds the maximum result in the pilot study

*sampling location Span 7, Post 10, non-lead-based paint

The results from the current sampling round were generally within the range and below the mean of the results from the pilot study, which indicates that abrasive blasting discharges from these areas are being adequately managed by current controls. However, there were four sample locations where the results from the current study exceeded the results from the pilot study, and so the adequacy of the current controls cannot be confirmed for discharges from these areas based on the testing undertaken to-date.

5.3 Surface Dust

Bodle & Salome (2008) recommend the United States Environmental Protection Authority (US EPA) advice which considers lead to be a toxic element when equal to or exceeding 0.4mg/m^2 in dust (equivalent to 4µg/sample). This guideline was exceeded in four samples of dust wipes, at Span 1 PP 7/8, two locations at Span 1 PP 14 eastern green mile, and Span 2.

Bodle & Salome (2008) recommend that the level of chromate in surface dust should not exceed 0.025mg/m^2 (equivalent to 0.25µg/sample), based on the US EPA standard for lead in dust, and the relative occupational exposure standards for lead and chromate. Hexavalent chromium in surface dust exceeded the recommended threshold in four samples (S2A, S3A, S3B and S4A) all of which are in Spans 1 and 2. The concentration of chromium in surface dust exceeded recommended threshold in all dust wipe samples collected.

5.4 AS/NZS Guide to Hazardous Paint Management

The AS/NZS 4361.1:2017, Guide to Hazardous Paint Management Part 1: Lead and Other Hazardous Metallic Pigments in Industrial Applications provides thresholds for concentrations of key metals that would be considered hazardous during paint removal projects of various sizes. The objective of AS/NZS 4361.1 is to provide guidelines for the successful management of the disturbance or removal of paints containing hazardous metallic pigments used on industrial steel structures, to minimise health hazards to workers and the public, and pollution hazards to the environment.

The paint samples confirmed that lead-based paint at >5,000 ppm by weight in dry film (equivalent to 0.5% by weight) was present at Span 7 and is considered hazardous for projects of any size (removal of <50kg paint). Outside of Span 7, lead was found at levels considered to be hazardous during paint removal projects of >250kg in samples S1A and S2A.

Chromium is present across all areas of the bridge tested at levels that are considered hazardous according to the AS/NZS guide for projects removing <50kg of paint (i.e. projects of any size).

Arsenic and cadmium were not found at levels of concern.

5.5 Distribution of Contaminants

The number of samples taken during this study was not adequate to fully understand the likely distribution of metals in the coatings across all areas of the bridge. Samples were only taken in Span 1, Span 2 and Span 7, and it is not known whether the coatings in other areas of the bridge are likely to be the same.

AS/NZS 4361.1:2017, Guide to Hazardous Paint Management recommends using portable XRF as one method to analyse the composition of coatings on industrial structures. Using such a method allows a large number of samples to be taken in a short amount of time, which could be useful on the bridge to further characterise the distribution of coatings quickly and easily without undertaking full paint sampling and analysis.

6 Conclusion and Recommendations

This study showed that Span 7 has the highest lead concentration and remains a hotspot for historic lead paints, which was expected from prior studies. Outside of Span 7, concentrations of lead were still found in some areas at levels that would be considered hazardous under the AS/NZS guide for projects removing >250kg of paint.

Chromium is present across all areas of the bridge tested at levels that are considered hazardous according to the AS/NZS guide for projects removing <50kg of paint (i.e. projects of any size).

Arsenic and cadmium were not found at levels of concern.

Based on these results, we recommend the following:

- Evaluate the feasibility of using maintenance techniques that avoid the use of dry abrasive blasting (such as MC Ferrox overcoating), or if it cannot be avoided, continue to use spot-blasting to reduce the area needed to be blasted to a minimum.
- Review the requirements of the AS/NZS Guide to Hazardous Paint Removal to determine which aspects of it should be adopted during AHB maintenance.
- Take paint samples prior to blasting, and undertake further air testing during abrasive blasting if high chromium levels are found. Air Matters should be requested to review buffer zones after testing and confirm whether they are acceptable.
- Further research should be undertaken into the implications of the dust wipe results, especially in relation to current and future uses on the bridge (public access areas). Undertake surface wipe sampling inside the bungee pod and in other areas (e.g. handrails), to determine whether additional clean-up work is required following abrasive blasting to protect the health of workers and members of the public in these areas.
- Any future paint sample analysis carried out to further our knowledge of the issues described in this report should be undertaken in accordance with the methodologies described in the AS/NZS Guide to Hazardous Paint Removal. The use of portable XRF should be considered.
- Based on the findings of this study, no changes are required to the operational discharge model.

7 References

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