# Inherent Exposure Risk Assessment

## Proposed Resource Recovery Facility
## Block 11, Section 21, Hume

### June – December, 2019

**Certificate of approval for issue of documents**

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# 1 Introduction

Robson Environmental Pty Ltd (Robson) was engaged by Flexible Australia to undertake a Health Impact Assessment for the Proposed Resource Recovery Facility at Block 11, Section 21 in Hume. This report covers the Stage 2 assessment of the inherent exposure risks for possible health hazards identified in Stage 1 (see Robson report 10905, May 2019), as shown in Appendix 1.

The purpose of this Inherent Exposure Risk Assessment is to inform the Environmental Impact Statement for the development of the Proposed Resource Recovery Facility, as per Section 8.1.8 of the Scoping document, to 'describe the potential for health impacts where personnel (staff & public) come into contact with or are exposed to material on-site', as an Exposure Risk Assessment.

This Risk Assessment is to determine the inherent exposure risk for expected quantities of waste materials delivered to the resource recovery facility. This report should be read in conjunction with report 1090502 for assessment of the residual risk.

Possible exposure risks have been assessed for the following waste streams shown in Table 1.

**Table 1: Types, expected composition and expected quantities of waste streams**

| Waste Stream | Expected Composition | Expected Annual Quantity Processed |
|---|---|---|
| Stormwater (wet and dry) | Water, organic matter (e.g. leaves), soil/sand, litter including plastics, paper and metal, small quantities of vehicle and industrial related contaminants such as oil etc. | 6900 tonnes |
| Stormwater Retention Chambers | | 450 tonnes |
| Sedimentation Basins | | 110 tonnes |
| Street Sweepings | Organic matter (e.g. leaves), soil/sand, water, litter including plastics, paper and metal, vehicle related contaminants including oils, fuels, tyre particulates etc. | 11400 tonnes |
| Hydromud (hydro excavation, hydro drilling) | Rock, soil, organic matter (e.g. grass), water | 4070 tonnes |
| Bunker Sand from golf courses | Sand (silica), minor contaminants (e.g. litter) | 350 tonnes |

# 2 Exposure Risks Not Assessed

During hazard identification all hazards which could conceivably be present within the waste streams were identified, but further risk assessment of all of these hazards is not practical or necessary. Prioritisation of hazards has been undertaken, and hazards not expected to be significant have been excluded from this risk assessment, as per Table 2. This assessment also does not cover exposure which may occur during the construction phase.

**Table 2: Hazards excluded from further risk assessment**

| Hazard | Justification for exclusion |
|---|---|
| Per and Poly Fluoroalkyl Substances (PFAS – PFOS, PFOA) | Waste streams from within the Canberra area are not expected to have significant volumes of PFAS. If waste from outside of Canberra is to be processed, or volumes of hydromud are to increase this risk may need to be reassessed. |
| Bentonite clay | Hazards from process additive are to be managed as per the Manufacturer's Safety Data Sheet |

| Hazard | Justification for exclusion |
|---|---|
| Fungicides and Insecticides | Street sweepings and stormwater waste from the Canberra area are not expected to have significant volumes of fungicides and insecticides. If waste from outside of Canberra is to be processed this risk may need to be reassessed. |
| Faeces | The hazards from exposure to faeces are covered in the exposure risk assessment for 'Viruses, Bacteria and Fungi' |
| Cigarette butts | Exposure are not expected to be significant as litter material will be removed early in processing |
| pH Adjusters, Flocculants, Coagulants | Hazards from process additive are to be managed as per the Manufacturer's Safety Data Sheet |

# 3 Risk Assessment Method

The risk assessment method used in this assessment is based on the guidance of the *Health Monitoring for Exposure to Hazardous Chemicals – Guide for Persons conducting a Business or Undertaking* (Safe Work Australia, 2013). The level of risk posed by exposure to a contaminant is dependant on the intrinsic hazard of the substance and the dose (frequency, duration and amount of exposure). In this assessment, only the intrinsic hazard has been assessed.

The nature and severity of the hazard for each chemical was assessed based on GHS Hazard Categories provided in the Safe Work Australia Hazardous Chemical Information System (HCIS) sources, to give a consequence rating from the assessment tool shown in Table 1, for the GHS Hazard Categories, as classified in Table 4.

**Table 3: Consequence assessment for GHS Hazard Categories**

| Rating | Consequence - the outcome if event occurs |
|---|---|
| **Severe** | Known carcinogens, mutagens, reproductive toxins, chemicals which could cause fatality or injury causing significant permanent loss of function |
| **Major** | Suspected carcinogens, mutagens, reproductive toxins, chemicals which could cause injury causing permanent loss of function |
| **Moderate** | Chemicals which could cause injury causing temporary loss of function or hospital admission |
| **Minor** | Chemicals which could cause minor injury, requiring first aid or out-patient medical treatment |
| **Insignificant** | Chemicals not expected to cause injury or injury requiring notification only |

**Table 4: Classification & hazard statements assigned under GHS criteria, and consequence ratings, as per Table 3**

| Classification | | Hazard statement |
|---|---|---|
| Acute Toxicity | Category 4 | H332- Harmful if inhaled |
| | | H312 - Harmful in contact with skin |
| | | H302 - Harmful if swallowed |
| | Category 3 | H331 - Toxic if inhaled (gas, dust, mist) |
| | | H311 - Toxic in contact with skin |
| | | H301 - Toxic if swallowed |

| Classification | | Hazard statement |
|---|---|---|
| | Category 2 | H330 - Fatal if inhaled (vapour) |
| | | H330 - Fatal if inhaled (gas, dust, mist) |
| | | H300 - Fatal if swallowed |
| | Category 1 | H330 - Fatal if inhaled (vapour) |
| | | H310 - Fatal in contact with skin |
| Skin Irritation – Category 2 | | H315 - Causes skin irritation |
| Skin Corrosion | Sub-category 1B or 1C | H314 - Causes severe skin burns and eye damage |
| | Sub-category 1A | |
| Eye Irritation – Category 2A | | H319 - Causes serious eye irritation |
| Eye Damage – Category 1 | | H318 - Causes serious eye damage |
| Specific Target Organ Toxicity – Single exposure | Category 3 | H335 - May cause respiratory irritation |
| | | H336 - May cause drowsiness and dizziness |
| | Category 2 | H371 - May cause damage to organs |
| | | H371 - May cause damage to organs |
| | Category 1 | H371 - May cause damage to organs |
| | | H370 - Causes damage to organs |
| Specific Target Organ Toxicity – Repeated Exposure | Category 2 | H373 - May cause damage to organs through prolonged or repeated exposure |
| | Category 1 | H372 - Causes damage to organs through prolonged or repeated exposure |
| Respiratory Sensitisation – Category 1 | | H334 - May cause allergy or asthma symptoms or breathing difficulties if inhaled |
| Skin Sensitisation – Category 1 | | H317 - May cause an allergic skin reaction |
| Effects on or via lactation | | H362 - May cause harm to breast-fed children |
| Aspiration hazard – Category 1 | | H304 - May be fatal if swallowed and enters airways |
| Carcinogenicity | Category 2 | H351 - Suspected of causing cancer |
| | Category 1B | H350 - May cause cancer |
| | | H350i - May cause cancer via inhalation |
| | Category 1A | H350 - May cause cancer |
| | | H350i - May cause cancer via inhalation |
| Mutagenicity | Category 2 | H341 - Suspected of causing genetic defects |
| | Category 1A | H340 - May cause genetic defects |
| | Category 1B | |
| Toxic to Reproduction | Category 2 | H361 - Suspected of damaging fertility or the unborn child |
| | Category 1A | H360 - May damage fertility or the unborn child |
| | Category 1B | H360 - May damage fertility or the unborn child |

The degree of workers' possible exposure (without controls) was based on the expected volume of the contaminant in the waste stream, based on the literature review presented in Section 4. This information was used to determine the likelihood rating from Table 5. This rating is the likelihood that an adverse health effect will occur from uncontrolled exposure to the volume of contaminant expected to be present within the waste streams.

**Table 5: Likelihood assessment**

| Rating | Likelihood – The potential for events to occur | Probability |
|---|---|---|
| **Very Likely** | The event is expected to occur. e.g. common or repetitive occurrence | >90% |
| **Likely** | The event will probably occur. e.g. has a record of occurrence | 50% to 90% |
| **Possible** | The event might occur e.g. has occurred several times | 10% to 50% |
| **Unlikely** | The event probably won't occur. e.g. has occurred a few times, is known to occur within the industry | 2% to 10% |
| **Very Unlikely** | The event may occur in exceptional circumstances e.g. event is plausible, would only occur in exceptional circumstances in the industry | <2% |

Risk assessment for each contaminant is done using the matrix in Table 6. Risk is described as:

- Not significant (Low) – workers are unlikely to be exposed at a level which would adversely affect their health; or
- Significant (High/medium) – workers may be exposed at a level which may adversely affect their health.

**Table 6: Risk Assessment Matrix**

| Consequence | Very Likely | Likely | Possible | Unlikely | Very Unlikely |
|---|---|---|---|---|---|
| **Severe** | High | High | High | Medium | Medium |
| **Major** | High | High | Medium | Medium | Low |
| **Moderate** | High | Medium | Medium | Low | Low |
| **Minor** | Medium | Medium | Low | Low | Low |
| **Insignificant** | Medium | Low | Low | Low | Low |

# 4 Literature Review – Expected Amounts of Contaminants in Waste Streams

A literature review of the amounts of contaminants which could be present in the identified waste streams is shown in Table 7.

**Table 7: Literature review – expected contaminant levels in waste streams**

| Hazard | Reference | Source | Level |
|---|---|---|---|
| Lead | Depree, 2008 | Road derived sediments | Median: 122 ug/g |
| | | Street sweepings | Median: 117 ug/g |
| | | Catchpit sediment | Median: 133 ug/g |
| | | New Zealand soils | Range: 10 – 30 ug/g |
| | Cheah et. al., 2007 | Roof runoff | Mean particulate: 33 ug/L<br>Mean dissolved: 19 ug/L |
| | Martin, Roberts, Griffiths, 2013 | Street sweepings | Median: 21.5 mg/kg |
| | | Street dusts and road sweepings | Range: 1.4 – 660 mg/kg |
| | Wei B, Y and L, 2009 | Urban road dust | Range: 53.33 – 408.4 mg/kg |
| Copper | Depree, 2008 | Road derived sediments | Median: 67 ug/g |
| | | Street sweepings | Median: 55 ug/g |
| | | Catchpit sediment | Median: 85 ug/g |
| | | New Zealand soils | Median: 27 ug/g |
| | Darvodelsky, 2011 | Biosolids | Typical: 550 mg/kg |
| | Cheah et. al., 2007 | Roof runoff | Mean particulate: 523 ug/L<br>Mean dissolved: 1530 ug/L |
| | Martin, Roberts, Griffiths, 2013 | Street sweepings | Median: 22.1 mg/kg |
| | | Street dusts and road sweepings | Range: 28 – 3 721 mg/kg |
| | Wei B, Y and L, 2009 | Urban road dust | Range: 94.98 – 196.8 mg/kg |
| Zinc | Depree, 2008 | Road derived sediments | Median: 422 ug/g |

| Hazard | Reference | Source | Level |
|---|---|---|---|
| | Depree, 2008 | Street sweepings | Median: 336 ug/g |
| | | Catchpit sediment | Median: 464ug/g |
| | | New Zealand soils | Median: 68 ug/g |
| | Darvodelsky, 2011 | Biosolids | Typical: 800 mg/kg |
| | Cheah et. al., 2007 | Roof runoff | Mean particulate: 28 ug/L<br>Mean dissolved: 120 ug/L |
| | Martin, Roberts, Griffiths, 2013 | Street sweepings | Median: 113 mg/kg |
| | | Street dusts and road sweepings | Range: 4.3 – 796 mg/kg |
| | Wei B, Y and L, 2009 | Urban road dust | Range: 294.47 – 1450 mg/kg |
| Cadmium | Cheah et. al., 2007 | Roof runoff | Mean particulate: 0.03 ug/L<br>Mean dissolved: 0.11 ug/L |
| | Martin, Roberts, Griffiths, 2013 | Street sweepings | Median: 0.2 mg/kg |
| | | Street dusts and road sweepings | Range: <0.1 – 1.5 mg/kg |
| | Wei B, Y and L 2009 | Urban road dust | Range: 1.17 – 3.77 mg/kg |
| Iron | Cheah et. al., 2007 | Roof runoff | Mean particulate: 2422 ug/L<br>Mean dissolved: 37 ug/L |
| | Martin, Roberts, Griffiths, 2013 | Street dusts and road sweepings | Range: 2955 – 65000 mg/kg |
| Manganese | Cheah et. al., 2007 | Roof runoff | Mean particulate: 13 ug/L<br>Mean dissolved: 19 ug/L |
| | Martin, Roberts, Griffiths, 2013 | Street dusts and road sweepings | Range: 386 – 899 mg/kg |
| | | Street sweepings | Median: 651 mg/kg |
| Magnesium | Cheah et. al., 2007 | Roof runoff | Mean particulate: 189 ug/L<br>Mean dissolved: 757 ug/L |
| | Walch, 2006 | Street sweeping stockpiles | Range: 6882 – 13290 mg/kg |
| Antimony | Martin, Roberts, Griffiths, 2013 | Street sweepings | Median: 1.4 mg/kg |
| Arsenic | Martin, Roberts, Griffiths, 2013 | Street sweepings | Median: 3.2 mg/kg |

| Hazard | Reference | Source | Level |
|---|---|---|---|
| | | Street dusts and road sweepings | Range: 0.5 – 17 mg/kg |
| Barium | Martin, Roberts, Griffiths, 2013 | Street sweepings | Median: 62 mg/kg |
| | | Street dusts and road sweepings | Range: 1.4 – 130 mg/kg |
| Boron | Martin, Roberts, Griffiths, 2013 | Street sweepings | Median: 15.5 mg/kg |
| Chromium | Martin, Roberts, Griffiths, 2013 | Street sweepings | Median: 11.4 mg/kg |
| | | Street dusts and road sweepings | Range: 1.3 – 552 mg/kg |
| | Wei B, Y and L, 2009 | Urban road dust | Range: 51.29 – 167.28 mg/kg |
| Cobalt | Martin, Roberts, Griffiths, 2013 | Street sweepings | Median: 5.8 mg/kg |
| Fluoride | Martin, Roberts, Griffiths, 2013 | Street sweepings | Median: 18.7 mg/kg |
| Mercury | Martin, Roberts, Griffiths, 2013 | Street sweepings | Median: 0.05 mg/kg |
| Molybdenum | Martin, Roberts, Griffiths, 2013 | Street sweepings | Median: 0.75 mg/kg |
| Nickel | Cheah et. al., 2007 | Roof runoff | Mean particulate: 15.89 ug/L<br>Mean dissolved: 0.66 ug/L |
| | Martin, Roberts, Griffiths, 2013 | Street sweepings | Median: 8.9 mg/kg |
| | | Street dusts and road sweepings | Range: 1.7 – 78 mg/kg |
| | Wei B, Y and L, 2009 | Urban road dust | Range: 23 – 86.26 |
| Selenium | Martin, Roberts, Griffiths, 2013 | Street sweepings | Median: 0.16 mg/kg |
| Silver | Martin, Roberts, Griffiths, 2013 | Street sweepings | Median: 0.1 mg/kg |
| Thallium | Martin, Roberts, Griffiths, 2013 | Street sweepings | Median: 0.044 mg/kg |
| Tin | Martin, Roberts, Griffiths, 2013 | Street sweepings | Median: 0.54 mg/kg |
| Vanadium | Martin, Roberts, Griffiths, 2013 | Street sweepings | Median: 10.6 mg/kg |

| Hazard | Reference | Source | Level |
|---|---|---|---|
| Asbestos | Department of Health 2013 | Outdoor air | Asbestos is a naturally occurring mineral, and its widespread use means that fibres are ubiquitous in the outdoor environment. Ambient or background air usually contains between 10 and 200 asbestos fibres in every 1000 cubic metre of air (equivalent to 0.01 to 0.20 fibres per litre of air). |
| Hydrocarbons | Martin, Roberts, Griffiths, 2013 | Street leaf sweeping | Gasoline range organics (C6–C10) range: 5–184 mg/kg<br>Gasoline range organics (C6–C10) median: 5 mg/kg |
| | | | Extractable petroleum hydrogen (EPH) (C10–C25) range:245–8973 mg/kg<br>EPH (C10–C25) median: 1189 mg/kg |
| | | | EPH (C25–C40) range: 506–21 941 mg/kg<br>EPH (C25–C40) median: 2639 mg/kg |
| | | | EPH (C10–C40) range:868–30 913 mg/kg<br>EPH (C10–C40) median: 4233 mg/kg |
| | Walch, 2006 | Street sweepings | Leachable BTEX: not detected |
| | | | Leachable PCBs: not detected |
| | | | Leachable TCLP semi-volatiles: not detected |
| | | | Leachable TCLP volatiles: not detected |
| Total Petroleum Hydrocarbons (TPH) | Walch, 2006 | Street sweepings | Range: 3410 – 8020 mg/kg |
| | Depree, 2008 | Street sweepings + catchpit sediment | Median: 1220 ug/g |
| | Latimer, 1990 | Highway RDS | Mean: 1680 ug/g |
| Polycyclic Aromatic Hydrocarbons (PAHs) | CRC Care, 2017t | Soil | Benzo(a)pyrene range: 0.5 – 1000 mg/kg<br>Benzo(a)pyrene median: 17.6 mg/kg<br>Higher in areas with historical industrial use |
| | CRC Care, 2017t | Sediment | Benzo(a)pyrene range: <0.01 – 6 800 ug/kg |
| | Walch, 2006 | Street sweeping stockpiles | Benzo(a)pyrene range: 541 ±162 µg/kg |
| | Depree, 2008 | RDS | Total PAH median: 6.3 ug/g |

| Hazard | Reference | Source | Level |
|---|---|---|---|
| | Brown and Peake, 2006 | Sweepings | Total PAH mean: 4.4 ug/g |
| | | Catchpit sediments | Total PAH mean: 6.5 ug/g |
| | Depree and Ahrens, 2003 | Highway RDS | Total PAH range: 3 – 6 ug/g |
| | Martin, Roberts, Griffiths, 2013 | Street leaf sweepings | Total PAH median: 8.6 mg/kg<br>Total PAH range BDL – 230 mg/kg |
| | | Street dusts and road sweepings | Total PAH range: 0.005 – 167 mg/kg |
| | Smith, 2009 | Sewage sludge | Total PAHs range: 6.4 – 72 mg/kg,<br>Total PAH mean: 130 mg/kg |
| Bacteria and Fungi | Sales-Ortells & Medema, 2015 | Urban stormwater – water plaza | *Cryptosporidium* was not found in any sample.<br>*L. pneumophila* was found in 20% of samples. *Campylobacter* was found in all samples and estimated disease risk was higher than the Dutch national incidence. |
| | Sidhu et. al., 2012 | Urban stormwater | Samples of stormwater assessed for faecal indicat bacteria frequently exceeded the upper limit of Australian guidelines for recreational waters.<br>*Enterococcus* sp. numbers as high as 3 x $10^4$/100ml were detected.<br>Human adenovirus and polyomavirus were frequently detected.<br>*Campylobacter jejuni*, *Campylobacter coli* and *Salmonella enteric* also detected. |
| | Grebel et. Al., 2013 | Urban stormwater | E. Coli: Median 9,200 CFU/100ml |
| | Bannerman et al., 1993 | Street/roof runoff in industrial area | Mean: faecal coliforms: 144 – 8 338 CFU/100 ml |
| | Grebel et. Al., 2013 | Urban stormwater | Faecal coliform: Median 5,600 CFU/100ml |
| | Tiefenthaler et al., 2011 | Runoff from industrial use | Log E coli (MPN/100mL): 100-100 000 |
| | | | Log enteroroocci 0-100 000 (MPN/100 mL) |
| | Grebel et. Al., 2013 | Urban stormwater | Enterococci: Median 5,000 CFU/100ml |
| | | | Total coliform: Median 26,000 CFU/100ml |
| | | | Staphylococcus aureus: Median 59,000 CFU/L |

| Hazard | Reference | Source | Level |
|---|---|---|---|
| | | | Salmonella: Median 50 CFU/L |
| | | | Coliphage: Median 2,900 CFU/100ml |
| | Department of Health, 2019 | Soil, dust, animal waste | Spores of the bacteria (*Clostridium tetani*) that cause tetanus are found in soil, dust and animal waste. |
| | Tooher, et. al. 2005 | Solid waste | A review of the literature found some evidence to support a theoretical risk of infection with hepatitis A, B and tetanus in waste handling workers; however, no studies could be found of the risk of these diseases in these workers. |
| | Marth, et. al. 1997 | Recycling and composting facilities | A review of bioaerosol health risks to workers at waste treatment facilities (recycling and composting) found no statistically significant increase of allergic diseases (including mould allergen-specific IgE), no changes in lung functions or obstructive changes in the respiratory system. |
| | McLaughlin, 2005 | Soil | Naturally occurring soil dwelling microbes including bacteria, (e.g. *Clostridia*, *Bacillusspecies* & *Listeria*) and fungi (e.g. *Histoplasma capsulatum* & *Blastomycoses dermatitidis*), which are documented as causes of illness in humans.<br>Soil can also be contaminated with pathogens present in urine or stools of wild or domesticated animals. |
| Legionella | Sales-Ortells & Medema, 2015 | Urban stormwater | Legionnaire's disease risks were lower than the Dutch national incidence |
| | Sakamoto, et. al. 2009 | Rainwater on roads | Sampling of rainwater in puddles on road found *Legionella pneumophila* in 36% of samples, with increased prevalence at higher temperatures. |
| | Hughes and Steele, 1994 | Soil, compost and potting mix | 85% of soil and compost samples from large scale composters contained *Legionella* species and 43% of soil samples from home gardeners contained *Legionella* species. |
| | Whiley & Bentham, 2011 | Compost and potting mix | All cases of legionellosis from to *Legionella longbeachae* in Australia & New Zealand for which a source was confirmed were associated with potting mixes & composts. |

# 5 Canberra Study

A summary of results taken from the provided Mid Project Review (Leslie & Yacobellis, 2017) of a study into contaminant values in street sweepings in Canberra is shown in Table 8. Comparison to the literature review values found that the contaminant levels in the Canberra street sweeping were mixed, but were mostly low.

**Table 8: Canberra contaminants in Street Sweepings (from Leslie & Yacobellis, 2017)**

| Hazard | Curtin (mg/kg) | Giralang (mg/kg) | Monash (mg/kg) | O'Connor (mg/kg) | Wanniassa (mg/kg) | Comparison to literature review values |
|---|---|---|---|---|---|---|
| Arsenic | 2.4 | <2 | <2 | 4.2 | 3.2 | Middle |
| Cadmium | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | Low – Mid (LOD is higher than median) |
| Chromium | 21 | 8.1 | 12 | 11 | 16 | Middle |
| Copper | 6.5 | 9.4 | 13 | 12 | 19 | Low |
| Lead | 14 | 11 | 8.4 | 19 | 24 | Low – Middle |
| Mercury | 0.1 | <0.1 | <0.1 | 0.1 | <0.1 | Low – Mid (LOD is higher than median) |
| Nickel | 5.8 | <5 | <5 | <5 | 9.5 | Low – Middle |
| Zinc | 85 | 72 | 36 | 53 | 84 | Low |
| TRH C10 – C36 (Total) | 13 800 | 5 690 | 1 510 | 8 190 | 10 800 | High |
| Benzo(a)pyrene TEQ (medium bound) | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | Low |
| Benzo(a)pyrene TEQ (upper bound) | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | Low |

# 6 Inherent Exposure Risk

The assessment outcomes for the inherent exposure risk assessment for identified hazards are shown in Table 9. Based on the expected composition of the waste streams, as shown in Table 1, the concentrations of most contaminants (particularly metals) would be expected to be higher in the street sweeping waste stream than in the stormwater waste streams. Where concentrations of contaminants within stormwater waste streams were not found in the literature review, the concentration for street sweepings has been used. This is likely to result in a conservative estimate of likely exposures. Further, given the limited industrial activities occurring in Canberra, concentrations of contaminants are likely to be relatively low compared to levels within the literature, which came from a range of environments.

Where available, contaminant concentrations have been compared to the Health Investigation Levels (HIL) of soil contaminants (Table 1A(1)) from Schedule B 1 – Guideline on Investigation Levels for Soils and Groundwater from the National Environment Protection (Assessment of Site Contamination) Measure 1999, for context as to the acceptable level of risk for the concentration of the contaminant in the waste stream.

**Table 9: Inherent Exposure Risk Assessment**

| Hazard | Consequence Assessment<br>What is the harm that the hazard could cause? | Likelihood Assessment<br>What is the likelihood that the harm would occur? | What is the inherent level of exposure risk? |
|---|---|---|---|
| **Elements/Metal Compounds** | | | |
| Antimony | • Acute toxicity – category 3 (antimony trifluoride)/ category 4<br>• Carcinogenicity – category 2 (antimony trioxide)<br>• Skin corrosion – category 1B (antimony pentachloride; antimony trichloride)<br>**Major** | Research found the median concentration of antimony in street sweepings to be 1.4mg/kg.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual antimony processing of around 26kg.<br>**Very Unlikely** | **Low** |
| Arsenic | • Acute toxicity – category 2 (arsenic selenide)/ category 3<br>• Carcinogenicity – category 1A;<br>• Germ cell mutagenicity – category 2;<br>• Specific target organ toxicity (repeated exposure) – category 1 (arsenic selenide)/ category 2<br>• Reproductive toxicity – category 2 (arsenic acids)<br>• Skin corrosion – category 1 (arsenic acids/oxides)<br>**Severe** | Research found the median concentration of arsenic in street sweepings to be 3.2mg/kg with a range up to 17mg/kg.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual arsenic processing of around 60kg, though possibly up to 320kg.<br>The NEPM Health-based Investigation Level for residential classification is 100mg/kg.<br>**Possible** | **High** |

| Hazard | Consequence Assessment<br>What is the harm that the hazard could cause? | Likelihood Assessment<br>What is the likelihood that the harm would occur? | What is the inherent level of exposure risk? |
|---|---|---|---|
| Barium | • Acute toxicity – category 3<br>**Major** | Research found the median concentration of barium in street sweepings to be 62mg/kg, with a range up to 130mg/kg.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual barium processing of around 1169kg, though possibly up to 2452kg.<br>**Possible** | **Medium** |
| Boron | • Reproductive Toxicity – category 1B<br>• Acute Toxicity – category 2 (boron trifluoride/ tribromide/trichloride)<br>• Skin Corrosion – category 1A (boron trifluoride/ tribromide/trichloride)<br>• Skin Sensitisation – category 1 (4-formylphenyl boronic acid)<br>**Severe** | Research found the median concentration of boron in street sweepings to be 15.5mg/kg.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual boron processing of 293kg.<br>The NEPM Health-based Investigation Level for residential classification is 4500mg/kg.<br>**Unlikely** | **Medium** |
| Cadmium | • Acute Toxicity – category 3<br>• Carcinogenicity – category 1B<br>• Germ cell mutagenicity – category 2<br>• Specific target organ toxicity (repeated exposure) – category 1<br>• Reproductive toxicity – category 2<br>**Severe** | Research found the median concentration of cadmium in street sweepings to be 0.2mg/kg, with a range up to 3.77mg/kg.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual cadmium processing of 3.8kg, though possibly up to 71kg.<br>The NEPM Health-based Investigation Level for residential classification is 20mg/kg.<br>**Unlikely** | **Medium** |

| Hazard | Consequence Assessment<br>What is the harm that the hazard could cause? | Likelihood Assessment<br>What is the likelihood that the harm would occur? | What is the inherent level of exposure risk? |
|---|---|---|---|
| Chromium | Hexavalent Chromium<br>• Carcinogenicity – category 1B<br>• Skin Sensitisation – category 1B<br>**Severe - Hexavalent Chromium**<br>**Insignificant – Chrome metal and trivalent chromium** | Research found the median concentration of chromium in street sweepings to be 11.4mg/kg, with a range up to 552mg/kg. Most chromium is not hexavalent chromium.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual chromium processing of 215kg, though possibly up to 10 413kg.<br>The NEPM Health-based Investigation Level for residential classification is 4500mg/kg.<br>**Very Unlikely** | **Low** |
| Cobalt | • Acute toxicity – category 1<br>• Carcinogenicity – category 1B<br>• Specific Target Organ Toxicity (single exposure) – category 3<br>• Specific Target Organ Toxicity (repeated exposure) – category 2<br>• Reproductive Toxicity – category 1B<br>• Respiratory Sensitisation – category 1<br>• Skin Sensitisation – category 1<br>**Severe** | Research found the median concentration of cobalt in street sweepings to be 5.8mg/kg.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual cobalt processing of 109kg.<br>The NEPM Health-based Investigation Level for residential classification is 100mg/kg.<br>**Very Unlikely** | **Medium** |
| Copper | • Acute Toxicity – category 4<br>• Eye Irritation – category 2 (copper suphate)<br>• Skin Irritation – category 2 (copper sulphate)<br>**Minor/Moderate** | Research found the median concentration of copper in street sweepings to be between 22.1 – 55mg/kg, with a range up to 3721mg/kg. The median concentration of road derived sediments (RDS) and catchpit sediment was 67 and 85mg/kg respectively.<br>The total annual volume of street sweepings and stormwater waste is 18 860 tonnes, which would result in annual copper processing of 417kg – 1037kg, though possibly up to 70 200kg.<br>The NEPM Health-based Investigation Level for residential classification is 6000mg/kg.<br>**Unlikely** | **Low** |

| Hazard | Consequence Assessment<br>What is the harm that the hazard could cause? | Likelihood Assessment<br>What is the likelihood that the harm would occur? | What is the inherent level of exposure risk? |
|---|---|---|---|
| Fluoride | **Insignificant**<br>All compound risk considered in other element consequence assessments | Research found the median concentration of fluoride in street sweepings to be 18.7mg/kg.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual fluoride processing of 353kg.<br>**Very Unlikely** | **Low** |
| Iron | • Acute toxicity – category 4<br>• Skin irritation – category 2 (iron (II) sulphate)<br>• Skin corrosion – category 1B (iron chloride)<br>• Eye irritation – category 2 (iron (II) sulphate)<br>**Minor/Moderate** | Research found the median concentration of iron in street sweepings to be between 2955mg/kg and 65 000mg/kg.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual iron processing of between 55 752kg and 1 226 420kg.<br>**Likely** | **Medium** |
| Lead (inorganic) | • Carcinogenicity – category 2<br>• Germ cell mutagenicity – category 2<br>• Reproductive Toxicity – category 1A<br>• Acute Toxicity – category 1 (lead alkyls)/category 4<br>• Specific Target Organ Toxicity (repeated exposures) – category 2<br>• Specific target organ toxicity (repeated exposure) – category 2<br>**Severe** | Research found the median concentration of lead in street sweepings to be between 21.5 and 117mg/kg, with a range up to 660mg/kg. The median concentration in road derived sediments and catchpit sediment was 112 and 117mg/kg respectively.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual lead processing of 405kg to 2207kg, though possibly up to 12 454kg.<br>The NEPM Health-based Investigation Level for residential classification is 300mg/kg.<br>**Likely** | **High** |
| Magnesium | • Acute toxicity – category 4<br>• Specific target organ toxicity (single exposure) – category 3<br>• Skin corrosion – category 1B<br>**Minor/Moderate** | Research found the median concentration of magnesium in street sweepings to be between 6882 and 13 290 mg/kg.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual magnesium processing of between 129 863 and 250 796kg.<br>**Likely** | **Medium** |

| Hazard | Consequence Assessment<br>What is the harm that the hazard could cause? | Likelihood Assessment<br>What is the likelihood that the harm would occur? | What is the inherent level of exposure risk? |
|---|---|---|---|
| Manganese | • Specific Target Organ Toxicity (repeated exposures) – category 1<br>• Acute Toxicity – category 4 (manganese chloride and manganese dioxide)<br>• Eye Damage – category 1 (manganese chloride)<br>**Severe** | Research found the median concentration of manganese in street sweepings to be 651mg/kg, with a range up to 899mg/kg.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual manganese processing of 12 286kg, though possibly up to 16 967kg.<br>The NEPM Health-based Investigation Level for residential classification is 3800mg/kg.<br>**Possible** | **High** |
| Mercury (inorganic) | • Acute Toxicity – category 1<br>• Reproductive Toxicity – category 1B<br>• Specific Target Organ Toxicity (repeated exposures) – category 1<br>• Acute Toxicity – category 2 (inorganic compounds)<br>• Specific Target Organ Toxicity (repeated exposures) – category 2 (inorganic compounds)<br>**Severe** | Research found the median concentration of mercury in street sweepings to be 0.05mg/kg.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual mercury processing of 0.94kg.<br>The NEPM Health-based Investigation Level for residential classification is 40mg/kg.<br>**Unlikely** | **Medium** |
| Molybdenum | Molybdenum trioxide<br>• Carcinogenicity – category 2<br>• Eye Irritation – category 2A<br>• Specific Target Organ Toxicity (single exposure) – category 3<br>**Major - molybdenum trioxide**<br>**Insignificant – other forms** | Research found the median concentration of molybdenum in street sweepings to be 0.75mg/kg. Molybdenum trioxide is rarely naturally occurring and primarily occurs as an intermediate stage of the production of molybdenum metal.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual molybdenum processing of 14.1kg.<br>**Very Unlikely** | **Low** |

| Hazard | Consequence Assessment<br>What is the harm that the hazard could cause? | Likelihood Assessment<br>What is the likelihood that the harm would occur? | What is the inherent level of exposure risk? |
|---|---|---|---|
| Nickel | • Acute Toxicity – category 4<br>• Carcinogenicity – category 2<br>• Specific Target Organ Toxicity (repeated exposure) – category 1<br>• Germ Cell Mutagenicity – category 2<br>• Reproductive Toxicity – category 1B<br>• Respiratory Sensitisation – category 1<br>• Skin Sensitisation – category 1<br>**Severe** | Research found the median concentration of nickel in street sweepings to be 8.9mg/kg, with a range up to 78mg/kg.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual nickel processing of 168kg, though possibly up to 1472kg.<br>The NEPM Health-based Investigation Level for residential classification is 400mg/kg.<br>**Possible** | **High** |
| Selenium | • Acute Toxicity – category 3<br>• Specific Target Organ Toxicity (repeated exposure) – category 2<br>**Major** | Research found the median concentration of selenium in street sweepings to be 0.16mg/kg.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual selenium processing of 3kg.<br>The NEPM Health-based Investigation Level for residential classification is 200mg/kg.<br>**Very Unlikely** | **Low** |
| Silver | • Skin Corrosion – category 1B (silver nitrate)<br>**Minor** | Research found the median concentration of silver in street sweepings to be 0.1mg/kg.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual silver processing of 1.9kg.<br>**Very Unlikely** | **Low** |
| Thallium | • Acute Toxicity – category 2<br>• Specific Target Organ Toxicity (repeated exposure) – category 2<br>**Severe** | Research found the median concentration of thallium in street sweepings to be 0.044mg/kg.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual thallium processing of 0.8kg.<br>**Very Unlikely** | **Medium** |

| Hazard | Consequence Assessment<br>What is the harm that the hazard could cause? | Likelihood Assessment<br>What is the likelihood that the harm would occur? | What is the inherent level of exposure risk? |
|---|---|---|---|
| Tin | **Insignificant** | Research found the median concentration of tin in street sweepings to be 0.54mg/kg.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual tin processing of 10kg.<br>**Very Unlikely** | **Low** |
| Vanadium | Vanadium pentoxide<br>• Acute toxicity – category 4<br>• Eye damage – category 1<br>• Germ cell mutagenicity – category 2<br>• Carcinogenicity – category 2<br>• Reproductive toxicity – category 2<br>• Specific target organ toxicity (single exposure) – category 3<br>• Specific target organ toxicity (repeated exposure) – category 1<br>**Severe – vanadium pentoxide**<br>**Insignificant – other forms** | Research found the median concentration of vanadium in street sweepings to be 10.6mg/kg. Vanadium pentoxide is rarely naturally occurring and is primarily used in production of other chemicals.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual vanadium processing of 200kg.<br>The NEPM Health-based Investigation Level for residential classification is 4500mg/kg.<br>**Very Unlikely** | **Medium** |
| Zinc | • Acute Toxicity – category 4 (zinc chloride, zinc sulphate)<br>• Skin Corrosion – category 1 (zinc chloride)<br>• Eye damage – category 1 (zinc sulphate)<br>**Severe** | Research found the median concentration of zinc in street sweepings and road dust to be between 113 and 336mg/kg. The median zinc concentration for road derived sediments (RDS) and catchpit sediment was 422 and 464mg/kg respectively.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual zinc processing of between 2131 and 8758kg.<br>The NEPM Health-based Investigation Level for residential classification is 7400mg/kg.<br>**Possible** | **High** |

| Hazard | Consequence Assessment<br>What is the harm that the hazard could cause? | Likelihood Assessment<br>What is the likelihood that the harm would occur? | What is the inherent level of exposure risk? |
|---|---|---|---|
| **Minerals and Particulates** | | | |
| Asbestos | • Carcinogenicity – category 1A<br>• Specific Target Organ Toxicity (repeated exposure) – category 1<br>**Severe** | Asbestos fibres are ubiquitous in the outdoor environment.<br>Inevitable there will be some fibres and likely small amounts of asbestos waste material in all waste streams but, on average, airborne concentrations are unlikely to be significantly elevated.<br>**Possible** | **High** |
| Respirable and Inhalable Dust | The consequence of exposure to respirable and inhalable size dust fractions depends on the nature of the dust, however even dust which is inherently low toxicity or free from toxic impurities can still cause illness such as inflammatory reaction in the lung, resulting in chronic obstructive pulmonary disease (COPD).<br>**Severe** | Processing of dry waste material can create airborne dust, which may present an exposure risk to workers if not appropriately controlled.<br>**Possible** | **High** |
| Respirable Crystalline Silica | • Carcinogenicity – category 1A<br>• Specific Target Organ Toxicity (repeated exposure) – category 1 (Silicosis)<br>**Severe** | Processing of dry waste material containing crystalline silica (particularly bunker sand) can create airborne dust, which may present an exposure risk to workers if not appropriately controlled.<br>**Possible** | **High** |

| Hazard | Consequence Assessment<br>What is the harm that the hazard could cause? | Likelihood Assessment<br>What is the likelihood that the harm would occur? | What is the inherent level of exposure risk? |
|---|---|---|---|
| **Volatile Organic Compounds (VOCs) & Hydrocarbons including PAHs** | | | |
| Hydrocarbons | The risk associated with exposure to hydrocarbons depends greatly on the specific composition of the compound. Examples of health effects include:<br>**Petroleum**<br>• Germ cell mutagenicity – category 1B<br>• Carcinogenicity – category 1B<br>• Reproductive toxicity – category 2<br>• Aspiration hazard – category 1<br>**Diesel**<br>• Acute toxicity – category 4<br>• Carcinogenicity – category 2<br>• Aspiration hazard – category 1<br>**Severe** | Research found the median concentration of TPH in street sweepings and catchpit sediment is 1220mg/kg, with a range up to 8020mg/kg.<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual total TPH processing of 23 031kg (about the volume of a large fuel truck), though possibly up to 15 1410kg.<br>**Unlikely** | **Medium** |
| PAHs | The risk associated with exposure to PAHs depends on the composition of the specific compound, but as exposures are generally to a mix of PAHs, exposure risks will be similar, regardless of specific composition.<br>**Benzo[a]pyrene**<br>• Carcinogenicity – category 1B<br>• Germ cell mutagenicity – category 1B<br>• Reproductive toxicity – category 1B<br>PAHs are also known to cause photosensitisation, anaemia and have respiratory effects (Safe Work Australia, 2013).<br>**Severe** | Research found the median concentration of Total PAH in street sweepings is 8.6mg/kg with a range up to 230mg/kg. Catchpit sediments had a similar concentration (median 6.5mg/kg).<br>The total annual volume of street sweepings and stormwater waste streams is 18 860 tonnes, which would result in annual total PAH processing of 162kg, though possibly up to 4341kg.<br>The NEPM Health-based Investigation Level for residential classification is 300mg/kg.<br>**Possible** | **High** |

| Hazard | Consequence Assessment<br>What is the harm that the hazard could cause? | Likelihood Assessment<br>What is the likelihood that the harm would occur? | What is the inherent level of exposure risk? |
|---|---|---|---|
| Other VOCs | The risk associated with exposure to VOCs depends greatly on the composition of the specific compound. Health effects can range from insignificant to severe, with some VOCs classified as known carcinogens, mutagens, reproductive toxins or chemicals which could cause fatality or injury causing significant permanent loss of function.<br>**Severe** | **Possible**<br>Other VOCs should be treated as 'Unknown chemicals' due to the lack of evidence of the presence within the waste streams. | **High** |
| **Biological Agents** | | | |
| Bacteria | Exposure to bacteria can have a wide range of effects, both positive and negative. Exposure to bacteria e.g. some strains of e.coli can cause serious illness, and death.<br>**Severe** | The literature review demonstrated that concentrations of bacteria known to cause illness, including *Enterococcus*, *Campylobacter*, and *Salmonella* species are frequently elevated in urban stormwater, at levels recognised to potentially present a risk of illness from exposure (e.g. from swimming in or drinking the water). These bacteria would be expected to be present in the stormwater waste stream.<br>A wide range of bacteria, including Clostridia (tetanus), Bacillusspecies and Listeria species are naturally occurring in soils and dust, and would be expected to be present at some level in street sweepings, hydromud and in bunker sand.<br>**Possible** | **High** |
| Fungi | The risk posed by exposure to fungi depends on the concentration of spores and the species, as well as an exposed person's individual susceptibility.<br>When exposure levels are very high, or species with specific allergenic, pathogenic or toxic effects are present, illness can occur. For immunocompetent people mould exposure poses little risk, but for people with compromised immune systems exposure to these mould species can cause serious illness or even death.<br>**Severe** | Given that fungi is naturally occurring and is ubiquitous in the outdoor environment there will be fungi present in the street sweepings, stormwater, bunker sand and hydromud waste streams.<br>There is no evidence that fungi within these waste streams will be notable elevated, or has speciation different to the normal environmental fungi for the Canberra region.<br>**Unlikely** | **Medium** |

| Hazard | Consequence Assessment<br>What is the harm that the hazard could cause? | Likelihood Assessment<br>What is the likelihood that the harm would occur? | What is the inherent level of exposure risk? |
|---|---|---|---|
| Legionella | Exposure can have no effect or can cause severe pneumonia, Legionnaires' disease or Pontiac fever. About 10% of people who gets sick with Legionnaires' disease will die due to complications (CDC, 2018).<br>**Severe** | Given that *Legionella* bacteria are naturally occurring, and are common in both soil and water, there will be *Legionella* bacteria present in the street sweepings, stormwater, bunker sand and hydromud waste streams. There is no evidence that legionella levels will be particularly elevated in these waste streams.<br>*Legionella* exposures are common, and most healthy people exposed to *Legionella* do not get sick. Most illness occurs from exposure to high concentrations of the aerosolised form of the bacteria (CDC, 2018).<br>**Unlikely** | **Medium** |
| **Other Hazards** | | | |
| Unknown chemicals | The consequence of exposure to an unknown chemical is inherently unknowable, but it is plausible that such a chemical could be a known carcinogen, mutagen or reproductive toxin, or could cause fatality or injury causing significant permanent loss of function.<br>**Severe** | **Possible** | **High** |

# 7 Summary

A summary of the inherent risk assessment outcomes is shown in Table 10.

**Table 10: Summary of inherent risks rating for all hazards assessed**

| Hazard | What is the inherent level of exposure risk? | |
|---|---|---|
| Arsenic | High | Potentially Significant |
| Lead (inorganic) | High | |
| Manganese | High | |
| Nickel | High | |
| Zinc | High | |
| Asbestos | High | |
| Respirable and Inhalable Dust | High | |
| Respirable Crystalline Silica | High | |
| PAH | High | |
| Bacteria | High | |
| Unknown chemicals (inc. Other VOCs) | High | |
| Barium | Medium | |
| Boron | Medium | |
| Cadmium | Medium | |
| Cobalt | Medium | |
| Iron | Medium | |
| Magnesium | Medium | |
| Mercury (inorganic) | Medium | |
| Thallium | Medium | |
| Vanadium | Medium | |
| Fungi | Medium | |
| Legionella | Medium | |
| Hydrocarbons | Medium | |
| Antimony | Low | Not Significant |
| Chromium | Low | |
| Copper | Low | |
| Fluoride | Low | |
| Molybdenum | Low | |
| Selenium | Low | |
| Silver | Low | |
| Tin | Low | |

# 8 Limitations

The report, including any risk assessment presented, is based on the information available to Robson at the time of assessment. To the best of Robson's knowledge, our assessment of the data represents a reasonable interpretation of the current state of knowledge, and subsequent risk at the time of assessment. Should you have any questions or require further information please contact Robson Environmental.

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# Appendix 1 Identified Hazards

**Table 11: Hazards identified in Stage 1**

| Hazard | | Potentially Affected Waste Streams | Sources |
|---|---|---|---|
| Aluminium (Al) | Heavy Metals/Elements | • Street Sweepings<br>• Storm Water | Road base materials, vehicular by-products deposits, soil, leaf litter, dust, smog fallout, vegetation leachate |
| Antimony (Sb) | | | Tyre/brakes, Road base materials, vehicular by-products deposits, soil, leaf litter, dust, smog fallout, vegetation leachate |
| Barium (Ba) | | | |
| Cadmium (Ca) | | | Road base materials, vehicular by-products deposits, soil, leaf litter, dust, smog fallout, vegetation leachate |
| Chromium (Cr) | | | |
| Copper (Cu) | | | Tyre/brakes, Road base materials, vehicular by-products deposits, soil, leaf litter, dust, smog fallout, vegetation leachate |
| Iron (Fe) | | | Road base materials, vehicular by-products deposits, soil, leaf litter, dust, smog fallout, vegetation leachate |
| Lead (Pb) | | | |
| Magnesium (Mg) | | | Tyre/brakes, Road base materials, vehicular by-products deposits, soil, leaf litter, dust, smog fallout, vegetation leachate |
| Manganese (Mn) | | | Road base materials, vehicular by-products deposits, soil, leaf litter, dust, smog fallout, vegetation leachate |
| Mercury (Hg) | | | Road base materials, vehicular by-products deposits, soil, leaf litter, dust, smog fallout, vegetation leachate |
| Nitrogen (N) | | • Storm Water | |
| Phosphorous (P) | | | |
| Platinum (Pt) | | • Street Sweepings | Engine oils/lube |
| Potassium (K) | | | Road base materials, |

| Hazard | | Potentially Affected Waste Streams | Sources |
|---|---|---|---|
| Vanadium (V) | | • Storm Water | vehicular by-products deposits, soil, leaf litter, dust, smog fallout, vegetation leachate |
| Zinc (Zn) | | | Tyre/brakes Road base materials, vehicular by-products deposits, soil, leaf litter, dust, smog fallout, vegetation leachate, engine oils/lube |
| Asbestos | Mineral fibres | • Street Sweepings<br>• Storm Water | Tyres/brakes, construction works |
| Volatile Organic Compounds | Compounds that easily become vapours or gasses | • Street Sweepings<br>• Storm Water<br>• Hydromud | Exhausts<br>CTPV in road base |
| Polycyclic Aromatic Hydrocarbons (PAHs) | Organic compounds containing only carbon and hydrogen composed of aromatic rings | | |
| Per and Poly Fluoroalkyl Substances (PFAS – PFOS, PFOA) | Man made chemicals that are very persistent in the environment and the body. Some evidence that they can lead to adverse health effects | • Hydromud<br>• Storm Water | Fire fighting foams (car accidents, fuel fires, training), Pesticides |
| Tetraethyl lead<br>Alcohol Methycyclopentadienyl Manganese tricarbonyl (MMT)<br>Ferrocene<br>Iron pentacanbonyl<br>Toluene<br>Isooctane | Gasoline additive used to reduce engine knocking and increase octane rating of fuels by raising auto-ignition temperature and pressure | • Street Sweepings<br>• Storm Water | Gasoline, fuel, exhaust |
| Bentonite | An absorbent aluminium phyllosilicate clay used for drilling as a lubricant and cooling substrate | • Hydromud | Additive during hydro drilling |
| Fungicides | Biocide chemical compound used to kill fungi or their spores | • Stormwater<br>• Street sweeping | Leaf litter, soils, vegetation leachate, creosote power-pole leaching, herbicide/fertilizer run off from garden beds |
| Insecticides | Substances used to kill insects. | | |

| Hazard | | Potentially Affected Waste Streams | Sources |
|---|---|---|---|
| Viruses, Bacteria, Fungi | Biological substances that pose a risk to human health. Includes viruses and toxins | • Street Sweepings<br>• Storm Water<br>• Bunker Sand | Animals, body fluids, needles, decomposing material, soil |
| Legionella (soil and water) | Pathogenic group of bacteria that causes Legionnaires' disease and/or Pontiac Fever | • Storm Water<br>• Street Sweepings<br>• Bunker Sand<br>• Hydromud | Warm, stagnant water, soil, end products (compost material) |
| Faeces | Waste matter remaining after food is digested (animals and human) | • Storm Water<br>• Bunker Sand | Scats (animals), human excrement |
| Cigarette butts | Un-smoked segments of cigarettes containing the filter with absorbed chemicals and some remaining tobacco | • Street Sweepings<br>• Storm Water<br>• Bunker Sand | Cigarettes not disposed of appropriately |
| Unknown Chemicals | Produced from poor industry practice and unventilated exhaust fall out, construction and spills | • Street Sweepings<br>• Storm Water<br>• Bunker Sand | Unknown |
| pH Adjusters | Acids and alkalis used to adjust the pH of solutions | • Additive during processing | Manufacturing, end products, flocculent cake |
| Flocculants | High MW, water soluble organic polymers used to clump fine particles together | | |
| Coagulants | Inorganic salts, generally of aluminium or iron, used to cause a fluid to change to a solid or semi-solid state | | |
| Hydrocarbons | Chemicals made up of only hydrogen and carbon, often found in fuels | • Hydro drilling<br>• Hydromud | Contaminated soil and mud |
| Dust (Respirable) | Dust less than 5 µm in diameter | • End Products<br>• Bunker Sand | Aggregate – all fractions, sands |
| Respirable Crystalline Silica | Crystalline form of silicon dioxide <5 µm in diameter | • End Products<br>• Bunker Sand | Aggregate – all fractions, sands |