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TECHNICAL MEMORANDUM

Date:	November 3, 2017
To:	Torrey Lindbo, Water Sciences Program Manager
	Keri Handaly, Stormwater Permit Program Coordinator
From:	Katie Holzer, Environmental Specialist
Subject:	Heavy Metals in Stormwater Runoff from New and Used Tires in Gresham, Oregon

Background

The outdoor storage of used automotive tires was identified as a potential water quality concern, yet there is little to no data available indicating whether or not the levels of heavy metals or other pollutants leaching from tires is a concern for stormwater. Numerous businesses within the City store tires outdoors, some new, but most typically used. Currently, 100 tires are allowed to be stored without a waste tire storage permit (http://www.oregon.gov/deq/mm/Pages/Waste-Tire-Management.aspx). This can often result in used tires being stored outdoors for weeks or months. This study was conducted to examine if outdoor storage of used and new tires is a potential issue for water quality, particularly with regard to heavy metals.

Methods

During this study stormwater runoff from tires was collected from multiple locations throughout the City. Sampling locations included:

- 3 businesses with outdoor racks of new tires;
- 3 businesses with outdoor piles of used tires; and
- 3 piles of used tires where stagnant rainwater collecting in the tire wells was sampled

To sample runoff from new tires we placed plastic trays under new tire racks and collected water from the trays (see Figure 1a for example). To sample runoff from used tire piles, grab samples were collected from the nearest downstream catch basin (See Figure 1b for example). The used tire sampling locations were selected to only include sites where the entire catchment of a catch basin was composed of a used tire pile. We sampled stormwater runoff from both the new and used tires during a moderate rain event on 13 March, 2017. To sample stagnant water sitting in tire wells, we collected dip samples from 20 tires from different manufacturers in three different tire piles at different timepoints throughout the rainy season. All samples were analyzed for total and dissolved metals (zinc, copper, lead, cadmium, chromium, mercury).

The results of the tire runoff samples were compared to several reference points: 1) to water quality criteria for streams (even though these are stormwater samples and mixing would likely dilute these concentrations when it mixes with other stormwater and stream runoff), 2) to 1200 Z benchmarks for industrial stormwater discharges, and 3) to existing City stormwater runoff data with ~200 samples. Because the water quality criteria for several metals depend on the hardness of the water (and on other parameters for dissolved Cu with the Biotic Ligand Model), we created reference values for comparison that represent the median criteria based on samples collected at long-term instream sampling locations. Hardness data used were calculated from samples collected throughout Gresham between 2008 and 2017. We chose to estimate an average toxicity value for each metal based on instream hardness data because the instream environment is where organisms come into contact with the metals. Stormwater samples typically have lower average hardness values than instream samples due to the limited contact with mineral soils at the point stormwater samples are collected.

Results

Levels of heavy metals in stormwater runoff from used tires was often higher than in typical street runoff, especially for lead (Kruskal-Wallis test for dissolved lead: $p=0.013$) and zinc (Kruskal-Wallis test for total and dissolved zinc: $p<0.001$). Outdoor tire storage, especially of used tires, produced levels of some heavy metals that were of concern for water quality. The full dataset of all metals collected from the tires, and comparisons to water quality standards, is presented in Table 1. Graphs for metals where at least one tire sample exceed at least one of the standards are shown in Figures 2 through 6.

New tire racks produced runoff with the level of zinc in one sample exceeding the median instream water quality criterion. Used tire piles produced stormwater runoff with levels of copper that exceeded median instream water quality criteria, and levels of zinc that exceeded median instream water quality standards and the 1200 Z stormwater benchmark. Stagnant rainwater in tire wells had levels of lead and copper that exceeded median instream water quality criteria, and levels of zinc that were more than an order of magnitude above instream water quality criteria and the 1200 Z benchmarks.

Recommendations

The results of this study indicate that outdoor tire storage, especially of used tires, can produce stormwater runoff with heavy metals at levels that are of concern for instream water quality. In order to be protective of aquatic life, this study indicates that tires should not be allowed to be stored outdoors in such a way that they could produce runoff that enters streams. This recommendation is based on a small number of samples, and additional samples are desirable to better understand the potential water quality impacts.

The best way to prevent runoff from tires entering streams is for tires to not be exposed to rain water. This can be accomplished by hauling them away to a recycling/disposal site or covering them. One potential challenge is that fire code can limit the options for covering tires. If tires are left uncovered, heavy metal pollution to streams could be reduced by reducing the number of tires allowed to be stored outdoors at a given time, by storing them on pervious surfaces such as gravel or soil, and/or by requiring tires to be stacked on racks where water it less likely to pool in the tire wells.

Figure 1a. Sampling trays for new tire racks.

Figure 1b. Catch basin downstream of used tire pile

Table 1. Table of heavy metals collected from tires as compared to 1200 Z benchmarks and typical water quality criteria. Red text indicates samples above at least one of the compared standards. Water quality criteria are calculated as the median criteria calculated from Gresham's long-term instream dataset based on hardness and input parameters for the Biotic Ligand Model (BLM).

	Type	Total Cd	Total Cr	Total Cu	Total Pb	Total Hg	Total Zn	Diss Cd	Diss Cr	Diss Cu	Diss Pb	Diss Hg	Diss Zn
Samples (ug/L)	New tire runoff	<0.1	0.391	2.14	0.69	0.00311	33.9	<0.1	<0.2	0.54	<0.1	0.00152	24.5
	New tire runoff	<0.1	0.255	1.72	0.537	0.00410	80.4	<0.1	<0.2	0.73	<0.1	0.00147	68.3
	New tire runoff	<0.1	<0.2	1.88	0.496	0.00309	52.1	<0.1	<0.2	0.66	<0.1	0.00174	41.8
	Used tire runoff	<0.1	0.319	5.31	1.57	0.00405	124	<0.1	<0.2	2.74	0.126	0.00124	105
	Used tire runoff	<0.1	0.534	9.27	2.11	0.01020	104	<0.1	<0.2	5.31	0.256	0.00403	74.7
	Used tire runoff	<0.1	<0.2	4.46	0.248	0.00570	89.9	<0.1	<0.2	1.97	<0.1	0.00294	73.1
	Used tire dip	<0.1	<0.2	3.02	0.766	0.00212	962	<0.1	0.20	2.49	0.663	0.00161	976
	Used tire dip	<0.1	0.502	5.91	1.70	0.00230	1290	<0.1	0.26	3.98	0.819	0.00127	1060
	Used tire dip	<0.1	0.224	4.08	0.371	0.00587	480	<0.1	<0.2	3.00	0.130	0.00261	433
Criteria (ug/L)	1200 Z benchmark			20	40		120						
	median instream aquatic life acute criterion (hardness-based)	1.7		8.8					310	4.4	19.1		54.5
	median instream aquatic life chronic criterion (hardness-based)			6.3				0.1	40.3	3.3	0.31		55.0
	median instream aquatic life acute criterion BLM-based)									3.9			
	median instream aquatic life chronic criterion BLM-based)									2.4			

Figure 2. Plot of dissolved lead (Pb) in runoff from tires compared to typical road runoff and water quality criteria. Data points collected in this study are shown in red, while a boxplot displays data from Gresham road runoff from 2009-2017.

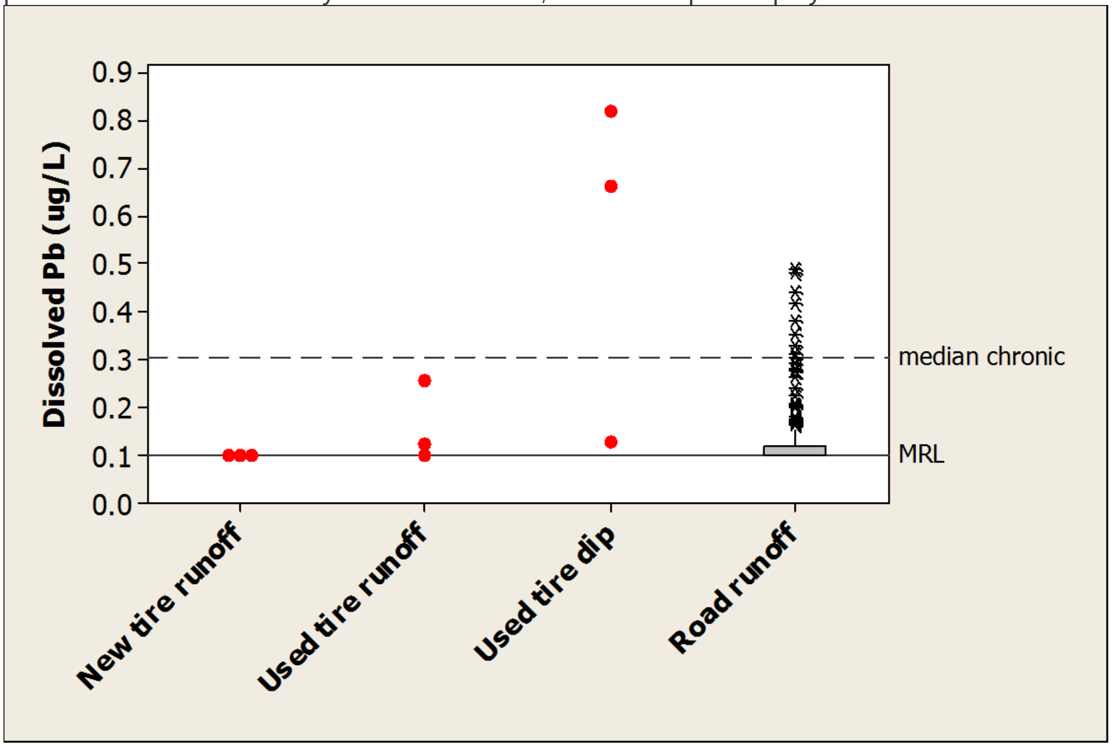

Figure 3. Plot of total copper (Cu) in runoff from tires compared to typical road runoff, water quality criteria, and 1200 Z benchmark values for reference. Data points collected in this study are shown in red, while a boxplot displays data from Gresham road runoff from 2009-2017.

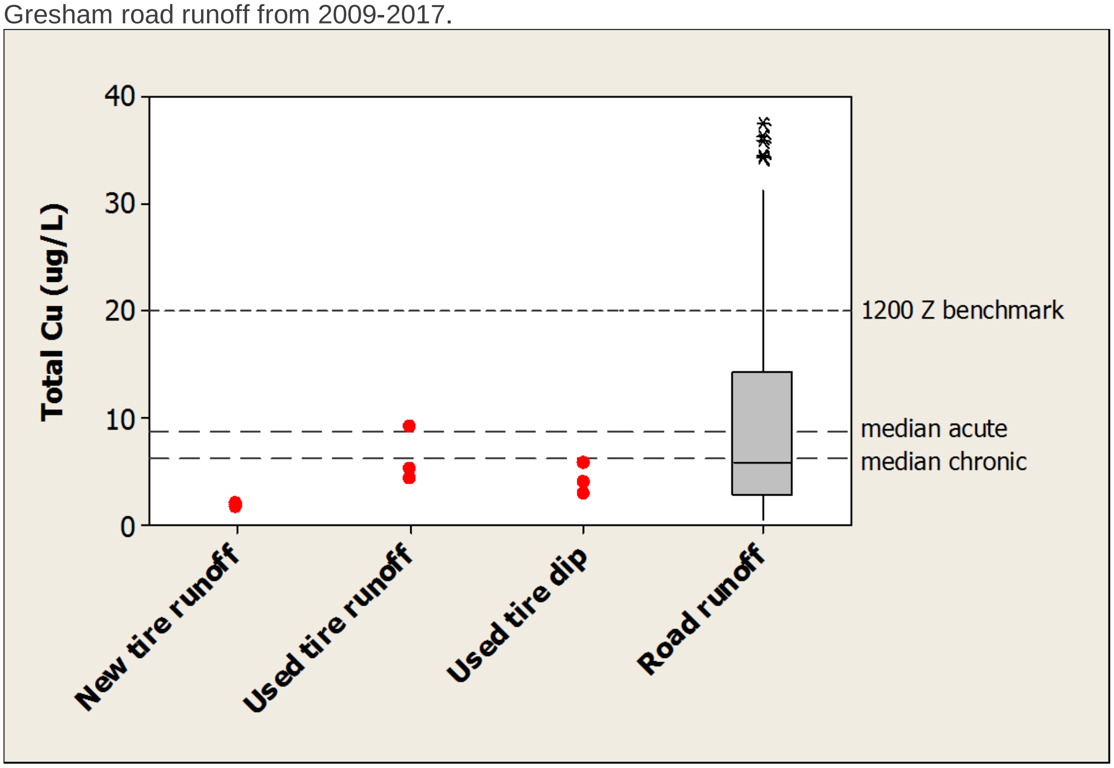

Figure 4. Dissolved copper (Cu) in runoff from tires compared to typical road runoff and water quality criteria. Data points collected in this study are shown in red, while a boxplot displays data from Gresham road runoff from 2009-2017.

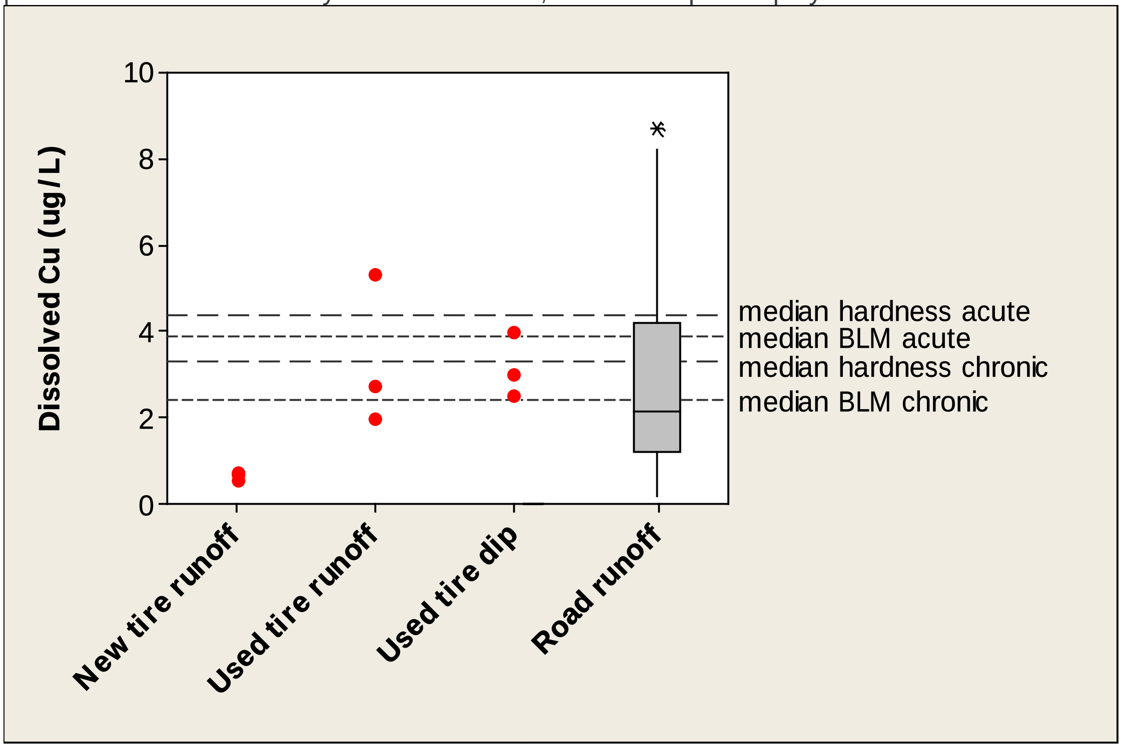

Figure 5. Plot of total zinc (Zn) in runoff from tires compared to typical road runoff and 1200-Z permit benchmark for reference. Data points collected in this study are shown in red, while a boxplot displays data from Gresham road runoff from 2009-2017.

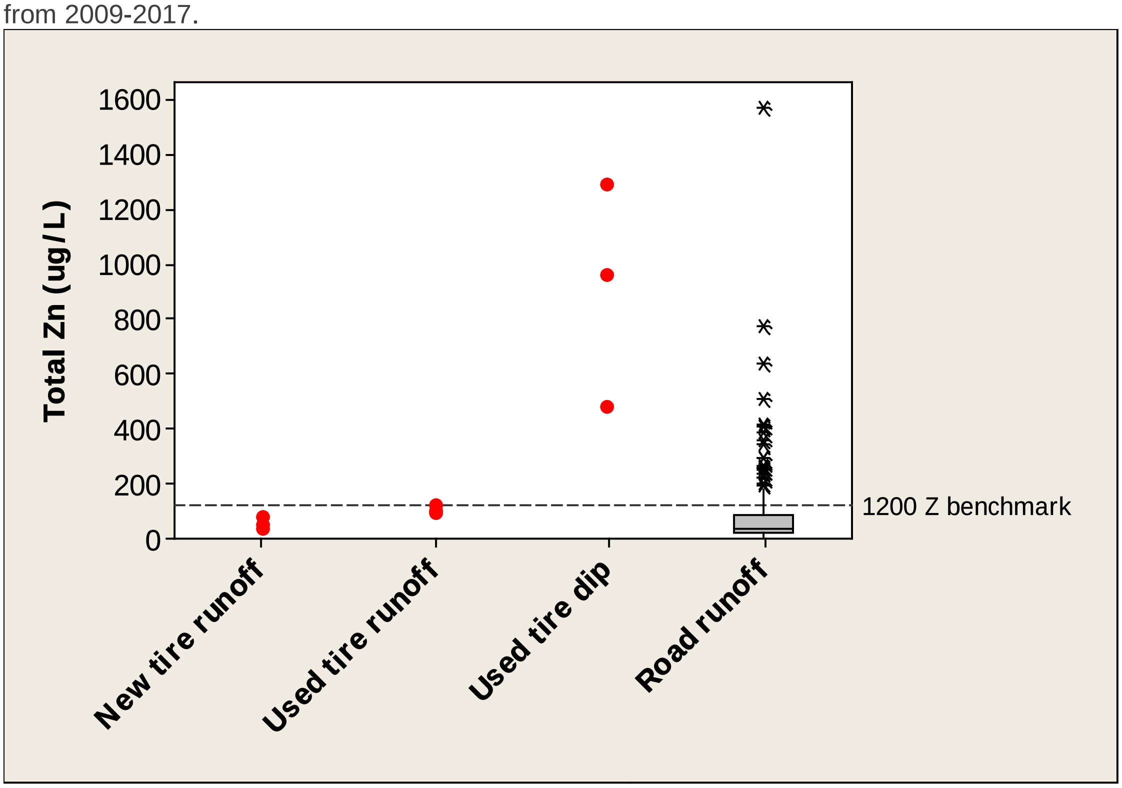

Figure 6a. Full-scale plot of dissolved zinc (Zn) in runoff from tires compared to typical road runoff and water quality criteria. The median chronic criterion is not shown as it is very similar to the median acute criterion. Data points collected in this study are shown in red, while a boxplot displays data from Gresham road runoff from 2009-2017.

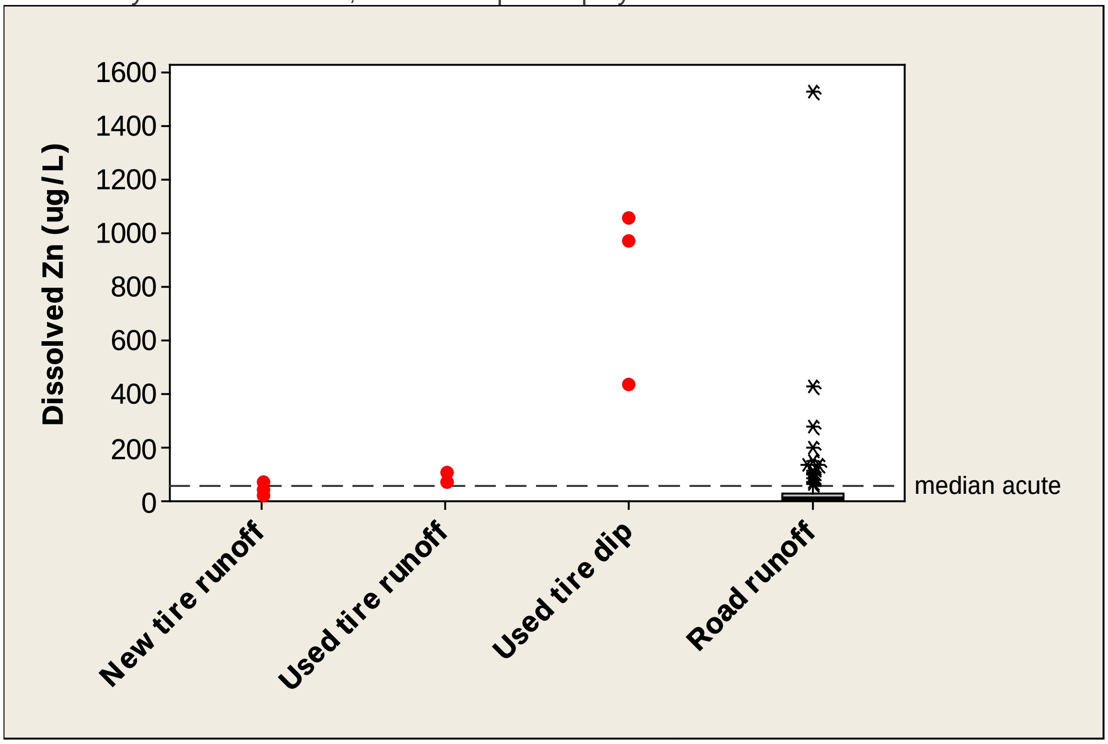

Figure 6b. Zoomed-in scale plot of dissolved zinc (Zn) in runoff from tires compared to typical road runoff and water quality criteria. Note that scale is zoomed in from 6a, so used tire dip data does not show. Data points collected in this study are shown in red, while a boxplot displays data from Gresham road runoff from 2009-2017.