

# ACT GLOBAL CRUMB RUBBER SAFETY STUDY

Prepared for Act Global

By R. William Tilford, PhD.

Published February 11, 2015

*Act Global initiated crumb rubber testing from three independent laboratories. To validate and triangulate the results, Dr. R. William Tilford was engaged by Act Global for objective and professional oversight and review. Dr. Tilford has a doctorate in organic chemistry and fourteen years of experience as a research chemist, with a thorough understanding of how organic molecules react with each other and their environments.*

## **Introduction**

Artificial turf has been used in sports fields since invented in 1962. Despite their many benefits, for years these fields suffered from one key drawback. The relatively thin layer of turf, normally installed over a hard durable surface such as concrete, did not provide sufficient shock absorption to accommodate the rigors of athletic competition. To address this issue, an intermediate cushioning layer of elastic material was implemented into the design in the 1990s. An ideal material with which to create this shock-absorbing interlayer was styrene butadiene rubber (SBR), which is often utilized for applications where it is necessary to protect bodies against repeated exposure to mechanical stress. The most notable example is in automobile tires which provide a constant elastic buffer between the road and automobile. Developments in recycling technologies enabled used automobile tires destined for landfills to instead be processed and repurposed as SBR crumb rubber infill. This source of SBR provides an efficient means of improving both the performance and safety of artificial turf systems.

Act Global initiated a review of a crumb rubber supply used in their synthetic turf systems to examine the potential presence of any chemical species that would cause concern over its use as a raw material. Samples were provided to three independently certified laboratories for evaluation of trace metals, semi-volatile, and volatile organic compounds (VOCs). Standardized test protocols established by the US Environmental Protection Agency (EPA) and European Union were employed. To further validate and triangulate the results, Dr. Tilford was engaged by Act Global to provide objective and professional oversight and review of the testing.

## **Testing and Methodologies**

The three testing agencies and corresponding methodologies are listed as follows:

- Labosport (Le Mans, France), which specializes in sports product, equipment, and site testing analyzed samples via method EN 71-3 which is used to establish compliance with European Union safety standards for toys.
- Paradigm Environmental Services (Syracuse, NY), specializing in consumer products and environmental testing, evaluated samples according to EPA methods 7471B (mercury), 6010C and 3050 (heavy metals), and 8270D and 3550C (semi-volatiles)

- Trace Analysis Inc. (Lubbock, TX), an ISO 17205 certified laboratory, evaluated samples according to EPA methods 7471B (mercury), 6010C (heavy metals), 8270D (semi-volatiles), and 8260C (VOCs).

### *Methodology Discussion*

The data discussed herein was produced from standard test methodology by three separate, independent and reputable agencies, to model the approach regulatory institutions such as the EPA or EU would take in this circumstance. The analysis conducted by these entities was no doubt comprehensive and performed within proper and acceptable scientific standards. It is reasonable to assume other testing entities would apply the same methods to investigate the presence of hazardous contaminants in these or similar samples. It is assumed that the samples provided were representative of their description and identification.

Upon examination of testing results such as these, it is essential to consider two key points. First, the analytical testing techniques utilized are highly sensitive, but no chemical analysis tool is ever capable of affirming the complete absence of any analyte. That is, it can never state with absolute certainty that the concentration of a particular chemical species in a sample is unequivocally zero. These and similar test methods determine the quantity of certain chemicals within a given sample so long as that quantity is greater than the limit of detection (LOD) for that method. When a chemical is not observed in a quantity greater than the LOD, it is customary to issue a reported value as “< LOD” (i.e. less than the detectable limit) or to simply denote “not detected.” Secondly, in cases where chemical species are present in detectable quantities, it is important to reiterate that many analysis methods are highly sensitive and capable of detecting levels of analyte far lower than what may be considered hazardous. The detectable presence of some hazardous material in a sample does not immediately infer that the sample origin is a contaminating entity within its environment. It is important to compare detected levels against known background levels for a given analyte. Lead for example is naturally present in soils at around 10 parts per million (ppm),<sup>1</sup> although many metals analysis methods, such as those employed herein, are capable of distinguishing single ppm levels. These points are noted with the intention of preempting any interpretation outside the proper context of the analysis methods used.

## Results

### *Results Executive Summary*

Of the eighty-three substances measured during testing, the vast majority were either not present or present well below acceptable limits of exposure. Nine compounds under the category of Semi-volatiles were present in the sample. Of these, two were considered to be of negligible concern due to their low abundance and minimal toxicity. The remaining seven substances belong to a class of compounds known as polycyclic aromatic compounds (PAHs). While they are known to be present in crumb rubber, studies have shown this to be a negligible source of exposure to these materials. Cognizant of this, the analyzed samples offered no apparent hazard.

### *Metals*

All three testing agencies analyzed samples for mercury (Hg) content, and in all three cases reported levels were below detectable limits. Method EN 71-3, employed by Labosport, was the least sensitive method with a limit of detection at 0.5 mg Kg<sup>-1</sup> (ppm). Paradigm's utilization of EPA Method 7471B proved to be the most sensitive with a detection limit at 0.018 ppm. Labosport's metals analysis was the most comprehensive of the three, which measured the presence of seventeen different metals. Zinc (Zn) was found in the highest concentration at 424 ppm, but still over a hundred times lower than its maximum allowable limit (46,000 ppm). Cobalt (Co) was detected closest to its maximum allowable limit of 130 ppm at 1.62 ppm, still over eighty times below the limit.

Arsenic (Ar) was not detected by any of the three analyses. EPA methods conducted by Paradigm and Trace Metals Inc. only found chromium (Cr) and lead (Pb) in detectable levels. Lead (Pb) was detected at a concentration of 9.83 ppm and 11.9 ppm, respectively. For comparison, background levels of lead in soil typically range from 7 - 20 ppm.<sup>1</sup> Labosport's methodology further distinguished between Cr(III) and Cr(VI), the latter of which is a higher oxidation state form of Chromium and is considered more hazardous. No Cr(VI) was detected in the crumb rubber samples.

### *Semi-volatiles*

Both Trace Analysis Inc. and Paradigm conducted semi-volatiles analysis by EPA Method 8270D. Paradigm followed a more rigorous protocol including implementation EPA

Method 3550C which utilizes an ultra-sonic bath during the extraction procedure to ensure intimate contact with the sample matrix and the extraction solvent. The extraction solvent pulls chemicals to be analyzed, in this case semi-volatile compounds, out of the sample to create a solution. The solution is then injected into a Gas Chromatograph (GC) which is used to determine the concentration of the species within that solution and subsequently the original sample matrix.

Out of a list of fourteen common semi-volatile compounds, none were found to be present above the detection limit of 0.05 ppm in results obtained by Trace Analysis Inc. The majority of compounds in this list were chlorinated organics with the exception of pyridine, cresols, nitrobenzene, and dinitrobenzene. Paradigm analyzed a far more extensive list of fifty-six compounds in their reported data. Forty-three compounds in that list were not present at levels above their detection limit of 1.42 ppm. Four other compounds were not present above their detection limit of 2.85 ppm. A total of nine compounds were found in the crumb rubber sample above their respective detection limits.

Bis(2-ethylhexyl)phthalate was present at 21 ppm. It is commonly used to improve plasticity in plastics and rubber and is generally considered to be of low or minimal toxicity.<sup>2</sup> *N*-nitrosodiphenylamine was present at 1.47 ppm. There is limited data suggesting that this substance is carcinogenic by oral exposure. However, this data was collected from animal models administered very high doses of 4000 ppm.<sup>3</sup> The remaining seven substances found in the crumb rubber sample were benzo[*a*]anthracene (2.24 ppm), benzo[*a*]fluoranthene (2.48 ppm), benzo[*k*]fluoranthene (2.48 ppm), chrysene (6.62 ppm), fluoranthene (10.80 ppm), phenanthrene (4.00 ppm), and pyrene (17.5 ppm). These compounds belong to a class of materials referred to as polycyclic aromatic hydrocarbons (PAHs). The aggregate concentration of PAHs in the sample was 46.1 ppm, which is no higher than other more prevalent environmental sources. PAHs are generally observed as byproducts of incomplete combustion processes, derived from both natural and man-made sources and often occur as mixtures, as is the case here. One of the most common sources of exposure comes from ingestion of charred or smoked meats. This is believed to be the primary source of human exposure.<sup>4</sup> The black char present on grilled hamburgers or steak for example are known to contain PAHs. Another common source of exposure is derived from asphalt paved roads and driveways.<sup>5</sup> PAHs are also present in automobile exhaust. Because they most commonly occur as complex mixtures of many compounds, studies to obtain precise toxicological data have been somewhat unclear,

although chronic elevated exposure to PAHs are generally associated with an increased risk of cancer.<sup>6</sup>

PAHs are very hydrophobic and prefer to remain in an environment like rubber, not water-based systems like human bodies. Athletes playing on synthetic turf fields have been monitored specifically for PAH exposure.<sup>7</sup> In one such study, levels were monitored the day before, the day of, and the day after playing two and a half hours, with intensive skin contact on a synthetic turf field containing crumb rubber infill. Results indicated that increased PAH levels were minimal and within background levels resulting from environmental and dietary sources.

### VOCs

Analysis provided by Trace Analysis Inc. included measurement for the presence of eleven different VOCs, including methyl ethyl ketone (MEK), benzene, vinyl chloride, along with a number of other volatile chlorinated compounds. No chemical species in this category were found above detectable levels (<0.05 ppm).

## Summary

The objective of this study on the part of Act Global was to obtain data that would answer the question, “*Is crumb rubber safe, especially for kids?*” The services of three separate accredited and independent testing laboratories were utilized in an effort to model the approach regulatory institutions such as the EPA or EU would take in this circumstance. The analysis conducted by these entities was no doubt comprehensive and performed within proper and acceptable scientific standards to investigate an array of metals, VOCs, as well as semi-volatiles.

The metals analysis appeared conclusive with corroborating results from all three agencies that the risk of hazardous exposure levels to these metals is minimal. Metals were either present below their limit of detection or well below maximum allowable limits. Risk of exposure to VOCs was also conclusive based on standard EPA methods that there is no observable risk of exposure to these materials based on test results. The semi-volatiles analysis conducted by Paradigm examined a more comprehensive list of chemical species than Trace Analysis Inc., and did detect the presence of seven PAHs, which are suspected of exhibiting carcinogenicity at chronically elevated exposure levels. However, the levels found in

this study were not higher than other more prevalent environmental sources, such as paved roads and asphalt driveways or charred and smoked meats. And furthermore, studies have concluded that PAH uptake from crumb rubber on sports fields is negligible at best. This collective body of data supports that this sample of crumb rubber is safe.

## **About the Author**

R. William Tilford PhD. began his career as a research chemist in 2001 as an intern for DuPont while in undergraduate studies. During that time, he participated in research on developing processes to recycle consumer plastics into a feedstock for insulation materials. He further obtained his doctorate in organic chemistry from the University of South Carolina, with a concentration in polymers and materials science. During dissertation, Tilford authored or co-authored three published articles in internationally renowned peer-reviewed scientific journals, as well as one book chapter and a granted patent. To date, Tilford has produced seven peer-reviewed publications and patents. Since 2008 Tilford has worked in the private sector, primarily in the development of chemical processing techniques employed in the manufacture of munitions, pharmaceuticals, and construction materials. Primary proficiencies are focused on understanding, analyzing and applying how organic molecules react with each other and their environments.

## References

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## **TECHNICAL REPORT**

Toxicological Analysis of performance infill for synthetic turf fields according to *EN 71-3* standard  
– Safety of toys Part 3: Migration of certain elements.

Report Number **R14549CAN-A1**

**Act Global**  
Client 4201 West Parmer Lane  
Suite B 175  
Austin, Texas 78727 USA

Date **November 20<sup>th</sup> 2014**

*This report contains 3 pages in total.*

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**Toxicological Analysis of performance infill for synthetic turf fields according to EN 71-3 standard  
– Safety of toys Part 3: Migration of certain elements.**



**SUMMARY**

Toxicology test according to **EN 71-3 - Safety of toys Part 3: Migration of certain elements (Material of Category III)** has been carried out on rubber samples.

Abstract:

The EN 71-3 standard specifies maximum migration limits for three categories of (toy) materials. The limits for the migration of certain elements are expressed in milligrams per kilogram material and are detailed in the report. The purpose of the limits is to minimise children’s exposure to certain potentially toxic elements. The EN 71-3 concerns all toys and materials that might be ingested.

Soluble elements are extracted from materials using conditions which simulate the material remaining in contact with gastric juices for a period of time after swallowing. The concentrations of the soluble elements are determined quantitatively by two different methods:

1. Method for determining general elements: Aluminium, Antimony, Arsenic, Barium, Boron, Cadmium, Chromium, Cobalt, Copper, Lead, Manganese, Mercury, Nickel, Selenium, Strontium, Tin and Zinc;
2. Method for determining Chromium (III) and Chromium (VI);

**DESCRIPTION OF THE PRODUCT**

Description of the product tested	PERFORMANCE INFILL FOR SYNTHETIC TURF FIELDS
Name of the product	SBR RUBBER – AMBIENT GROUND
Manufacturer	LIBERTY TIRE
Sample number	10462 (NOTE: THE RESULTS OF THIS REPORT ARE ONLY VALID FOR THIS SAMPLE).
Date of the tests	NOVEMBER 2014

**REPORTED BY:**

Mickaël Benetti, T.P.  
(Lab Manager) - Writer

Guillaume Loubersac  
(Director) - Approver

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Date	November 20th 2014	

**Toxicological Analysis of performance infill for synthetic turf fields according to EN 71-3 standard**  
**– Safety of toys Part 3: Migration of certain elements.**



**RESULTS**

**TOXICOLOGICAL ANALYSIS – EN71-3**

Element	Units	Test method	Results	Requirements Category III	Pass/Fail
Aluminium	mg/kg MS	NF EN ISO 11885	<b>8.27</b>	70 000	<b>Pass</b>
Antimony	mg/kg MS	NF EN ISO 11885	<b>n.d.*</b>	560	<b>Pass</b>
Arsenic	mg/kg MS	NF EN ISO 11885	<b>n.d.*</b>	47	<b>Pass</b>
Barium	mg/kg MS	NF EN ISO 11885	<b>3.03</b>	18 750	<b>Pass</b>
Boron	mg/kg MS	NF EN ISO 17294-1 et 2	<b>4.41</b>	15 000	<b>Pass</b>
Cadmium	mg/kg MS	NF EN ISO 11885	<b>n.d.*</b>	17	<b>Pass</b>
Cobalt	mg/kg MS	NF EN ISO 11885	<b>1.62</b>	130	<b>Pass</b>
Copper	mg/kg MS	NF EN ISO 11885	<b>35.0</b>	7 700	<b>Pass</b>
Lead	mg/kg MS	NF EN ISO 11885	<b>0.85</b>	160	<b>Pass</b>
Manganese	mg/kg MS	NF EN ISO 11885	<b>1.66</b>	15 000	<b>Pass</b>
Mercury	mg/kg MS	NF EN 13506	<b>n.d.*</b>	94	<b>Pass</b>
Nickel	mg/kg MS	NF EN ISO 11885	<b>1.11</b>	930	<b>Pass</b>
Selenium	mg/kg MS	NF EN ISO 11885	<b>n.d.*</b>	460	<b>Pass</b>
Strontium	mg/kg MS	NF EN ISO 17294-1 et 2	<b>1.02</b>	56 000	<b>Pass</b>
Tin	mg/kg MS	NF EN ISO 17294-1 et 2	<b>n.d.*</b>	180 000	<b>Pass</b>
Zinc	mg/kg MS	NF EN ISO 17294-1 et 2	<b>424</b>	46 000	<b>Pass</b>
Chromium III	mg/kg MS	NF EN ISO 11885	<b>n.d.*</b>	460	<b>Pass</b>
Chromium VI	mg/kg MS	NF T 90-043	<b>n.d.**</b>	0.2	<b>Pass</b>

\*Not detectable – substance could not be detected, the detection limit for the used test method is <0.5mg/kg MS

\*\* Not detectable – substance could not be detected, the detection limit for the used test method is <0.2mg/kg MS



**PARADIGM**  
ENVIRONMENTAL SERVICES, INC.

*Analytical Report For*  
**Testing Services Inc.**

*For Lab Project ID*

**145141**

*Referencing*

**Crum Rubber**

*Prepared*

**Tuesday, December 09, 2014**

Any noncompliant QC parameters or other notes impacting data interpretation are flagged or documented on the final report or are noted below.

A handwritten signature in black ink, appearing to be "D. Smith", is written over a horizontal line.

Certifies that this report has been approved by the Technical Director or Designee

179 Lake Avenue • Rochester, NY 14608 • (585) 647-2530 • Fax (585) 647-3311 • ELAP ID# 10958

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*Report Prepared Tuesday, December 09, 2014*



Lab Project ID: 145141

Client: **Testing Services Inc.**

Project Reference: Crum Rubber

Sample Identifier: ACT Global

Lab Sample ID: 145141-01

Matrix: Solid

Date Sampled: 11/24/2014

Date Received: 11/25/2014

**Mercury**

Analyte	Result	Units	Qualifier	Date Analyzed
Mercury	< 0.0180	mg/Kg		11/25/2014 16:04

Method Reference(s): EPA 7471B  
 Preparation Date: 11/25/2014  
 Data File: Hg141125B

**RCRA Metals (ICP)**

Analyte	Result	Units	Qualifier	Date Analyzed
Arsenic	< 1.03	mg/Kg		11/25/2014 19:44
Barium	< 10.3	mg/Kg		11/25/2014 19:44
Cadmium	< 0.517	mg/Kg		11/25/2014 19:44
Chromium	<b>1.17</b>	mg/Kg		11/25/2014 19:44
Lead	<b>9.83</b>	mg/Kg		11/25/2014 19:44
Selenium	< 1.03	mg/Kg		11/25/2014 19:44
Silver	< 1.03	mg/Kg		11/25/2014 19:44

Method Reference(s): EPA 6010C  
 EPA 3050  
 Preparation Date: 11/25/2014  
 Data File: 112514c

**Semi-Volatile Organics (Base Neutrals)**

Analyte	Result	Units	Qualifier	Date Analyzed
1,1-Biphenyl	< 1420	ug/Kg		12/2/2014 15:56
1,2,4,5-Tetrachlorobenzene	< 1420	ug/Kg		12/2/2014 15:56
1,2,4-Trichlorobenzene	< 1420	ug/Kg		12/2/2014 15:56
1,2-Dichlorobenzene	< 1420	ug/Kg		12/2/2014 15:56
1,3-Dichlorobenzene	< 1420	ug/Kg		12/2/2014 15:56
1,4-Dichlorobenzene	< 1420	ug/Kg		12/2/2014 15:56
2,4-Dinitrotoluene	< 1420	ug/Kg		12/2/2014 15:56
2,6-Dinitrotoluene	< 1420	ug/Kg		12/2/2014 15:56

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Lab Project ID: 145141

Client: **Testing Services Inc.**

Project Reference: Crum Rubber

Sample Identifier: ACT Global

Lab Sample ID: 145141-01

Date Sampled: 11/24/2014

Matrix: Solid

Date Received: 11/25/2014

2-Chloronaphthalene	< 1420	ug/Kg	12/2/2014	15:56
2-Methylnaphthalene	< 1420	ug/Kg	12/2/2014	15:56
2-Nitroaniline	< 2850	ug/Kg	12/2/2014	15:56
3,3'-Dichlorobenzidine	< 1420	ug/Kg	12/2/2014	15:56
3-Nitroaniline	< 2850	ug/Kg	12/2/2014	15:56
4-Bromophenyl phenyl ether	< 1420	ug/Kg	12/2/2014	15:56
4-Chloroaniline	< 1420	ug/Kg	12/2/2014	15:56
4-Chlorophenyl phenyl ether	< 1420	ug/Kg	12/2/2014	15:56
4-Nitroaniline	< 2850	ug/Kg	12/2/2014	15:56
Acenaphthene	< 1420	ug/Kg	12/2/2014	15:56
Acenaphthylene	< 1420	ug/Kg	12/2/2014	15:56
Acetophenone	< 1420	ug/Kg	12/2/2014	15:56
Anthracene	< 1420	ug/Kg	12/2/2014	15:56
Atrazine	< 1420	ug/Kg	12/2/2014	15:56
Benzaldehyde	< 1420	ug/Kg	12/2/2014	15:56
Benzo (a) anthracene	<b>2240</b>	ug/Kg	12/2/2014	15:56
Benzo (a) pyrene	< 1420	ug/Kg	12/2/2014	15:56
Benzo (b) fluoranthene	<b>2480</b>	ug/Kg	12/2/2014	15:56
Benzo (g,h,i) perylene	< 1420	ug/Kg	12/2/2014	15:56
Benzo (k) fluoranthene	<b>2480</b>	ug/Kg	12/2/2014	15:56
Bis (2-chloroethoxy) methane	< 1420	ug/Kg	12/2/2014	15:56
Bis (2-chloroethyl) ether	< 1420	ug/Kg	12/2/2014	15:56
Bis (2-chloroisopropyl) ether	< 1420	ug/Kg	12/2/2014	15:56
Bis (2-ethylhexyl) phthalate	<b>21000</b>	ug/Kg	12/2/2014	15:56
Butylbenzylphthalate	< 1420	ug/Kg	12/2/2014	15:56
Caprolactam	< 1420	ug/Kg	12/2/2014	15:56
Carbazole	< 1420	ug/Kg	12/2/2014	15:56
Chrysene	<b>6620</b>	ug/Kg	12/2/2014	15:56
Dibenz (a,h) anthracene	< 1420	ug/Kg	12/2/2014	15:56
Dibenzofuran	< 1420	ug/Kg	12/2/2014	15:56
Diethyl phthalate	< 1420	ug/Kg	12/2/2014	15:56
Dimethyl phthalate	< 2850	ug/Kg	12/2/2014	15:56

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Lab Project ID: 145141

Client: **Testing Services Inc.**

Project Reference: Crum Rubber

Sample Identifier: ACT Global

Lab Sample ID: 145141-01

Date Sampled: 11/24/2014

Matrix: Solid

Date Received: 11/25/2014

Di-n-butyl phthalate	< 1420	ug/Kg	12/2/2014	15:56
Di-n-octylphthalate	< 1420	ug/Kg	12/2/2014	15:56
Fluoranthene	<b>10800</b>	ug/Kg	12/2/2014	15:56
Fluorene	< 1420	ug/Kg	12/2/2014	15:56
Hexachlorobenzene	< 1420	ug/Kg	12/2/2014	15:56
Hexachlorobutadiene	< 1420	ug/Kg	12/2/2014	15:56
Hexachlorocyclopentadiene	< 1420	ug/Kg	12/2/2014	15:56
Hexachloroethane	< 1420	ug/Kg	12/2/2014	15:56
Indeno (1,2,3-cd) pyrene	< 1420	ug/Kg	12/2/2014	15:56
Isophorone	< 1420	ug/Kg	12/2/2014	15:56
Naphthalene	< 1420	ug/Kg	12/2/2014	15:56
Nitrobenzene	< 1420	ug/Kg	12/2/2014	15:56
N-Nitroso-di-n-propylamine	< 1420	ug/Kg	12/2/2014	15:56
N-Nitrosodiphenylamine	<b>1470</b>	ug/Kg	12/2/2014	15:56
Phenanthrene	<b>4000</b>	ug/Kg	12/2/2014	15:56
Pyrene	<b>17500</b>	ug/Kg	12/2/2014	15:56

Surrogate	Percent Recovery	Limits	Outliers	Date Analyzed
2-Fluorobiphenyl	<b>68.8</b>	5.5 - 127.8		12/2/2014 15:56
Nitrobenzene-d5	<b>80.1</b>	4.9 - 123.1		12/2/2014 15:56
Terphenyl-d14	<b>49.9</b>	0 - 165.8		12/2/2014 15:56

Method Reference(s): EPA 8270D  
EPA 3550C  
Preparation Date: 11/25/2014  
Data File: B02321.D



## Analytical Report Appendix

The reported results relate only to the samples as they have been received by the laboratory.

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All soil/sludge samples have been reported on a dry weight basis, unless qualified "reported as received". Other solids are reported as received.

Low level Volatiles blank reports for soil/solid matrix are based on a nominal 5 gram weight. Sample results and reporting limits are based on actual weight, which may be more or less than 5 grams.

The Chain of Custody provides additional information, including compliance with sample condition requirements upon receipt. Sample condition requirements are defined under the 2003 NELAC Standard, sections 5.5.8.3.1 and 5.5.8.3.2.

NYSDOH ELAP does not certify for all parameters. Paradigm Environmental Services or the indicated subcontracted laboratory does hold certification for all analytes where certification is offered by ELAP unless otherwise specified. Aliquots separated for certain tests, such as TCLP, are indicated on the Chain of Custody and final reports with an "A" suffix.

Data qualifiers are used, when necessary, to provide additional information about the data. This information may be communicated as a flag or as text at the bottom of the report. Please refer to the following list of analyte-specific, frequently used data flags and their meaning:

*"<" = Analyzed for but not detected at or above the quantitation limit.*

*"E" = Result has been estimated, calibration limit exceeded.*

*"Z" = See case narrative.*

*"D" = Sample, Laboratory Control Sample, or Matrix Spike Duplicate results above Relative Percent Difference limit.*

*"M" = Matrix spike recoveries outside QC limits. Matrix bias indicated.*

*"B" = Method blank contained trace levels of analyte. Refer to included method blank report.*

*"J" = Result estimated between the quantitation limit and half the quantitation limit.*

*"L" = Laboratory Control Sample recovery outside accepted QC limits.*

*"P" = Concentration differs by more than 40% between the primary and secondary analytical columns.*

*"NC" = Not calculable. Applicable to RPD if sample or duplicate result is non-detect or estimated (see primary report for data flags). Applicable to MS if sample is greater or equal to ten times the spike added. Applicable to sample surrogates or MS if sample dilution is 10x or higher.*

*"\*" = Indicates any recoveries outside associated acceptance windows. Surrogate outliers in samples are presumed matrix effects. LCS demonstrates method compliance unless otherwise noted.*

*"(1)" = Indicates data from primary column used for QC calculation.*

# GENERAL TERMS AND CONDITIONS

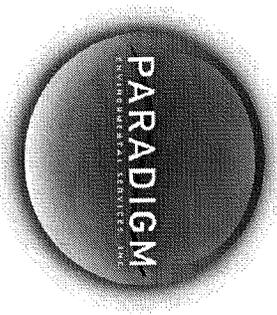
## LABORATORY SERVICES

These Terms and Conditions embody the whole agreement of the parties in the absence of a signed and executed contract between the Laboratory (LAB) and Client. They shall supersede all previous communications, representations, or agreements, either verbal or written, between the parties. The LAB specifically rejects all additional, inconsistent, or conflicting terms, whether printed or otherwise set forth in any purchase order or other communication from the Client to the LAB. The invalidity or unenforceability in whole or in part of any provision, term or condition hereof shall not affect in any way the validity or enforceability of the remainder of the Terms and Conditions. No waiver by LAB of any provision, term, or condition hereof or of any breach by or obligation of the Client hereunder shall constitute a waiver of such provision, term, or condition on any other occasion or a waiver of any other breach by or obligation of the Client. This agreement shall be administered and interpreted under the laws of the state which services are procured.

- Warranty.** Recognizing that the nature of many samples is unknown and that some may contain potentially hazardous components, LAB warrants only that it will perform testing services, obtain findings, and prepare reports in accordance with generally accepted analytical laboratory principles and practices at the time of performance of services. LAB makes no other warranty, express or implied.
- Scope and Compensation.** LAB agrees to perform the services described in the chain of custody to which these terms and conditions are attached. Unless the parties agree in writing to the contrary, the duties of LAB shall not be construed to exceed the services specifically described. LAB will use LAB default method for all tests unless specified otherwise on the Work Order. Payment terms are net 30 days from the date of invoice. All overdue payments are subject to an interest charge of one and one-half percent (1-1/2%) per month or a portion thereof. Client shall also be responsible for costs of collection, including payment of reasonable attorney fees if such expense is incurred. The prices, unless stated, do not include any sale, use or other taxes. Such taxes will be added to invoice prices when required.
- Prices.** Compensation for services performed will be based on the current Lab Analytical Fee Schedule or on quotations agreed to in writing by the parties. Turnaround time based charges are determined from the time of resolution of all work order questions. Testimony, court appearances or data compilation for legal action will be charged separately.
- Limitations of Liability.** In the event of any error, omission, or other professional negligence, the sole and exclusive responsibility of LAB shall be to re-perform the deficient work at its own expense and LAB shall have no other liability whatsoever. All claims shall be deemed waived unless made in writing and received by LAB within ninety (90) days following completion of services. LAB shall have no liability, obligation, or responsibility of any kind for losses, costs, expenses, or other damages (including but not limited to any special, direct, incidental or consequential damages) with respect to LAB's services or results. All results provided by LAB are strictly for the use of its clients and LAB is in no way responsible for the use of such results by clients or third parties. All reports should be considered in their entirety, and LAB is not responsible for the separation, detachment, or other use of any portion of these reports. Client may not assign the lab report without the written consent of the LAB. Client covenants and agrees, at its/his/her sole expense, to indemnify, protect, defend, and save harmless the LAB from and against any and all damages, losses, liabilities, obligations, penalties, claims, litigation, demands, defenses, judgments, suits, actions, proceedings, costs, disbursements and/or expenses (including, without limitation attorneys' and experts' fees and disbursements) of any kind whatsoever which may at any time be imposed upon, incurred by or asserted or awarded against client relating to, resulting from or arising out of (a) the breach of this agreement by this client, (b) the negligence of the client in handling, delivering or disclosing any hazardous substance, (c) the violation of the Client of any applicable law, (d) non-compliance by the Client with any environmental permit or (e) a material misrepresentation in disclosing the materials to be tested.
- Hazard Disclosure.** Client represents and warrants that any sample delivered to LAB will be preceded or accompanied by complete written disclosure of the presence of any hazardous substances known or suspected by Client. Client further warrants that any sample containing any hazardous substance that is to be delivered to LAB will be packaged, labeled, transported, and delivered properly and in accordance with applicable laws.
- Sample Handling.** Prior to LAB's acceptance of any sample (or after any revocation of acceptance), the entire risk of loss or of damage to such sample remains with Client. Samples are accepted when receipt is acknowledged on chain of custody documentation. In no event will LAB have any responsibility for the action or inaction of any carrier shipping or delivering any sample to or from LAB premises. Client authorizes LAB to proceed with the analysis of samples as received by the laboratory, recognizing that any samples not in compliance with all current DOH-ELAP-NELAP requirements for containers, preservation or holding time will be noted as such on the final report. Disposal of hazardous waste samples is the responsibility of the Client. If the Client does not wish such samples returned, LAB may add storage and disposal fees to the final invoice. Maximum storage time for samples is 30 days after completion of analysis unless modified by applicable state or federal laws. Client will be required to give the LAB written instructions concerning disposal of these samples. LAB reserves the absolute right, exercisable at any time, to refuse to receive delivery of, refuse to accept, or revoke acceptance of any sample, which, in the sole judgment of LAB (a) is of unsuitable volume, (b) may be or become unsuitable for or may pose a risk in handling, transport, or processing for any health, safety, environmental or other reason whether or not due to the presence in the sample of any hazardous substance, and whether or not such presence has been disclosed to LAB by Client or (c) if the condition or sample date make the sample unsuitable for analysis.
- Legal Responsibility.** LAB is solely responsible for performance of this contract, and no affiliated company, director, officer, employee, or agent shall have any legal responsibility hereunder, whether in contract or tort including negligence.
- Assignment.** LAB may assign its performance obligations under this contract to other parties, as it deems necessary. LAB shall disclose to Client any assignee (subcontractor) by ELAP ID # on the submitted final report.
- Force Majeure.** LAB shall have no responsibility or liability to the Client for any failure or delay in performance by LAB, which results in whole or in part from any cause or circumstance beyond the reasonable control of LAB. Such causes and circumstances shall include, but not limited to, acts of God, acts or orders of any government authority, strikes or other labor disputes, natural disasters, accidents, wars, civil disturbances, difficulties or delays in transportation, mail or delivery services, inability to obtain sufficient services or supplies from LAB's usual suppliers, or any other cause beyond LAB's reasonable control.
- Law.** This contract shall be continued under the laws of the State of New York without regard to its conflicts of laws provision.

This report is part of a multipage document and should only be evaluated in its entirety. The Chain of Custody provides additional sample information, including compliance with the sample condition requirements upon receipt.

# CHAIN OF CUSTODY



PARADIGM  
LABORATORY SERVICES

REPORT TO:

INVOICE TO:

LAB PROJECT ID

CLIENT: Testing Services Inc  
 ADDRESS: 617 Shovelers Ave PO Box 3021  
 CITY: Dalton STATE: GA ZIP: 30721  
 PHONE: 706-226-1400  
 ATTN: Ete Miles

CLIENT: ADDRESS: CITY: STATE: ZIP: PHONE: ATTN:  
 Quotation #: 145141  
 Email:

PROJECT REFERENCE  
 Crum Rubber

Matrix Codes: AQ - Aqueous Liquid WA - Water DW - Drinking Water SO - Soil SD - Solid WP - Wipe OL - Oil  
 NA - Non-Aqueous Liquid WG - Groundwater WW - Wastewater SL - Sludge PT - Paint CK - Caulk AR - Air

REQUESTED ANALYSIS

DATE COLLECTED	TIME COLLECTED	COMPONENTS	GARB	SAMPLE IDENTIFIER	MCAOTDRIS	NUMBERS	REMARKS	PARADIGM LAB SAMPLE NUMBER
11/24/14				ACT Global			sample ID per label. Analyses + sample date per EM. WS 11/25/14 matrix per visual	GI
2								
3								
4								
5								
6								
7								
8								
9								
10								

**Turnaround Time**

Availability contingent upon lab approval; additional fees may apply.

Standard 5 day  Batch QC  Basic EDD

Rush 3 day  Category A  NYSDEC EDD

Rush 2 day  Category B

Rush 1 day

Other  Other EDD

please indicate: today

**Report Supplements**

Sampled By \_\_\_\_\_ Date/Time \_\_\_\_\_ Total Cost \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date/Time \_\_\_\_\_

Received By \_\_\_\_\_ Date/Time \_\_\_\_\_ P.I.F.

Received @ Lab By \_\_\_\_\_ Date/Time \_\_\_\_\_

RETURN WS 11/25/14

10/22

See additional page for sample conditions.

2010



### Chain of Custody Supplement

Client: Testing Services Completed by: Kyle Smoock  
 Lab Project ID: 145141 Date: 11/25/14

**Sample Condition Requirements**  
 Per NELAC/ELAP 210/241/242/243/244

Condition	NELAC compliance with the sample condition requirements upon receipt		
	Yes	No	N/A
Container Type	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Comments	_____		
Transferred to method-compliant container	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Headspace (<1 mL)	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Comments	_____		
Preservation	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Comments	_____		
Chlorine Absent (<0.10 ppm per test strip)	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Comments	_____		
Holding Time	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Comments	_____		
Temperature	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Comments	_____		
Sufficient Sample Quantity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Comments	_____		

## Summary Report

Fred Gregg  
ACT Global Sports  
380 Marine Dr. SE  
Calhoun, GA 30701

Report Date: November 19, 2014

Work Order: 14103028



Project Location: Calhoun, GA  
Project Name: Crumb Rubber

Sample	Description	Matrix	Date Taken	Time Taken	Date Received
378296	Crumb Rubber	solid	2014-10-28	00:00	2014-10-30

### Sample: 378296 - Crumb Rubber

Param	Flag	Result	Units	RL
Pyridine	Qs	<0.0500	mg/L	0.05
1,4-Dichlorobenzene (para)		<0.0500	mg/L	0.05
o-Cresol		<0.0500	mg/L	0.05
m,p-Cresol		<0.0500	mg/L	0.05
Hexachloroethane		<0.0500	mg/L	0.05
Nitrobenzene		<0.0500	mg/L	0.05
Hexachlorobutadiene		<0.0500	mg/L	0.05
2,4,6-Trichlorophenol		<0.0500	mg/L	0.05
2,4,5-Trichlorophenol		<0.0500	mg/L	0.05
2,4-Dinitrotoluene	Qs	<0.0500	mg/L	0.05
2,4-Dichlorophenoxyacetic acid		<0.0500	mg/L	0.05
Hexachlorobenzene		<0.0500	mg/L	0.05
2,4,5-Trichlorophenoxypropionic acid		<0.0500	mg/L	0.05
Pentachlorophenol		<0.0500	mg/L	0.05
Vinyl Chloride		<0.0500	mg/L	0.001
1,1-Dichloroethene		<0.0500	mg/L	0.001
2-Butanone (MEK)	Qc	<0.500	mg/L	0.01
Chloroform		<0.0500	mg/L	0.001
1,2-Dichloroethane (EDC)		<0.0500	mg/L	0.001
Benzene		<0.0500	mg/L	0.001
Carbon Tetrachloride		<0.0500	mg/L	0.001
Trichloroethene (TCE)		<0.0500	mg/L	0.001

continued ...

sample 378296 continued ...

Param	Flag	Result	Units	RL
Tetrachloroethene (PCE)		<0.0500	mg/L	0.001
Chlorobenzene		<0.0500	mg/L	0.001
1,4-Dichlorobenzene (para)		<0.0500	mg/L	0.001
Total Silver		<0.500	mg/Kg	0.5
Total Arsenic		<2.00	mg/Kg	2
Total Barium	Qs	<b>5.04</b>	mg/Kg	1
Total Cadmium		<0.500	mg/Kg	0.5
Total Chromium		<b>1.48</b>	mg/Kg	0.5
Total Mercury		<0.0250	mg/Kg	0.025
Total Lead		<b>11.9</b>	mg/Kg	1
Total Selenium		<2.00	mg/Kg	2