

# Scrap Tire Mulch on Duluth Public Schools' Playgrounds

*A Summary of Children's Environmental Health Concerns*



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## Executive Summary

Duluth Parents for Healthy Playgrounds is a group of parents and citizens who are concerned about the contents of the scrap tire mulch (a.k.a. “rubber mulch”) that covers most of the playgrounds within Independent School District (ISD) 709. Our concern was born from our suspicion that scrap tires contain a multitude of hazardous substances, and that long-term exposure through inhalation, ingestion, and absorption through the skin could threaten the health of our children.

We voiced our concerns to District officials, who reassured us that the Environmental Protection Agency (EPA) deemed the material safe in 2009. However, in 2013 the EPA acknowledged limitations in the 2009 study and has passed regulatory discretion onto state and local governments. As a result, school districts and municipalities across the country have banned the use of recycled tires for recreational play surfaces. International toxicologists have stated that the mulch warrants regulatory concern (Llompert et al., 2013), while scientists are increasingly concerned with the presence of carbon nanoparticles, including carbon nanotubes, in new tire manufacturing processes. When carbon nanotubes become airborne, they are absorbable through the lungs and skin, where they are believed to behave like asbestos (Donaldson, 2006; Greenmeier, 2008; Poland, 2008). We know that the mulch produces dust because we see it on our children’s clothes, on their skin, and even in their nostrils when they come home from school.

Rubberific, the company that supplies the mulch used in ISD 709, does not indicate whether its product contains tires that used nanoparticle-manufacturing processes. Given the variability of contents, consistent labeling of this product appears to be difficult, if not impossible. Meanwhile, the Consumer Product Safety Commission (CPSC) has been petitioned to regulate the mulch as a “children’s product” because of clear evidence of marketing toward kids. A “children’s product” label would carry legally-mandated strict lead exposure limits.

In September 2015, Duluth Parents for Healthy Playgrounds hired a private toxicology firm that used EPA-approved methodologies to test a sample of mulch taken from Lester Park Elementary School alongside a sample of “raw” mulch taken from an unopened Rubberific bag. The samples were tested for metals, Polycyclic Aromatic Hydrocarbons (PAHs), and Volatile Organic Compounds (VOCs). Specific chemicals within each of these chemical classes are known toxicants, some of which are developmental toxicants, which means they are uniquely toxic to babies and children (Booker, 2012).

Of the 13 different chemicals found in the mulch at levels detectable by the analytical methods used, 12 are listed by the Minnesota Department of Health (MDH) as “Chemicals of High Concern.” The chemical level variations between the “raw” and playground samples may indicate either a high variability of the composition of the tire mulch, and/or the leaching and/or off-gassing of chemicals into the environment over time. While the lead in the playground sample was well below U.S. federal standards, the Centers for Disease Control and Prevention have stated that “no safe blood lead level in children has been identified” (2013). Furthermore,

the levels of four of the PAHs present in the “raw” bagged sample tested at levels above the standards recently set forth by the European Union in Commission Regulation (EU) No. 1272/2013. Our results show that while the tire mulch used by ISD 709 falls below U.S. federal minimum standards, it would not be legal in Europe.

Our test does not account for possible interactions or “synergistic” effects of the 12 “Chemicals of High Concern,” nor for carbon nanotubes. Given the variety of chemicals different tire manufacturers use, and the variability of the tire brands in Rubberific mulch, the eight grams from Lester Park Elementary that were tested may account for only a few of the estimated 12,000 tires in the whole playground. More in-depth and better-funded studies have detected nearly a hundred different chemicals in rubber mulch from scrap tires (Environment and Human Health, 2015).

With the presence of so many unknowns and the absence of adequate regulation, we believe that the precautionary principle should be used in choosing the surfacing material on elementary school playgrounds. The precautionary principle is a tool for policy- and decision-makers to prevent damage to human health and ecosystems when scientific information is lacking or incomplete. The principle states that “in the case of serious or irreversible threats to the health of humans or the ecosystem, acknowledged scientific uncertainty should not be used as a reason to postpone preventive measures” (World Health Organization, 2004, p. 1). Furthermore, “If progress is to be made in this direction, one should encourage the replacement of dangerous substances and activities with less dangerous substances or technologies where suitable alternatives are available” (p. 5).

Following the precautionary principle, we recommend that ISD 709 remove the scrap tire mulch and replace it with a non-toxic alternative. In this report we begin to explore options that can meet the District’s criteria for attenuation properties. Of these alternatives, an engineered wood fiber product, such as Fibar, seems most promising.

# Introduction

We are a group of parents and citizens in Duluth, Minnesota that is concerned about the potential toxicity of the scrap tire mulch (a.k.a. “rubber mulch”) that covers our children’s playgrounds within Independent School District (ISD) 709. We are concerned because scrap tire mulch on playgrounds may mean regular, long-term exposure to a multitude of hazardous substances through inhalation, ingestion, and absorption through the skin. Schools have reported a fine gray dust on interior surfaces when they leave doors or windows open, and we have seen this dust on our children’s clothes, skin, and even inside their nostrils when they come home from school.

The substances that may be present in this dust include

- phthalates (plasticizers that can affect hormones);
- polycyclic aromatic hydrocarbons (PAHs), which contain several known carcinogenic compounds (e.g., benzo(a)pyrene is classified as known human carcinogen, while pyrene, phenanthrene, and fluorene are classified as probable human carcinogens);
- volatile organic compounds (VOCs), which in sufficient quantities, can cause eye, nose, and throat irritations, headaches, dizziness, visual disorders, memory impairment. Some VOCs are known to cause cancer in animals; whereas some are suspected of causing, or are known to cause, cancer in humans (EPA, 2015);
- chemicals, such as benzene, lead, mercury, and arsenic, that are known or suspected to cause adverse health effects (Booker, 2012). Metals such as lead and arsenic have been shown to cause harm to developing nervous systems. Lead, in particular, has been demonstrated to cause decreases in child IQ at very low exposures (Gilbert, 2005, p. 92, 121);
- carbon black, a filler and reinforcing agent that may be manufactured with nanoparticles, including carbon nanotubes. Carbon nanotubes have been found to behave like asbestos (Donaldson, 2006; Greenmeier, 2008).

Our concern is compounded by the fact that children are more susceptible to health impacts from toxic chemical exposures because they are smaller and are developing rapidly (Booker, 2012).

The Material Safety Data Sheet provided by the International Mulch Company (which supplies Rubberific, the product used by ISD 709), Section 5: Health Hazard Data, the primary route of entry is identified as “inhalation,” and symptoms of exposure include itching, irritation of mucous membranes, and irritation of eyes. In Section 8: Special Protection Information, those who work with the mulch are advised to wear a dust and mist respirator for up to 10 mg, to ventilate the area, to “use safety goggles to prevent dust entry,” and to allow “enough fresh air [to] flow past the user to prevent exposure to airborne fibers and particles” (International Mulch Company, 2001).

As individual parents and as part of a group called “Duluth Parents for Healthy Playgrounds,” we have publicly voiced our concerns to the District’s Risk Manager, the city-wide

PTA, the Superintendent and Vice-Superintendent, members of the School Board, and the larger community via social media and TV and newspaper outlets<sup>1</sup>. We have distributed brochures and collected more than 500 online and paper signatures asking the Superintendent and the School Board to consider nontoxic alternatives<sup>2</sup>.

In response, the District's Risk Manager, Kerry Leider, and Superintendent, William Gronseth, assured members of our group and the School Board that, according to the Federal Environmental Protection Agency (EPA), the chemicals in the mulch are "below levels of concern." Furthermore, school officials assured us that the mulch provides superior attenuation to prevent bodily injury from falls, and it tends to resist mold and fungus growth to which alternative surfaces are prone. (W. Gronseth, Personal Communication, August 2015).

We do not doubt that ISD 709 is committed to ensuring the short and long-term safety and health of all of its students. However, we worry that the District made decisions based on limited data. The EPA has acknowledged that the 2009 study was limited and that "it is not possible to extend the results beyond the four study sites or to reach any more comprehensive conclusions without the consideration of additional data" (EPA, 2013). Despite a 2013 peer-reviewed study published in an international toxicology journal that stated the mulch should be "a matter of regulatory concern" (Llompart et al., 2013), the EPA has passed regulatory discretion onto state and local governments.

The Los Angeles Unified School District, the City of Los Angeles, the City of New York, and Montgomery County, Maryland, have banned the use of crumb rubber (smaller pieces of scrap tires than mulch) on artificial playing fields (Mellio, 2015; Perez, 2009; Burke, 2015). The state of Kentucky's Division of Waste Management, Energy and Environment Cabinet recently stopped issuing grants to use scrap tire products on facilities for children, stating

...there are no large-scale, national studies on the possible health issues associated with inhalation, ingestion or contact to the skin for those who use these fields and playgrounds for recreational purposes. Out of an abundance of caution, the EEC has made the decision to redirect crumb rubber grant allocations to other uses rather than continue funding applicants wishing to use crumb rubber on playgrounds and athletic fields. (Commonwealth of Kentucky, 2015)

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<sup>1</sup> Duluth media began covering local parents' concerns in July and August 2015

WDIO <http://www.wdio.com/article/stories/s3854233.shtml>

KDLH <http://www.northlandsnewscenter.com/news/local/Duluth-parent-sounds-alarm-on-toxic-playground-mulch-321650452.html>

KQDS <http://www.fox21online.com/news/local-news/health-concerns-about-rubber-mulch-on-duluth-playgrounds/34771746>

KDAL <http://kdal610.com/podcasts/talk-of-the-town/854/talk-of-the-town-81515/>

<sup>2</sup> Petition started in Duluth in August 2015 <https://www.change.org/p/tell-duluth-public-schools-officials-remove-shredded-tire-mulch-from-playgrounds>

Minneapolis petition also started August 2015 <https://www.change.org/p/mark-bollinger-minneapolis-public-schools-remove-shredded-waste-tires-from-minneapolis-public-schools-playgrounds>

A bill that would halt installation of the mulch until more data becomes available was introduced (but rejected) in the Minnesota State legislature in spring, 2015. Meanwhile, in addition to walking back its previous claims about safety<sup>3</sup>, the Consumer Product Safety Commission (CPSC) has been petitioned to regulate the mulch as a “children’s product” because of clear evidence of marketing toward kids.<sup>4</sup> A “children’s product” label would carry legally-mandated strict lead exposure limits. In 2008, Congress mandated safeguards for children’s products by imposing a lead content limit of 100 parts per million and third-party testing to ensure compliance.

Dissatisfied with the dearth of data and federal and state regulation, Duluth Parents for Healthy Playgrounds independently hired North Shore Analytical to collect a sample of the shredded tires from Lester Park Elementary School in September, 2015. Along with a comparison sample of “raw” mulch from an unopened bag of Rubberific-brand Premium Shredded Rubber Mulch, purchased on August 3rd, 2015, the playground sample was sent to Legend Technical Services in St. Paul to perform chemical analyses using EPA-approved methodologies. This report will summarize the state of current research on the potential health effects of scrap tire mulch and describe the results and implications of the testing of the material on the Lester Park Elementary playground. This report will also examine the benefits and drawbacks of alternative playground surfaces and make recommendations to ISD 709 administrators and school board members.

## A Limited Literature Review

### Tire Mulch Chemical Composition and Toxicity

In 2007, California’s Office of Environmental Health Hazard Assessment (OEHHA) conducted a study to assess the risk of skin contact and ingestion of scrap tire mulch. The experiment used guinea pigs and heated samples of the mulch to mimic a child’s stomach. The results of the OEHHA study showed that while a one-time ingestion or exposure would probably not cause adverse health effects, repeated or long-term exposure could. Of the five chemicals identified in the experiment, one of the PAHs exceeded what the OEHHA established as a minimal risk level; therefore, it could potentially increase the risk of cancer in children.

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<sup>3</sup> CPSC Communications Director Scott Wolfson recently said of ground-up tire use: “Chairman Elliot Kaye has deep concerns with the (2008) press release and it is not the agency’s current position. What was done in 2008 was not good enough to make a claim either way as to the safety of those fields.” (Stockman, 2015). Then, Chairman Kaye stated in Congressional testimony: “ ‘Safe to play on’ means something to parents that I don’t think we intended to convey, and I don’t think we should have conveyed.” (Kaye, 2015)

<sup>4</sup> In 2013, Public Employees for Environmental Responsibility (PEER) filed a formal rule-making petition, requesting that CPSC regulate synthetic turf products, including scrap tire mulch, as “children’s products”. PEER submitted 26 examples of marketing directed at children: [http://www.peer.org/assets/docs/epa/8\\_1\\_13\\_Turf\\_pitches\\_at\\_kids.pdf](http://www.peer.org/assets/docs/epa/8_1_13_Turf_pitches_at_kids.pdf).

A year later, the EPA created a workgroup to conduct a limited-scale study to measure the mass, metals, and morphology of particulate matter and to analyze samples of for 56 VOCs for total extractable concentrations of several metals and bioaccessible lead. In the EPA's definition, VOCs are

Compounds that vaporize (become a gas) at room temperature. Common sources which may emit VOCs into indoor air include housekeeping and maintenance products, and building and furnishing materials. In sufficient quantities, VOCs can cause eye, nose, and throat irritations, headaches, dizziness, visual disorders, memory impairment; some are known to cause cancer in animals; some are suspected of causing, or are known to cause, cancer in humans. At present, not much is known about what health effects occur at the levels of VOCs typically found in public and commercial buildings. (EPA, 2013, Terminology Services).

In their report, titled *A scoping-level field monitoring study of synthetic turf fields and playgrounds*, the EPA workgroup found that in playground areas, concentrations of particulates were higher than "background levels," while VOCs were far below "a level of concern." While the methods to measure particulate matter and VOCs were found to be reliable, there were limitations in time, money, and access to a representative number of playgrounds. The EPA study also acknowledged that the "uptake" of particulate metals was poorly understood. In addition, the EPA reported that *average* levels were determined to be below levels of concern; some individual sample results varied greatly. For example, six of the seven playground tire crumb samples had lead levels below 50 ppm (EPA, 2009, Table 7). One sample, however, had a lead level of 453 ppm, over four times the current federal limit for children's products (100 ppm).

In 2013, the EPA updated the webpage to access the 2009 study with a summary of public concerns and a list of thirty compounds and materials that may be found in the tires (including arsenic, acetone, benzene, lead, and polycyclic aromatic hydrocarbons).<sup>5</sup> The webpage notes

Given the very limited nature of this study (i.e., limited number of components monitored, samples sites, and samples taken at each site) and the wide diversity of tire crumb material, it is not possible to extend the results beyond the four study sites or to reach any more comprehensive conclusions without the consideration of additional data.

The EPA website also recommended that children wash their hands after any contact with the mulch.

Benzene, for example, has been linked with acute myeloid leukemia, among other illnesses (IARC, 2012). In a 28-year follow-up of almost 74,000 benzene-exposed workers in twelve Chinese cities, it was found that inhalation was found to be the major route in which workers were exposed to benzene. Long-term exposure of even relatively low levels of benzene

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<sup>5</sup> At the time of this report's release, the EPA's tire crumb webpage ([http://www.epa.gov/nerl/features/tire\\_crumbs.html](http://www.epa.gov/nerl/features/tire_crumbs.html)) redirects visitors to the "About" page of the EPA's National Exposure Research Laboratory and includes the header "We are improving our website to help you find what you are looking for. During this transition, some URLs may change."

greatly increased the risks of lung cancer, lymphomas, and respiratory diseases (Linnet et al., 2015).

A peer-reviewed study by Llompart et al. (2013) on recycled tire mulch found “the presence of a large number of hazardous substances including PAHs, phthalates, antioxidants (e.g. BHT, phenols), benzothiazole and derivatives, among other chemicals.” Based on the “high content of toxic chemicals in these recycled materials,” the researchers concluded that “...Uses of recycled rubber tires, especially those targeting play areas and other facilities for children, should be a matter of regulatory concern” (2013, p. 423).

In the same year, Cardno ChemRisk compiled a 62-page literature review commissioned by the Rubber Manufacturers Association titled *Review of the Human Health & Ecological Safety of Exposure to Recycled Tire Rubber found at Playgrounds and Synthetic Turf Fields*. It concluded that adverse health effects are not likely for children or athletes exposed to recycled tire materials found at playgrounds or athletic fields (p. 43). It acknowledged: “while these conclusions are supported by existing studies or screening risk assessments, additional research would provide useful supplemental and/or confirmatory data regarding the safety of recycled tire products and enhance the weight of evidence used in risk communication” (p. iii). Cardno ChemRisk’s review did not include the study by Llompart et al. (2013).

Several of the studies that Cardno ChemRisk summarized in its 2013 review made reasonable and even cautious attempts to estimate the probable frequency and rates of ingestion and/or inhalation of various hazardous substances in scrap tire mulch. However, they did not account for possible synergistic effects of exposure to multiple chemicals at once, nor how chemical exposures may impact the rapidly developing bodies of children differently and more intensely than adults. In an article published by the National Center for Health Research (2012), Dr. Nydra Booker acknowledged that “children are much more likely to be harmed by exposure to chemicals in their environment than adults because they are smaller (so the exposure is greater) and because their bodies are still developing.”

The most recent study, which was conducted at Yale and is still under peer-review, detected 96 chemicals in tire mulch. Half of those chemicals had not had toxicity assessments, the other half underwent incomplete toxicity assessments, and of those, 20 percent were considered probable carcinogens. The Yale study also found that almost half of those chemicals can to cause irritation in the lungs, skin, and eyes (Environment and Human Health, 2015). The lead investigator, Gaboury Benoit, Ph.D., Yale Professor of Environmental Chemistry and Engineering, stated in the press release, “Not surprisingly, the shredded tires contain a veritable witches brew of toxic substances. It seems irresponsible to market a hazardous waste as a consumer product.”

We have also learned that every tire company uses a different “recipe” for their tires, and the manufacturers of tire mulch (e.g., Rubberific, the vendor used by ISD 709) do not discriminate about the tire brands they shred into their product. This is precisely what makes this product difficult to label and regulate. As an example of this variability, the EPA’s 2009

scoping study found that one of the seven tire crumb samples from playgrounds had lead levels over four times the legal limit for children's products.

## **Carbon Black Uncertainties and Concerns**

Nearly a third of tire material is made of carbon black, a filler and reinforcing petroleum product that helps to conduct heat away from the tread and belt area of the tire. Newer tire manufacturing processes may use carbon nanoparticles, including carbon nanotubes (Felix, 2014). The nanoparticles do not normally pose a risk until the tire that contains them is shredded or pulverized (at any temperature). Then the surface area to volume increases exponentially, and the nanoparticles could become available for inhalation (Nowack et al., 2013).

Growing evidence suggests that carbon nanotubes behave much like asbestos fibers and may cause similar health effects, such as mesothelioma may pose similar health risks as inhaling asbestos (Donaldson, 2006; Greenmeier, 2008). Furthermore, Poland et al. (2008) discovered that exposing the mesothelial lining of the body cavity of mice to carbon nanotubes resulted in "asbestos-like, length-dependent, pathogenic behavior. This includes inflammation and the formation of lesions known as granulomas." The study also noted that the public may have been assuming that carbon nanotubes were "no more hazardous than graphite," when in fact, their results suggested the "need for further research and great caution before introducing such products into the market if long-term harm is to be avoided" (Poland, 2008).

Dr. Gehr, a scientist who studies bodily tissue at the University of Bern in Switzerland, has stated that synthetic nanoparticles do not have to be inhaled; they can penetrate tissue and cells, and spread throughout the body, even to the brain. He has stated, "If nanoparticles are not solidly bound to another material, there is a risk that we could inhale them. They can enter the bloodstream and spread throughout the entire body. The mere fact that particles penetrate into the body is a problem" (qtd. in Novak, 2011, p. 3).

The U.S. government and the World Health Organization have identified carbon black as "possibly carcinogenic to humans" (International Programme, 2010), and while it comprises up to 30% of some tires, the studies we have cited thus far (including all of the studies reviewed by ChemRisk) have not accounted for it. The 2015 study conducted at Yale openly acknowledged that it did not have the resources (e.g., an electron microscope) to monitor nanoparticles of carbon black (Environment and Human Health, 2015).

## **California's Research on Children's Environmental Health**

As referenced earlier, California's OEHHA has conducted some studies on the risks of exposure to scrap tire mulch. California is on the forefront of researching children's environmental health and considering potential regulatory actions. Recognizing that children are

often differently impacted by environmental contaminants, the state's Children's Environmental Health Program was established in 1999, and now OEHHA and the California Environmental Protection Agency (Cal/EPA) work together "to identify those chemical contaminants commonly found at school sites and determined by OEHHA to be of greatest concern based on child-specific physiological sensitivities." (California Office of Environmental Health Hazard Assessment, 2007).

To this end, OEHHA develops numerical health guidance values (HGVs) to help assess risk posed by chemical contaminants at proposed or existing California school sites. In the form of child-specific reference doses (chRDs) - the highest level of intake of a chemical by weight of a child per day before the exposure would be considered toxic - OEHHA has finalized chRDs for 12 different chemicals to date (California Office of Environmental Health Hazard Assessment, 2009).

While the recent Yale study detected nearly 100 different chemicals in scrap tire mulch on school playgrounds (Environment and Human Health, 2015), OEHHA has finalized chRDs for only the *non-cancer* effects of a handful of chemicals. In fact, the agency acknowledged, "The state of scientific knowledge pertaining to chemical effects on children is and continues to be a limiting factor in OEHHA's ability to develop child-specific HGVs for these contaminants" (California Office of Environmental Health Hazard Assessment, 2010, p. 4).

In 2014, OEHHA hosted a Symposium with the theme: "Impacts of Environmental Chemicals on Development – Are complex interactions captured by traditional risk assessment practices?" OEHHA stated,

The goals of this symposium are to get regulatory scientists in California thinking about:

- How to incorporate complex interactions into risk assessment, particularly for early life exposures;
- How to incorporate information from new toxicity testing paradigms into risk assessments now; and
- How to incorporate impacts of non-chemical stressors that increase vulnerability, and whether current methods of risk assessment adequately account for at least some of the vulnerabilities (e.g., use of weighting factors in cancer risk assessment, use of uncertainty factors).

Although we applaud California's efforts to research, discuss, and regulate children's exposure to toxic chemicals, it is abundantly clear that much remains to understand which chemicals and at what concentrations may be hazardous in the short- and long-term. As agencies like OEHHA continue to wrestle with questions of toxicity and children's health, applying the precautionary principle is warranted in choosing amongst the different options for playground surfacing material.

## Minnesota's Toxic Free Kids Act

While California leads state efforts to protect children's environmental health in many respects, several other states, including Minnesota, Maine, and Washington, have developed programs to assess chemical risks and inform potential regulation. In 2009, the Minnesota Department of Health (MDH) collaborated with the Minnesota Pollution Control Agency (MPCA) to enact the Toxic Free Kids Act, which resulted in a list of "Chemicals of High Concern," defined in Minnesota Statutes 2012, 116.9401. A "chemical of high concern" means a chemical identified on the basis of credible scientific evidence by a state, federal, or international agency as being known or suspected with a high degree of probability to:

- (1) harm the normal development of a fetus or child or cause other developmental toxicity;
- (2) cause cancer, genetic damage, or reproductive harm;
- (3) disrupt the endocrine or hormone system;
- (4) damage the nervous system, immune system, or organs, or cause other systemic toxicity;
- (5) be persistent, bioaccumulative, and toxic; or
- (6) very persistent, and very bioaccumulative.

In addition, MDH lists lead as one of nine "Priority Chemicals" - a subset of the "Chemicals of High Concern" - defined in Minnesota Statutes 2010, 116.9403 as:

- 1) has been identified as a high-production volume chemical by the United States Environmental Protection Agency; and
- (2) meets any of the following criteria:
  - (i) the chemical has been found through biomonitoring to be present in human blood, including umbilical cord blood, breast milk, urine, or other bodily tissues or fluids;
  - (ii) the chemical has been found through sampling and analysis to be present in household dust, indoor air, drinking water, or elsewhere in the home environment; or
  - (iii) the chemical has been found through monitoring to be present in fish, wildlife, or the natural environment.

While Minnesota state law only requires MDH to publish the two chemical lists, other states, such as Washington, have used similar lists to create requirements for manufacturers to report which products contain certain chemicals.

## Testing of Tire Mulch at Lester Park Elementary

A founding member of Duluth Parents for Healthy Playgrounds, Cory Kirsling, initiated a local independent study of the scrap mulch that covers the playground at Lester Park Elementary where his son attends school. Kirsling raised funds through a GoFundMe website<sup>6</sup>, acquired permission from District officials, and hired North Shore Analytical<sup>7</sup> to collect a sample to test for metals, Polycyclic Aromatic Hydrocarbons (PAHs), and Volatile Organic Compounds (VOCs). These chemical classes were tested because of their reported presence in tire mulch and tire products (EPA, 2009; Llompарт et al., 2013; Environment and Human Health, 2015; California Office of Environmental Health Hazard Assessment, 2007).

On September 3, 2015 at 10 AM, Christopher Gross, Analytical Chemist at North Shore Analytical, took an eight-gram sample of the mulch near the center of the playground, several inches below the surface of the cover. North Shore Analytical then contracted with Legend Technical Services<sup>8</sup> in Saint Paul, MN to analyze the sample from the playground along with a second sample from an unopened bag of Rubberific-brand Premium Shredded Rubber Mulch, purchased on August 3rd, 2015. Legend Technical Services used the following methods from EPA publication SW-846, titled *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*: 6010C for metals, 8270D for PAHs, and 8260B for VOCs.<sup>9</sup>

The full chemical analysis report by Legend Technical Services is available in Appendix A. Table 1 highlights chemicals that were present in the playground or raw mulch in concentrations above the test's reporting limit (RL) and cross-references with the MDH list of "Chemicals of High Concern." The MDH list does not establish "safe levels."

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<sup>6</sup> <http://www.gofundme.com/testtherubbermulch>

<sup>7</sup> <http://www.northshoreanalytical.com/>

<sup>8</sup> <http://www.legend-group.com/contact/saint-paul>

<sup>9</sup> <http://www3.epa.gov/epawaste/hazard/testmethods/sw846/>

**Table 1:** “Chemicals of High Concern” present in testing of Lester Park Elementary playground and raw samples, September 2015, Duluth, MN.

Chemical	Class	Playground Sample (mg/kg dry)	Raw Sample (mg/kg dry)	"Chemical of High Concern"	PBT or vPvB <sup>10</sup>	Health Endpoints <sup>11</sup>
Barium	Metals	1.1	1.4	x		Cardiovascular system, Kidney
Chromium <sup>12</sup>	Metals	0.7	1.2	x		Cancer, Respiratory system
Lead	Metals	<RL	2.1	x		Cancer, Development, Reproduction
Zinc	Metals	2500	3900	x		Blood chemistry
Anthracene	PAHs	<RL	1.5	x	x	not stated
Benzo(a)anthracene	PAHs	<RL	1.9	x	x	Cancer
Benzo(a)pyrene	PAHs	<RL	1.6	x	x	Cancer, Endocrine system
Benzo(b)fluoranthene	PAHs	1.4	3.6	x	x	Cancer
Chrysene <sup>13</sup>	PAHs	1.8	4.6	x	x	Cancer
Fluoranthene	PAHs	5.4	10			
Phenanthrene	PAHs	2.9	9.3	x	x	not stated
Pyrene	PAHs	6.2	9.8	x	x	Kidney
Methyl isobutyl ketone	VOCs	<RL	22	x		Cancer

Of the 13 different chemicals found in the playground or raw mulch at levels detectable by the analytical methods used, 12 are listed by the MDH as “Chemicals of High Concern” and lead is listed as one of nine “Priority Chemicals.” While these MDH lists do not set any enforceable standards, they are intended as a starting point for any future state regulatory action.

Lead was detected in the raw mulch sample at 2.1 mg/kg, and according to the Centers for Disease Control and Prevention (CDC), “no safe blood lead level in children has been

<sup>10</sup> Listed by MDH as Persistent, Bioaccumulative, Toxic (PBT) or very Persistent, very Bioaccumulative (vPvB).

<sup>11</sup> According to the Minnesota Chemicals of High Concern Report, “...the included health endpoints are those from the Screening Information Data Set (SIDS) used by the international organization, OECD, for assessing chemical hazards” (Minnesota Department of Health, 2013).

<sup>12</sup> MDH lists chromium (VI) and chromium (VI) trioxide as “Chemicals of High Concern”. The testing method used here detected but did not distinguish between variations of chromium.

<sup>13</sup> Chrysene is a common name for the chemical more properly known as benzo(a)phenanthrene (Chemical Abstract Service Registry Number 218-01-9).

identified” (2013). The MDH also stresses the health risks of lead, stating “Scientific research indicates that there is no safe level of lead and that there is a need to help children and pregnant women recognize and avoid lead exposure before their level reaches 5ug/dL” (Minnesota Department of Health, 2013). While lead was not at a detectable level in the playground sample, the difference between the raw and playground sample lead levels may suggest one or two things: composition of tire mulch varies greatly, and/or lead has been leaching out of the material.

The chemical concentrations in Table 1 are within the legal limits of current U.S. federal standards. However, four of the PAHs – (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and chrysene – tested at levels *above* the standards recently set forth by the European Union in Commission Regulation (EU) No. 1272/2013. While not enforceable in the U.S., the European regulatory body is based on the risks that PAHs in various products pose to the health of consumers, especially children. The regulation states

Articles shall not be placed on the market for supply to the general public, if any of their rubber or plastic components that come into direct as well as prolonged or short-term repetitive contact with the human skin or the oral cavity, under normal or reasonably foreseeable conditions of use, contain more than 1 mg/kg (0,0001 % by weight of this component) of any of the listed PAHs.

From our measurements at Lester Park Elementary, the average depth of mulch tends to be about 10 inches, with approximately 10,000 square feet of surface area. Using the coverage calculator provided on Rubberific’s website, we estimated that Lester Park Elementary alone contains about 12,000 tires.<sup>14</sup> Given the variety of chemicals different tire manufacturers use, and the variability of the tire brands in Rubberific mulch, the results from the eight grams of that were tested constitute a *limited* assessment of the chemicals that might be present within the playground at Lester Park Elementary, let alone other schools within ISD 709. More in-depth and better-funded studies have already detected nearly a hundred different chemicals in rubber mulch from scrap tires (Environment and Human Health, 2015). Moreover, carbon nanomaterial is another exposure of concern that was not part of the suite of analytical tests; testing for this material would require an electron microscope

With the presence of so many unknowns and the absence of adequate regulation, we believe that the precautionary principle should be used in choosing the surfacing material on elementary school playgrounds. The precautionary principle is a tool for policy- and decision-makers to prevent damage to human health and ecosystems when scientific information is lacking or incomplete. The principle states that “in the case of serious or irreversible threats to the health of humans or the ecosystem, acknowledged scientific uncertainty should not be used as a reason to postpone preventive measures” (World Health Organization, 2004, p. 1).

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<sup>14</sup> Rubberific coverage calculator: <http://www.rubberific.com/resources/coverage-calculator>. Inputting the calculator’s maximum depth of six inches and a coverage of 10,000 square feet, Rubberific estimates 6250 bags of mulch are needed. Each bag weighs approximately 40 pounds. Assuming a car tire weights roughly 20 pounds, two tires would be shredded to fill one bag of mulch.

Furthermore, “If progress is to be made in this direction, one should encourage the replacement of dangerous substances and activities with less dangerous substances or technologies where suitable alternatives are available” (p. 5). Support for applying the precautionary principle includes:

- Variability in the chemicals and concentrations present in scrap tires make it difficult to estimate specific risk levels associated with the material on individual playgrounds.
- Scientific consensus on the dangers of any kind of childhood exposure to lead.
- More stringent standards for PAH levels recently developed by the European Union.
- The potential “synergistic” effects of multiple chemicals, even at low doses.
- The effects of long-term exposure to these chemicals (at least five hours a week over a five to six year period).

## Potentially Suitable Alternatives for Playground Cover

The CPSC Public Playground Safety Handbook (Section 2.4 Surfacing, p. 8-11) states that, based on their attenuation properties, the following materials are appropriate as playground surfacing:

- Any material tested to ASTM F1292, including unitary surfaces, engineered wood fiber, etc.
- Pea gravel
- Sand
- Shredded/recycled rubber mulch
- Wood mulch (not CCA-treated)
- Wood chips

The Handbook also lists minimum required depths of loose-fill material needed based on material type and fall height (Handbook, Table 2). For playgrounds with fall heights greater than seven feet (like those in ISD 709), pea gravel, sand, and wood mulch are *not* acceptable surfacing materials. Wood chips and shredded/recycled rubber are the only materials the Handbook specifically lists as protecting to a fall height of 10 feet.

While not specifically listed in the Handbook’s table of minimum compressed loose-fill surfacing depths, engineered wood fiber may also protect to fall heights of 10 feet or more. The Handbook states: “Each manufacturer of engineered wood fiber and rubber mulch should provide maintenance requirements for and test data on:

- Critical height based on ASTM F1292 impact attenuation testing.
- Minimum fill-depth data.
- Toxicity.
- ADA/ABA accessibility guidelines for firmness and stability based on ASTM F1951.”

Engineered wood fiber products are not wood chips but made specifically for use as a playground safety surface under and around playground equipment. For example, the Fibar brand of engineered wood fiber products are used on many playgrounds across the U.S.,

including the elementary school in Bagley, Minnesota (ISD 162). It is an all-natural wood product that is not chemically treated. Fibar “has been rigorously tested in accordance with ASTM F1292 impact tests, ASTM F2075 for purity and quality, and ASTM F1951 for accessibility.” According to its website, Fibar “meets or exceeds ASTM Standards and CPSC guidelines,” and is “IPEMA Certified.” ATSM International is a worldwide voluntary standards development organization with over 30,000 members, with a mission “to create consensus and improve performance in manufacturing and materials, products and processes, systems and services” (ASTM, 2015). According to the International Playground Equipment Manufacturers Association (IPEMA), Fibar engineered wood fiber is rated to protect a fall height of 12 feet using a fill-depth of 12 inches (2015).

## Recommendations

Regarding toxic chemicals and children's health, we believe that the precautionary principle should be used in choosing the surfacing material on elementary school playgrounds. Duluth Public Schools should remove scrap tire mulch until independent research further defines and confirms adequate safety for children's health and government agencies properly regulate it as a children's product.

The potential for exposure to harmful chemicals in scrap tires, the unique susceptibility of children to toxins, the lack of regulatory involvement, and the immediate availability of satisfactory alternatives support removal of the material now.

For these reasons, Duluth Parents for Healthy Playgrounds recommends that ISD 709 Duluth Public Schools:

- 1) Commit to removing the scrap tire mulch from elementary school playgrounds at the end of the 2015-2016 school year or earlier.
- 2) Consider using engineered wood fiber, such as Fibar products, as a replacement cover material.
- 3) Work directly with each elementary school's parent groups to coordinate the outreach, volunteering, and fundraising that may facilitate and expedite the removal of the tire mulch and replacement with a suitable alternative.

We believe that it is never too soon or too late to choose a less-toxic playground cover for our children to play on. Together, Duluth Public Schools officials, staff, teachers, and parents can figure out the necessary time, labor, and money to keep our kids both safe and healthy on our elementary school playgrounds.

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## Appendix A

Complete results from the tests of the scrap tire mulch samples from the Lester Park Elementary School playground and the “raw” bagged Rubberific mulch.

North Shore Analytical, Inc.  
4511 W. 1st.  
Duluth, MN 55807

Project: Analytical Services  
Project Number: Rubber Mulch  
Project Manager: Ms. Linda Christensen

Work Order #: 1503733  
Date Reported: 09/21/15

### ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
LPS Playground	1503733-01	Other	09/03/15 10:00	09/04/15 11:15
Raw Mulch	1503733-02	Other	09/03/15 00:00	09/04/15 11:15
Trip Blank	1503733-03	Methanol	09/03/15 00:00	09/04/15 11:15

#### Shipping Container Information

**Default Cooler**

Temperature (°C): 20.5

Received on ice: No

Temperature blank was present

Received on ice pack: No

Received on melt water: Yes

Ambient: No

Acceptable (IH/ISO only): No

Custody seals: No

#### Case Narrative:

North Shore Analytical, Inc.  
 4511 W. 1st.  
 Duluth, MN 55807

 Project: Analytical Services  
 Project Number: Rubber Mulch  
 Project Manager: Ms. Linda Christensen

 Work Order #: 1503733  
 Date Reported: 09/21/15

### TOTAL METALS ANALYSIS

Legend Technical Services, Inc.

Analyte	Result	RL	MDL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
<b>LPS Playground (1503733-01) Other Sampled: 09/03/15 10:00 Received: 09/04/15 11:15</b>										
Arsenic	<0.51	0.51	0.10	mg/kg dry	1	B5I0412	09/04/15	09/09/15	EPA 6010C	
Barium	1.1	1.0	0.067	mg/kg dry	1	"	"	"	"	
Cadmium	<0.26	0.26	0.0089	mg/kg dry	1	"	"	"	"	
Chromium	0.70	0.51	0.037	mg/kg dry	1	"	"	"	"	
Lead	<1.0	1.0	0.063	mg/kg dry	1	"	"	"	"	
Mercury	<0.51	0.51	0.23	mg/kg dry	1	"	"	"	"	
Selenium	<1.0	1.0	0.30	mg/kg dry	1	"	"	"	"	
Zinc	2500	10	1.2	mg/kg dry	10	"	"	09/10/15	"	
<b>Raw Mulch (1503733-02) Other Sampled: 09/03/15 00:00 Received: 09/04/15 11:15</b>										
Arsenic	<0.51	0.51	0.10	mg/kg dry	1	B5I0412	09/04/15	09/09/15	EPA 6010C	
Barium	1.4	1.0	0.067	mg/kg dry	1	"	"	"	"	
Cadmium	<0.25	0.25	0.0088	mg/kg dry	1	"	"	"	"	
Chromium	1.2	0.51	0.036	mg/kg dry	1	"	"	"	"	
Lead	2.1	1.0	0.063	mg/kg dry	1	"	"	"	"	
Mercury	<0.51	0.51	0.23	mg/kg dry	1	"	"	"	"	
Selenium	<1.0	1.0	0.29	mg/kg dry	1	"	"	"	"	
Zinc	3900	10	1.2	mg/kg dry	10	"	"	09/10/15	"	

North Shore Analytical, Inc.  
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 Project: Analytical Services  
 Project Number: Rubber Mulch  
 Project Manager: Ms. Linda Christensen

 Work Order #: 1503733  
 Date Reported: 09/21/15

**PAH 8270D**  
**Legend Technical Services, Inc.**

Analyte	Result	RL	MDL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
<b>LPS Playground (1503733-01) Other Sampled: 09/03/15 10:00 Received: 09/04/15 11:15</b>										
2-Chloronaphthalene	<1.1	1.1	0.22	mg/kg dry	1	B510903	09/09/15	09/09/15	EPA 8270D	
2-Methylnaphthalene	<1.1	1.1	0.26	mg/kg dry	1	"	"	"	"	
Acenaphthene	<1.1	1.1	0.21	mg/kg dry	1	"	"	"	"	
Acenaphthylene	<1.1	1.1	0.23	mg/kg dry	1	"	"	"	"	
Anthracene	<1.1	1.1	0.23	mg/kg dry	1	"	"	"	"	
Benzo(a)anthracene	<1.1	1.1	0.21	mg/kg dry	1	"	"	"	"	
Benzo(a)pyrene	<1.1	1.1	0.23	mg/kg dry	1	"	"	"	"	
<b>Benzo(b)fluoranthene</b>	<b>1.4</b>	1.1	0.19	mg/kg dry	1	"	"	"	"	
Benzo(g,h,i)perylene	<1.1	1.1	0.23	mg/kg dry	1	"	"	"	"	
Benzo(k)fluoranthene	<1.1	1.1	0.23	mg/kg dry	1	"	"	"	"	
<b>Chrysene</b>	<b>1.8</b>	1.1	0.21	mg/kg dry	1	"	"	"	"	
Dibenz(a,h)anthracene	<1.1	1.1	0.27	mg/kg dry	1	"	"	"	"	
<b>Fluoranthene</b>	<b>5.4</b>	1.1	0.22	mg/kg dry	1	"	"	"	"	
Fluorene	<1.1	1.1	0.21	mg/kg dry	1	"	"	"	"	
Indeno (1,2,3-cd) pyrene	<1.1	1.1	0.24	mg/kg dry	1	"	"	"	"	
Naphthalene	<1.1	1.1	0.23	mg/kg dry	1	"	"	"	"	
<b>Phenanthrene</b>	<b>2.9</b>	1.1	0.22	mg/kg dry	1	"	"	"	"	
<b>Pyrene</b>	<b>6.2</b>	1.1	0.19	mg/kg dry	1	"	"	"	"	
Surrogate: 2-Fluorobiphenyl	66.1		46.3-96.2 %			"	"	"	"	
Surrogate: Nitrobenzene-d5	55.4		49.3-94 %			"	"	"	"	
Surrogate: Terphenyl-d14	35.4		51.5-94.6 %			"	"	"	"	S-BN

**Raw Mulch (1503733-02) Other Sampled: 09/03/15 00:00 Received: 09/04/15 11:15**

2-Chloronaphthalene	<1.3	1.3	0.27	mg/kg dry	1	B510903	09/09/15	09/09/15	EPA 8270D	
2-Methylnaphthalene	<1.3	1.3	0.32	mg/kg dry	1	"	"	"	"	
Acenaphthene	<1.3	1.3	0.25	mg/kg dry	1	"	"	"	"	
Acenaphthylene	<1.3	1.3	0.29	mg/kg dry	1	"	"	"	"	
<b>Anthracene</b>	<b>1.5</b>	1.3	0.28	mg/kg dry	1	"	"	"	"	
<b>Benzo(a)anthracene</b>	<b>1.9</b>	1.3	0.26	mg/kg dry	1	"	"	"	"	
<b>Benzo(a)pyrene</b>	<b>1.6</b>	1.3	0.28	mg/kg dry	1	"	"	"	"	
<b>Benzo(b)fluoranthene</b>	<b>3.6</b>	1.3	0.24	mg/kg dry	1	"	"	"	"	
Benzo(g,h,i)perylene	<1.3	1.3	0.29	mg/kg dry	1	"	"	"	"	
Benzo(k)fluoranthene	<1.3	1.3	0.28	mg/kg dry	1	"	"	"	"	
<b>Chrysene</b>	<b>4.6</b>	1.3	0.26	mg/kg dry	1	"	"	"	"	
Dibenz(a,h)anthracene	<1.3	1.3	0.33	mg/kg dry	1	"	"	"	"	
<b>Fluoranthene</b>	<b>10</b>	1.3	0.27	mg/kg dry	1	"	"	"	"	
Fluorene	<1.3	1.3	0.26	mg/kg dry	1	"	"	"	"	
Indeno (1,2,3-cd) pyrene	<1.3	1.3	0.29	mg/kg dry	1	"	"	"	"	
Naphthalene	<1.3	1.3	0.29	mg/kg dry	1	"	"	"	"	
<b>Phenanthrene</b>	<b>9.3</b>	1.3	0.27	mg/kg dry	1	"	"	"	"	

North Shore Analytical, Inc. 4511 W. 1st. Duluth, MN 55807	Project: Analytical Services Project Number: Rubber Mulch Project Manager: Ms. Linda Christensen	Work Order #: 1503733 Date Reported: 09/21/15
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**PAH 8270D**  
**Legend Technical Services, Inc.**

Analyte	Result	RL	MDL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
<b>Raw Mulch (1503733-02) Other    Sampled: 09/03/15 00:00    Received: 09/04/15 11:15</b>										
Pyrene	9.8	1.3	0.24	mg/kg dry	1	B510903	09/09/15	09/09/15	EPA 8270D	
Surrogate: 2-Fluorobiphenyl	67.3			46.3-96.2 %		"	"	"	"	
Surrogate: Nitrobenzene-d5	53.9			49.3-94 %		"	"	"	"	
Surrogate: Terphenyl-d14	44.4			51.5-94.6 %		"	"	"	"	S-BN

North Shore Analytical, Inc.  
4511 W. 1st.  
Duluth, MN 55807

Project: Analytical Services  
Project Number: Rubber Mulch  
Project Manager: Ms. Linda Christensen

Work Order #: 1503733  
Date Reported: 09/21/15

**PERCENT SOLIDS**  
**Legend Technical Services, Inc.**

Analyte	Result	RL	MDL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
<b>LPS Playground (1503733-01) Other Sampled: 09/03/15 10:00 Received: 09/04/15 11:15</b>										
% Solids	98			%	1	B511409	09/14/15	09/14/15	% calculation	
<b>Raw Mulch (1503733-02) Other Sampled: 09/03/15 00:00 Received: 09/04/15 11:15</b>										
% Solids	99			%	1	B511409	09/14/15	09/14/15	% calculation	

North Shore Analytical, Inc.  
4511 W. 1st.  
Duluth, MN 55807

Project: Analytical Services  
Project Number: Rubber Mulch  
Project Manager: Ms. Linda Christensen

Work Order #: 1503733  
Date Reported: 09/21/15

**VOC 8260B**  
**Legend Technical Services, Inc.**

Analyte	Result	RL	MDL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
<b>LPS Playground (1503733-01) Other Sampled: 09/03/15 10:00 Received: 09/04/15 11:15</b>										
1,1,1,2-Tetrachloroethane	<0.76	0.76	0.15	mg/kg dry	1	B511717	09/16/15	09/17/15	EPA 8260B	W-03
1,1,1-Trichloroethane	<0.76	0.76	0.18	mg/kg dry	1	"	"	"	"	
1,1,2,2-Tetrachloroethane	<0.76	0.76	0.12	mg/kg dry	1	"	"	"	"	
1,1,2-Trichloroethane	<0.76	0.76	0.11	mg/kg dry	1	"	"	"	"	
1,1,2-Trichlorotrifluoroethane	<0.76	0.76	0.15	mg/kg dry	1	"	"	"	"	T-1
1,1-Dichloroethane	<0.76	0.76	0.074	mg/kg dry	1	"	"	"	"	
1,1-Dichloroethene	<0.76	0.76	0.099	mg/kg dry	1	"	"	"	"	
1,1-Dichloropropene	<0.76	0.76	0.11	mg/kg dry	1	"	"	"	"	
1,2,3-Trichlorobenzene	<1.9	1.9	0.74	mg/kg dry	1	"	"	"	"	
1,2,3-Trichloropropane	<0.76	0.76	0.23	mg/kg dry	1	"	"	"	"	
1,2,4-Trichlorobenzene	<1.9	1.9	0.54	mg/kg dry	1	"	"	"	"	
1,2,4-Trimethylbenzene	<0.76	0.76	0.14	mg/kg dry	1	"	"	"	"	
1,2-Dibromo-3-chloropropane	<1.9	1.9	0.35	mg/kg dry	1	"	"	"	"	
1,2-Dibromoethane (EDB)	<0.76	0.76	0.18	mg/kg dry	1	"	"	"	"	
1,2-Dichlorobenzene	<0.76	0.76	0.099	mg/kg dry	1	"	"	"	"	
1,2-Dichloroethane	<0.76	0.76	0.17	mg/kg dry	1	"	"	"	"	
1,2-Dichloropropane	<0.76	0.76	0.16	mg/kg dry	1	"	"	"	"	
1,3,5-Trimethylbenzene	<0.76	0.76	0.19	mg/kg dry	1	"	"	"	"	
1,3-Dichlorobenzene	<0.76	0.76	0.069	mg/kg dry	1	"	"	"	"	
1,3-Dichloropropane	<0.76	0.76	0.11	mg/kg dry	1	"	"	"	"	
1,4-Dichlorobenzene	<0.76	0.76	0.12	mg/kg dry	1	"	"	"	"	
2,2-Dichloropropane	<0.76	0.76	0.40	mg/kg dry	1	"	"	"	"	
2-Butanone	<3.8	3.8	0.72	mg/kg dry	1	"	"	"	"	
2-Chlorotoluene	<0.76	0.76	0.15	mg/kg dry	1	"	"	"	"	
4-Chlorotoluene	<0.76	0.76	0.17	mg/kg dry	1	"	"	"	"	
Acetone	<3.8	3.8	0.92	mg/kg dry	1	"	"	"	"	
Allyl chloride	<0.76	0.76	0.19	mg/kg dry	1	"	"	"	"	
Benzene	<0.76	0.76	0.11	mg/kg dry	1	"	"	"	"	
Bromobenzene	<0.76	0.76	0.15	mg/kg dry	1	"	"	"	"	
Bromochloromethane	<0.76	0.76	0.18	mg/kg dry	1	"	"	"	"	
Bromodichloromethane	<0.76	0.76	0.15	mg/kg dry	1	"	"	"	"	
Bromoform	<0.76	0.76	0.28	mg/kg dry	1	"	"	"	"	
Bromomethane	<0.76	0.76	0.23	mg/kg dry	1	"	"	"	"	
Carbon tetrachloride	<0.76	0.76	0.19	mg/kg dry	1	"	"	"	"	
Chlorobenzene	<0.76	0.76	0.11	mg/kg dry	1	"	"	"	"	
Chloroethane	<0.76	0.76	0.23	mg/kg dry	1	"	"	"	"	
Chloroform	<0.76	0.76	0.24	mg/kg dry	1	"	"	"	"	
Chloromethane	<0.76	0.76	0.21	mg/kg dry	1	"	"	"	"	
cis-1,2-Dichloroethene	<0.76	0.76	0.092	mg/kg dry	1	"	"	"	"	

North Shore Analytical, Inc.  
 4511 W. 1st.  
 Duluth, MN 55807

 Project: Analytical Services  
 Project Number: Rubber Mulch  
 Project Manager: Ms. Linda Christensen

 Work Order #: 1503733  
 Date Reported: 09/21/15

### VOC 8260B

#### Legend Technical Services, Inc.

Analyte	Result	RL	MDL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
<b>LPS Playground (1503733-01) Other</b> Sampled: 09/03/15 10:00 Received: 09/04/15 11:15										
										W-03
cis-1,3-Dichloropropene	<0.76	0.76	0.19	mg/kg dry	1	B511717	09/16/15	09/17/15	EPA 8260B	
Dibromochloromethane	<0.76	0.76	0.19	mg/kg dry	1	"	"	"	"	
Dibromomethane	<0.76	0.76	0.19	mg/kg dry	1	"	"	"	"	
Dichlorodifluoromethane	<0.76	0.76	0.28	mg/kg dry	1	"	"	"	"	
Dichlorofluoromethane	<0.76	0.76	0.076	mg/kg dry	1	"	"	"	"	T-1
Ethyl ether	<0.76	0.76	0.18	mg/kg dry	1	"	"	"	"	
Ethylbenzene	<0.76	0.76	0.16	mg/kg dry	1	"	"	"	"	
Hexachlorobutadiene	<1.9	1.9	0.60	mg/kg dry	1	"	"	"	"	
Isopropylbenzene	<0.76	0.76	0.23	mg/kg dry	1	"	"	"	"	
m,p-Xylene	<1.5	1.5	0.37	mg/kg dry	1	"	"	"	"	
Methyl isobutyl ketone	<0.76	0.76	0.33	mg/kg dry	1	"	"	"	"	
Methyl tert-butyl ether	<0.76	0.76	0.074	mg/kg dry	1	"	"	"	"	
Methylene chloride	<1.9	1.9	0.46	mg/kg dry	1	"	"	"	"	
Naphthalene	<1.9	1.9	0.37	mg/kg dry	1	"	"	"	"	
n-Butylbenzene	<0.76	0.76	0.12	mg/kg dry	1	"	"	"	"	
n-Propylbenzene	<0.76	0.76	0.076	mg/kg dry	1	"	"	"	"	
o-Xylene	<0.76	0.76	0.13	mg/kg dry	1	"	"	"	"	
p-Isopropyltoluene	<0.76	0.76	0.084	mg/kg dry	1	"	"	"	"	
sec-Butylbenzene	<0.76	0.76	0.17	mg/kg dry	1	"	"	"	"	
Styrene	<0.76	0.76	0.12	mg/kg dry	1	"	"	"	"	
tert-Butylbenzene	<0.76	0.76	0.20	mg/kg dry	1	"	"	"	"	
Tetrachloroethene	<0.76	0.76	0.29	mg/kg dry	1	"	"	"	"	
Tetrahydrofuran	<3.8	3.8	0.84	mg/kg dry	1	"	"	"	"	T-1
Toluene	<0.76	0.76	0.052	mg/kg dry	1	"	"	"	"	
trans-1,2-Dichloroethene	<0.76	0.76	0.14	mg/kg dry	1	"	"	"	"	
trans-1,3-Dichloropropene	<0.76	0.76	0.15	mg/kg dry	1	"	"	"	"	
Trichloroethene	<0.76	0.76	0.14	mg/kg dry	1	"	"	"	"	
Trichlorofluoromethane	<0.76	0.76	0.22	mg/kg dry	1	"	"	"	"	
Vinyl chloride	<0.76	0.76	0.16	mg/kg dry	1	"	"	"	"	
Surrogate: 4-Bromofluorobenzene	90.2			80-124 %		"	"	"	"	
Surrogate: Dibromofluoromethane	91.5			77.1-123 %		"	"	"	"	
Surrogate: Toluene-d8	93.2			78.1-125 %		"	"	"	"	
<b>Raw Mulch (1503733-02) Other</b> Sampled: 09/03/15 00:00 Received: 09/04/15 11:15										
										W-03
1,1,1,2-Tetrachloroethane	<0.68	0.68	0.14	mg/kg dry	1	B511717	09/16/15	09/17/15	EPA 8260B	
1,1,1-Trichloroethane	<0.68	0.68	0.16	mg/kg dry	1	"	"	"	"	
1,1,2,2-Tetrachloroethane	<0.68	0.68	0.11	mg/kg dry	1	"	"	"	"	
1,1,2-Trichloroethane	<0.68	0.68	0.095	mg/kg dry	1	"	"	"	"	
1,1,2-Trichlorotrifluoroethane	<0.68	0.68	0.14	mg/kg dry	1	"	"	"	"	T-1
1,1-Dichloroethane	<0.68	0.68	0.066	mg/kg dry	1	"	"	"	"	

North Shore Analytical, Inc.  
4511 W. 1st.  
Duluth, MN 55807

Project: Analytical Services  
Project Number: Rubber Mulch  
Project Manager: Ms. Linda Christensen

Work Order #: 1503733  
Date Reported: 09/21/15

**VOC 8260B**  
**Legend Technical Services, Inc.**

Analyte	Result	RL	MDL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
<b>Raw Mulch (1503733-02) Other</b>										
<b>Sampled: 09/03/15 00:00 Received: 09/04/15 11:15</b>										W-03
1,1-Dichloroethene	<0.68	0.68	0.088	mg/kg dry	1	B511717	09/16/15	09/17/15	EPA 8260B	
1,1-Dichloropropene	<0.68	0.68	0.10	mg/kg dry	1	"	"	"	"	
1,2,3-Trichlorobenzene	<1.7	1.7	0.66	mg/kg dry	1	"	"	"	"	
1,2,3-Trichloropropane	<0.68	0.68	0.20	mg/kg dry	1	"	"	"	"	
1,2,4-Trichlorobenzene	<1.7	1.7	0.48	mg/kg dry	1	"	"	"	"	
1,2,4-Trimethylbenzene	<0.68	0.68	0.12	mg/kg dry	1	"	"	"	"	
1,2-Dibromo-3-chloropropane	<1.7	1.7	0.31	mg/kg dry	1	"	"	"	"	
1,2-Dibromoethane (EDB)	<0.68	0.68	0.16	mg/kg dry	1	"	"	"	"	
1,2-Dichlorobenzene	<0.68	0.68	0.088	mg/kg dry	1	"	"	"	"	
1,2-Dichloroethane	<0.68	0.68	0.15	mg/kg dry	1	"	"	"	"	
1,2-Dichloropropane	<0.68	0.68	0.14	mg/kg dry	1	"	"	"	"	
1,3,5-Trimethylbenzene	<0.68	0.68	0.17	mg/kg dry	1	"	"	"	"	
1,3-Dichlorobenzene	<0.68	0.68	0.061	mg/kg dry	1	"	"	"	"	
1,3-Dichloropropane	<0.68	0.68	0.10	mg/kg dry	1	"	"	"	"	
1,4-Dichlorobenzene	<0.68	0.68	0.11	mg/kg dry	1	"	"	"	"	
2,2-Dichloropropane	<0.68	0.68	0.35	mg/kg dry	1	"	"	"	"	
2-Butanone	<3.4	3.4	0.64	mg/kg dry	1	"	"	"	"	
2-Chlorotoluene	<0.68	0.68	0.14	mg/kg dry	1	"	"	"	"	
4-Chlorotoluene	<0.68	0.68	0.15	mg/kg dry	1	"	"	"	"	
Acetone	<3.4	3.4	0.81	mg/kg dry	1	"	"	"	"	
Allyl chloride	<0.68	0.68	0.17	mg/kg dry	1	"	"	"	"	
Benzene	<0.68	0.68	0.10	mg/kg dry	1	"	"	"	"	
Bromobenzene	<0.68	0.68	0.14	mg/kg dry	1	"	"	"	"	
Bromochloromethane	<0.68	0.68	0.16	mg/kg dry	1	"	"	"	"	
Bromodichloromethane	<0.68	0.68	0.13	mg/kg dry	1	"	"	"	"	
Bromoform	<0.68	0.68	0.24	mg/kg dry	1	"	"	"	"	
Bromomethane	<0.68	0.68	0.20	mg/kg dry	1	"	"	"	"	
Carbon tetrachloride	<0.68	0.68	0.17	mg/kg dry	1	"	"	"	"	
Chlorobenzene	<0.68	0.68	0.095	mg/kg dry	1	"	"	"	"	
Chloroethane	<0.68	0.68	0.20	mg/kg dry	1	"	"	"	"	
Chloroform	<0.68	0.68	0.21	mg/kg dry	1	"	"	"	"	
Chloromethane	<0.68	0.68	0.18	mg/kg dry	1	"	"	"	"	
cis-1,2-Dichloroethene	<0.68	0.68	0.081	mg/kg dry	1	"	"	"	"	
cis-1,3-Dichloropropene	<0.68	0.68	0.17	mg/kg dry	1	"	"	"	"	
Dibromochloromethane	<0.68	0.68	0.17	mg/kg dry	1	"	"	"	"	
Dibromomethane	<0.68	0.68	0.17	mg/kg dry	1	"	"	"	"	
Dichlorodifluoromethane	<0.68	0.68	0.25	mg/kg dry	1	"	"	"	"	
Dichlorofluoromethane	<0.68	0.68	0.068	mg/kg dry	1	"	"	"	"	T-1
Ethyl ether	<0.68	0.68	0.16	mg/kg dry	1	"	"	"	"	

North Shore Analytical, Inc.  
 4511 W. 1st.  
 Duluth, MN 55807

 Project: Analytical Services  
 Project Number: Rubber Mulch  
 Project Manager: Ms. Linda Christensen

 Work Order #: 1503733  
 Date Reported: 09/21/15

**VOC 8260B**  
**Legend Technical Services, Inc.**

Analyte	Result	RL	MDL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
<b>Raw Mulch (1503733-02) Other</b> <b>Sampled: 09/03/15 00:00</b> <b>Received: 09/04/15 11:15</b>										
										W-03
Ethylbenzene	<0.68	0.68	0.14	mg/kg dry	1	B511717	09/16/15	09/17/15	EPA 8260B	
Hexachlorobutadiene	<1.7	1.7	0.53	mg/kg dry	1	"	"	"	"	
Isopropylbenzene	<0.68	0.68	0.20	mg/kg dry	1	"	"	"	"	
m,p-Xylene	<1.4	1.4	0.32	mg/kg dry	1	"	"	"	"	
<b>Methyl isobutyl ketone</b>	<b>22</b>	0.68	0.29	mg/kg dry	1	"	"	"	"	
Methyl tert-butyl ether	<0.68	0.68	0.066	mg/kg dry	1	"	"	"	"	
Methylene chloride	<1.7	1.7	0.41	mg/kg dry	1	"	"	"	"	
Naphthalene	<1.7	1.7	0.32	mg/kg dry	1	"	"	"	"	
n-Butylbenzene	<0.68	0.68	0.11	mg/kg dry	1	"	"	"	"	
n-Propylbenzene	<0.68	0.68	0.068	mg/kg dry	1	"	"	"	"	
o-Xylene	<0.68	0.68	0.11	mg/kg dry	1	"	"	"	"	
p-Isopropyltoluene	<0.68	0.68	0.074	mg/kg dry	1	"	"	"	"	
sec-Butylbenzene	<0.68	0.68	0.15	mg/kg dry	1	"	"	"	"	
Styrene	<0.68	0.68	0.11	mg/kg dry	1	"	"	"	"	
tert-Butylbenzene	<0.68	0.68	0.18	mg/kg dry	1	"	"	"	"	
Tetrachloroethene	<0.68	0.68	0.26	mg/kg dry	1	"	"	"	"	
Tetrahydrofuran	<3.4	3.4	0.74	mg/kg dry	1	"	"	"	"	T-1
Toluene	<0.68	0.68	0.046	mg/kg dry	1	"	"	"	"	
trans-1,2-Dichloroethene	<0.68	0.68	0.12	mg/kg dry	1	"	"	"	"	
trans-1,3-Dichloropropene	<0.68	0.68	0.14	mg/kg dry	1	"	"	"	"	
Trichloroethene	<0.68	0.68	0.12	mg/kg dry	1	"	"	"	"	
Trichlorofluoromethane	<0.68	0.68	0.20	mg/kg dry	1	"	"	"	"	
Vinyl chloride	<0.68	0.68	0.14	mg/kg dry	1	"	"	"	"	
Surrogate: 4-Bromofluorobenzene	92.8		80-124	%		"	"	"	"	
Surrogate: Dibromofluoromethane	92.0		77.1-123	%		"	"	"	"	
Surrogate: Toluene-d8	93.9		78.1-125	%		"	"	"	"	
<b>Trip Blank (1503733-03) Methanol</b> <b>Sampled: 09/03/15 00:00</b> <b>Received: 09/04/15 11:15</b>										
1,1,1,2-Tetrachloroethane	<0.20	0.20	0.040	mg/kg wet	1	B511717	09/16/15	09/17/15	EPA 8260B	
1,1,1,1-Trichloroethane	<0.20	0.20	0.046	mg/kg wet	1	"	"	"	"	
1,1,1,2,2-Tetrachloroethane	<0.20	0.20	0.032	mg/kg wet	1	"	"	"	"	
1,1,1,2-Trichloroethane	<0.20	0.20	0.028	mg/kg wet	1	"	"	"	"	
1,1,1,2-Trichlorotrifluoroethane	<0.20	0.20	0.040	mg/kg wet	1	"	"	"	"	T-1
1,1-Dichloroethane	<0.20	0.20	0.019	mg/kg wet	1	"	"	"	"	
1,1-Dichloroethene	<0.20	0.20	0.026	mg/kg wet	1	"	"	"	"	
1,1-Dichloropropene	<0.20	0.20	0.030	mg/kg wet	1	"	"	"	"	
1,2,3-Trichlorobenzene	<0.50	0.50	0.19	mg/kg wet	1	"	"	"	"	
1,2,3-Trichloropropene	<0.20	0.20	0.060	mg/kg wet	1	"	"	"	"	
1,2,4-Trichlorobenzene	<0.50	0.50	0.14	mg/kg wet	1	"	"	"	"	
1,2,4-Trimethylbenzene	<0.20	0.20	0.036	mg/kg wet	1	"	"	"	"	

North Shore Analytical, Inc.  
 4511 W. 1st.  
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 Project: Analytical Services  
 Project Number: Rubber Mulch  
 Project Manager: Ms. Linda Christensen

 Work Order #: 1503733  
 Date Reported: 09/21/15

**VOC 8260B**  
**Legend Technical Services, Inc.**

Analyte	Result	RL	MDL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
<b>Trip Blank (1503733-03) Methanol Sampled: 09/03/15 00:00 Received: 09/04/15 11:15</b>										
1,2-Dibromo-3-chloropropane	<0.50	0.50	0.092	mg/kg wet	1	B511717	09/16/15	09/17/15	EPA 8260B	
1,2-Dibromoethane (EDB)	<0.20	0.20	0.048	mg/kg wet	1	"	"	"	"	
1,2-Dichlorobenzene	<0.20	0.20	0.026	mg/kg wet	1	"	"	"	"	
1,2-Dichloroethane	<0.20	0.20	0.044	mg/kg wet	1	"	"	"	"	
1,2-Dichloropropane	<0.20	0.20	0.042	mg/kg wet	1	"	"	"	"	
1,3,5-Trimethylbenzene	<0.20	0.20	0.050	mg/kg wet	1	"	"	"	"	
1,3-Dichlorobenzene	<0.20	0.20	0.018	mg/kg wet	1	"	"	"	"	
1,3-Dichloropropane	<0.20	0.20	0.030	mg/kg wet	1	"	"	"	"	
1,4-Dichlorobenzene	<0.20	0.20	0.032	mg/kg wet	1	"	"	"	"	
2,2-Dichloropropane	<0.20	0.20	0.10	mg/kg wet	1	"	"	"	"	
2-Butanone	<1.0	1.0	0.19	mg/kg wet	1	"	"	"	"	
2-Chlorotoluene	<0.20	0.20	0.040	mg/kg wet	1	"	"	"	"	
4-Chlorotoluene	<0.20	0.20	0.044	mg/kg wet	1	"	"	"	"	
Acetone	<1.0	1.0	0.24	mg/kg wet	1	"	"	"	"	
Allyl chloride	<0.20	0.20	0.050	mg/kg wet	1	"	"	"	"	
Benzene	<0.20	0.20	0.030	mg/kg wet	1	"	"	"	"	
Bromobenzene	<0.20	0.20	0.040	mg/kg wet	1	"	"	"	"	
Bromochloromethane	<0.20	0.20	0.046	mg/kg wet	1	"	"	"	"	
Bromodichloromethane	<0.20	0.20	0.038	mg/kg wet	1	"	"	"	"	
Bromoform	<0.20	0.20	0.072	mg/kg wet	1	"	"	"	"	
Bromomethane	<0.20	0.20	0.060	mg/kg wet	1	"	"	"	"	
Carbon tetrachloride	<0.20	0.20	0.050	mg/kg wet	1	"	"	"	"	
Chlorobenzene	<0.20	0.20	0.028	mg/kg wet	1	"	"	"	"	
Chloroethane	<0.20	0.20	0.060	mg/kg wet	1	"	"	"	"	
Chloroform	<0.20	0.20	0.062	mg/kg wet	1	"	"	"	"	
Chloromethane	<0.20	0.20	0.054	mg/kg wet	1	"	"	"	"	
cis-1,2-Dichloroethene	<0.20	0.20	0.024	mg/kg wet	1	"	"	"	"	
cis-1,3-Dichloropropene	<0.20	0.20	0.050	mg/kg wet	1	"	"	"	"	
Dibromochloromethane	<0.20	0.20	0.050	mg/kg wet	1	"	"	"	"	
Dibromomethane	<0.20	0.20	0.050	mg/kg wet	1	"	"	"	"	
Dichlorodifluoromethane	<0.20	0.20	0.074	mg/kg wet	1	"	"	"	"	
Dichlorofluoromethane	<0.20	0.20	0.020	mg/kg wet	1	"	"	"	"	T-1
Ethyl ether	<0.20	0.20	0.048	mg/kg wet	1	"	"	"	"	
Ethylbenzene	<0.20	0.20	0.042	mg/kg wet	1	"	"	"	"	
Hexachlorobutadiene	<0.50	0.50	0.16	mg/kg wet	1	"	"	"	"	
Isopropylbenzene	<0.20	0.20	0.060	mg/kg wet	1	"	"	"	"	
m,p-Xylene	<0.40	0.40	0.096	mg/kg wet	1	"	"	"	"	
Methyl isobutyl ketone	<0.20	0.20	0.086	mg/kg wet	1	"	"	"	"	
Methyl tert-butyl ether	<0.20	0.20	0.019	mg/kg wet	1	"	"	"	"	

North Shore Analytical, Inc.  
 4511 W. 1st.  
 Duluth, MN 55807

 Project: Analytical Services  
 Project Number: Rubber Mulch  
 Project Manager: Ms. Linda Christensen

 Work Order #: 1503733  
 Date Reported: 09/21/15

**VOC 8260B**
**Legend Technical Services, Inc.**

Analyte	Result	RL	MDL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
<b>Trip Blank (1503733-03) Methanol Sampled: 09/03/15 00:00 Received: 09/04/15 11:15</b>										
Methylene chloride	<0.50	0.50	0.12	mg/kg wet	1	B511717	09/16/15	09/17/15	EPA 8260B	
Naphthalene	<0.50	0.50	0.096	mg/kg wet	1	"	"	"	"	
n-Butylbenzene	<0.20	0.20	0.032	mg/kg wet	1	"	"	"	"	
n-Propylbenzene	<0.20	0.20	0.020	mg/kg wet	1	"	"	"	"	
o-Xylene	<0.20	0.20	0.034	mg/kg wet	1	"	"	"	"	
p-Isopropyltoluene	<0.20	0.20	0.022	mg/kg wet	1	"	"	"	"	
sec-Butylbenzene	<0.20	0.20	0.044	mg/kg wet	1	"	"	"	"	
Styrene	<0.20	0.20	0.032	mg/kg wet	1	"	"	"	"	
tert-Butylbenzene	<0.20	0.20	0.052	mg/kg wet	1	"	"	"	"	
Tetrachloroethene	<0.20	0.20	0.076	mg/kg wet	1	"	"	"	"	
Tetrahydrofuran	<1.0	1.0	0.22	mg/kg wet	1	"	"	"	"	T-1
Toluene	<0.20	0.20	0.014	mg/kg wet	1	"	"	"	"	
trans-1,2-Dichloroethene	<0.20	0.20	0.036	mg/kg wet	1	"	"	"	"	
trans-1,3-Dichloropropene	<0.20	0.20	0.040	mg/kg wet	1	"	"	"	"	
Trichloroethene	<0.20	0.20	0.036	mg/kg wet	1	"	"	"	"	
Trichlorofluoromethane	<0.20	0.20	0.058	mg/kg wet	1	"	"	"	"	
Vinyl chloride	<0.20	0.20	0.042	mg/kg wet	1	"	"	"	"	
Surrogate: 4-Bromofluorobenzene	91.9			80-124 %		"	"	"	"	
Surrogate: Dibromofluoromethane	91.2			77.1-123 %		"	"	"	"	
Surrogate: Toluene-d8	92.5			78.1-125 %		"	"	"	"	

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 Work Order #: 1503733  
 Date Reported: 09/21/15

### TOTAL METALS ANALYSIS - Quality Control

#### Legend Technical Services, Inc.

Analyte	Result	RL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	%RPD	%RPD Limit	Notes
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**Batch B5I0412 - EPA 3050B**
**Blank (B5I0412-BLK1)**

Prepared: 09/04/15 Analyzed: 09/09/15

Arsenic	< 0.50	0.50	0.10	mg/kg wet
Barium	< 1.0	1.0	0.066	mg/kg wet
Cadmium	< 0.25	0.25	0.0087	mg/kg wet
Chromium	< 0.50	0.50	0.036	mg/kg wet
Lead	< 1.0	1.0	0.062	mg/kg wet
Mercury	< 0.50	0.50	0.23	mg/kg wet
Selenium	< 1.0	1.0	0.29	mg/kg wet
Zinc	< 1.0	1.0	0.12	mg/kg wet

**LCS (B5I0412-BS1)**

Prepared: 09/04/15 Analyzed: 09/09/15

Arsenic	41.8	0.50	0.10	mg/kg wet	39.9	105	80-120
Barium	42.4	1.0	0.066	mg/kg wet	39.9	106	80-120
Cadmium	43.5	0.25	0.0087	mg/kg wet	39.9	109	80-120
Chromium	42.0	0.50	0.036	mg/kg wet	39.9	105	80-120
Lead	42.8	1.0	0.062	mg/kg wet	39.9	107	80-120
Mercury	13.5	0.50	0.23	mg/kg wet	12.5	108	80-120
Selenium	41.9	1.0	0.29	mg/kg wet	39.9	105	80-120
Zinc	41.2	1.0	0.12	mg/kg wet	39.9	103	80-120

**LCS Dup (B5I0412-BSD1)**

Prepared: 09/04/15 Analyzed: 09/09/15

Arsenic	42.0	0.50	0.10	mg/kg wet	39.9	105	80-120	0.611	20
Barium	42.6	1.0	0.066	mg/kg wet	39.9	107	80-120	0.323	20
Cadmium	44.0	0.25	0.0087	mg/kg wet	39.9	110	80-120	1.02	20
Chromium	42.1	0.50	0.036	mg/kg wet	39.9	106	80-120	0.374	20
Lead	43.2	1.0	0.062	mg/kg wet	39.9	108	80-120	0.929	20
Mercury	13.7	0.50	0.23	mg/kg wet	12.5	109	80-120	1.59	20
Selenium	42.4	1.0	0.29	mg/kg wet	39.9	106	80-120	1.20	20
Zinc	42.9	1.0	0.12	mg/kg wet	39.9	107	80-120	3.91	20

**Matrix Spike (B5I0412-MS1)**

Source: 1503691-01

Prepared: 09/04/15 Analyzed: 09/09/15

Arsenic	61.2	0.67	0.13	mg/kg dry	52.4	6.89	104	75-125
Barium	212	1.3	0.088	mg/kg dry	52.4	149	121	75-125
Cadmium	51.6	0.33	0.012	mg/kg dry	52.4	0.491	97.5	75-125
Chromium	82.6	0.67	0.048	mg/kg dry	52.4	27.4	105	75-125
Lead	66.6	1.3	0.083	mg/kg dry	52.4	15.1	98.4	75-125
Mercury	15.2	0.67	0.31	mg/kg dry	16.4	<0.67	92.4	75-125
Selenium	53.6	1.3	0.39	mg/kg dry	52.4	<1.3	102	75-125
Zinc	124	1.3	0.16	mg/kg dry	52.4	70.2	103	75-125

**Matrix Spike Dup (B5I0412-MSD1)**

Source: 1503691-01

Prepared: 09/04/15 Analyzed: 09/09/15

Arsenic	64.0	0.67	0.13	mg/kg dry	51.9	6.89	110	75-125	4.49	20
Barium	209	1.3	0.088	mg/kg dry	51.9	149	117	75-125	1.21	20

North Shore Analytical, Inc.  
4511 W. 1st.  
Duluth, MN 55807

Project: Analytical Services  
Project Number: Rubber Mulch  
Project Manager: Ms. Linda Christensen

Work Order #: 1503733  
Date Reported: 09/21/15

**TOTAL METALS ANALYSIS - Quality Control**  
**Legend Technical Services, Inc.**

Analyte	Result	RL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	%RPD	%RPD Limit	Notes
<b>Batch B5I0412 - EPA 3050B</b>											
<b>Matrix Spike Dup (B5I0412-MSD1)</b>											
	<b>Source: 1503691-01</b>				<b>Prepared: 09/04/15 Analyzed: 09/09/15</b>						
Cadmium	50.8	0.33	0.012	mg/kg dry	51.9	0.491	97.0	75-125	1.51	20	
Chromium	80.4	0.67	0.048	mg/kg dry	51.9	27.4	102	75-125	2.70	20	
Lead	66.9	1.3	0.083	mg/kg dry	51.9	15.1	99.9	75-125	0.440	20	
Mercury	14.9	0.67	0.31	mg/kg dry	16.2	<0.67	91.8	75-125	1.65	20	
Selenium	52.0	1.3	0.39	mg/kg dry	51.9	<1.3	100	75-125	2.87	20	
Zinc	118	1.3	0.16	mg/kg dry	51.9	70.2	91.3	75-125	5.60	20	

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 Project: Analytical Services  
 Project Number: Rubber Mulch  
 Project Manager: Ms. Linda Christensen

 Work Order #: 1503733  
 Date Reported: 09/21/15

**PAH 8270D - Quality Control**  
**Legend Technical Services, Inc.**

Analyte	Result	RL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	%RPD	%RPD Limit	Notes
<b>Batch B5I0903 - EPA 3545 ASE Extraction</b>											
<b>Blank (B5I0903-BLK1)</b>						Prepared & Analyzed: 09/09/15					
2-Chloronaphthalene	< 0.33	0.33	0.068	mg/kg wet							
2-Methylnaphthalene	< 0.33	0.33	0.080	mg/kg wet							
Acenaphthene	< 0.33	0.33	0.063	mg/kg wet							
Acenaphthylene	< 0.33	0.33	0.071	mg/kg wet							
Anthracene	< 0.33	0.33	0.069	mg/kg wet							
Benzo(a)anthracene	< 0.33	0.33	0.065	mg/kg wet							
Benzo(a)pyrene	< 0.33	0.33	0.070	mg/kg wet							
Benzo(b)fluoranthene	< 0.33	0.33	0.059	mg/kg wet							
Benzo(g,h,i)perylene	< 0.33	0.33	0.071	mg/kg wet							
Benzo(k)fluoranthene	< 0.33	0.33	0.070	mg/kg wet							
Chrysene	< 0.33	0.33	0.064	mg/kg wet							
Dibenz(a,h)anthracene	< 0.33	0.33	0.082	mg/kg wet							
Fluoranthene	< 0.33	0.33	0.068	mg/kg wet							
Fluorene	< 0.33	0.33	0.065	mg/kg wet							
Indeno (1,2,3-cd) pyrene	< 0.33	0.33	0.072	mg/kg wet							
Naphthalene	< 0.33	0.33	0.071	mg/kg wet							
Phenanthrene	< 0.33	0.33	0.066	mg/kg wet							
Pyrene	< 0.33	0.33	0.059	mg/kg wet							
Surrogate: 2-Fluorobiphenyl	74.2			ug/ml	100		74.2	46.3-96.2			
Surrogate: Nitrobenzene-d5	65.1			ug/ml	100		65.1	49.3-94			
Surrogate: Terphenyl-d14	61.3			ug/ml	100		61.3	51.5-94.6			
<b>LCS (B5I0903-BS1)</b>						Prepared & Analyzed: 09/09/15					
Acenaphthylene	2.21	0.33	0.071	mg/kg wet	3.33		66.2	55-95			
Anthracene	2.34	0.33	0.069	mg/kg wet	3.33		70.2	60-100			
Benzo(a)anthracene	2.48	0.33	0.065	mg/kg wet	3.33		74.3	55-100			
Benzo(a)pyrene	2.35	0.33	0.070	mg/kg wet	3.33		70.4	55-100			
Benzo(b)fluoranthene	2.33	0.33	0.059	mg/kg wet	3.33		70.0	55-100			
Benzo(g,h,i)perylene	1.99	0.33	0.071	mg/kg wet	3.33		59.6	50-100			
Benzo(k)fluoranthene	2.30	0.33	0.070	mg/kg wet	3.33		68.9	55-100			
Chrysene	2.52	0.33	0.064	mg/kg wet	3.33		75.5	50-100			
Dibenz(a,h)anthracene	1.95	0.33	0.082	mg/kg wet	3.33		58.6	50-100			
Fluoranthene	2.44	0.33	0.068	mg/kg wet	3.33		73.1	55-100			
Fluorene	2.34	0.33	0.065	mg/kg wet	3.33		70.2	55-95			
Indeno (1,2,3-cd) pyrene	2.01	0.33	0.072	mg/kg wet	3.33		60.4	55-110			
Naphthalene	1.95	0.33	0.071	mg/kg wet	3.33		58.4	50-95			
Phenanthrene	2.36	0.33	0.066	mg/kg wet	3.33		70.9	60-100			
Surrogate: 2-Fluorobiphenyl	57.9			ug/ml	100		57.9	46.3-96.2			
Surrogate: Nitrobenzene-d5	51.6			ug/ml	100		51.6	49.3-94			
Surrogate: Terphenyl-d14	63.5			ug/ml	100		63.5	51.5-94.6			

North Shore Analytical, Inc.  
4511 W. 1st.  
Duluth, MN 55807

Project: Analytical Services  
Project Number: Rubber Mulch  
Project Manager: Ms. Linda Christensen

Work Order #: 1503733  
Date Reported: 09/21/15

**PAH 8270D - Quality Control**  
**Legend Technical Services, Inc.**

Analyte	Result	RL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	%RPD	%RPD Limit	Notes
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**Batch B5I0903 - EPA 3545 ASE Extraction**

**Matrix Spike (B5I0903-MS1)**

Source: 1503655-01

Prepared & Analyzed: 09/09/15

Acenaphthylene	3.15	0.45	0.097	mg/kg dry	4.56	<0.45	69.0	40-100			
Anthracene	3.47	0.45	0.095	mg/kg dry	4.56	<0.45	76.0	45-100			
Benzo(a)anthracene	3.73	0.45	0.089	mg/kg dry	4.56	<0.45	81.7	45-100			
Benzo(a)pyrene	3.55	0.45	0.096	mg/kg dry	4.56	<0.45	77.8	40-100			
Benzo(b)fluoranthene	3.51	0.45	0.081	mg/kg dry	4.56	<0.45	77.0	40-100			
Benzo(g,h,i)perylene	2.95	0.45	0.097	mg/kg dry	4.56	<0.45	64.6	35-110			
Benzo(k)fluoranthene	3.37	0.45	0.096	mg/kg dry	4.56	<0.45	73.8	40-100			
Chrysene	3.82	0.45	0.088	mg/kg dry	4.56	<0.45	83.7	40-100			
Dibenz(a,h)anthracene	2.93	0.45	0.11	mg/kg dry	4.56	<0.45	64.3	35-110			
Fluoranthene	3.64	0.45	0.093	mg/kg dry	4.56	<0.45	79.9	45-100			
Fluorene	3.34	0.45	0.089	mg/kg dry	4.56	<0.45	73.2	45-100			
Indeno (1,2,3-cd) pyrene	2.95	0.45	0.099	mg/kg dry	4.56	<0.45	64.6	35-110			
Naphthalene	2.84	0.45	0.097	mg/kg dry	4.56	<0.45	62.3	35-100			
Phenanthrene	3.55	0.45	0.090	mg/kg dry	4.56	<0.45	77.8	45-100			
Surrogate: 2-Fluorobiphenyl	59.8			ug/ml	100		59.8	46.3-96.2			
Surrogate: Nitrobenzene-d5	53.4			ug/ml	100		53.4	49.3-94			
Surrogate: Terphenyl-d14	69.6			ug/ml	100		69.6	51.5-94.6			

**Matrix Spike Dup (B5I0903-MSD1)**

Source: 1503655-01

Prepared & Analyzed: 09/09/15

Acenaphthylene	2.68	0.45	0.097	mg/kg dry	4.57	<0.45	58.7	40-100	15.9	20	
Anthracene	3.04	0.45	0.095	mg/kg dry	4.57	<0.45	66.6	45-100	13.0	20	
Benzo(a)anthracene	3.34	0.45	0.089	mg/kg dry	4.57	<0.45	73.1	45-100	10.9	20	
Benzo(a)pyrene	3.19	0.45	0.096	mg/kg dry	4.57	<0.45	69.9	40-100	10.6	20	
Benzo(b)fluoranthene	3.11	0.45	0.081	mg/kg dry	4.57	<0.45	68.1	40-100	12.1	20	
Benzo(g,h,i)perylene	2.66	0.45	0.097	mg/kg dry	4.57	<0.45	58.2	35-110	10.2	20	
Benzo(k)fluoranthene	3.09	0.45	0.096	mg/kg dry	4.57	<0.45	67.7	40-100	8.41	20	
Chrysene	3.36	0.45	0.088	mg/kg dry	4.57	<0.45	73.5	40-100	12.8	20	
Dibenz(a,h)anthracene	2.64	0.45	0.11	mg/kg dry	4.57	<0.45	57.8	35-110	10.5	20	
Fluoranthene	3.19	0.45	0.093	mg/kg dry	4.57	<0.45	69.9	45-100	13.2	20	
Fluorene	2.90	0.45	0.089	mg/kg dry	4.57	<0.45	63.4	45-100	14.0	20	
Indeno (1,2,3-cd) pyrene	2.70	0.45	0.099	mg/kg dry	4.57	<0.45	59.0	35-110	8.85	20	
Naphthalene	2.22	0.45	0.097	mg/kg dry	4.57	<0.45	48.6	35-100	24.5	20	R5
Phenanthrene	3.04	0.45	0.090	mg/kg dry	4.57	<0.45	66.4	45-100	15.6	20	
Surrogate: 2-Fluorobiphenyl	50.0			ug/ml	100		50.0	46.3-96.2			
Surrogate: Nitrobenzene-d5	43.0			ug/ml	100		43.0	49.3-94			S-BN
Surrogate: Terphenyl-d14	63.0			ug/ml	100		63.0	51.5-94.6			

North Shore Analytical, Inc.  
 4511 W. 1st.  
 Duluth, MN 55807

Project: Analytical Services  
 Project Number: Rubber Mulch  
 Project Manager: Ms. Linda Christensen

Work Order #: 1503733  
 Date Reported: 09/21/15

**PERCENT SOLIDS - Quality Control**  
**Legend Technical Services, Inc.**

Analyte	Result	RL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	%RPD	%RPD Limit	Notes
<b>Batch B5I1409 - General Preparation</b>											
<b>Duplicate (B5I1409-DUP1)</b>											
						<b>Source: 1503838-01</b>		<b>Prepared &amp; Analyzed: 09/14/15</b>			
% Solids	87.0			%		86.0			1.16	20	

North Shore Analytical, Inc.  
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Project: Analytical Services  
Project Number: Rubber Mulch  
Project Manager: Ms. Linda Christensen

Work Order #: 1503733  
Date Reported: 09/21/15

**VOC 8260B - Quality Control**  
**Legend Technical Services, Inc.**

Analyte	Result	RL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	%RPD	%RPD Limit	Notes
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**Batch B511717 - EPA 5035 Soil (Purge and Trap)**

**Blank (B511717-BLK1)**

Prepared: 09/16/15 Analyzed: 09/17/15

1,1,1,2-Tetrachloroethane	< 0.20	0.20	0.040	mg/kg wet
1,1,1-Trichloroethane	< 0.20	0.20	0.046	mg/kg wet
1,1,2,2-Tetrachloroethane	< 0.20	0.20	0.032	mg/kg wet
1,1,2-Trichloroethane	< 0.20	0.20	0.028	mg/kg wet
1,1,2-Trichlorotrifluoroethane	< 0.20	0.20	0.040	mg/kg wet
1,1-Dichloroethane	< 0.20	0.20	0.019	mg/kg wet
1,1-Dichloroethene	< 0.20	0.20	0.026	mg/kg wet
1,1-Dichloropropene	< 0.20	0.20	0.030	mg/kg wet
1,2,3-Trichlorobenzene	< 0.50	0.50	0.19	mg/kg wet
1,2,3-Trichloropropane	< 0.20	0.20	0.060	mg/kg wet
1,2,4-Trichlorobenzene	< 0.50	0.50	0.14	mg/kg wet
1,2,4-Trimethylbenzene	< 0.20	0.20	0.036	mg/kg wet
1,2-Dibromo-3-chloropropane	< 0.50	0.50	0.092	mg/kg wet
1,2-Dibromoethane (EDB)	< 0.20	0.20	0.048	mg/kg wet
1,2-Dichlorobenzene	< 0.20	0.20	0.026	mg/kg wet
1,2-Dichloroethane	< 0.20	0.20	0.044	mg/kg wet
1,2-Dichloropropane	< 0.20	0.20	0.042	mg/kg wet
1,3,5-Trimethylbenzene	< 0.20	0.20	0.050	mg/kg wet
1,3-Dichlorobenzene	< 0.20	0.20	0.018	mg/kg wet
1,3-Dichloropropane	< 0.20	0.20	0.030	mg/kg wet
1,4-Dichlorobenzene	< 0.20	0.20	0.032	mg/kg wet
2,2-Dichloropropane	< 0.20	0.20	0.10	mg/kg wet
2-Butanone	< 1.0	1.0	0.19	mg/kg wet
2-Chlorotoluene	< 0.20	0.20	0.040	mg/kg wet
4-Chlorotoluene	< 0.20	0.20	0.044	mg/kg wet
Acetone	< 1.0	1.0	0.24	mg/kg wet
Allyl chloride	< 0.20	0.20	0.050	mg/kg wet
Benzene	< 0.20	0.20	0.030	mg/kg wet
Bromobenzene	< 0.20	0.20	0.040	mg/kg wet
Bromochloromethane	< 0.20	0.20	0.046	mg/kg wet
Bromodichloromethane	< 0.20	0.20	0.038	mg/kg wet
Bromoform	< 0.20	0.20	0.072	mg/kg wet
Bromomethane	< 0.20	0.20	0.060	mg/kg wet
Carbon tetrachloride	< 0.20	0.20	0.050	mg/kg wet
Chlorobenzene	< 0.20	0.20	0.028	mg/kg wet
Chloroethane	< 0.20	0.20	0.060	mg/kg wet
Chloroform	< 0.20	0.20	0.062	mg/kg wet
Chloromethane	< 0.20	0.20	0.054	mg/kg wet
cis-1,2-Dichloroethene	< 0.20	0.20	0.024	mg/kg wet

North Shore Analytical, Inc.  
4511 W. 1st.  
Duluth, MN 55807

Project: Analytical Services  
Project Number: Rubber Mulch  
Project Manager: Ms. Linda Christensen

Work Order #: 1503733  
Date Reported: 09/21/15

**VOC 8260B - Quality Control**  
**Legend Technical Services, Inc.**

Analyte	Result	RL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	%RPD	%RPD Limit	Notes
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**Batch B511717 - EPA 5035 Soil (Purge and Trap)**

**Blank (B511717-BLK1)**

Prepared: 09/16/15 Analyzed: 09/17/15

cis-1,3-Dichloropropene	< 0.20	0.20	0.050	mg/kg wet							
Dibromochloromethane	< 0.20	0.20	0.050	mg/kg wet							
Dibromomethane	< 0.20	0.20	0.050	mg/kg wet							
Dichlorodifluoromethane	< 0.20	0.20	0.074	mg/kg wet							
Dichlorofluoromethane	< 0.20	0.20	0.020	mg/kg wet							
Ethyl ether	< 0.20	0.20	0.048	mg/kg wet							
Ethylbenzene	< 0.20	0.20	0.042	mg/kg wet							
Hexachlorobutadiene	< 0.50	0.50	0.16	mg/kg wet							
Isopropylbenzene	< 0.20	0.20	0.060	mg/kg wet							
m,p-Xylene	< 0.40	0.40	0.096	mg/kg wet							
Methyl isobutyl ketone	< 0.20	0.20	0.086	mg/kg wet							
Methyl tert-butyl ether	< 0.20	0.20	0.019	mg/kg wet							
Methylene chloride	< 0.50	0.50	0.12	mg/kg wet							
Naphthalene	< 0.50	0.50	0.096	mg/kg wet							
n-Butylbenzene	< 0.20	0.20	0.032	mg/kg wet							
n-Propylbenzene	< 0.20	0.20	0.020	mg/kg wet							
o-Xylene	< 0.20	0.20	0.034	mg/kg wet							
p-Isopropyltoluene	< 0.20	0.20	0.022	mg/kg wet							
sec-Butylbenzene	< 0.20	0.20	0.044	mg/kg wet							
Styrene	< 0.20	0.20	0.032	mg/kg wet							
tert-Butylbenzene	< 0.20	0.20	0.052	mg/kg wet							
Tetrachloroethene	< 0.20	0.20	0.076	mg/kg wet							
Tetrahydrofuran	< 1.0	1.0	0.22	mg/kg wet							
Toluene	< 0.20	0.20	0.014	mg/kg wet							
trans-1,2-Dichloroethene	< 0.20	0.20	0.036	mg/kg wet							
trans-1,3-Dichloropropene	< 0.20	0.20	0.040	mg/kg wet							
Trichloroethene	< 0.20	0.20	0.036	mg/kg wet							
Trichlorofluoromethane	< 0.20	0.20	0.058	mg/kg wet							
Vinyl chloride	< 0.20	0.20	0.042	mg/kg wet							
Surrogate: 4-Bromofluorobenzene	52.9			ug/L	56.0		94.4	80-124			
Surrogate: Dibromofluoromethane	53.0			ug/L	56.0		94.6	77.1-123			
Surrogate: Toluene-d8	53.1			ug/L	56.0		94.9	78.1-125			

**LCS (B511717-BS1)**

Prepared & Analyzed: 09/16/15

1,1,2,2-Tetrachloroethane	48.3			ug/L	50.0		96.5	75-120			
1,1-Dichloroethane	51.4			ug/L	50.0		103	79.6-120			
1,1-Dichloroethene	51.4			ug/L	50.0		103	78.3-120			
1,3,5-Trimethylbenzene	49.4			ug/L	50.0		98.8	77-120			
1,4-Dichlorobenzene	49.5			ug/L	50.0		99.0	75-125			
2-Chlorotoluene	48.9			ug/L	50.0		97.8	75.9-120			

North Shore Analytical, Inc.  
4511 W. 1st.  
Duluth, MN 55807

Project: Analytical Services  
Project Number: Rubber Mulch  
Project Manager: Ms. Linda Christensen

Work Order #: 1503733  
Date Reported: 09/21/15

**VOC 8260B - Quality Control**  
**Legend Technical Services, Inc.**

Analyte	Result	RL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	%RPD	%RPD Limit	Notes
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**Batch B511717 - EPA 5035 Soil (Purge and Trap)**

**LCS (B511717-BS1)**

Prepared & Analyzed: 09/16/15

Benzene	51.0			ug/L	50.0		102	80-120			
Bromoform	53.9			ug/L	50.0		108	80-120			
Chlorobenzene	51.2			ug/L	50.0		102	80-120			
Chloroform	49.3			ug/L	50.0		98.5	80-120			
Ethylbenzene	52.0			ug/L	50.0		104	80-120			
n-Butylbenzene	48.6			ug/L	50.0		97.1	75-125			
n-Propylbenzene	50.3			ug/L	50.0		101	75-120			
Toluene	51.4			ug/L	50.0		103	80-120			
Trichloroethene	50.1			ug/L	50.0		100	80-120			
Vinyl chloride	52.2			ug/L	50.0		104	75-130			
Surrogate: 4-Bromofluorobenzene	52.8			ug/L	56.0		94.2	80-124			
Surrogate: Dibromofluoromethane	52.8			ug/L	56.0		94.4	77.1-123			
Surrogate: Toluene-d8	54.4			ug/L	56.0		97.2	78.1-125			

**Matrix Spike (B511717-MS1)**

Source: 1503838-01

Prepared: 09/16/15 Analyzed: 09/17/15

1,1,2,2-Tetrachloroethane	45.2			ug/L	50.0	<	90.4	75-125			
1,1-Dichloroethane	51.5			ug/L	50.0	<	103	78.7-123			
1,1-Dichloroethene	50.1			ug/L	50.0	<	100	75.8-121			
1,3,5-Trimethylbenzene	48.1			ug/L	50.0	<	96.1	75-120			
1,4-Dichlorobenzene	48.1			ug/L	50.0	<	96.2	75-125			
2-Chlorotoluene	46.8			ug/L	50.0	<	93.5	75-120			
Benzene	50.9			ug/L	50.0	<	102	80-120			
Bromoform	51.0			ug/L	50.0	<	102	80-120			
Chlorobenzene	51.2			ug/L	50.0	<	102	80-120			
Chloroform	48.8			ug/L	50.0	<	97.5	80-120			
Ethylbenzene	50.9			ug/L	50.0	<	102	80-120			
n-Butylbenzene	46.4			ug/L	50.0	<	92.8	73.8-125			
n-Propylbenzene	47.1			ug/L	50.0	<	94.2	75-120			
Toluene	51.1			ug/L	50.0	<	102	80-120			
Trichloroethene	50.0			ug/L	50.0	<	100	80-120			
Vinyl chloride	51.7			ug/L	50.0	<	103	74.8-130			
Surrogate: 4-Bromofluorobenzene	53.2			ug/L	56.0		94.9	80-124			
Surrogate: Dibromofluoromethane	51.9			ug/L	56.0		92.7	77.1-123			
Surrogate: Toluene-d8	53.1			ug/L	56.0		94.8	78.1-125			

**Matrix Spike Dup (B511717-MSD1)**

Source: 1503838-01

Prepared: 09/16/15 Analyzed: 09/17/15

1,1,2,2-Tetrachloroethane	46.4			ug/L	50.0	<	92.8	75-125	2.65	20	
1,1-Dichloroethane	49.6			ug/L	50.0	<	99.3	78.7-123	3.62	20	
1,1-Dichloroethene	50.0			ug/L	50.0	<	100	75.8-121	0.113	20	
1,3,5-Trimethylbenzene	48.5			ug/L	50.0	<	96.9	75-120	0.841	20	

North Shore Analytical, Inc.  
4511 W. 1st.  
Duluth, MN 55807

Project: Analytical Services  
Project Number: Rubber Mulch  
Project Manager: Ms. Linda Christensen

Work Order #: 1503733  
Date Reported: 09/21/15

**VOC 8260B - Quality Control**  
**Legend Technical Services, Inc.**

Analyte	Result	RL	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	%RPD	%RPD Limit	Notes
<b>Batch B5I1717 - EPA 5035 Soil (Purge and Trap)</b>											
<b>Matrix Spike Dup (B5I1717-MSD1)</b>		<b>Source: 1503838-01</b>				<b>Prepared: 09/16/15</b>		<b>Analyzed: 09/17/15</b>			
1,4-Dichlorobenzene	48.7			ug/L	50.0	<	97.4	75-125	1.22	20	
2-Chlorotoluene	47.6			ug/L	50.0	<	95.3	75-120	1.85	20	
Benzene	50.6			ug/L	50.0	<	101	80-120	0.577	20	
Bromoform	50.9			ug/L	50.0	<	102	80-120	0.181	20	
Chlorobenzene	50.9			ug/L	50.0	<	102	80-120	0.665	20	
Chloroform	48.0			ug/L	50.0	<	96.0	80-120	1.60	20	
Ethylbenzene	49.7			ug/L	50.0	<	99.3	80-120	2.38	20	
n-Butylbenzene	47.8			ug/L	50.0	<	95.6	73.8-125	2.95	20	
n-Propylbenzene	48.5			ug/L	50.0	<	96.9	75-120	2.89	20	
Toluene	50.4			ug/L	50.0	<	101	80-120	1.35	20	
Trichloroethene	48.7			ug/L	50.0	<	97.4	80-120	2.73	20	
Vinyl chloride	48.9			ug/L	50.0	<	97.8	74.8-130	5.57	20	
Surrogate: 4-Bromofluorobenzene	52.7			ug/L	56.0		94.2	80-124			
Surrogate: Dibromofluoromethane	51.8			ug/L	56.0		92.5	77.1-123			
Surrogate: Toluene-d8	53.0			ug/L	56.0		94.6	78.1-125			

North Shore Analytical, Inc.  
4511 W. 1st.  
Duluth, MN 55807

Project: Analytical Services  
Project Number: Rubber Mulch  
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Date Reported: 09/21/15

### Notes and Definitions

W-03 The initial sample weight was less than 8.0 grams.  
T-1 MDH does not offer certification for this parameter.  
S-BN Base/Neutral surrogate recovery outside of control limits. The data was accepted based on valid recovery of remaining two base/neutral surrogates.  
R5 MS/MSD RPD exceeded the laboratory acceptance limit. Recoveries met acceptance criteria.  
< Less than value listed  
dry Sample results reported on a dry weight basis  
NA Not applicable. The %RPD is not calculated from values less than the reporting limit.  
MDL Method Detection Limit; Equivalent to the method LOD (Limit of Detection)  
RL Reporting Limit; Equivalent to the method LOQ (Limit of Quantitation)  
RPD Relative Percent Difference  
LCS Laboratory Control Spike = Blank Spike (BS) = Laboratory Fortified Blank (LFB)  
MS Matrix Spike = Laboratory Fortified Matrix (LFM)

Page \_\_\_\_ of \_\_\_\_  
 LEGEND TECHNICAL SERVICES, INC.  
 88 Empire Drive, St Paul, MN 55103 - Telephone: 651-642-1150, Fax: 651-642-1239  
 CHAIN-OF-CUSTODY RECORD

Client Name: North Shore Analytical Address: 4511 W 1st St Ste 1 Duluth MN 55807		Bill To: Same Address: _____ PO #: _____		LEGEND Project: 1503733 Turn Around Time: <input type="checkbox"/> Normal <input type="checkbox"/> RUSH Requested Due Date: _____ Condition Received: <input type="checkbox"/> Received at 20.5 °C <input type="checkbox"/> Temp. from unopened sample <input type="checkbox"/> Received on ice <input type="checkbox"/> No temp. blank <input type="checkbox"/> Received on ice pack <input type="checkbox"/> Received on melt water <input type="checkbox"/> Received ambient <input type="checkbox"/> Acceptable (HHSB only) Custody Seals: _____		COC/Sample Comments: LPS Playground = mulch from play area Raw Mulch = supplied from vendor	
Project Name: Rubber Mulch		To: northshoreanalytical Project: Rubber mulch		Major Sample Components (if greatest, including hazardous)		ANALYSIS	
Item No.	Sample Name	Lab ID	Sample Matrix	Collection Date	Time	Number of Containers	
1	LPS Playground	✓	solid	9/15/15	1000	1	Vol
2	Raw mulch	✓	solid	9/15/15	1000	1	Vol
3	TRUE Blank (1) VIAL w/ meoh	✓	solid	9/15/15	1000	1	Vol
4							
5							
6							
7							
8							
9							
10							
Sample Collector (please print): CHAS CROSS		Relinquished By: [Signature]		Time: 1300		Date: 9/15/15	
Comments: For Cory Kirsling Re LPS Playground		Relinquished By: [Signature]		Time: 1115		Date: 9/15/15	

PLEASE REVIEW TERMS AND CONDITIONS ON BACK BEFORE SIGNING  
 White Copy - Original Accompanies Shipment to Lab  
 Yellow Copy - Lab  
 Pink Copy - Customer or Field Copy

Form LAB-208-5 (12/14)