Committee of the Whole
Duluth Public Schools, ISD 709
Agenda
Tuesday, April 26, 2016
District Services Center
709 Portia Johnson Dr.
Duluth, MN 55811
4:30 PM

1. **Call to Order**
2. **Roll Call**
3. **Playground Surfacing Information and Discussion**
   A. Information will be shared by District Administration, Minnesota Department of Health, and Parents for Healthy Playgrounds 2
4. **Adjournment**

Committee of the Whole:

Playground Surfacing

4/26/16

ISD 709 Duluth Public Schools

Playground Surfacing

- The safety and health of our students is the highest priority.
- We appreciate hearing from parents and share their desire that our playgrounds be safe and healthy places to play.
- Online petition and parent group expressing concern for potential toxicity and other issues regarding rubber mulch.
- Many studies, with results ranging from low or no risk to some potential risk of exposure to contaminants. As yet inconclusive.
- Recent news reports and comments from the public continue to raise questions.
- Two major studies underway: EPA and California Office of Health Hazard Assessment.

ISD 709 Duluth Public Schools

Playground Surfacing

Minnesota Department of Health:

James Kelly, M.S.
Manager, Environmental Surveillance & Assessment Section
Environmental Health Division

ISD 709 Duluth Public Schools

Playground Surfacing

Kerry Leider:
ISD 709 Property and Risk Manager

- Recent Injury Background
- History for Surfacing on Playgrounds
- Construction Details

ISD 709 Duluth Public Schools

Playground Injuries Reported

2015

- Total **54**
- Slip/Fall **31**
- Slip/Fall - Injury to Head **14**

2014

- Total **84**
- Slip/Fall **41**
- Slip/Fall - Injury to Head **20**

ISD 709 Duluth Public Schools

Playground Surfacing

Shredded Wood – Beginning 1997 – 2007

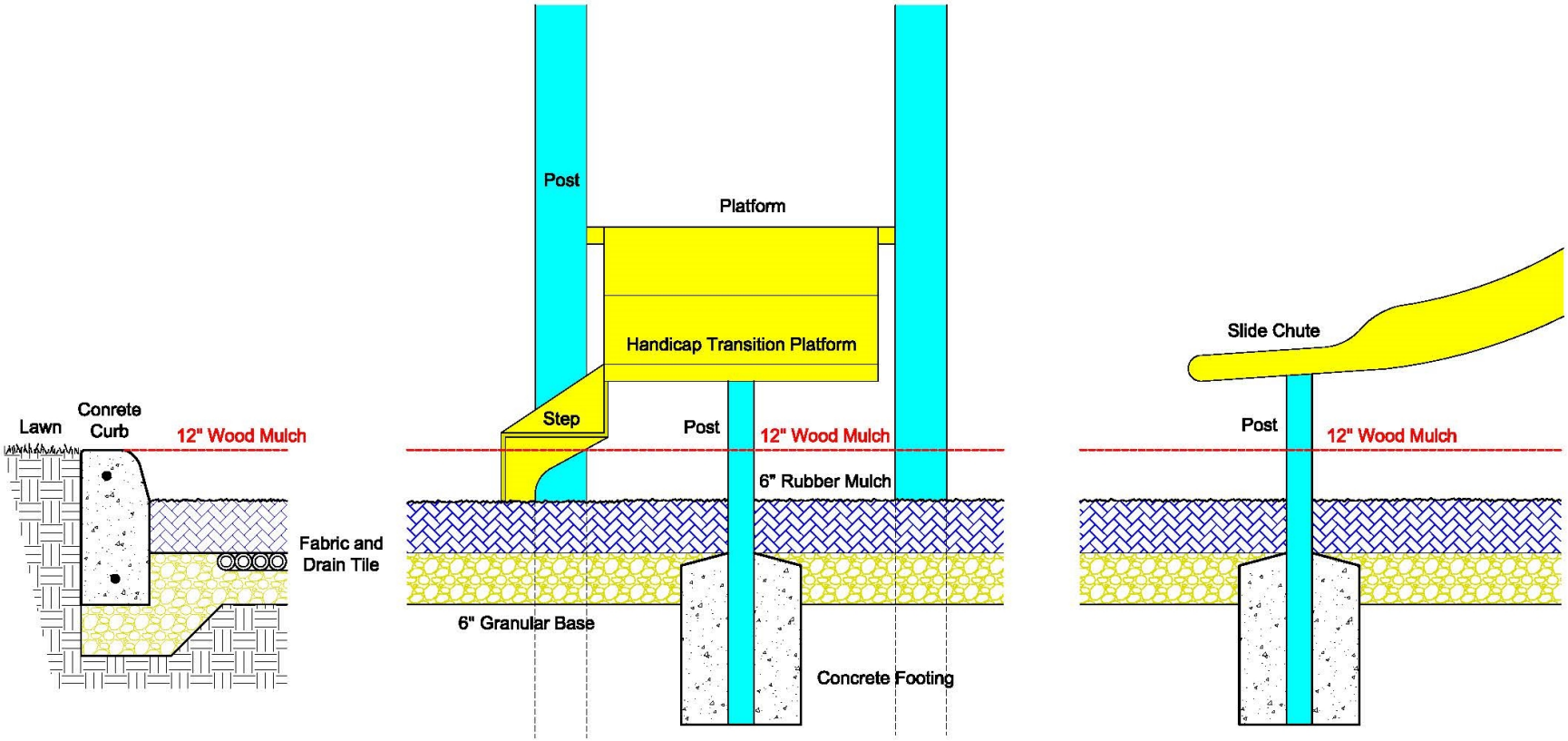
2006

- **LRFP Identified Needs District-wide**
- **Rubber Surfacing (Tradeshows and Barkers Island)**
- **Engineered shredded wood approaching 10 years installed**
  - Composting
  - Microbial growth concerns (mushrooms)
  - Compaction and reduced attenuation
  - Replacement and Lifecycle Cost

2007-2013

- Lakewood and Stowe 2008 rubber nugget (Accessibility ?)
- Stowe, Lowell, Homecroft shredded rubber (Rubberific)
- Piedmont, Lester Park, Laura MacArthur (Rubberific)
- Congdon Park Expansion (Expanded wood vs. replace with rubber)

ISD 709 Duluth Public Schools


Lawn
Conrete Curb
12" Wood Mulch
Fabric and Drain Tile
Post
Platform
Handicap Transition Platform
Step
Post
12" Wood Mulch
6" Rubber Mulch
6" Granular Base
Concrete Footing
Slide Chute
Post
12" Wood Mulch

PLAY STRUCTURE INFORMATION

site	*supplier/installer*	*manufacturer*	*installed*	*comments*
Congdon Park	Minnesota Playground	Gametime (Phase 1)	2002	(Duluth-Superior general contractor)
	Minnesota Playground	Gametime (Phase 2)	2003	installed by ISD 709 Utility
Homecroft	MN WI Playground	Gametime	2009	
Lakewood	Earl F. Anderson	Landscape Structures	2008	
Laura MacArthur	Flagship Recreation	Landscape Structures	2010	
Lester Park	Flagship Recreation	Landscape Structures	2010	2011 new structure (fire)
Lowell	Earl F. Anderson	Landscape Structures	2009	
Myers-Wilkins	Flagship Recreation	Landscape Structures	2013	
Piedmont	Flagship Recreation	Landscape Structures	2010	
Stowe	Value Recreation	Playworld	1994	
	MN WI Playground	GameTime	2008	

Table 2. Minimum compressed loose-fill surfacing depths

Inches	Of	(Loose-Fill Material)	Protects to	Fall Height (feet)
6*		Shredded/recycled rubber		10
9		Sand		4
9		Pea Gravel		5
9		Wood mulch (non-CCA)		7
9		Wood chips		10

* Shredded/recycled rubber loose-fill surfacing does not compress in the same manner as other loose-fill materials. However, care should be taken to maintain a constant depth as displacement may still occur.

Playground Surfacing

Duluth Parents for Healthy Playgrounds

ISD 709 Duluth Public Schools

Playground Surfacing

Kerry Leider:
ISD 709 Property and Risk Manager

- Surface Options and Cost Estimates

ISD 709 Duluth Public Schools

Playground Surfacing

Discussion

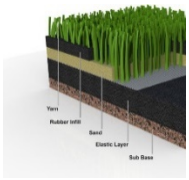
Crumb Rubber in Athletic Fields

QUESTIONS REGARDING POTENTIAL HEALTH EFFECTS FROM THE USE OF CRUMB RUBBER IN ATHLETIC FIELDS.

What is Crumb Rubber?

Crumb rubber is created by reducing scrap tires or other rubber into small, uniform pellets. Tires are broken up by either grinding or by freezing and then breaking. The steel and other fibers in scrap tires are almost entirely removed in the manufacturing process.[1] Using scrap tires can provide a community and environmental benefit by removing mosquito breeding grounds and reducing fire hazards.

How is it used?



Because crumb rubber is used in a wide variety of products, it comes in a range of sizes. One common use for crumb rubber is as a filler in synthetic turf fields. The crumb rubber helps support the artificial blades of "grass" to give the field a more natural texture and feel. It is also used in floor mats, carpet padding, as foundation for roads and railroads, and as filler in packaging.[2]

Are there health concerns?

Tires contain a number of materials that can be harmful to health if significant exposure (swallowing, breathing, or through the skin) occurs, including metals (zinc, lead), volatile organic compounds (methyl isobutyl ketone), semi-volatile organic compounds (benzothiazole, PAHs), and particulates (carbon black).[3] Studies done by states (CA, NY) have shown that exposure to chemicals in crumb rubber is likely to be small and unlikely to increase the risk for any health effect. However, recent news reports and comments from the public continue to raise questions about exposure to crumb rubber. A study from Connecticut urged caution until additional information is gathered.

What is being done?

Two major studies are currently underway examining potential health effects from crumb rubber and synthetic turf. One is being led by the federal Environmental Protection Agency; a draft status report is expected in late 2016. Additional federal research may result from these findings.[4] The second is by the California Office of Health Hazard Assessment and will run through 2018. The California study will be very comprehensive and include a review of current knowledge, public input, exposure assessment, and estimated health outcomes.[5] The Minnesota Department of Health is tracking each of these studies and will consider their results in any future recommendations regarding the use of crumb rubber in synthetic turf fields.

Are there other considerations?

In addition to concerns about chemical exposures, synthetic turf can become extremely warm during summer days, causing heat-related stress. Because the surface is different than natural grass, sports equipment may need to be adjusted (e.g. shorter cleats on shoes) to avoid injury.

There have been reports of skin infections from scrapes suffered on indoor surfaces especially.

Are there health benefits?

Regular physical activity reduces the risk of many chronic diseases, including cardiovascular disease, diabetes and some cancers, can improve your mental health and mood, and increase your chances of living longer.[6] Synthetic turf is also able to be used more often and longer than traditional grass fields, increasing opportunities for physical activity for both students and community residents.

Are there other benefits?

There can be environmental advantages to using synthetic turf. Depending on the region of the country, a typical grass sports field requires 500,000 to one million gallons of water per year in addition to significant amounts of pesticides and fertilizers.[7] Synthetic turf fields require neither watering nor application of chemicals.

The availability of community sports facilities can also help reduce health disparities in underserved areas by helping to create environmental, economic, and social conditions that promote health.[8]

Now What?

Given the extensive use of synthetic turf in Minnesota and the lack of reported health issues associated with their use, it is unlikely that they pose a significant, acute public health concern. However, more information is needed to assess possible long-term issues. MDH will continue to gather information and track ongoing studies to assess possible health risks. In the meantime, users of these fields can take some simple precautions such as:

- Washing with soap and water after use, especially any scrapes or cuts
- Shaking out clothes/shoes to limit take home of rubber crumbs
- Cover food/beverages to prevent contamination with rubber material

References

1. http://scraptirenews.com/crumb.php
2. http://infohouse.p2ric.org/ref/11/10504/html/usa/usechip.htm
3. Llompart, et. al. 2013. Chemosphere. 90(2):423-31
4. https://www.epa.gov/chemical-research/federal-research-recycled-tire-crumbs-used-playing-fields
5. http://oehha.ca.gov/risk/SyntheticTurfStudies/pdf/TurfStudyFactSheet102015.pdf
6. http://www.cdc.gov/physicalactivity/basics/pa-health/
7. http://www.syntheticturfcouncil.org/?page=FAQs
8. http://www.health.state.mn.us/divs/chs/healthequity/ahe_leg_report_020414.pdf

Minnesota Department of Health
Environmental Health Division
PO Box 64975
St. Paul, MN 55164-0975
www.health.state.mn.us

April 2016

MDH
Minnesota Department *of* Health

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	District	email	total types used in district	wood/ EWF	pea rock	poured /mats	rubber mulch	sand/ other	Any Mold?	Mold effected students health?	Any slivers?	Date of Response	Additional notes
2	Ada-Borup	MichaelK@ada.k12.mn.	1	1								11-Mar	
3	Albany	gregjohnson@albany.k1	1		1							8-Apr	
4	Alexandria	jcritz@alexandria.k12.n	2		1	1						8-Apr	
5	Anoka-Hennepir	David.Law@anoka.k12.	1	1					1			10-Apr	Occasional mold
6	Black Duck	sent through website	1		1							11-Mar	
7	Braham	kgagner@braham.k12.r	1	1								11-Mar	
8	Brandon-Evansv	mwestby@b-e.k12.mn.	1	1								14-Mar	
9	Brooklyn Center	cjechorek@brookcntr.k	1	1								11-Mar	
10	Browerville	svedbraaten@browervi	1	1								11-Mar	replenished every 3 years
11	Buffalo Lake-He	rdoetsch@blh.k12.mn.u	1	1								8-Apr	wood replaced often
12	Burnsville-Eagar	jgothard@isd191.org	1	1								8-Apr	
13	Chisago Lakes	jthimm@isd2144.org	1	1								8-Apr	rubber mulch is extremely expensive. Kids and weather compact the mulch down after a few weeks
14	Chisholm	jvaricha@chisholm.k12	3	1	1		1					8-Apr	prek-k rubber, 1-3 pea, 4-6 wood
15	Cloquet	kscarbro@isd94.org	1	1								8-Apr	
16	Columbia Heigh	kellyk@colheights.k12.r	1	1								11-Mar	some splinters from wood equip., but never from mulch
17	Comfrey	khutchison@comfrey.m	1	1								8-Apr	
18	Cook County	bschwarz@isd166.org	1				1					11-Apr	not happy with rubber mulch and parents are concerned. Considering poured rubber. Had wood previously with some mold issues.
19	Dover-Eyota	mikecarolan@deschool	1	1								8-Apr	mats under some fall zones
20	Eden Valley-Wa	mmessman@eagles.ev	1		1							8-Apr	
21	Edgerton	kbuckridge@edgertonp	1		1							8-Apr	
22	Edina	superintendent@edinas	3	1		1	1					11-Apr	most are wood mulch or poured rubber, 1 rubber mulch

	A	B	C	D	E	F	G	H	I	J	K	L	M
23	Ely	kabrahamson@ely.k12.	1					1				8-Apr	neither mulch or rubber. No green space at this time
24	Fergus Falls	jness@fergusotters.org	1			1						8-Apr	
25	Fillmore Central	richard.keith@isd2198.	1		1							11-Mar	
26	Frazee-Vergas	tkarger@frazee.k12.mn	1		1							8-Apr	
27	Fulda	luther.onken@fps.mntr	1		1							11-Mar	
28	G.F.W.	Tami.Martin@gfwschoc	1				1					14-Mar	
29	Glenville-Emmo	reshetarj@geschools.cc	1		1							14-Mar	
30	Goodhue	mredmond@goodhue.k	1			1						14-Mar	Very happy with it. Nearly 3 years old and wearing very well.
31	Grand Meadow	jreshetar@gm.k12.mn.u	1		1							14-Mar	
32	Hastings	tcollins@hastings.k12.n	1	1								9-Apr	
33	Hawley	pjensen@hawley.k12.m	2	1			1					8-Apr	
34	Herman-Norcro	rbleichner@hncs.k12.m	1		1							22-Mar	
35	Hibbing	bradjohn@hibbing.k12.	1					1				8-Apr	
36	Hill City	dyocum@isd002.org	1					1				12-Mar	
37	Hills-Beaver Cre	t.holthaus@isd671.net	1		1							8-Apr	
38	Hinckley-Finlays	rprater@hf.k12.mn.us	1	1					1			14-Mar	Have had a few issues with mold and recycle regulary. Some concerned parents at first, but safety advisors feel it is fine.
39	Holdingford	chris.swenson@isd738.	1	1								8-Apr	tested 5 years ago for various types and levels of mold and met required standards
40	Hopkins	John Schultz, emailed th	3	1		1	1		1			18-Mar	4-poured rubber, 1 rubber tiles, 1 rubber mulch, 3 wood mulch. Rarely find mold. Try to maintain good drainage, no dogs allowed.
41	International Fa	kgrover@isd361.k12.m	1	1								14-Mar	
42	Janesville-Waldo	badams@isd2835.org	1		1							8-Apr	
43	LaCrescent-Hok	kevin.cardille@isd300.k	2			1	1					8-Apr	
44	Lake City	eenger@lake-city.k12.n	1	1								14-Mar	
45	Lake Park-Audul	dhogie@lpa.k12.mn.us	1		1							14-Mar	

	A	B	C	D	E	F	G	H	I	J	K	L	M
46	Lake Superior	bcrandall@isd381.k12.r	1				1					9-Apr	donation request at Jamie's place of employment for auction items to get rubber chips removed to be ADA compliant. Looking to replace with poured rubber.
47	Lakeview	chrisfenske@lakeview2	2			1	1					15-Mar	previously has wood mulch
48	Lancaster	sswiontek@lancaster.k1	1	1								15-Mar	currently looking at rubber surface
49	Lewiston-Altura	japse@lewalt.k12.mn.u	1	1								8-Apr	
50	M.A.C.C.R.A.Y.	koslofskyb@maccray.k1	1		1							8-Apr	Would prefer wood. Cheaper than rubber, but needs fresh top coat every 2-3 years
51	Marshall County	jlund@mccfreeze.org	1	1								14-Mar	
52	McGregor	pgrams@isd4.org	2		1	1						15-Mar	
53	Medford	rdahman@medford.k12	1			1						14-Mar	
54	Menahga	kwellen@menahga.k12	1	1								8-Apr	
55	Milaca	tim.truebenbach@mila	1		1							8-Apr	
56	Minnetonka	dennis.peterson@minn	1	1								15-Mar	in summer transitioning to all engineered wood - had rubber mulch
57	Minnewaska	gschmidt@minnewaska	1				1					11-Apr	
58	Monticello	jim.johnson@monticell	1				1					9-Apr	
59	Moose Lake	bob.indihar@isd97.org	1	1								8-Apr	
60	Mounds View	webmaster@moundsvi	1	1								15-Mar	
61	Murray County	Luther Onken (supt at F	1	1								15-Mar	considering rubber
62	New London-Sp	carlsonp@nls.k12.mn.u	1			1						14-Mar	had wood before the poured rubber and occasionaly had mold
63	New Prague Are	tdittber@isd721.org	1	1								15-Mar	
64	Norman County	markl@nce.k12.mn.us	1		1							15-Mar	
65	Norman County	khedstrom@ncw.k12.m	1				1					8-Apr	
66	Northfield	CRichardson@northfiel	2	1		1						16-Mar	use wood mulch for general areas and rubber mats in landing areas (swings, slides)
67	Northland Comr	tmayclin@isd118.org	1										
68	Paynesville	rhuot@paynesville.k12.	1		1							16-Mar	

	A	B	C	D	E	F	G	H	I	J	K	L	M
69	Pierz	gweber@pierz.k12.mn.	2	1	1							8-Apr	
70	Pillager	mmalmberg@isd116.or	1	1								8-Apr	
71	Pine City	wgilman@isd578.org	1	1								8-Apr	
72	Pine Island	tammyb@pineisland.k1	1	1							1	16-Mar	Sliver on occasion. New elementary with new playground, cost was a factor
73	Prior Lake-Savag	tstaloch@priorlake-sava	2	1		1						18-Apr	
74	Richfield	Steven.Unowsky@rpsm	1			1						18-Apr	
75	Rockford	durandp@rockford.k12	1				1					18-Apr	
76	Rocori	michalskib@rocori.k12.	1		1							18-Apr	
77	Rosemount-App	supt@district196.org	1	1								18-Apr	converting the pea rock to EWF
78	Sauk Centre	dan_brooks@isd743.k1	2	1		1						18-Apr	
79	Spring Grove	rachel.udstuen@springg	1	1								16-Apr	
80	St. Charles	mroubinek@schs.k12.m	1	1							1	18-Apr	slivers once in a great while-all minor
81	St. James	bcselovszki@isd840.org	1		1							18-Apr	
82	St. Paul	supt.silva@spps.org	1	1								18-Apr	
83			total types used	Total Wood	Total Pea Rock	Total Poured /Mats	Total Rubber Mulch	Total Sand/ Other	Experienced Mold	Absences due to mold	Slivers Reported		
84			96	42	23	14	13	3	3	0	2		
85													
86				44%	24%	15%	14%	3%	7%	0%	5%		

Dear Valued Members of our Community,

April 7, 2016

In August 2015, the Minnehaha PTA created a plan to update the community playground located at the Minnehaha Elementary School. The plan includes removing outdated equipment that does not meet the Americans with Disabilities Act (ADA) requirements and could pose a safety hazard to our children. The plan also includes updating the rubber chip surface because it is not inclusive for all children, updating equipment, and providing a green space. The object of the plan is to create a safe and exciting play space for children, as well as to make the playground more accessible to all children regardless of their needs and abilities.

The Minnehaha playground is located in Two Harbors along Eighth Street between Fourth and Fifth Avenues. Not only is the playground the sole source of outdoor play for Minnehaha students, but it also serves community members year round.

During the planning process, the committee identified the first priority for the playground project would be to remove all structures that do not meet ADA requirements. This equipment is unsafe for children to play on. The next priority, that is crucial to the success of our students, is to make the playground accessible for our special needs children. The current rubber chip surfacing makes it difficult for children using wheelchairs, walkers, or crutches to access the play areas. We would solve this problem by installing a pour and play surface material. This material would allow for an even surface that all children would be able to navigate to access their peers and playground equipment.

The new playground plan is designed for children 3 to 12 years old. It is intended to provide a great variety of creative play opportunities that will intrigue all children while helping to develop both physical and social skills.

The playground's projected install date is July 2016. We are using a volunteer based install as a way to cut back costs. The volunteer install involves community members assembling and installing the entire playground.

We are collecting items for our Spring Carnival to be used in raffle baskets and at our silent auction. Our Spring Carnival will be held on Saturday, April 23rd from 4:00-7:00.

Any donations, large or small, would be greatly appreciated and will show that the community supports the new playground project. Thank you for your consideration. If you have any questions, please contact Jenny Falk at (218) 391-6286 or jfalk@isd381.k12.mn.us. Donations can be mailed to:

Minnehaha PTA Playground Project
421 7th Street
Two Harbors, MN 55616

Healthy Legacy

Healthy people,
a clean environment
and a thriving economy

Moratorium on Use of Recycled Waste Tires in Playgrounds & Athletic Fields (SF 3108, HF 3496)

Healthy Legacy supports a policy to prevent potential adverse health effects to children and athletes from exposure to shredded waste tire mulch in playgrounds and athletic fields. SF 3108 / HF 3496 will:

- Establish a moratorium on the use of public funds for new playgrounds and athletic fields using shredded tire mulch or crumb rubber infill until July 2019.
- Requires the Minnesota Department of Health to review and evaluate a report to be issued by the California Office of Environmental Health Hazard Assessment[1] and report back to the Minnesota legislature on potential health risks to children and athletes of continued use of waste tires for playgrounds and athletic fields.
- Require signage to caution users of existing playgrounds and athletic fields of potential exposure and ways to reduce exposure to toxins in waste tire material.

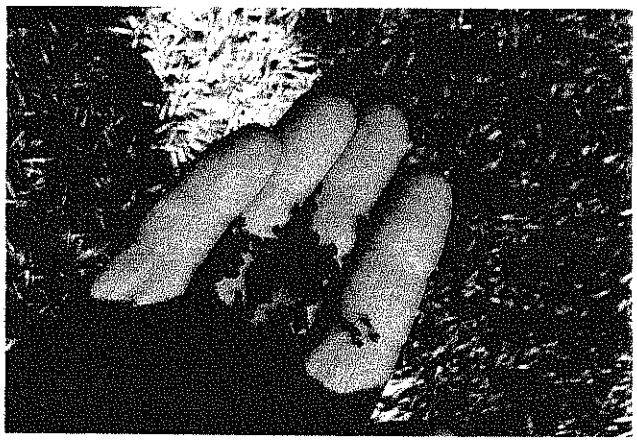
Safer Playground and Synthetic Turf Materials

Playground Alternative

Engineered wood fiber (EWF) is a safer and less expensive alternative to shredded tire mulch for use on playgrounds, with comparable fall protection. EWF is made from 100% virgin wood fiber and is not chemically treated in any way.

Synthetic Turf Infill Alternative

Organic infill made from a coconut fiber, cork and rice husk blend is a safer alternative to crumb rubber that is 100% recyclable, odor free, non-toxic and mold resistant.



This bill is an important step in addressing potentially harmful exposures of children and athletes to known toxic chemicals while they are at play.

Recycling of Waste Tires

Nearly 300 million car and truck tires are discarded every year, about one for every person. To address the problem of tire stockpiles emitting hazardous compounds into the environment, since 1995 the U.S. EPA has been encouraging the recycling of waste tires into playground mulch and synthetic turf athletic field infill. Although waste tires meet the Resource Conservation and Recovery Act's criteria for hazardous waste, they have received a special exemption for these uses.

Waste tires are ground up into pieces for use as playground mulch and processed into smaller pieces known as "crumb rubber" for use as synthetic turf infill. Use of recycled waste tires has grown over the last two decades. Thousands of playgrounds across the U.S. use shredded tire mulch as cushioning under outdoor play equipment. This includes nearly all Minneapolis public school playgrounds. Ninety-eight percent of the over 11,000 synthetic turf fields in the U.S. use crumb rubber infill.[2]

To leave a healthy legacy, Minnesota needs safe products and safe ways to make them.

Healthy Legacy

Safe products made safely

healthylegacy.org

Provided by Duluth Parents for Healthy Playgrounds

Toxic Chemicals Detected in Recycled Waste Tire Materials

According to a chemical analysis conducted by Yale University,[3] 96 chemicals were found in samples of shredded rubber tire playground mulch. For half of these chemicals, there is no government testing – so whether they are safe for human health is unknown.

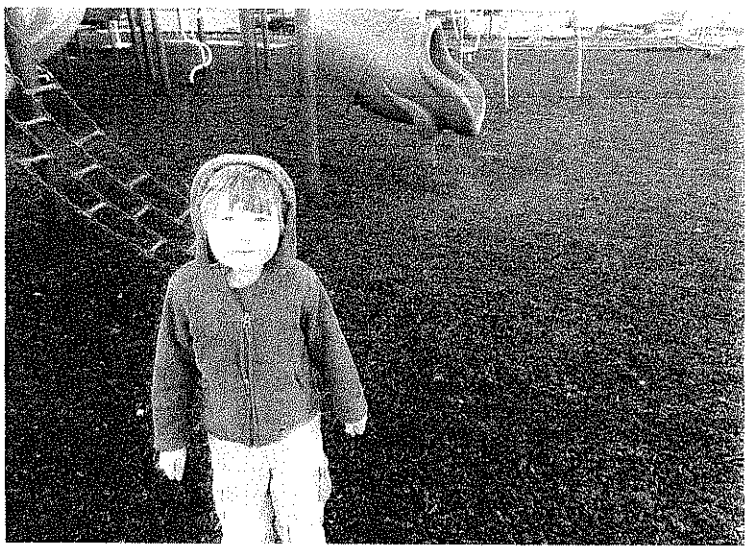
- Chemicals detected in shredded tire material include carcinogens, neurotoxins, respiratory/ eye/skin irritants and reproductive and developmental toxins.
- Chemicals detected include the brain toxins styrene, lead and cadmium, as well as carcinogens, arsenic, pyrene, carbon black, polycyclic hydrocarbons (PAHs), and butadiene.
- Another study confirms the presence of hazardous chemicals in tire mulch, including PAHs that are released through volatilization and can be inhaled. The authors caution, "Uses of recycled rubber tires, especially those targeting play areas and other facilities for children, should be a matter of regulatory concern."[4]
- Athletes playing on synthetic turf are exposed to chronic toxicity from PAHs, known carcinogens.[5] When the material gets hot, off-gassing of volatile organic compounds (VOCs) into the air increases.
- There is concern that soccer goalies with chronic exposure to crumb rubber on synthetic turf fields may be at higher risk for lymphoma and leukemia cancers.[6]

Contact us for more information:

• *Jenna Grove* •
jgrove@cleanwater.org
612-627-1539
• *Kathleen Schuler* •
Kathleen@conservationminnesota.org
612-767-1570

"Children go to playgrounds almost daily, and gifted athletes are on the soccer field almost every day. That sort of cumulative exposure results in a buildup in their body of these toxic chemicals, and can result in a buildup of cellular damage that's caused by these chemicals, that can then result in disease years or decades late. Little children should not be put in a situation where they're forced to be in intimate contact with carcinogenic chemicals."

Dr. Philip Landrigan
Dean of Global Health at Mount Sinai Medical Center and leading expert on the effects of chemicals on children.



Citations

[1]Office of Environmental Health Hazard Assessment (OEHHA) California Environmental Protection Agency http://oehha.ca.gov/risk/SyntheticTurf-Studies.html

[2]Synthetic Turf Council, http://www.syntheticturfcouncil.org/

[3]Environment & Human Health, Inc., 2007 http://www.ehhi.org/turf/metal_analysis2016.shtml

[4]Llompart M, Sanchez-Prado L, Lamas JP, Garcia-Jares c et al. Hazardous organic chemicals in rubber recycled tire playgrounds and pavers. Chemosphere 2013;90:423-31.

[5]Marsili L, Coppola D, Bianchi N, Maltese S et al. release of polycyclic aromatic hydrocarbons and heavy metals from rubber crumb in synthetic turf fields: preliminary hazard assessment for athletes. Environmental & Analytical Toxicology 2014;5(2):265.

[6]NBC News Investigation http://www.nbcnews.com/news/investigations/how-safe-artificial-turf-your-child-plays-n220166

[7]NBC News, used with permission of Dr. Landrigan http://www.nbcnews.com/news/investigations/rubber-mulch-safe-surface-your-childs-playground-n258586

SAMPLE MOCK-UP of Proposed Legislation

Provided by Duluth Parents for Healthy Playgrounds

Sample

State of Minnesota Dept. of Health

The Minnesota Dept. of Health encourages all those using athletic fields and playgrounds containing crumb rubber to observe the following recommendations:

1. **Wash hands and exposed body parts aggressively after playing on the field.**
2. **Turn clothes inside out as soon as possible after using the field to avoid tracking dust and infill to other locations.**
3. **Keep beverages closed and in bags or coolers when not drinking to minimize contamination from field dust and fibers.**
4. **Be aware of signs of heat-related illness and dehydration. Fields can get excessively hot on warm, sunny days. Take all necessary precautions.**

Scrap Tire Mulch Concerns and Replacement Ideas

Duluth Parents for Healthy Playgrounds

Precautionary Principle

"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)

There are numerous toxic substances in scrap tires.

- Phthalates are plasticizers that can affect hormones.
- Polycyclic aromatic hydrocarbons (PAHs) contain several known carcinogenic compounds.
- Volatile organic compounds (VOCs), in sufficient quantities, can cause eye, nose, and throat irritations, headaches, dizziness, visual disorders, and memory impairment. Some VOCs are suspected of or known to cause cancer.
- Benzene, lead, mercury, and arsenic are known or suspected to cause adverse health effects. Metals such as lead and arsenic can cause harm to developing nervous systems.
- Carbon black is a filler and reinforcing agent that may be manufactured with nanoparticles, including carbon nanotubes. Carbon nanotubes can behave like asbestos fibers.
- Rubberific mulch – the brand used at Lester Park Elementary – contained at least 12 "Chemicals of High Concern" listed by the Minnesota Department of Health. Four of the PAHs tested at levels higher than European Union regulations would allow.

Kids do more than simply run around on top of playground tire mulch.

- They bury each other in it, stuff it inside their clothes in "fat suit" games, and put it in their mouths during "rubber chip challenges".
- Many parents notice the fine, gray dust on kids' clothes, skin, and even inside their nostrils when they come home from school.
- The substances in the mulch are inhaled, ingested, and absorbed through kids' skin.
- The Material Safety Data Sheet (MSDS) for the mulch states that protective gloves are recommended, as is "frequent washing with soap and water of exposed areas, remove and clean soiled clothing".

Kids' higher risk to toxins is the subject of ongoing science and incomplete regulation.

- "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." (Dr. Nydra Booker, National Center for Health Research).
- Combinations of chemicals, even in small doses, may have synergistic effects that cause harm. Chemical mixture testing is not required yet by U.S. regulators (Harris-Lovett, 2015).
- One of the goals of a 2014 symposium hosted by the California Office of Environmental Health Hazard Assessment was "to get" regulatory scientists thinking about "how to incorporate complex interactions into risk assessment, particularly for early life exposures".
- A federal joint action plan to study key environmental human health questions of scrap tire crumb and mulch was recently initiated by multiple U.S. federal agencies.
- Because of clear evidence of marketing toward kids, the Consumer Product Safety Commission (CPSC) has been petitioned to regulate the mulch as a "children's product" – a label would carry strict lead exposure limits.

Suitable, affordable alternatives for playground surface cover are available now.

- For playgrounds with equipment fall heights greater than 10 feet, wood chips and engineered wood fiber (EWF) meet standards in the CPSC Public Playground Safety Handbook. Poured-in-place surfacing might also be a possible alternative to loose material.
- EWF is not chemically treated. With proper drainage, molds go away once EWF dries out. EWF tends to give or move upon contact so splinters are not a problem (IPEMA FAQ sheet).
- It also appears that mold and slivers have not been a significant issue at Minnesota schools. Of 79 districts that responded, 42 playgrounds use wood chips and/or EWF. None reported student absences due to mold (respiratory issues) or slivers (infections). Only 6 districts reported any mold on the playgrounds, and only 2 reported minor slivers.
- Other MN school districts are switching to EWF to save money. Paul Bourgeois, Executive Director of Finance & Operations for Minnetonka ISD 276 wrote:
    - "Right now our elementary schools use either rubber mulch or engineered wood chips, but in summer we are transitioning to all engineered wood chips. Rubber mulch is expensive and we are not going to spend further dollars for something that does not add value when something works just as well for much less cost. We are getting rid of the rubber mulch because of wanting to lower our costs and stretch scarce dollars."

Cost of removal and replacement could be lowered through community contributions.

- Business owners have expressed willingness to donate labor and equipment for mulch removal and excavation.
- Instead of disposal, road-surfacing companies have expressed interest in reusing tire mulch.
- Parents have volunteered for manual labor like spreading wood chips or EWF.
- Local wood chip donations could add volume before toping off playgrounds with EWF.
- Parents have expressed willingness to fundraise and also explore grant possibilities from environmental and health foundations to help offset cost.

Get around the uncertainties, create peace of mind, and bring people together around keeping kids healthy.

While research and assessment efforts recently initiated by the Environmental Protection Agency and other federal and state agencies are laudable, U.S. regulatory frameworks have a long way to go to satisfactorily incorporate the precautionary principle. The uncertainties regarding the complex interactions of multiple toxic chemicals in the developing bodies of young children suggest years of research to come, let alone incorporation into regulatory analyses and policies.

The immediate availability of suitable alternatives and potential support from parents and the business community can enable removal of the scrap tire mulch now. While the Minnesota legislature is considering a bill (SF 3108) to require warning signs be posted on playgrounds with tire mulch, ISD 709 could take real, preventative action now to help reduce children's exposure to toxic chemicals. By coordinating and creatively planning with parents, businesses, and other concerned members of the Duluth community, the financial impact of tire mulch removal and replacement can be minimized.

Scrap Tire Mulch on Duluth Public Schools' Playgrounds

A Summary of Children's Environmental Health Concerns

Prepared by

Duluth Parents for Healthy Playgrounds

October 19, 2015

Table of Contents

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 (Llompart 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[1]. We have distributed brochures and collected more than 500 online and paper signatures asking the Superintendent and the School Board to consider nontoxic alternatives[2].

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)

---

[1] 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/

[2] 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[3], 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.[4] 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.

[3] 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)

[4] 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.

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).[5] 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

[5] At the time of this report's release, the EPA's tire crumb webpage (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 (Linet 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[6], acquired permission from District officials, and hired North Shore Analytical[7] 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; Llompart 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[8] 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.[9]

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."

[6] http://www.gofundme.com/testtherubbermulch
[7] http://www.northshoreanalytical.com/
[8] http://www.legend-group.com/contact/saint-paul
[9] 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[10]	Health Endpoints[11]
Barium	Metals	1.1	1.4	x		Cardiovascular system, Kidney
Chromium[12]	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[13]	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

[10] Listed by MDH as Persistent, Bioaccumulative, Toxic (PBT) or very Persistent, very Bioaccumulative (vPvB).
[11] 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).
[12] 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.
[13] 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.[14] 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).

[14] 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.

References

ASTM International. (2015). About. Retrieved from http://www.astm.org/ABOUT/overview.html

Brown, D. (2007, June). Artificial turf: Exposures to ground-up rubber tires in athletic fields, gardens, and playgrounds. *Environment and Human Health, Inc.* Retrieved from http://www.ehhi.org/reports/turf/turf_report07.pdf

Booker, N. (2012, October). Caution: children at play on potentially toxic surfaces. National Center for Health Research. Retrieved from http://center4research.org/child-teen-health/early-childhood-development/caution-children-at-play-on-potentially-toxic-surfaces/

Burke, S. (2015, Feb.10) Councilmember Berliner applauds 'turning the page' on artificial turf" *Montgomery Community Media*. Retrieved from http://www.mymcmedia.org/councilmember-berliner-applauds-council-turning-the-page-on-artificial-turf/

California Office of Environmental Health Hazard Assessment (OEHHA). (2007, January). *Contractor's report to the board. Evaluation of health effects of recycled waste tires in playground and track products*. Retrieved from http://www.calrecycle.ca.gov/publications/Documents/Tires%5C62206013.pdf

California Office of Environmental Health Hazard Assessment (OEHHA). (2007, October 4). *Development of health criteria for school site risk assessment pursuant to health and safety code section 901(g): child specific reference doses (chRDs) for school site risk assessment: atrazine and delatmethrin: Final report.* Retrieved from http://www.oehha.ca.gov/public_info/public/kids/schools100407.html

California Office of Environmental Health Hazard Assessment (OEHHA). (2009, June 22). *Table of all child chRDs finalized to-date.* Retrieved from http://www.oehha.ca.gov/public_info/public/kids/chrdtable.html

California Office of Environmental Health Hazard Assessment (OEHHA) and California Environmental Protection Agency (Cal/EPA). (2010, June). *Development of health criteria for school site risk assessment pursuant to health and safety code section 901(g): child-specific reference dose (chRD) for school site risk assessment-Chlorpyrifos. Final Report.* Prepared by Qiao, D. Retrieved from http://oehha.ca.gov/public_info/public/kids/pdf/061710Chlorpyrifos.pdf

California Office of Environmental Health Hazard Assessment (OEHHA) and California Environmental Protection Agency (Cal/EPA). (2014, February). *Children's environmental health program, report to the California State Legislature.* Prepared by Ekanayake, R.,

Miller, M., & Marty, M. Retrieved from http://www.oehha.ca.gov/public_info/public/kids/pdf/2014legreport.pdf

California Office of Environmental Health Hazard Assessment (OEHHA). (2014). *Children's Health Symposium February 25 & 26, 2014. Call for Proposals.* Retrieved from http://oehha.ca.gov/public_info/public/kids/2014KidsHealth.html

Cardno ChemRisk. (2013, August 1). Review of the human health & ecological safety of exposure to recycled tire rubber found at playgrounds and synthetic turf fields. Prepared for Rubber Manufacturers of America. Retrieved from http://www.rma.org/download/scrap-tires/Environmental%20Issues/literature_review_0813.pdf

Centers for Disease Control and Prevention. (2013, June 15). Lead Fact Sheet. Retrieved from http://www.cdc.gov/nceh/lead/

Commission Regulation (EU) No 1272/2013 (2013, December 6). EUR Lex, Access to European Law Database. Retrieved from http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013R1272

Commonwealth of Kentucky Energy and Environment Cabinet. (2015). *Changes to crumb rubber grant program for fiscal year 2015.* Retrieved from http://waste.ky.gov/RLA/Waste%20Tires/Pages/CrumbRubber.aspx

Donaldson, K. et al. (2006). Carbon nanotubes: a review of their properties in relation to pulmonary toxicology and workplace safety. *Toxicological Sciences 92*, 5–22. Retrieved from http://toxsci.oxfordjournals.org/content/92/1/5.short

Environment and Human Health, Inc. (2015, August). Findings of the chemical analysis conducted by Yale University of the crumb rubber tire infill used in synthetic turf and the rubber tire mulch used as surfacing material in toddler playgrounds. Retrieved from http://www.ehhi.org/turf/findings0815.shtml

Environmental Protection Agency, (2009, November). *A scoping-level field monitoring study of synthetic turf fields and playgrounds.* Retrieved from http://www.libertytire.com/Libraries/Documents/USEPA-Study-Synthetic-Turf-Fields-Playrgounds-Nov-2009.sflb.ashx

Environmental Protection Agency. (2013, February 21). Terminology Services. http://ofmpub.epa.gov/sor_internet/registry/termreg/searchandretrieve/termsandacronyms/search.do

Environmental Protection Agency (2013, October 30). The use of recycled tire materials on playgrounds and artificial turf fields. Retrieved September 2015 from http://www.epa.gov/nerl/features/tire_crumbs.html

Environmental Protection Agency (2015, September 28). Introduction to indoor air quality. *Indoor Air Quality (IAQ Online).* Retrieved from http://www2.epa.gov/indoor-air-quality-iaq/introduction-indoor-air-quality

Felix, D.G. and SivaKumar, G. (2014, July-August). Nano particles in Automobile Tires. *IOSR Journal of Mechanical and Civil Engineering 11*(4) Version I: 07-11. Retrieved from http://www.iosrjournals.org/iosr-jmce/papers/vol11-issue4/Version-1/B011410711.pdf

Fibar Playground Surfaces. (2015, Oct. 6). *Frequently Asked Questions.* Retrieved from http://www.fibar.com/Playgrounds/systems_faq.htm

Gilbert, Steven. (2005). *A small dose of toxicology.* Boca Raton: CRC Press. Retrieved from https://books.google.com/books?id=wE_2riRrUgUC&printsec=frontcover&dq=A+Small+Dose+of+Toxicology&hl=en&sa=X&ved=0CB0Q6AEwAGoVChMIjbmOleKsyAIVkuCACh0f5gD0#v=onepage&q&f=false

Greenmeier, L. (2008, May 20). Study says carbon nanotubes as dangerous as asbestos. *Scientific American.* Retrieved from http://www.scientificamerican.com/article/carbon-nanotube-danger/

International Agency for Research on Cancer (IARC). (2012). *IARC monograph on the evaluation of carcinogenic risk to humans, 100(f),* 1-46. Retrieved from http://monographs.iarc.fr/ENG/Monographs/vol100F/

International Mulch Company. (2001, June 18). *Material Safety Data Sheet.*

International Programme on Chemical Safety. (2010, July 5) Chemical Safety Card on Carbon Black. Retrieved from http://www.inchem.org/documents/icsc/icsc/eics0471.htm

International Playground Equipment Manufacturers Association (2015, October). Certified Products. Retrieved from http://www.ipema.org/certified_products_search.cfm

Kaye, Elliot (2015, May 19). Hearing of the House Commerce, Manufacturing, and Trade Subcommittee of the Energy and Commerce Committee - Oversight of the Consumer Product Safety Commission. Available at https://www.youtube.com/watch?v=7crcxR8aYjo. Accessed October 7, 2015.

Linet, M. et al. (2015). A retrospective cohort study of cause-specific mortality and incidence of hematopoietic malignancies in Chinese benzene-exposed workers. *International Journal of Cancer, 37*, 2184-2197. Retrieved from http://onlinelibrary.wiley.com/doi/10.1002/ijc.29591/abstract

Llompart, M., Sanchez-Pradoa, L., J.P., Lamas, Garcia-Jeresa, C., Roca, E., and Dagnac, T., (2013). Hazardous organic chemicals in rubber recycled tire playgrounds and pavers. *Chemosphere, 90*(2), 423-431. doi:10.1016/j.2012.07.053. Retrieved from http://www.sciencedirect.com/science/article/pii/S0045653512009848

Mellio, C. (2015, January 22). Is artificial turf safe for your children?" *EcoWatch.* Retrieved from http://ecowatch.com/2015/01/22/artificial-turf-safe-children/

Minnesota Department of Health. (2013, July 1). *Chemicals of high concern report.* Toxic Free Kids Program. Retrieved from http://www.health.state.mn.us/divs/eh/hazardous/topics/toxfreekids/highconcern.html

Novak, J. (2011, June-July). Is artificial turf hiding a 800 pound gorilla? *Turfgrass Producers International E-Newsletter.* Retrieved from www.turfgrasssod.org/files/file/c440ccb1-0c69-41a4-b98a-ee8a414effb1

Nowack, B., David, R.M., Fissan, H., Morris, H., Shatkin, J.A., Stintz, M., Zepp, R., and Brouwer, D. (2013, May 23). Potential release scenarios for carbon nanotubes used in composites. *Environment International 59*:1-11. doi: 10.1016. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/23708563

Perez, A.J. (2009, June 10). Two cities spurn crumb rubber in artificial turf" *USAToday*. Retrieved from http://usatoday30.usatoday.com/sports/2009-06-10-artificial-turf_N.htm

Poland, C., Duffin, R., Kinloch, I., Maynard, A., Wallace, W., Seaton, A., Stone, V., Brown, S., MacNee, W., and Donaldson, K. (2008, May 20). Carbon nanotubes introduced into the abdominal cavity of mice show asbestos-like pathogenicity in a pilot study. *Nature Nanotechnology, 3*423-428. Retrieved from http://www.nature.com/nnano/journal/v3/n7/full/nnano.2008.111.html

Stockman, R. (2015, April 29). *CPSC no longer stands behind the safety of artificial turf.* WSB-TV Atlanta. Retrieved from http://www.wsbtv.com/news/news/local/cpsc-says-they-no-longer-think-crumb-rubber-artifi/nk6Ch/

United States Consumer Product Safety Commission. (2010, November). *Public Playground Safety Handbook.* Retrieved from http://www.cpsc.gov/PageFiles/122149/325.pdf

World Health Organization. (2004). *The precautionary principle: protecting public health, the environment and the future of our children.* Eds. Martuzzi, M., and Tickner, J. Retrieved from http://www.euro.who.int/__data/assets/pdf_file/0003/91173/E83079.pdf

Acknowledgements

Writers and contributors
Avesa Rockwell
Aaron Crowell
Cory Kirsling
Jamie Parent

Reviewers
Kellie Fay, PhD
John Morrice, PhD
Judith Johnson, MD

Contact info
healthyplayduluth@gmail.com

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.

LEGEND
Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

North Shore Analytical, Inc.	Project:	Analytical Services	
4511 W. 1st.	Project Number:	Rubber Mulch	Work Order #: 1503733
Duluth, MN 55807	Project Manager:	Ms. Linda Christensen	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:

LEGEND
Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

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

TOTAL METALS ANALYSIS
Legend Technical Services, Inc.

Analyte	Result	RL	MDL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
LPS Playground (1503733-01) Other Sampled: 09/03/15 10:00 Received: 09/04/15 11:15										
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	"	
Raw Mulch (1503733-02) Other Sampled: 09/03/15 00:00 Received: 09/04/15 11:15										
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	"	

LEGEND
Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

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

PAH 8270D
Legend Technical Services, Inc.

Analyte	Result	RL	MDL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
LPS Playground (1503733-01) Other Sampled: 09/03/15 10:00 Received: 09/04/15 11:15										
2-Chloronaphthalene	<1.1	1.1	0.22	mg/kg dry	1	B5I0903	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	"	"	"	"	
Benzo(b)fluoranthene	**1.4**	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	"	"	"	"	
Chrysene	**1.8**	1.1	0.21	mg/kg dry	1	"	"	"	"	
Dibenz(a,h)anthracene	<1.1	1.1	0.27	mg/kg dry	1	"	"	"	"	
Fluoranthene	**5.4**	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	"	"	"	"	
Phenanthrene	**2.9**	1.1	0.22	mg/kg dry	1	"	"	"	"	
Pyrene	**6.2**	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	B5I0903	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	"	"	"	"	
Anthracene	**1.5**	1.3	0.28	mg/kg dry	1	"	"	"	"	
Benzo(a)anthracene	**1.9**	1.3	0.26	mg/kg dry	1	"	"	"	"	
Benzo(a)pyrene	**1.6**	1.3	0.28	mg/kg dry	1	"	"	"	"	
Benzo(b)fluoranthene	**3.6**	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	"	"	"	"	
Chrysene	**4.6**	1.3	0.26	mg/kg dry	1	"	"	"	"	
Dibenz(a,h)anthracene	<1.3	1.3	0.33	mg/kg dry	1	"	"	"	"	
Fluoranthene	**10**	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	"	"	"	"	
Phenanthrene	**9.3**	1.3	0.27	mg/kg dry	1	"	"	"	"	

LEGEND
Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

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

PAH 8270D
Legend Technical Services, Inc.

Analyte	Result	RL	MDL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Raw Mulch (1503733-02) Other	**Sampled: 09/03/15 00:00**		**Received: 09/04/15 11:15**							
Pyrene	**9.8**	1.3	0.24	mg/kg dry	1	B5I0903	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*

LEGEND
Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

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

PERCENT SOLIDS
Legend Technical Services, Inc.

Analyte	Result	RL	MDL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
LPS Playground (1503733-01) Other Sampled: 09/03/15 10:00 Received: 09/04/15 11:15										
% Solids	98			%	1	B5I1409	09/14/15	09/14/15	% calculation	
Raw Mulch (1503733-02) Other Sampled: 09/03/15 00:00 Received: 09/04/15 11:15										
% Solids	99			%	1	B5I1409	09/14/15	09/14/15	% calculation	

LEGEND
Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

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

VOC 8260B
Legend Technical Services, Inc.

Analyte	Result	RL	MDL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
LPS Playground (1503733-01) Other	**Sampled: 09/03/15 10:00**			**Received: 09/04/15 11:15**						W-03
1,1,1,2-Tetrachloroethane	<0.76	0.76	0.15	mg/kg dry	1	B5I1717	09/16/15	09/17/15	EPA 8260B	
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	"	"	"	"	

LEGEND
Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

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

VOC 8260B
Legend Technical Services, Inc.

Analyte	Result	RL	MDL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
LPS Playground (1503733-01) Other	**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	B5I1717	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 %*		"	"	"	"	
Raw Mulch (1503733-02) Other	**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	B5I1717	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	"	"	"	"	

LEGEND
Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

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

VOC 8260B
Legend Technical Services, Inc.

Analyte	Result	RL	MDL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Raw Mulch (1503733-02) Other	**Sampled: 09/03/15 00:00**		**Received: 09/04/15 11:15**							W-03
1,1-Dichloroethene	<0.68	0.68	0.088	mg/kg dry	1	B5I1717	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	"	"	"	"	

LEGEND
Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

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

VOC 8260B
Legend Technical Services, Inc.

Analyte	Result	RL	MDL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Raw Mulch (1503733-02) Other	**Sampled: 09/03/15 00:00**		**Received: 09/04/15 11:15**							W-03
Ethylbenzene	<0.68	0.68	0.14	mg/kg dry	1	B5I1717	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	"	"	"	"	
Methyl isobutyl ketone	**22**	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 %*		"	"	"	"	
Trip Blank (1503733-03) Methanol	**Sampled: 09/03/15 00:00**		**Received: 09/04/15 11:15**							
1,1,1,2-Tetrachloroethane	<0.20	0.20	0.040	mg/kg wet	1	B5I1717	09/16/15	09/17/15	EPA 8260B	
1,1,1-Trichloroethane	<0.20	0.20	0.046	mg/kg wet	1	"	"	"	"	
1,1,2,2-Tetrachloroethane	<0.20	0.20	0.032	mg/kg wet	1	"	"	"	"	
1,1,2-Trichloroethane	<0.20	0.20	0.028	mg/kg wet	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-Trichloropropane	<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	"	"	"	"	

LEGEND
Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

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

VOC 8260B
Legend Technical Services, Inc.

Analyte	Result	RL	MDL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Trip Blank (1503733-03) Methanol	**Sampled: 09/03/15 00:00**		**Received: 09/04/15 11:15**							
1,2-Dibromo-3-chloropropane	<0.50	0.50	0.092	mg/kg wet	1	B5I1717	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	"	"	"	"	

LEGEND
Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

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

VOC 8260B
Legend Technical Services, Inc.

Analyte	Result	RL	MDL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Trip Blank (1503733-03) Methanol	**Sampled: 09/03/15 00:00**		**Received: 09/04/15 11:15**							
Methylene chloride	<0.50	0.50	0.12	mg/kg wet	1	B5I1717	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 %*		"	"	"	"	

LEGEND
Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

North Shore Analytical, Inc.	Project:	Analytical Services	
4511 W. 1st.	Project Number:	Rubber Mulch	Work Order #: 1503733
Duluth, MN 55807	Project Manager:	Ms. Linda Christensen	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
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	

LEGEND
Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

North Shore Analytical, Inc.	Project:	Analytical Services	
4511 W. 1st.	Project Number:	Rubber Mulch	Work Order #: 1503733
Duluth, MN 55807	Project Manager:	Ms. Linda Christensen	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
Batch B5I0412 - EPA 3050B											
Matrix Spike Dup (B5I0412-MSD1)		**Source: 1503691-01**			Prepared: 09/04/15		Analyzed: 09/09/15				
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	

LEGEND
Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

North Shore Analytical, Inc.	Project:	Analytical Services	
4511 W. 1st.	Project Number:	Rubber Mulch	Work Order #: 1503733
Duluth, MN 55807	Project Manager:	Ms. Linda Christensen	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
Batch B5I0903 - EPA 3545 ASE Extraction											
Blank (B5I0903-BLK1)					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*			
LCS (B5I0903-BS1)					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*			

LEGEND Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

North Shore Analytical, Inc.	Project:	Analytical Services	
4511 W. 1st.	Project Number:	Rubber Mulch	Work Order #: 1503733
Duluth, MN 55807	Project Manager:	Ms. Linda Christensen	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
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*			

LEGEND
Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

North Shore Analytical, Inc.	Project:	Analytical Services	
4511 W. 1st.	Project Number:	Rubber Mulch	Work Order #: 1503733
Duluth, MN 55807	Project Manager:	Ms. Linda Christensen	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
Batch B5I1409 - General Preparation											
Duplicate (B5I1409-DUP1)		**Source: 1503838-01**			Prepared & Analyzed: 09/14/15						
% Solids	87.0			%		86.0			1.16	20	

LEGEND
Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

North Shore Analytical, Inc.	Project:	Analytical Services	
4511 W. 1st.	Project Number:	Rubber Mulch	Work Order #: 1503733
Duluth, MN 55807	Project Manager:	Ms. Linda Christensen	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
Batch B5I1717 - EPA 5035 Soil (Purge and Trap)											
Blank (B5I1717-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							

LEGEND
Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

North Shore Analytical, Inc.	Project:	Analytical Services	
4511 W. 1st.	Project Number:	Rubber Mulch	Work Order #: 1503733
Duluth, MN 55807	Project Manager:	Ms. Linda Christensen	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
Batch B5I1717 - EPA 5035 Soil (Purge and Trap)											
Blank (B5I1717-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 (B5I1717-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			

LEGEND
Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

North Shore Analytical, Inc.	Project:	Analytical Services	
4511 W. 1st.	Project Number:	Rubber Mulch	Work Order #: 1503733
Duluth, MN 55807	Project Manager:	Ms. Linda Christensen	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
Batch B5I1717 - EPA 5035 Soil (Purge and Trap)											
LCS (B5I1717-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 (B5I1717-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 (B5I1717-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	

LEGEND
Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

North Shore Analytical, Inc.	Project:	Analytical Services	
4511 W. 1st.	Project Number:	Rubber Mulch	Work Order #: 1503733
Duluth, MN 55807	Project Manager:	Ms. Linda Christensen	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
Batch B5I1717 - EPA 5035 Soil (Purge and Trap)											
Matrix Spike Dup (B5I1717-MSD1)	**Source: 1503838-01**				Prepared: 09/16/15 Analyzed: 09/17/15						
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*			

LEGEND
Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

North Shore Analytical, Inc.	Project:	Analytical Services	
4511 W. 1st.	Project Number:	Rubber Mulch	Work Order #: 1503733
Duluth, MN 55807	Project Manager:	Ms. Linda Christensen	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 critieria.
<	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)

LEGEND Technical Services, Inc.
www.legend-group.com

88 Empire Drive
St Paul, MN 55103
Tel: 651-642-1150
Fax: 651-642-1239

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
Attn: CHRIS/LINDA
Phone: 218 729 4658
Project Name: Rubber Mulch

Bill To: Same ←
Address:
PO #:
E-mail: info@northshoreanalytical.com
Project#: Rubber Mulch

LEGEND Project#: 1503733
Turn Around Time: ☐ Normal ☐ RUSH
Requested Due Date:
Condition Received:
☐ Received at 20.5 °C
☐ Temp. from unpreserved sample
☐ Received on ice
☐ No temp. blank
☐ Received on ice pack
☒ Received on melt water
☐ Received ambient
☐ Acceptable (IH/ISO only)
☐ Custody Seals

COC/Sample Comments:
LPS Playground = rubber mulch from play area
Raw Mulch = supplied from vendor

Item No.	Sample Name	Grab	Comp.	Collection Date	Collection Time	Sample Matrix	Lab ID No.	Number of Containers	VOC	PAH	RCRA-Ag+Zn				Major Sample Components (5 greatest, including hazardous)
1	LPS Playground	✓		9/3/15	1000	Solid	01AC		X	X	X				Shredded rubber
2	Raw Mulch	✓		9/3/15		Solid	02 ↓		X	X	X				↓
3	TRIP BLANK (1) VIAL w/ MeOH	✓		9/3/15		"	03 A		X						
4															
5															
6															
7															
8															
9															
10															

Sample Collector (please print): CHRIS GROSS
Comments: For Cory Kirsling Re: LPS Playground

Relinquished By:	Date:	Time:	Accepted by:	Date:	Time:
[signature]	9/3/15	1300			
Relinquished By:	Date:	Time:	Received by Lab:	Date:	Time:
			[signature]	9/4/15	1115

PLEASE REVIEW TERMS AND CONDITIONS ON BACK BEFORE SIGNING

Form LAB-268.5 (12/14) **White Copy** - Original Accompanies Shipment to Lab **Yellow Copy** - Lab **Pink Copy** - Customer or Field Copy

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Options	Pros	Cons	Notes
1. Replace 6 “of rubber nuggets (RN) with 6” of wood fiber	Lowest cost in short term but will require regular replenishment	Fall height protection would require removal of all components with fall heights > 6’	This would include, space net, swings, most of the slides and many other components
2. Excavate down 6” and replace with 12” of wood fiber	Allows existing components to be kept	Current site has been engineered for 6” of material (curb height and footer depth) – this would mean 6” of compacted soil would be removed from around the footers	Because of the potential to compromise the structural integrity of the footers I am in the process of talking to structural engineer at the manufacturer to determine if this option can be done safely
3. Remove rubber and replace with poured in place (PIP) surface	This would be a more accessible (ADA) and aesthetically pleasing surface	Price – in addition to the price of removing the rubber a compacted aggregate or concrete would need to be placed in as a base. The surfacing is then mixed on site and then troweled on. This is likely to cost in the $22 to $25 a sq ‘ range	Using the existing RN in the mix was investigated but is cost prohibitive – RN would need to be shipped to Ohio processed and then shipped back. Because of freight and labor costs it would be less expensive to put in new product
4. Keep existing RN- but cover it with a playground grass (Foreverlawn)– product is laid down like a carpet	Provides a more natural appearance and greater accessibility. Would likely be at least half the price of PIP. Would encapsulate existing RB so migration of product and dispersal of rubber dust would be mostly eliminated	Installation would require cutting around existing components so numerous seams may be needed	Will discuss the current situation with the manufacturer to see if 1) the product can be secured using RB as the base and 2) if there are recommendations on placing product around existing equipment to minimize ongoing maintenance

PLAYGROUND SURFACING: TO REPLACE RUBBER WITH ENGINEERED WOOD MULCH

ENGINEERED SHREDDED WOOD SURFACE
$2,238 per truck load (90 yards)
Total amount needed is aprox. 42 truck loads
Aprox. **$92,000** for Engineerd Wood Material Only
Installation Estimated **$18,500** ($5/yrd)

SHREDDED RUBBER SURFACE REMOVAL COST
Aprox. 1,480 cubic yards
Weight aprox. 660 tons
Estimated cost **$40,000** to remove rubber -

salvaged by District for use as landscape mulch

(Lakewood and Stowe) Surface material flush with at top of curb
Removal of existing 6" of rubber surfacing
Excavate 6" of granular subgrade, remove top 6" of concrete footings, and install new fabric and rubber pads (may impact drainage)
Estimated cost ($30K each) **$60,000** total
NOTE: Because of concrete footings, equipment may required removal and reinstalled (20" depth and block footings)
If necessary add : Estimated cost $25K each or $50,000 Total

(Homecoft, Laura MacArthur, Lester Park, Lincoln Park MS, Lowell, Myers-Wilkins,Ordean East MS, Piedmont)
Surface Material 6" below top of curb
Remove existing 6" of rubber surfacing
Excavate 6" of granular subgrade, remove top 6" of concrete footings, and install new fabric and rubber pads (may inpact drainage)
NOTE: Because of concrete footings, equipment may be required to be removed and reinstalled (20" depth and block footings)

OPTION: Remove and reinstall equipment at existing subgrade, install mulch to top of curb
Considered the lowest cost at Estimated **$175,000** ($25K each): note will result in wood mulch flush with curb.
Maintaining mulch a elevation 6" below top of curb reduces maintenance and loss of material from spill over.

Total Estimated Cost: $385,000

PLAYGROUND SURFACING: TO REPLACE RUBBER WITH ENGINEERED WOOD MULCH

SCHOOL	ADDRESS	SQ.FT. AREA	CUBIC YRDS RUBBER (6")	CUBIC YRDS *wood (12")*	CUBIC YRDS ** **wood (15" loose)**
Homecroft	4784 Howard Gnesen Road	8,714	161	*323*	**403**
Lakewood	5207 North Tischer Road	9,939	184	*368*	**460**
Laura MacArthur	720 North Central Avenue	9,145	169	*339*	**423**
Lester Park	5300 Glenwood Road	10,592	196	*392*	**490**
Lincoln Park MS	3215 West 3rd Street	4,107	76	*152*	**190**
Lowell	2000 Rice Lake Road	8,970	166	*332*	**415**
Myers-Wilkins	1027 North 8th Avenue East	7,834	145	*290*	**363**
Ordean East MS	2900 East 4th Street	3,137	58	*116*	**145**
Piedmont	2827 Chambersburg Avenue	9,359	173	*347*	**433**
Stowe	715 - 101st Avenue West	8,144	151	*302*	**377**
(** Quantity Adjusted for Compaction)			1,480	2,961	**3,701**