

## Artificial Turf Fields Cannot Be Considered Safe for Children and Should Be Removed from Contact with Children



The Safe Healthy Playing Fields Coalition (SHPF) is a national coalition working since 2008 to alert communities, schools, and individuals to rising concerns over the hazards of synthetic turf athletic fields. We are an all-volunteer coalition of parents, coaches, athletes, and professionals in fields such as medicine, public health, environmental health, waste management, engineering, and law.

Recognizing that schools, sports groups, communities and parent groups do not normally have resources to conduct impartial technical due diligence on toxicity issues, particularly for pediatric toxicity, and there was a need to question industry claims of safety, our technical members have donated thousands of professional hours to researching and documenting the health and safety problems of these fields.



Our mission is to help close enormous information gaps that still exist in safety, testing ambiguity, superheating effects, concussive impacts, and the 11 known carcinogens and 90+ known harmful single substances in tire crumb and plastics commonly used in every field.

The group started in 2009, and enjoys participation from professionals and volunteers across the country.



January 11, 2017

Dr. Elliot Kaye, Chairman  
Consumer Product Safety Commission  
4330 EastWest Highway  
Bethesda, MD 20814

via email

**Re: Tire Crumb Athletic Field Safety; Children's Product Designation; Federal Study on the Use of Tire Crumb in Athletic Fields**

Dear Chairman Kaye,

***“Mom, we just got a reading of 1257 ppm of lead from the first sample that we tested our tire crumb turf field extraction lab this afternoon.”*** *via text, November 13, 2016.*

A concerned parent and member of SHPFC received this text from her college chemistry major/athlete son recently. Sobering. Frightening. Real. Similar actionable results have been reported both by buyers who have had their fields tested and multiple studies reported in the government and scientific literature across the country. Not only lead, but many other toxic substances are delivered daily to playground and field users including hundreds of thousands of school children, from waste tire crumb athletic turf fields. Some parents report that their young children “look like coal miners” after playing in the tire crumb surfaced playgrounds. Schools are reluctant to test, reluctant to take on the liability... but we need action to stop the spread of these dangerous fields, and the relentless, often misleading marketing that pummels schools, park authorities, and sports facilities serving children.

We are writing to you to ask for a meeting personally, and with each CPSC Commission Member individually, immediately, to explain the case for CPSC regulation of synthetic turf as a children's product. We have found, and can show that synthetic turf exposes children to highly toxic substances for ingestion, inhalation and dermal uptake, possible with every single use and contact with the fields.

**LANDFILLS TO SCHOOL FIELDS:** That 12,000 fields were in built in schools and sports facilities, most in the past 4 years, is a situation that results from well intentioned but misguided efforts to recycle and use of tens of millions of waste tire generated annually in the US. (California alone reports receipt of about 40,000,000 tires annually; CalRecycle 2016.) Waste tires can be used for many purposes (concrete girders, rubber mats, fuel) but using them for play fields had (has) very impressive profit margins. A single field uses about 40,000 tires, and it was an expeditious, fairly simple process to sort, shred, bag and ship to a school anxious to update its field. **However, this profitable industry has transferred the contamination load from a tire waste site (landfill, used tire distribution center) to communities and school fields where children are in direct contact with the toxic substances in the tire and plastics in pulverized, inhalable, ingestible form.**

Currently **4,760,000,000 pounds of loose, unencapsulated, pulverized waste tires**, are spread across play surfaces of more than 12,000 fields in schools, sports centers, and playgrounds, putting hundreds of thousands of players and families, including **school children across the US, into direct, unimpeded contact with enormous quantities of at least 11 known carcinogens, over 90 known harmful substances, and myriad dangerous gas/particulate mixtures.**

*Tire crumb playgrounds and synthetic turf fields concentrate tens of thousands of pulverized waste tires into an area in which children play in. Children's activities re-suspend dust and microscopic particulate matter, increasing inhalation, ingestion and dermal exposure. Warm sunny days cause fields to superheat, exponentially increasing the off gassing of toxic VOCs and SVOCs. Children are unlikely to be intentionally exposed to a more toxic environment anywhere in this country.*

The Federal regulatory framework established in RCRA resulted in a loophole allowing used waste tires to escape toxicity and apparently safety scrutiny when they are shredded and “repurposed” for children’s sports fields, playgrounds and garden mulch. As we understand it, a basic used tire is considered a waste product, and in fact considered a toxic waste product due to corrosive, carcinogenic and flammable ingredients (*which may have a reporting exemption*). However, under RCRA, when a waste tire is shredded and therefore “repurposed” it is then considered a “product” and evidently loses the regulatory scrutiny that might have kept a pulverized, inhalable version of a tire away from contact with children’s skin, lungs and clothing.

The industry’s persistent arguments that the material is not a children’s product are ridiculous, self serving and inaccurate, since the product is clearly and unambiguously marketed to schools and is now used by hundreds of thousands, if not millions of children. Those arguments, and the loophole, have been to the detriment of the health and safety of our children. In fact, we are beginning to see the results in the 230+ young athletes with cancers associated with exposure to the ingredients in the fields, some after less than 5 years of contact with these fields. But this group could be just the tip of the iceberg.

Our focus has been primarily on tire crumb use as playfield infill, the exposure risk posed by waste tire based field systems, and synthetic fields in general. We also ask the commission to consider the aggravating factors of high variability among tires, toxicity of other field products and addendums, their interactions, in high heat, over time and in actual play and use situations. Compounding the complex concerns of toxicity are synergistic health effects from repeated heat injury, and the increased likelihood of repeated concussive injury due to surface hardness when fields are improperly maintained or are used past their natural lifespan. We urge the commission to close the inadvertent regulatory gap by taking action to classify and regulate these fields as children's products.

**After several years of investigation, we advise that tire crumb based athletic fields and playgrounds cannot be considered safe from inhalation, ingestion and dermal exposure to multiple toxins, and in fact pose unacceptable risks of acute and low dose toxic exposure due to direct and/or indirect contact with multiple toxins and heat high enough to cause severe injury.**

The CPSC should:

- 1. Immediately regulate the tire crumb that is used for fields and playgrounds as a children's product.**
- 2. Direct field owners to immediately remove tire crumb surfaced fields from contact with children.**
- 3. Issue warning statements to schools and parents that the tire crumb and plastic dust from these fields contain multiple carcinogens and other toxic substances which are inhalable, ingestible and dermally available under many typical field conditions.**
- 4. Prohibit further construction of the artificial fields until adequate biological testing is done on children and the testing shows unambiguously that inhalation, ingestion or dermal exposure from particulate and field components is safe.**

This letter respectfully, and anxiously, asks the CPSC to meet with us now, prior to the coming change in Administrations.

Sincerely,

Safe Healthy Playing Fields Coalition  
January 11, 2017

## WHITE PAPER

# ARTIFICIAL TURF FIELDS CANNOT BE CONSIDERED SAFE FOR CHILDREN AND SHOULD BE REMOVED FROM CONTACT WITH CHILDREN

ASKS FOR CPSC TO REGULATE TIRE CRUMB USED FOR FIELDS AND PLAYGROUNDS AS A CHILDREN'S PRODUCT AND OUTLINES THE RATIONALE FOR REMOVAL OF TIRE CRUMB ARTIFICIAL TURF FIELDS FROM CONTACT WITH CHILDREN BASED ON CONTACT WITH KNOWN CARCINOGENS, NEUROTOXINS, AND OTHER HARMFUL MATERIALS, KNOWN INJURY RISK FROM EXTRAORDINARY HEAT, KNOWN CONCUSSIVE RISK, and STILL UNKNOWN SYNERGISTIC HEALTH IMPACTS.

### EXECUTIVE SUMMARY

**Any of the following concerns or issues, taken alone, is reason enough to remove tire crumb infills and plastic “grass” carpets from contact with children. Taken together, the rationale for removal of these fields is clear, unambiguous and a moral if not legal imperative for immediate protective action.**

### A PERFECT STORM OF TERRIBLE CHARACTERISTICS

The unfortunate mix of characteristics in tire crumb athletic fields create a “Perfect Storm” of terrible traits to have in a consumer product and especially in a product that has direct contact with hundreds of thousands of children.

Key concerns include:

1. **Tire crumb is marketed as a children's product** and sold to child care centers, schools, and parks departments for use on **playgrounds and playfields** where children will play.
2. **High contact, high use product, with high chance of toxic exposure.** With an estimated 12,000 to 16,000 artificial turf fields with crumb rubber infill in existence, we estimate that many millions of children are being exposed to the toxic materials in tires. 9 million children aged 7-14 are registered in organized “tackle” and field sports now, with regular, frequent contact with fields. Children in organized sports have constant, multiple contacts at practice, during games, and at school, over days, weeks, and over several years. Millions more have regular direct contact with fields at their schools, regardless of their level of team play.

**The nearly 5 billion pounds of infill material now spread on surfaces in schools and sports centers is in pulverized, high surface area, loose, unencapsulated, in a pulverized crumb form, which breaks down into smaller, microscopic particles, that coat tire crumbs, plastic “grass blades”, players, and field surfaces.**

**Children and families cannot easily opt out of contact with fields and playgrounds that are associated with schools, for example.** Neither can teaching staffs, facilities staff, adjacent neighbors, maintenance workers, marching band, sports fans, parents, spectators, referees, field orchestra, PE teachers... the number of people who could have direct, regular contact is enormous.

3. **Toxic Components: Over 50%**, by weight, of crumb rubber is composed of known **carcinogens, neurotoxins** and other known toxicants. Tire crumbs include a **nonuniform** mixture of over 350 ingredients including 11 known carcinogens in over 90 known harmful substances, including **lead, chromium, carbon black, PAHs, flame retardants, phthalates, benzothiazoles and nanoparticles.** While tire crumbs are large, over time, they breakdown into microscopic particles that can be easily inhaled and ingested. The toxicants may be ingested, absorbed dermally, or inhaled. The fields concentrate the multiple known toxins used in tires, plastics and field treatments, making them likely the highest concentration of toxins a child, or anyone, could have contact with in their lifetime (outside of a factory environment).
4. **Hot Spots and Variability:** Because tire crumb is a waste product, it is not uniform and can contain chemical hot spots. Hot spots are a particular threat to goal keepers who tend remain in one area, *and can present acute exposure to anyone who makes contact.*
5. **Dust and Particulate Matter:** Weathering, aging, constant high heat and the grinding action of normal play grind crumb rubber into dust and particulate matter, including **PM 2.5 and PM 10.** **The dust and particulate matter coat “grass” and crumb surfaces, skin, clothing, water bottles, belongings and all field surfaces.**

Tire crumbs are loose and impacts like a running, bouncing balls, and diving for balls loft the particulate matter and dust into the breathing and contact zone. **The lofted toxic particulate remains suspended in the breathing zone, and is breathed in by players on the field, bystanders, fans and probably adjacent buildings or neighbors.**

6. **Cancer Cluster:** At least one cancer cluster that may be linked to crumb rubber has been identified. Over 230 individuals or family members of affected individuals have contacted Amy Griffin. All of the individuals on the list played on artificial turf fields at young age. Due to the self-reported nature of the list, and the concentration of cases from Washington State, it is likely that it represents only a tiny fraction of all cases.

7. **Heat and Superheating:** Surfaces get very hot; tire crumb field surfaces commonly superheat to over 140F on sunny days with an ambient temperature in the 80's. Play surface temperatures of 180+F are documented and common in warm, sunny weather in DC metro area, and similar areas. The extreme heat of these fields poses a risk of burns, heat stroke, heat exhaustion, and dehydration. It is so hot that it melts shoes and shoe adhesives, and breaks down field materials and adhesives.
8. **Risk Estimation Problems:** Although crumb rubber contains massive amounts of toxic chemicals that are bioavailable, the level of the risks posed by these fields is still unclear. Risks from low dose exposures tend to be ignored in industry statements of safety, but in fact, low dose exposure risks need to be examined in sharp focus. Risks from synergetic and or antagonistic effects have not been accounted for in existing models. Toxicity studies on crumb rubber and epidemiological studies are needed. No such studies exist or are known to be planned.
9. **G-Max, Concussions and Injuries:** The hardness of a field can be a hidden danger. Hardness is highly variable due to nonuniform distribution of material, loss of material, temperature, humidity shifts, degradation of material, and presence or lack of subsurface cushioning. Risk of increased concussive injury, joint injury, and abrasion injury and even death increases with hardness for all, but particularly for children. FieldTurf's own documents indicate that heavily used fields, without cushioning pads, and with rubber crumb displaced from use, can have G-Max readings up to 260. This is well above the threshold that can cause concussions.
10. **Environment:** The fields lose about 30% of their original material into the environment and municipal sewer and drainage systems, carried by rainfall/irrigation runoff, offgassing, and carried away by athletes on clothes, bags, and bodies. This presents a contamination question in terms of impacts on children, and to the environment. Leachate and particulate loss into the environment is in the tens of tons per field, and very likely in violation with the intention of the Clean Water Act, though no enforcement or scrutiny exists yet. There is a strong possibility that of the 12,000 tire crumb fields now installed, there are 12,000 contaminated streams, stormwater systems, and aquatic ecosystems adversely affected by harmful levels of leachate, and tire particulate including metals such as zinc, lead, mercury, chromium, and cadmium. The fields are a "heat island", and require additional irrigation for cooling. Pesticides and other biocide treatments are routinely used, presenting significant threats to children and the surrounding aquatic ecosystems.
11. **Regulatory Issues:** In 2008 Congress directed the CPSC to limit lead in children's products to 100 parts per million. Congress also required that lead-testing be conducted by an agency-approved third-party lab. .  
To date the Commission has declined to characterize tire crumb fields and playgrounds as "children's products." Several years ago when the CPSC was invited to take enforcement

action on tire crumb under the standard for a children's product, it declined, stating in part:

Upon further exploration, Compliance staff concluded, at that time, specific product enforcement was unlikely to be the best option, based upon the need for individual health assessments, among other factors. To my knowledge, this information has also been communicated to PEER.”

[Letter to Senator Warren, July 20, 2015]

SHPFC asks the Commission to recognize that for enforcement purposes, an individual health assessment is neither required nor useful. Rather, CPSC has only to direct these manufacturers to obtain approved testing and to submit the results to the Commission.

Failing this, tire crumb fields and playgrounds will continue to be used and new ones will be installed. In the absence of CPSC action to enforce the CPSIA lead limits, millions of children will predictably be in close, frequent physical contact with these products, often in high heat and over years. This is precisely the use to which manufacturers intended their product to be put, and it is the use over which CPSC has been given regulatory and enforcement authority.

The CPSC has the authority to recognize the heavy use of these products by children, and to direct appropriate enforcement of lead standards, to prevent further exposure of children to synturf fields and playgrounds.

The studies supporting our rationale are for the most part, already in the federal/ EPA record, and include Pavilonis, Llompart, Shalat, Marsili, PEER filings, OEHHA, State of New York, Norway Regulatory Study, He et al. study, and many more. The studies clearly document that the fields generate a broad range of inhalable size particulate (e.g. ultrafines, PM<sub>2.5</sub>, PM<sub>10</sub>) and establish the direct risk of inhalation, ingestion and dermal absorption of metals, tire derived substances, PAHs, and the substances found in tires and plastic field systems. Attached is an annotated bibliography of citations that support our rationale.

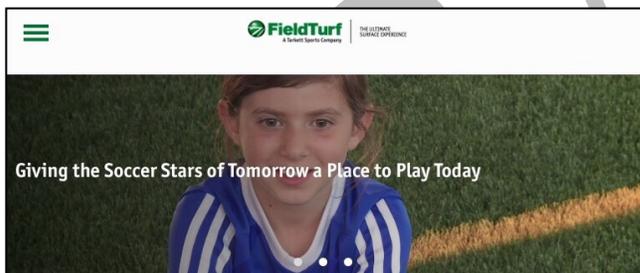


## THE ISSUES

We assert that any one of these issues, on its own merit, should be enough to warrant the removal of tire crumb fields from contact with children, but taken together, show overwhelming arguments that compel the CPSC to act without reservation.

### 1. Tire crumb is marketed and used as a children's product.

Public Employees for Environmental Responsibility, PEER, established that tire crumb is used as a children's product when it presented CPSC with numerous examples of shredded tire play surfaces marketed specially to children, under product names such as TotTurf, KidWise and PlaySafer. The widespread use of tire crumb on playgrounds, which are used almost exclusively by children twelve and under is another reason to consider tire crumb a children's product. Artificial turf fields with tire crumb are also marketed extensively to primary, elementary, middle and high schools. Children 12 and under are present in all levels of these schools except high school, and may use any of the fields after school hours. Tire crumb is also used on community play fields which are utilized by children. Children's heavy exposure to this product justifies regulating it as a children's product.



## 2. Millions of children are being exposed to the toxic particulate in tire crumb and plastic fields.

About 3 million children between ages 7 and 14 are registered soccer players, that is, on a team with a league that sets up a season's play schedule. About 3 million more are in tackle sports, like football. Marching bands, baseball, lacrosse, field hockey and other field sports are equally popular. So, we estimate about 9 million children, or 20% of children in that age group, are registered players who, assuming they have regular practice, consistently have contact with a turf field to pursue their sport or activity. Of those 9 million children on turf fields, there are certainly groups with high contact, like goalies and football linemen, who might dive into a field, or dive and roll during a practice "100 times a day, or even more". Additional focus needs to illuminate those patterns of use and contact rates.

Nonetheless, with the information we know now, we can still say that millions of children have multiple contacts with toxins, each day or even each month, that may provide acute and low dose exposures of the carcinogens and toxic ingredients from the particulate that is inherent in the field. Presuming kids are breathing during play, and since the particulate of inhalable size is in the breathing zone of every field, the exposures are inescapable.

## 3. Toxic Components.

- a. 11 known carcinogenic substances in at least 90 known harmful or dangerous substances. (Yale Study)
- b. Identified substances include PAHs, VOCs, SVOCs, **lead, chromium** (hexavalent chromium and trivalent chromium), mercury, arsenic, cadmium, phthalates, benzothiazoles, styrene, butadiene, benzene, toluene, carbon black, acetone, nanoparticle based strengthening additives, added flame retardants, microbicides, fungicides, pesticides, fabric softeners, and other treatments in relatively massive quantities per field.
- c. The EPA list of ingredients identified in tire crumb includes: acetone, aniline, arsenic, barium, benzene, benzothiazole, carbon black, cadmium, chloroethane, chromium, cobalt, copper, halogenated flame retardants, isoprene, latex, **lead**, manganese, mercury, methyl ethyl ketone, methyl isobutyl ketone, naphthalene, nickel, phenol, pigments, polycyclic aromatic hydrocarbons, styrene-butadiene, toluene, and trichloroethylene.
- d. The studies that found these substances are already, for the most part, in the federal/ EPA record, and include Pavilionis, Llompert, Shalat, Marsili, PEER filings, OEHHA, State of New York, Norway Regulatory Study, He et al study, and many more studies. Attached is an annotated bibliography of citations that support our rationale.
- e. **Many of these known harmful ingredients are regulated in other settings:** lead, mercury, chromium, cadmium, phthalates, PAH, VOCs, SVOCs, benzene, zinc, butadiene, styrene, PBDEs. (PEER CPSC/EPA

filings, 2010-2016)

**Benzothiazoles:** The pervasive presence of benzothiazoles in synthetic turf field systems (infills and carpet) increases multiple health risks (cancer, immune system suppression, among others). Routinely identified in artificial fields by multiple studies, this family of chemicals is released by the plastic “grass” carpet and tire derived products. They can also be present in infill plastic “add ins” such as shoe factory waste or car dashboards, and many more products that can make their way into a field. Benzothiazoles can be ingested, inhaled and dermally absorbed. Pavilonis et al found benzothiazole derivatives from tire crumb in synthetic body fluids indicating bioavailability upon exposure ).

Importantly, new findings show that benzothiazoles bind to same cell receptors as the potent known carcinogen dioxin (He et al study). The indication is that benzothiazoles in tire derived materials and plastics may be potent carcinogens, the level of which to be determined in future studies. A gravely important signal, these findings alone should ignite immediate precautionary measures to protect children from the consistent benzothiazole exposures from tire/plastic field contact.

**Again, benzothiazoles, which bind to the same cell receptor as dioxin, are consistently found in synthetic turf fields, in multiple studies regardless of author. Because of the enormous scope of quantity of the material and its form, synthetic turf fields are likely to be the most potent, concentrated source of benzothiazole exposure that a child, or anyone, might face.**

**Lead:** The CDC and American Academy of Pediatrics say there is “NO SAFE LEVEL OF LEAD” and the AAP notes that regulatory levels are for convenience only and only give an “illusion of safety.” Like other materials, such as benzothiazoles, the potential for lead “hotspots” exists in every field. Lead is routinely found at high levels in both the plastic carpet “grass” (including different colors) and in tire crumb, and can be in add-in products. (Shalat, Pavilonis, et al.; multiple other studies.) Presence of lead in other synthetic turf inputs (such as factory waste inputs, ground up autoparts, etc.) is very possible, and unpredictable. The synthetic field industry admitted in 2016 testimony that their fields contained lead. Please see the 2015 Annapolis Statehouse testimony available in video from SHPFC and from official records.

The statement is recorded here:

<http://www.sierraclub.org/maryland/blog/2016/12/sierra-club-letter-umd-regarding-turf-athletic-fields#.WHSezBKJRQ.mailto>



Common field deterioration example next to goal post. Note black smears on goal supports from hands touching the pole. This field is 4 years old. Washington DC 2015.

**Carbon black:** Thirty percent, 30%, of tires are made of carbon black, a probable human carcinogen. Hundreds of studies (e.g. air pollution and tobacco use studies) document multiple adverse health effects of inhalation and ingestion of carbon black. Multiple cancers (lung, kidney, bladder, testicular, and brain) are linked to these exposures. In addition, asthma, pulmonary disease, and multiple cognitive disorders are also linked to more dilute exposures than what a daily “soccer bugs” team member would receive on a turf field on a hot day.

**Nanoparticles:** Since the early 2000s, tire manufacturers have used nanoparticles made of ceramic, metal, carbon black and synthetics to improve tire performance. Some are in the tire material, others are in fiber layers in a tire, others in tire treatments.

[IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 11, Issue 4 Ver. I (Jul- Aug. 2014), PP 07-11 [www.iosrjournals.org](http://www.iosrjournals.org) “Nano particles in Automobile Tires”. 1D. Giftson Felix, 2Dr. G. SivaKumar. 1,2Department of Mechanical Engineering. Panimalar Engineering College. Chennai-123]

Carbon nanotubes (CNT) have repeatedly and specifically been compared to asbestos in both structure and behavior in a cell (they cause mesothelioma) in occupational settings.

They are associated with pleural and interstitial lung disease.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3266021/>  
<https://www.cdc.gov/niosh/docs/2013-145/pdfs/2013-145.pdf>

Knowingly subjecting children to enormous amounts of material known to be full of the worrisome substances is unethical. **As with other substances, tire crumb fields are likely the most potent source of nanoparticle exposure that a child**

**may encounter.** Leading law firms and the National Association of Insurance Commissioners predict that future litigation over tire crumb will import both the legal and medical record built after decades of study and litigation.

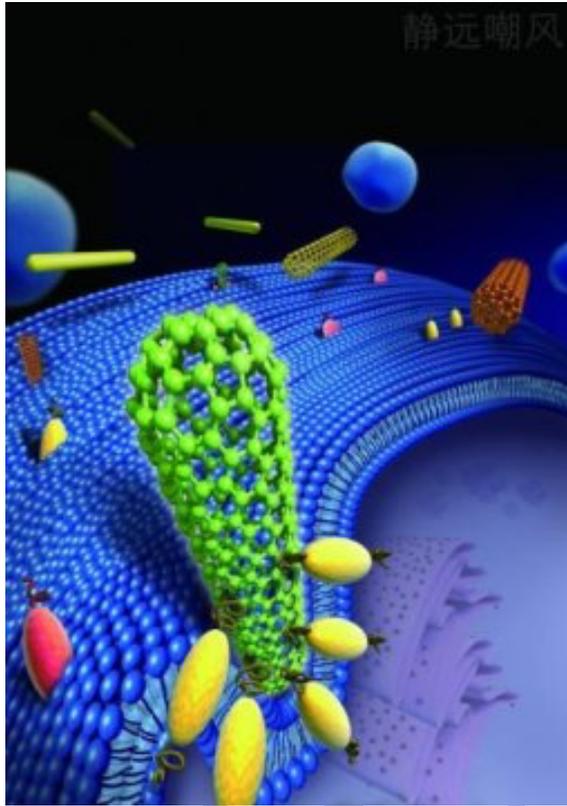


Illustration of a nanoparticle passing through a cell membrane; reference below.

The toxic ingredients in tire crumb field systems are also found in other products in a child's world and in ambient air. The fields nonetheless present an unprecedented combination and concentration of dangerous ingredients, in such chronically intimate contact at play that the risk associated with these exposures is constant, pervasive and enormous in scale.

#### 4. **Chemical Hot Spots and Variability**

Due to the "high variation ingredients with multiple known carcinogens and multiple known dangerous substances, in high surface area form," chemical hotspots must be assumed, by definition. Hotspots can cause both acute and low dose exposures to toxic substances. In fact, the presence of hotspots was noted in multiple relevant studies, (Pavilonis; CT Department of Health).

##### **For example:**

- a. **Lead:** It is known from multiple studies that fields have lead and lead chromate, in varying levels. Colors used to demarcate are a common and fairly easy place to look, but it can occur from variations in tires as well, which would be difficult to observe visually. (Remember the high lead levels

found from professor and student collaboration noted in the letter in the beginning of this document!) The Pavilonis et al study also found them, as did other studies.

- b. Benzene example:** The CT Department of Health found benzene in the clip-on monitors of children playing on a field in CT, then tracked it to a single area of the field that was close to a parking lot and car exhaust sources, (an example of contamination through adsorption). A child who dove into the field in that area would be at risk for an acute exposure to benzene. But neither he nor his parents would be aware of that exposure.

Extreme variability, *even within a single field*, creates an insurmountable barrier to study results that are both accurate and complete... and schools and parents are still unaware of that significant knowledge gap. The upshot is that parents/schools cannot know if their children were exposed to any single chemical hotspot, or multiple hotspots for any field.

This is an extremely bad characteristic for a material that is intended for repeated contact with children, and athletes.

Conventional sampling techniques, such as those being used in the current federal study on crumb rubber, cannot assess risk in a field with chemical hotspots. Any conclusions would be applicable only to the sampled portion of each field.

Extreme variation in a mixture presents a difficult testing and risk assessment problem: conventional sampling techniques can easily miss the inherent hotspots on a field, so actual risk of acute exposures is masked in conventional sampling used by most facilities and communities. Conventional sampling is helpful with a positive “find”, but NOT finding an acute substance cannot be considered safety in this case, since it could easily have been missed in 200 tons of pulverized tire crumb. That is, simple sampling cannot be used to assess actual risk, since each sample cannot be representative of a whole field.

Many studies that reported “no findings”, or low levels of substances, in fact had high levels in one or two samples. These may have been hot spots. However, these were routinely discarded as outliers, averaged out, or diluted (all normal steps). This is practically a case study of how conventional sampling methods can be ineffective for assessing toxicology risk in a complex, highly-variable, material with multiple known toxicants.



## 5. Dust and Particulate Matter

Weathering, aging, constant high heat and the grinding action of normal play grind crumb rubber into dust and particulate matter, including **PM 10/PM2.5**. **The dust and particulate matter coat “grass” and crumb surfaces, skin, clothing, water bottles, belongings and all field surfaces.** Tire crumbs are loose and impacts like a running, bouncing balls, and diving for balls loft the particulate matter and dust into the breathing and contact zone.



**The Bounce: Material “loft” behavior inherent in pulverized surface fields lifts crumbs into the air and aerosolizes particulate dust that coats the crumbs and plastic “grass” blades.**

The bounce is momentary, but microscopic dust that coats the crumbs and plastic blades of “grass” stays suspended in the breathing zone, and may combine with gases and other materials, all of which may be inhaled by players and those on or near the fields.

The lofted toxic particulate remains suspended in the breathing zone and is breathed in by players on the field, bystanders, fans and probably adjacent buildings or neighbors. The tiny crumb form and its dust increases likelihood of travel from field to environment, soils, surface water, homes and airway, with material losses of crumb and material from each field in the tens of tons.

Studies clearly document that the fields generate particle size PM10 and smaller, and establish the direct risk of inhalation, ingestion and dermal absorption of metals, tire derived substances, PAHs, and the substances found in tires and plastic field systems.

**In fact, system design inadvertently generates dust:** Some fields have crystalline silica (mixed with tire crumb or underneath) that contributes to a grinding effect that, with deterioration of the material due to weathering, treatments, and constant pounding use generates particulate dust full of the tire crumb ingredients. Constant weathering, including exposure to daily temperature swings (from ambient to superheated high temperatures over 150F on sunny

days), and ultraviolet exposure contribute to field material degradation and dust generation. Since waste tires can be of variable age and “recipe”, the breakdown rates could vary by field or even by field area. Chemical treatments, (pesticides, flame retardants, fabric softeners, etc.), the existence of subsurface cushioning membranes or lack thereof, unanticipated chemical interactions among the variable synthetics could all be reasonably expected to contribute to field integrity breakdown and the generation of dust in the deterioration process.

### **The “Pig Pen Effect”**

Running feet, pounding tackles, marching band steps, falling bodies, and multiple players apply continuous raking and grinding force on the tire crumbs and plastic “grass” creating tiny and microscopic plastic and tire dust, that coats plastic grass blades, tire crumbs, balls, gear and athletes. The “Pig Pen Effect” coined by particle expert and epidemiologist Dr. Stuart Shalat, explains the cloud of microscopic particulate that surrounds a child at play and in motion on a tire crumb field. As more players move on a field, the “Pig Pen Effect” increases, and the more particulate is stirred up and gets suspended into the breathing zone. The suspended particles can stay in breathing zone for an extended period of time, posing a constant source of exposure. However, when studies have measured PM 2.5 and PM 10, they have not done so using personal breathing space monitors or mobile air monitors. No study has looked at the particulate cloud in a child’s breathing space while the child was playing on a field with 21 other kids.

It should be noted that in their 2008 scoping study, EPA did put a stationary air monitor on a playground while over a dozen children were playing. The PM10 level was 26.7 ug/m<sup>3</sup> as compared to a background rate of 14.2 ug/m<sup>3</sup>. However, it is difficult to draw scientific conclusions from a single sample.

**Of critical importance: Contact with dust is inescapable.** The tiny dust coats the tire crumbs (see photos below), coats the “grass” blades, covers or gets onto players’ skin and clothes, and generally can coat all the surfaces around a field.

This particulate dust makes direct contact with the dangerous substances in the tire crumb and plastic fields inevitable, and can easily happen in multiple delivery types: inhalation, ingestion and dermal absorption. Children are more susceptible to these exposures, and are unable to protect themselves from the exposures.

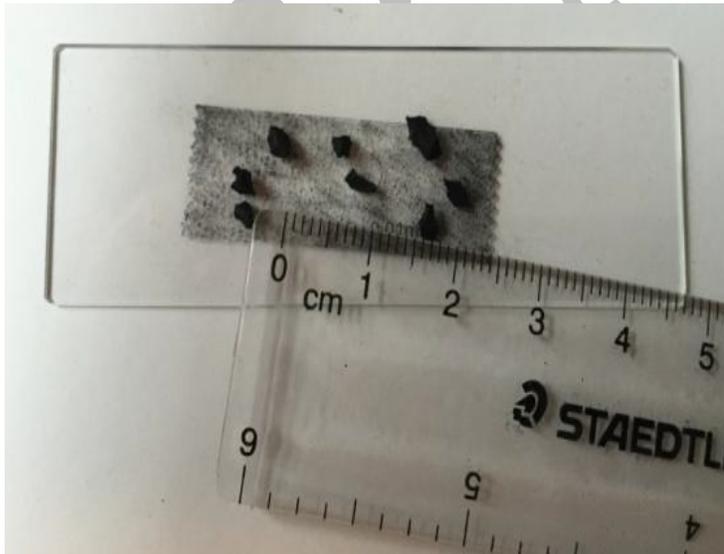
How dust covers tire crumbs is illustrated in photos below.

**TIRE CRUMB UNDER THE MICROSCOPE:**

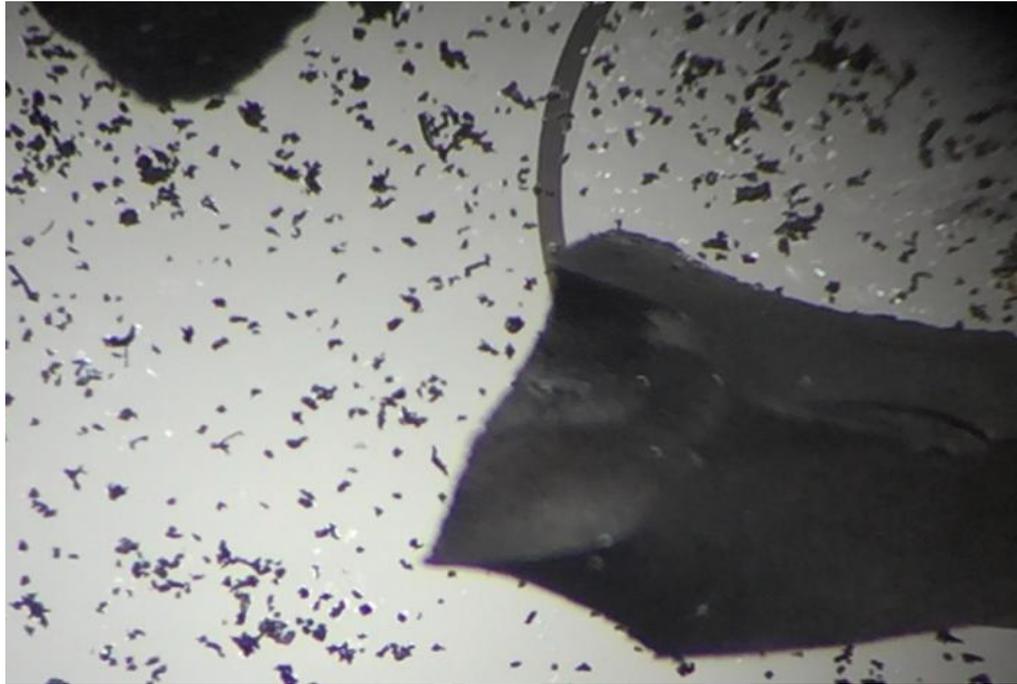
**A.** The sample source shows crumbs and “dust”.



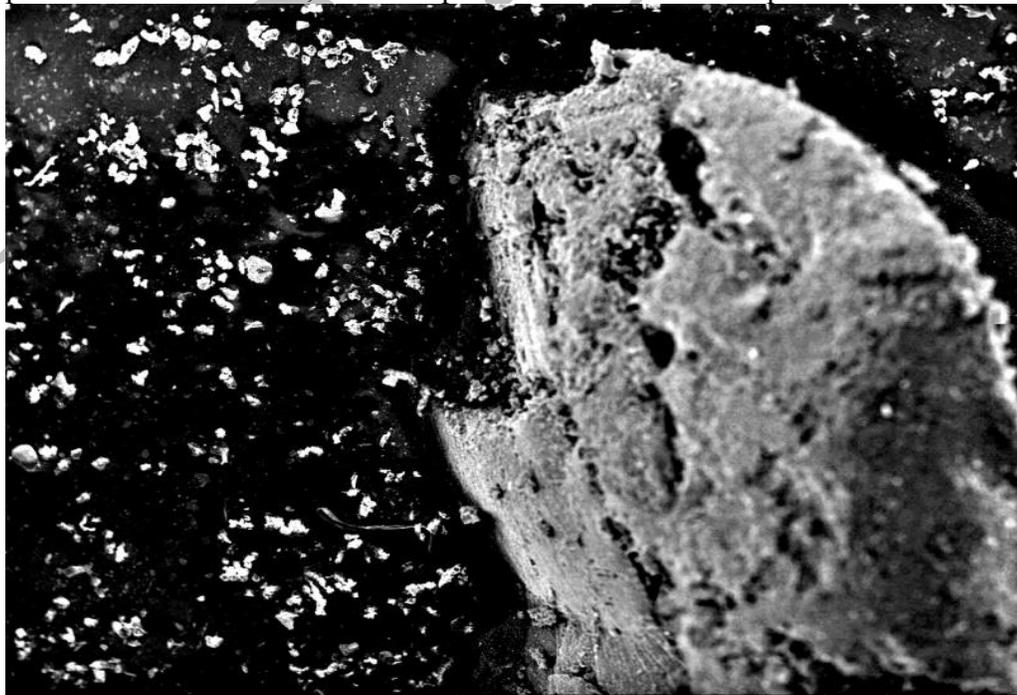
**B.** Scale of typical tire crumb is about 4mm. Of course, the observable dust is smaller.



- C. Looking more closely at the 4mm crumbs above, the small particulate dust that covers the crumbs is clearly observable.

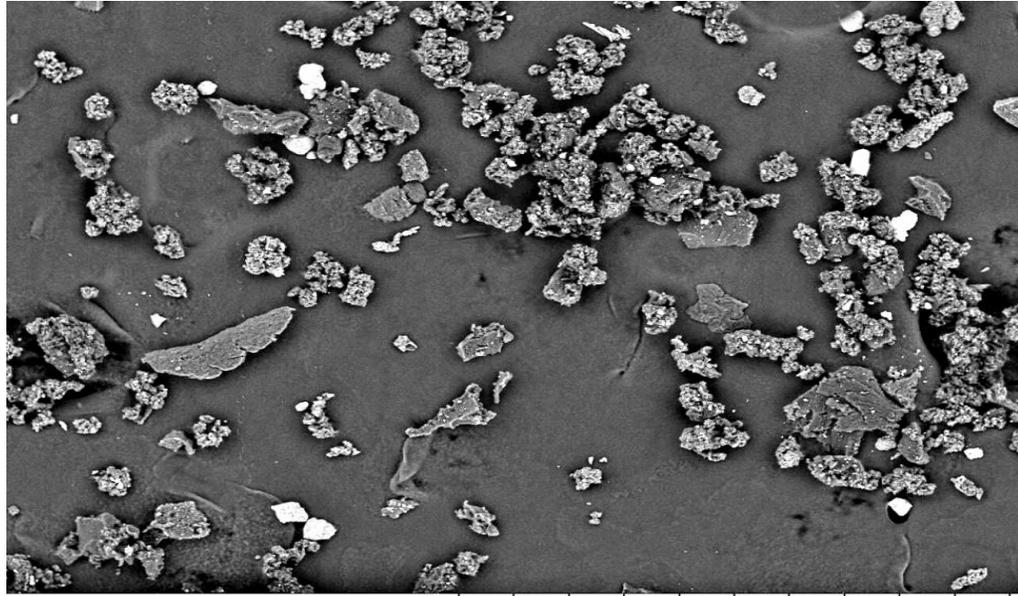


Using a more powerful microscope available in most labs, dust and its smaller particles are observable, and omnipresent in non rinsed samples.



TM3000\_1374

2016/01/28 15:21 N D6.2 x50 2 mm



TM3000\_1375 2016/01/28 15:40 N D3.9 x180 500 um

**Tire crumb and plastic field dust contains particulate of many sizes including the PM10/PM2.5 and smaller size, as shown in the photos above.** (Note that PM 10 are those less than 10um and the PM 2.5 are those less than 2.5 um.) They are well known to effectively penetrate deeply into lungs and other tissues. (This size is the indicator size for risk and is used to determine public health standards.)

**Particles of this size are a “delivery system” or vector for deep lung exposures to substances in the particulate.**

There are thousands of examples and epidemiology studies that document the harm caused from PM10 particle exposures. For example, looking solely at carbon black particulate (which is a carcinogen and makes up 30% of a typical car tire), the PM10 particle size (and the smaller sizes associated with that group) are extremely well documented in decades of air pollution studies, tobacco studies and contamination studies to cause cancers (blood, kidney, brain, heart and lung), inflammation, asthma, neurocognitive disease, implications for Alzheimer’s disease and adverse immune system impacts like immune system suppression.

Since the pulverized tire crumb fields are literally the most enormous source of a concentrated form of carbon black a child could have contact with, and the worrisome class of this particulate is easy to find on the plastics and crumbs, the exposure to carbon black particulate from use of athletic fields alone should be considered in and of itself sufficient to warrant the stop to the use of the fields by children.



## Variability of Multiple Known Toxins in a High Surface Area Material.

The inhalable, ingestible, dermally absorbable particulate matter and dust is more highly variable than the tire crumb because it will contain any substance, or some combination of the substances from: tire crumb, artificial turf, paints, adhesives, other field components, settled air pollution, skin cells, blood, vomit, cleaning chemicals, and anything else that has come into contact with the field.

The variability in substances comes from:

**A. Tire crumb:** Hundreds of substances, including: lead, mercury, cadmium, arsenic, chromium, benzene, formaldehyde, nitromethane, phthalates, benzothiazoles, plastics, sulphur products, styrenes, butadienes, acetone, PAHs, VOCs, SVOC, carbon black, among others. ( EHHI, Pavilonis, Marsili, Llompart, Norway Reg, multiple MSDS/SDS for variety of tires, tire crumb, etc.; see EHHI list attached.) None of the ingredients in tires is known to be safe for children to inhale, ingest or dermally absorb.

**B. Plastic “grass”:** benzothiazoles, butadienes, styrene, nylon, PAHs of many types, VOCs, SVOCs, lead chromate, lead, chromium, cadmium and more. None of the ingredients in plastic grass fields are known to be safe for children to inhale, ingest or dermally absorb.

**C. Infill additions, amendments and mixed in “fillers” materials, and cushioning** such as:

- i. **Plastic coated silica and/or crystalline silica** (known carcinogen; [https://www.osha.gov/OshDocdata/General\\_Facts/crystalline-factsheet.pdf](https://www.osha.gov/OshDocdata/General_Facts/crystalline-factsheet.pdf), presented as engineered sand, simple sand and engineered silica products)
- ii. **Multiple types of non uniform plastic factory waste; nonspecific; source variable** (i.e. Nike Grind, auto parts waste, waste recycling, etc.)
- iii. **Waste products (miscellaneous)** like pulverized car dashboards, auto waste parts, shredded synthetic shoe fibers (Nike Grind.)
- iv. **Paint pigment additives, such as hexavalent chromium, cadmium and lead.** Enormous quantities of paint/colorings that are applied to the component infills and plastic carpet “grass”.

**D. Field management compounds and material treatments:** Flame retardants (PBDEs), fabric softeners, fungicides, pesticides, herbicides, and microbicides. These materials can be in the particulate. None of these materials are known to be safe for children to inhale.

**E. Tire contamination from road use and the adsorption characteristic.** The high quantity of carbon black in tires makes them able to adsorb hydrocarbons and other materials from ambient air and contact with contamination on roads. The more surface area, the more contact with the immediate environment and the more adsorption ability. Tire crumb has the ability to adsorb orders of magnitude greater amounts than whole tires.



**Adsorption characteristic means tire crumb fields can get dirtier:** The enormous amount of carbon black in tire crumb adsorbs and concentrates harmful ingredients like hydrocarbons and benzene from ambient air and surroundings. Then, they can become re-aerosolized as part of the particulate that gets lofted, increasing inhalation and ingestion risks of known carcinogenic substances like benzene.

As noted earlier, benzene, a potent carcinogen with no known safe level, was found in an area of a field in CT that was adjacent to a parking lot. The benzene had been adsorbed into the material, then re-aerosolized into the breathing and contact zone of children when the material was stirred up with playing feet.

## 6. “Classic Cancer Cluster”

Reports of cancer in young athletes began around 2008. Athletes who spent the longest time in closest contact with the synthetic turf surface, soccer goalies, are disproportionately represented in the affected young adult athletes.

In addition, blood cancers are also disproportionately present, and are associated with benzene and butadiene exposure. Both substances occur, consistently, in high amounts in tires and tire derived materials.



### **Cancer found in goalies.**

In 2009, soccer Coach Amy Griffin was personally impacted by the cancer diagnosis of two goalkeepers whom she knew. As the team captain of the Women’s US Soccer Team that won the World Cup, Olympic champion, and coach to elite collegiate players, Amy had close, continuous contact with young players who had spent years in training on tire crumb fields.

During visits to oncology for treatment, Ms. Griffin detected a pattern emerged among soccer players, particularly goalkeepers, being diagnosed with cancer.

Ms. Griffin started taking notes, questioning the fields and keeping a list of turf athletes with cancer, **Amy's List**. Amy's List grew organically over the years, through casual conversations and friends of friends in the world of women's soccer.

By 2014, the data was too compelling to ignore and Amy's List received national and international attention.

<http://www.espn.com/espnw/news-commentary/article/14206717/how-safe-fields-where-play>

<http://www.nbcnews.com/storyline/artificial-turf-debate/how-safe-artificial-turf-your-child-plays-n220166>

**To date, the numbers of goalkeepers has expanded well beyond epidemic levels.**

As of January 8, 2017 the statistically interesting data on Amy's List includes, but is not limited to:

**Cancer data:**

- 237 young athletes with Cancer
- 74% cancer cases were diagnosed between the ages of 12 and 26 years old
- 53 cases of Leukemia
- 33 cases of Non-Hodgkin's Lymphoma
- 63 cases of Hodgkin's Lymphoma

Cancer	American Cancer Society Incident Projections for 2009-2013 *	Amy's List
Leukemia	<b>13.5</b>	<b>22.3%</b>
Non-Hodgkin's Lymphoma	<b>19.1</b>	<b>13.9%</b>
Hodgkin's Lymphoma	<b>2.7</b>	<b>26.6%</b>

\*Average annual rate per 100,000, age adjusted to the 2000 US standard population.  
[\(https://cancerstatisticscenter.cancer.org/?\\_ga=1.1247220.4921615.1475740866#/\)](https://cancerstatisticscenter.cancer.org/?_ga=1.1247220.4921615.1475740866#/)

**Soccer-specific cluster data:**

188 soccer players  
 117 of the soccer players are goalkeepers

The cancer cases of goalkeepers make up 62% of soccer players while goalkeepers represent 10% or less of a team's roster.

**Turf use reported:**

33% played on turf fields 4-6 years

51% played for 7+ years on turf

*84% of the athletes played on synthetic turf fields for 4 years or longer*

41% played in high school

37% played in college and beyond

*58% of players spent 7 or more hours on the turf each week*

**No human or animal studies have been conducted on turf exposure, ingestion or inhalation to date. What we do know about goalkeepers that make their exposure/risk to toxic and carcinogens unique:**

- Club, high school and college-level goalkeepers can dive on the field up to 100 times per practice
- Goalkeepers proximity and full body contact with turf increases risk of gas/particle inhalation, ingestion and abrasions
- The goalkeeper box generally sees the most wear and tear on a soccer field translating to an expedient breakdown of turf materials

Amy's List for January 2017 is attached as Appendix K.

**Even simple internet searches uncover myriad cancer cases that should be further investigated with epidemiological evaluation methods.** For example, the following is an excerpt from a letter that SHPFC received from a teacher concerned about exposure to toxic materials in tire crumb fields.

Conducting a straightforward internet search of local and regional papers across the country, and some local sources, she was able to locate 230 football players who had cancer, including 123 cases where she established that the football players played on tire crumb fields. She was able to observe patterns that could have epidemiological significance, and need to be addressed.

**” There are at least 123 football players confirmed who played on synthetic turf before being diagnosed with cancer.** This list primarily focuses on high school football players, but also includes college and professional football players with cancers diagnosed in 1999 or after.

**Observations**

**TOTALS**

- 123 football players with cancer who played on synthetic turf fields
- 45 of those were linemen
- “There are players from the same school with cancer.”
- “There are twins, where the twin who played football got cancer.”

She and the growing body of concerned parents, teachers, community leaders and athletes will continue to locate these players and collect additional data.

Attached as Appendix L is her letter to the SHPFC, a spreadsheet of players she found for your reference.

**More cancer clusters should be expected to exist.**

It is presumed that installation and maintenance workers who are in constant contact with dust from tire crumb are at risk. However, diagnosis and self-reporting may be low in this group if many of the workers lack health insurance or if the industry employs undocumented workers.

High contact is an obvious risk factor, but many researchers are looking at low dose chronic exposures that could provoke responses that might be preconditions for cancer response in cells. In any case, more sophisticated study needs to be done to understand how the exposures work together, and to predict and find cancer clusters.

However, no “collection point” for reporting illness exists, and hospital cancer screening protocols do not include screening for tire crumb exposure... so we rely on volunteers to locate more groups with high contact.

**7. Heat**

On a sunny, warm day, a synthetic field surface can routinely reach 120F-185F, creating heat injuries and increasing toxic load from off gassing and gas/particulate exposures. No rules or guidelines exist for parents and schools to remove their students when it gets hot. Superheating conditions are well documented in the Penn State Turf Field Heat Study here:

<http://plantscience.psu.edu/research/centers/ssrc/documents/heat-progress-report.pdf>.

We hope that the CPSC looks carefully at the data provided in this study (notably paid for by Field Turf, Inc.), which clearly demonstrates superheating effects, and shows heat levels that supercede basic safety levels for children users, (or any users).



The 2012 Penn State Turf Field Heat Study found that all synthetic fields and infills tested have a high heat problem, and none compare with the coolness of grass which is not higher than ambient temperatures. The study tested the plastic rug alone, infill alone and various combinations.

Their summary notes:

"No product in this test substantially reduced surface temperature compared to the traditional system of green fibers filled with black rubber in both the indoor and outdoor test. Reductions of five or even ten degrees offer little advantage when temperatures still exceed 150° F. Until temperatures can be reduced by at least twenty or thirty degrees for an extended period of time, surface temperature will remain a major issue on synthetic turf fields."

Heat Injury Inflection Points:

1. At 111° F humans begin to feel a burning pain, with first-degree burns developing at 118 F.
2. At 131° F exposed skin develops second-degree burns.
3. At 140° F skin develops third-degree burns and pain receptors overload and become numb.
4. At 162° F human tissue is destroyed on contact, and damage is so extensive that there may not be any pain because of nerve damage.
5. At 212° F water boils.

(Source: <https://www.nist.gov/%3Cfront%3E/fire-dynamics>)



Skin burns, nausea, dehydration, heat stroke and heat exhaustion are common injuries caused by contact with and play on superheated fields. Our volunteers and concerned parents have collected hundreds of examples of burns and injuries during practice, games, tournaments and events and can offer many examples and case studies that demonstrate unacceptable play conditions due to heat.

Some examples and notes from our archives are listed below.

- a. Recently in Toronto, surface temps on a tire crumb field soared to 203F [<http://www.cbc.ca/news/canada/toronto/summer-heat-turf-1.3714351>].
- b. Recently in Boston, a football team experienced burned hands from contact during workout. <http://www.fox25boston.com/news/framingham-high-schools-synthetic-field-at-center-of-football-crisis/431162912>



- c. In a preseason training period in August in the DC area, it is “normal” for multiple athletes on a team to vomit during routine practice on tire crumb field, due to heat. (recorded story; 16 year old player)
- d. Scores of equipment failure from excessive heat including melted cleats and melted shoe adhesive.



It's so hot in Texas, turf is melting cleats



- e. **Melted** water bottles from simply being placed on a hot tire crumb field.



- f. Skin abrasions and burns (multiple examples we documented; and a report of hundreds of cases found by a volunteer)



- g. Melted infills (as in the case in CA when buyer sued manufacturer because the field was warranted to 180F but melted at 140F; alternative infill was used with a plastic “grass” carpet.)

**In addition to injuries and heat related illnesses, superheating multiplies toxic exposure risk** because it can contribute to dust/particulate generation. We discussed earlier that constant heating cooling cycles have the effect of accelerating breakdown of material, and likely increase the generation of dust in tire crumb fields.

In addition to the direct heat injuries, superheating:

- increases chemical yield from off-gassing products;
- increases risk of direct inhalation exposure from gases;
- accelerates formation of dangerous gas/particulate combinations that are inhalable, ingestible and available for dermal uptake, and 10-20 times more dangerous than the single substances alone. (Dr. David Brown, EHHI).
- accelerates deterioration of the material, which could contribute to increased particulate

**As temperatures climb on the field surface, exposure risks from both heat and toxic particulate increase exponentially, putting children at further risk during hot temperatures.** Complex gas/particulate mixture composition, distribution and impacts have not been studied, and are not planned in federal

study, although these are likely extremely relevant and the source of acute exposures.

## 8. Risk Estimation

**Low Dose Impacts on Immune System:** Multiple studies on tire crumb and plastic fields frequently confirm the appearance of a harmful substance, but note that the test did not show levels of exposure that might warrant regulatory action. However, there is increasing documentation and growing concern that chronic exposures to low dose, chronic exposures to multiple substances (benzothiazoles, plastics and PAHs) cause unwanted immune system suppression impacts and endocrine system disruption. These “gateway changes” can make a person, particularly a child, even more vulnerable to other toxic or carcinogenic exposures. Low dose exposure effects can be cumulative, and involve several steps, and occur prior to being symptomatic. Since the fields are in schools, the fields provide enormous “availability” for the low dose exposures to occur. No such studies have been completed on tire crumb, despite several findings of low dose, chronic exposure risk. Inhalable, ingestible and dermally available exposures from tire crumb fields contribute to over the all toxic load that children receive everyday.

### **Synergistic risk of multiple exposures from complex material and heat**

The tire crumb fields pose unacceptable risks from multiple types of exposures, but their synergies are not taken into account in most safety studies. For example, exposures can occur at acute levels, i.e. from a chemical hotspots, lead, other metals, and/or chronic levels from off gassing from PAH or benzothiazoles, where even low level exposure might cause harmful effects after chronic exposure.

Synergistic effects from the multiple types of exposures present an enormous challenge to those who might try to understand the health impacts and assess risk.

### **From Environmental Coalition Paper:**

A study conducted by the California Environmental Protection Agency Office of Environmental Health Hazard Assessment (OEHHA) in 2009 concludes that artificial turf fields with tire crumb rubber infill create a cancer risk of approximately 18.8 per million — 18 times above the CEQA significance threshold. The OEHHA Study concludes:

*"Estimated inhalation exposures of soccer players to five of these (benzene, formaldehyde, naphthalene, nitromethane and styrene) gave theoretical increased lifetime cancer risks that exceeded the insignificant risk level of  $10^{-6}$  (OEHHA, 2006)." (p.33)*



- Constant off-gassing of 24 harmful substances (Norway Regulatory Agency Study) from tire crumb is well established. Particulate in toxic sizes is well established. Those gases react among themselves and with particulate. They can produce low dose exposures in some conditions, acute exposures in some conditions, or both. The modeling for this chemical behavior and its impacts are not well tested for anyone, and not for children, even though it is clear that they are present.
- Philip Landrigan, MD and an epidemiologist, and Director of Mt. Sinai School of Medicine Children's Environmental Health Center, commented on gases becoming more dynamic with heat. He noted that we "don't know impacts under those heat conditions" (12-8-08 USA Today). His discussion on synergy noted the following:
  - "The fundamental problem is truly how little we know about interactions," Landrigan says. "When you compound that situation by simultaneously exposing children to a number of chemicals, there are just gaps in knowledge that (are) really of grave concern."  
<http://usatoday30.usatoday.com/news/nation/environment/school-air-chemicals.html>

Dr. Phillip Landrigan, submitted a letter to the City Planning Department on May 8, 2012, stating:

*"The major chemical components of crumb rubber are styrene and butadiene, the principal ingredients of the synthetic rubber used for tires in the United States. Styrene is neurotoxic. Butadiene is a proven human carcinogen. It has been shown to cause leukemia and lymphoma. The crumb rubber pellets that*

*go into synthetic turf fields also contain lead, cadmium and other metals. Some of these metals are included in tires during manufacture, and others picked up by tires as they roll down the nation's streets and highways. There is a potential for all of these toxins to be inhaled, absorbed through the skin and even swallowed by children who play on synthetic turf fields.”*

The **synergistic effects** of inhaling particulate that contains metals (lead, chromium, mercury, asbestos) and silica (in inhalable sizes) together is relevant to assessing tire crumb field risk. For example, a recent study that examined particulate inhalation with both silica and metals in a naturally occurring form (desert soil/sand outside of Las Vegas), showed a marked inflammation response and immune system suppression. (Keil, 2016)

In addition, all the synthetic fields, including tire crumb, silica, and plastic field systems present a direct and repeated risk of a variety of heat injuries; a risk of concussion, joint, and similar hardness-related injury from slower post-game recovery to lower-body torque injuries to broken bones of varying severity. <http://plantscience.psu.edu/research/centers/ssrc/documents/understanding-gmax.pdf>.

In the course of a month, many athletic children might easily suffer multiple exposures, and multiple injuries. Do the harmful effects build up?

**Inadequate, Unacceptable Study Methodology to assess risk in this type of system:** The most misleading message given to unsuspecting schools and sports directors are the claims of safety, or statements of “no harm found”. Knowing that harmful substances that cause cancer and illness are present in the tire crumb/plastic fields in enormous quantities in a form that is inhalable, should be enough to stop their use among children and schools.

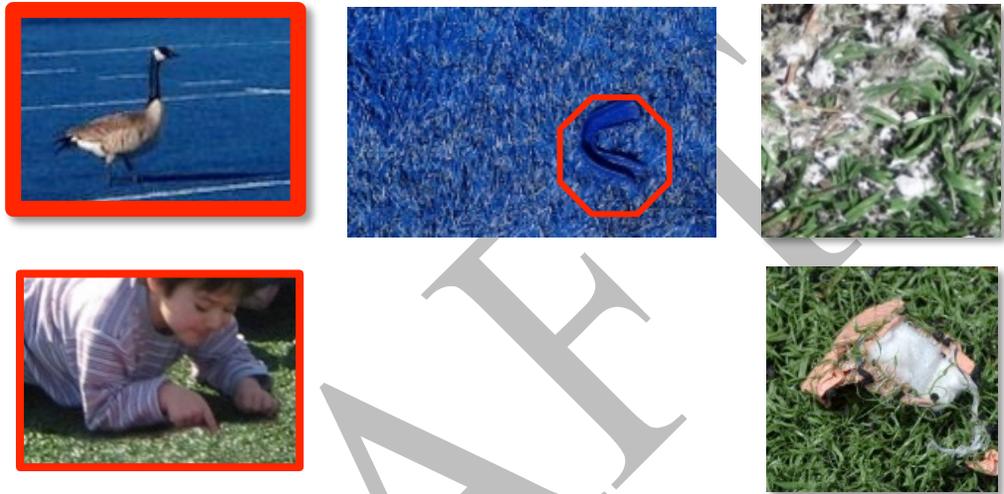
We looked carefully at the study methodologies and found literally hundreds of systematic methodological problems in the myriad studies available. Among the study methodological failures repeatedly noted in risk assessment or safety studies are:

- a. Failure to design study with a qualified toxicologist trained in pediatric epidemiology and risk assessment.
- b. Failure to model, or test the complexity of the inhalation and ingestion risks, in general;
- c. Failure to study exposures at high temperatures.
- d. Failure to use or correctly model real world play situations (i.e. real play with multiple players/teams in motion, multiple contact force with field like sliding, group drops with force, balls bouncing; for example, the EPA

installed particulate box filters on the side of the fields to not get in the way of play – and recognized the weakness of the results)

- e. Failure to recognize that simple sampling would not show risk of acute, hotspots, chronic, or low dose exposures that are apparent in a heterogeneous, non uniform, multi sourced material with multiple known carcinogens and multiple known harmful substances.
- f. Failure to recognize that basic statistical sampling methodology, such as abandoning top readings of harmful ingredients in a material with “hotspots” will hide actual risk of acute exposures.
- g. Failure to use statistical assessments appropriate for a material with high variability and multiple substances with known harmful effects. For example, if benzene is found in one sample in a field where 6 samples were taken, it is not correct to average that amount with the whole sample for the result because it will not properly show acute risk. If the benzene hotspot is where a goal keeper practices dives, the child can receive an acute exposure to a Class 1 carcinogen, benzene. **A child has the right to be protected against such exposure.**
- h. Failure to acknowledge, examine or even contemplate synergistic effects of multiple substance exposures (i.e. the possible role of low dose exposure to multiple types of plastic in suppressing the immune system, allowing carcinogenic material a “window” of opportunity).
- i. No study of possible synergistic impacts from multiple known carcinogens or toxins. (For example, the plastic particulate in breathing zones might cause an endocrine disruption effect in a child, the metals might initiate a suppression of immune system, and might be a gateway for a body’s response to multiple carcinogens.)
- j. Failure to conduct biomonitoring in general (the best way to study highly variable material with multiple known harmful materials in ingestible/inhalable sizes) to know what substances are taken into a child’s body; that is, failure to conduct blood, dermal, urine and tissue studies on a longitudinal basis, or any basis.
- k. Common, simple mistakes are found frequently in “safety studies”. For example, washing a sample with water prior to testing removes the particulate prior to testing the material. This was found in industry studies and several community studies. Another is the inappropriate use of buffered or unbuffered water in the lab process, since it can alter leachate results dramatically.

- l. The use of component-based methodologies to estimate the toxicity of a highly variable, complex mixture.
- m. The provision of numerical risk estimates when data quality is poor.
- n. We can, in fact, go on and on. Essentially the studies that claim the fields are safe are basing their information on lack of findings because the methodologies used to find harmful materials were not appropriate. *It is easy to NOT FIND problems.*



**Known off gassing risks from multiple substances are pervasive, continuous, and they increase at high temperatures.** Though off gassing calculations are complex, and there is much more to learn, what became clear is the continuous release of carcinogenic PAHs throughout the life of the fields. There are multiple sources of these findings on PAHs. For example:

The Marsili et al study found that on warm (80° F or higher) sunny days when fields can heat to 140° F, fields can release very high levels of carcinogenic PAHs. “The exposure of an athlete exercising on the field for 8 hours per week would be approximately 1000 times the toxic equivalent of the virtually safe level of exposure to benzo(a)pyrene in food”.

From the same study, citing a Swedish study from 2006,

“Sport grounds fitted with synthetic turf filled with crumb of recycled tyres may release dangerous particles in air, contaminate soil and groundwater with soluble contaminants leached by rain, and pose health hazards for residents and users due to inhalation of volatile substances [Marsili reference to Swedish Chemicals Inspectorate. Synthetic turf from a chemical perspective — a status report. Sweden: Sundbyberg 2006].

The study further stated,

“The main conclusion we can draw from this preliminary study, which will be validated by further field and laboratory research, is that although synthetic turf offers various advantages over natural grass, **the quantity of toxic substances it releases when heated does not make it safe for public health.**”

Study link: <http://www.omicsonline.org/open-access/release-of-polycyclic-aromatic-hydrocarbons-and-heavy-metals-from-rubber-crumb-in-synthetic-turf-fields-2161-0525.1000265.pdf>

PAHs were found in playground pavers in Llompart Study, a study published in the journal *Chemosphere*, entitled “Hazardous Organic Chemicals in Rubber Recycled Tire Playgrounds and Pavers” (Llompart, M., et. al.2012) which investigated the presence of hazardous organic chemicals in surfaces containing waste tires. The study was initiated because of a concern that the application of used tires in recycled products such as rubber mulch used for sport fields and playground surfaces places children at risk. The study revealed that the used tire products used on sport fields and playground surfaces contain a large number of hazardous substances including polycyclic aromatic hydrocarbons (PAHs), phthalates, antioxidants, benzothiazole and derivatives, among other chemicals. Many of these hazardous substances were at high or extremely high levels. In addition, vapor studies revealed that many of the organic compounds are volatile even at room temperature. *The study concludes that because of the “presence of a high number of harmful compounds, frequently at high or extremely high levels, in these recycled rubber materials...they should be carefully controlled, and their final use should be restricted or even prohibited in some cases.”*

#### **Main points about PAHs exposures in tire crumb field systems:**

- Continuous release of carcinogenic PAHs found
- On warm sunny days, fields can release unhealthy levels of PAHs;
- PAH levels can change with conditions.
- Higher levels found during installation and pouring material (a worrisome indication for installers and schools)
- Acute risk of PAH exposure during and after installation and pouring of pulverized tire crumb. (Installers and field maintenance workers at risk.)



- Constant, harmful off gassing found even in encapsulated playground pavers made of tire

## 9. Injury

**Known Increased Concussive Risk among children users:** Fields are frequently built directly on concrete or packed stone, with variable padding or no padding and no uniform standards for hardness or safety design. Field hardness, and infill hardness can vary from field to field and day to day. Underfield pads, humidity, compaction, adequacy of infill replenishment, maintenance procedures, and age of field, are some factors.

Looking at overall concussion rates, in 2008, the injury rates spiked, and continued to increase.



Common construction technique: field built directly on concrete or packed gravel; lack of cushioning underpad.

The Concussion Legacy Foundation concluded last year that “youth athletes are at greatest risk”, and that “concussions in children aged 5-9 occurred from surface impacts”.

Paraphrasing their White Paper, developmental patterns and less developed neck musculature in children lead to an inability to prevent their head from striking the ground when they fall. Since artificial turf fields receive “ten times as much play as natural grass fields, upwards of 4250 hours per year”, their pediatric use warrants protective attention.

From their White Paper on The Role of Synthetic Turf in Concussion:

“Turf field components and conditions can degrade over time and require regular maintenance. With regard to concussion, the protective characteristics of an artificial turf field have been found to degrade as the field sees more use. From a structure perspective, the choice of components, including the foam under pad, can significantly alter impact attenuation. Further, in fields using rubber infill, a popular design among newer turf fields, significant compaction can occur further decreasing impact attenuation in areas of the field that are more frequently used. Decreased impact attenuation could increase the amount of forces transferred to an athlete’s head during a fall, potentially increasing their risk of sustaining a concussion.”

A low G-Max (a measure of field hardness), is essential for preventing injuries. Probably the biggest factors in keeping a field’s G-Max rating low are regular maintenance and the replenishment of lost tire crumb. Although regular maintenance and G-Max testing is required in the NFL, most school and community fields do not receive that level of attention and quality control. In his conversation with EPA for the federal study on tire crumb rubber Professor Andrew McNitt, Penn State Turf Study Center, estimated that less than 5% of the fields in this country receive routine topdressing or maintenance.

A field may look fine and have a G-Max above 200, high enough to cause concussion or life threatening injury. Unmaintained artificial turf fields can pose a hidden danger to children.

It should be noted that many areas, like Western Washington have a soft, sandy soil. A poorly or even unmaintained grass field cannot get a G-Max above 100. Any dangers in a poorly maintained grass field, such as divots and weeds will be obvious



Cushioning underpads that attenuate force can cause field drainage problems, which create tripping hazards. Because perforations to allow permeability get clogged with dust, tend to block or redirect drainage, and add additional expense to an already very expensive field, the cushioning underpads are not used in many fields. There is no requirement to install a cushioning pad. They appear on only a fraction of the installed fields, due to either cost increase, or drainage issues that arise when the subsurface membrane, which should be permeable, gets blocked with small particulate or silica pieces.



Community Field in McLean, VA, 2015. Illustration of effects from a blocked subsurface membrane, and/or blocked drainage perforations in carpet.

Drainage failure, above, causes undulation in surfaces, and contributes to uneven distribution of infill, which can pose tripping hazards. Tripping hazards increase with field breakdown and poor repairs/

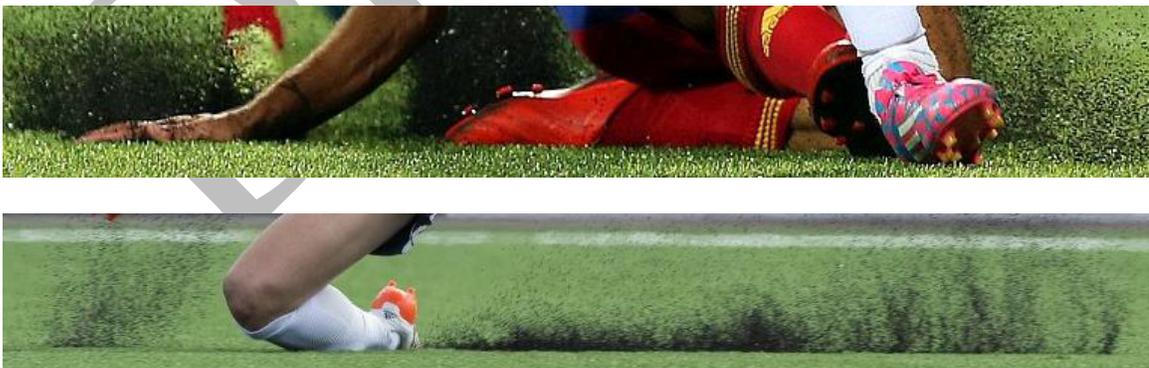


Community Field in San Francisco. 2014. Uneven surfaces from shoddy repairs.



Community Field in Washington, DC. Fall 2016. Typical field degradation from normal use.

#### 10. Known Increased Joint Injury Risk from hard surface conditions.





**11. Known Increased Risk of Abrasion with contamination from pulverized infill ingredients. Examples of common abrasion injuries:**

Artificial Turf Abrasions

Sydney Leroux  
United States



April 14, 2013  
Twitter: [@sydneyleroux](https://twitter.com/sydneyleroux)

Samantha Kerr  
Australia



May 12, 2013  
Twitter: [@samkerr1](https://twitter.com/samkerr1)

Nadine Angerer  
Germany



January 24, 2014  
Twitter: [@NAngerer](https://twitter.com/NAngerer)

**12. Known Increased Risk of Abrasion with contamination from pulverized infill ingredients. Examples of common abrasion injuries: Synthetic turf fields are notorious for shredding or shaving skin from players' limbs.**

Abrasive contact with a pulverized surface field introduces small particulate directly into the wound. There is a relatively very high incidence of MRSA and difficult to cure infections; (refer to story archive.)

2013 Weber State University study on growth of bacteria on artificial turf infill finds highest concentrations on sidelines:

Abstract: [http://skyline.bigskyconf.com/journal/vol1/iss1/1/?utm\\_source=skyline.bigskyconf.com%2Fjournal%2Fvol1%2Fiss1%2F1&utm\\_medium=PDF&utm\\_campaign=PDFCoverPages](http://skyline.bigskyconf.com/journal/vol1/iss1/1/?utm_source=skyline.bigskyconf.com%2Fjournal%2Fvol1%2Fiss1%2F1&utm_medium=PDF&utm_campaign=PDFCoverPages) and Full article: <http://skyline.bigskyconf.com/cgi/viewcontent.cgi?article=1000&context=journal>

### **Unintended public health issue from MRSA and/or other infection**

**prevention efforts:** The high incidence of MRSA or virulent infections from abrasions creates a worrisome public health issue: field managers may use industrial strength microbicides, antibacterial agents and solvents, *in absolutely enormous, unchecked quantities*, to try to mitigate the growth of infecting cultures.

Though the Weber study advocates for cleaning to prevent the fields from becoming a vector for infection, the downstream implications of using enormous quantities of microbicides that would be required to disinfect a field were not contemplated. Should those microbicides land in local stormwater systems, short and long term impacts must be studied for drainage systems, which could easily become “petri dishes” for the very microbes, and possibly the super-versions of those microbes, that cleaning was intended to prevent. Stopping MRSA or biological infections with microbicides could create a “Pandora’s Box” of public health issues, if it has not done so already.

### **13. US Federal Regulatory Action:**

The existing status is for commercial vendors to sell and install (with no interference from CPSC) hundreds of tons of known toxic and carcinogenic material, in endlessly variable combinations, on playing fields and in playgrounds intended for children.

The application of a “secondary product” designation from RCRA cannot be allowed to affect the question of whether these products should be regulated as children’s products. Public Employees for Environmental Responsibility (PEER) challenged the CPSC in two areas: children’s product designation, and in a petition to protect school children from heat injury.

Artificial turf fields often have levels of lead that exceed U.S. regulatory levels for lead in children’s products. Despite repeated actions by PEER, CPSC has thus far failed to enforce U.S. regulations for children’s products for crumb rubber despite being provided ample evidence that it is being marketed as a children’s product. Crumb rubber does **not** meet *relevant* European toy safety standards despite claims to the contrary.

### **U.S. Regulations for Children’s Products**

Not only did the CPSC and EPA not regulate use of tire crumb near children, they actually said it was safe.

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. Playgrounds made with shredded tires, however, generally exceed this lead limit, including in CPSC’s own testing.

After PEER presented CPSC with numerous examples of shredded tire play surfaces marketed specifically to children, under product names such as TotTurf, KidWise and PlaySafer, on September 27, 2013 the CPSC informed PEER that it had tasked its Office of Compliance and Field Operations with a “**review and determination of whether any enforcement action is appropriate.**” [Emphasis added, note that this would be an enforcement, not a regulatory decision.]

Over a year passed without word of the results of this playground review. When its emailed requests went unanswered, PEER submitted a formal request under the Freedom of Information Act. After the agency failed to answer the FOIA request, PEER sued the agency for an answer in February 2015.

Members of Congress also began to inquire. On July 20, 2015, CPSC sent a letter to U.S. Senator Elizabeth Warren (D-MA) which contained the following statement:

“Upon further exploration, Compliance staff concluded, at that time, specific product enforcement was unlikely to be the best option, based upon the need for individual health assessments, among other factors. To my knowledge, this information has also been communicated to PEER.”

This statement is curious in several respects:

- The children’s product enforcement route does not require a health assessment. It only requires a test for lead content – a test which is supposed to be done by a third party tester at the expense of the operator or manufacturer;
- In response to the PEER FOIA suit, the CPSC has not been able to locate any paper trail documenting this decision. The only thing PEER obtained was an internal email suggesting the decision was never reduced to writing; and
- If enforcement was not “the best option,” CPSC cannot identify what other options it examined.

See links at the end of this for copies of referenced documents:

<http://www.peer.org/news/news-releases/cpsc-drops-artificial-turf-playground-safety-review.html>

PEER’s HEAT PETITION TO CPSC:

<http://www.peer.org/news/news-releases/artificial-turf-field-heat-dangers-require-safeguards.html>

CPSC response attached.

Additional PEER actions are displayed here, for quick reference

<http://www.peer.org/campaigns/public-health/artificial-turf/news-releases.html>

## **European Toy Safety Regulations**

While European toy safety regulations have not been adopted by the U.S., they are relevant for a couple of reasons. First, as noted by Terry Ward in a Nov, 25, 2014 Synthetic Turf Council Industry News article, they are the most advanced in the world. ([www.syntheticurfCouncil.org/news/204292/New-Independent-Lab-Testing-of-Synthetic-Turf-Crumb-Rubber-Infill-Re-confirms-Health-and-Safety.htm](http://www.syntheticurfCouncil.org/news/204292/New-Independent-Lab-Testing-of-Synthetic-Turf-Crumb-Rubber-Infill-Re-confirms-Health-and-Safety.htm)) America's children deserve the safest play surfaces available.

Second, the synthetic turf industry has already (erroneously) stated that their product meets these high standards. Since the synthetic turf industry obviously thinks these standards are an outstanding measure of safety, they should be held the standards they claim to meet.

In a July 20, 2015 conference call with Chairman Elliot Kaye and others at the CPSC Rom Reddy stated: "Crumb rubber passed every single test versus the European toy standard." With this statement, Rom Reddy, the current President and CEO of Sprinturf, indicates that he believes that European toy standards are relevant to crumb rubber. However, crumb rubber does not meet European toy standards EN 71.3 for dry, brittle or powder-like substances, nor does it meet EU REACH standards limiting carcinogenic PAH's in toys to 0.5mg/kg each.

The Nov 5, 2014 Labosport technical report that found that crumb rubber met EN 71.3 category III requirements looked only at particles 0.8 to 2.5 mm in diameter with a variation of only 1%. This clearly indicates that the crumb had been washed to remove dust and particulates. In the real world, as documented above in this white paper, people who use crumb rubber surfaces are exposed to significant amounts of dust and particulate matter. Therefore, the appropriate test would be whether unwashed crumb rubber meets EN 71.3 category I standards, or more stringently whether its dust meets these standards. Other leaching and bioavailability studies, such as the Pavilonis et al study, the 2009 Li et al study, and the 2008 Zhang et al study show levels of heavy metals such as lead, cadmium, and zinc well above the EU guidelines. High levels of these toxicants are especially likely to be found in gastric digestion studies. This is of particular relevance to young children who exhibit high rates of hand-to-mouth behavior and pica.

When the EU adopted its current standards for PAH limits in consumer products and toys, the synthetic turf and recycled rubber industries realized that crumb rubber could never meet the standards, even for consumer products. They lobbied heavily for, and received, an exemption. Studies such as the Marsili 2014 study clearly indicate that the carcinogenic PAHs exceed the 1mg/kg limit.

The existing status is for commercial vendors to sell and install (with no interference from CPSC) hundreds of tons of known toxic and carcinogenic material, in endlessly variable combinations, on playing fields and in playgrounds intended for children.

The application of a “secondary product” designation from RCRA cannot be allowed to affect the question of whether these products should be regulated as children’s products. PEER challenged the CPSC in two areas: children’s product designation, and in a petition to protect school children from heat injury.

#### WASTE PRODUCT vs. PRODUCT LOOPHOLE?

Since waste material is “repurposed” under RCRA and is considered a “product.” However, its “product” status will not protect children from inhalation, ingestion or dermal exposure risks inherent in tire crumb/plastic field systems. Paradoxically, tire crumb fields, and synthetic fields go back into landfills, thus generating more waste than there was originally.

Further, while on the field, tire crumb breaks down into dust and particulate matter. Tens of tons of crumbs, dust, and smaller particulates migrate away from each field, spreading this toxic material through the environment. Thus, toxicants that were once well contained within whole tires, are now widely dispersed in the environment and able to add to the toxic load of current and future generations. Regardless of the secondary product designation under RCRA, installing known toxic and carcinogenic material on a playfield is inappropriate use of a waste product with known carcinogens and toxins.

While the government should consider industry interests when developing regulations, it should be noted that any regulations that restrict the use of crumb rubber and artificial turf simultaneously help competing industries. Increasing the appeal of professionally maintained grass fields would create local jobs that could not be outsourced. Most of these jobs would be in small companies, or government jobs with benefits. It is not a matter job destruction. It is a matter of whether we pay for sod farms or plastic grass factories. Do we pay people to scientifically maintain grass fields, or cover them with toxic waste material?

**Finally, the commercial interests of industry should never supersede the most basic health interests of our children.**

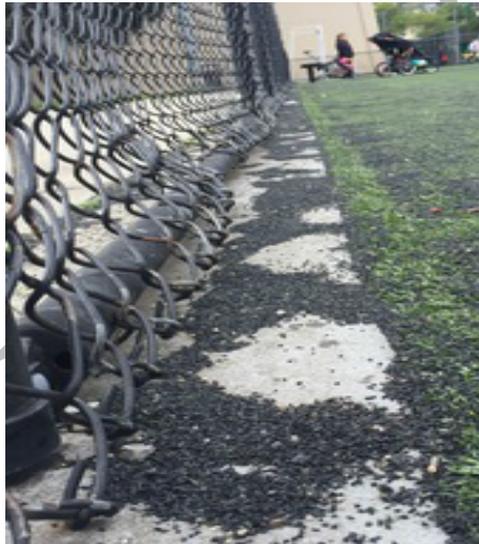
#### **14. Environment**

A related, though secondary concern for the CPSC is the environmental impact of synthetic turf fields on the immediate area around the fields, including school grounds... and the financial and toxic damage they could leave behind.

While there are many versions of synthetic turf fields, and there is no uniform construction standard, nearly all share the two principal components on which we focus here: the 50 ton plastic carpet of “grass” and the hundreds of thousands of pounds of shredded, pulverized waste tire infill (from about 40,000 tires used per field), per 8-10 year product cycle.



An average field costs schools, taxpayers and/or sports centers, about \$850,000. Many of the new fields cost millions in taxpayer and private funding. However, the costs of contamination of the local stormwater systems, health impact costs, greenhouse gas emissions, and regulatory costs are never contemplated in industry studies. Since there are no material controls, the field infills may contain many other substances, *literally anything*, so the costs are a moving target.



Typical movement from field surface to sidewalk or field edge. K-12 School field in DC 2016.

Tire crumb infills, are known to be highly mobile, as attested to by the frequent need for infill replenishment. There are tens of tons of material lost into the environment and adjacent buildings from each field depending on the proximity, conditions, and use of the field.

Schools and communities need to be aware that the heavy metals in the tons of material will stay in soils and will bioaccumulate throughout the local ecosystem, and that some substances, such as metals or metabolites can remain for many years.

From a public health standpoint, what will a community do when a field with 200 tons of toxic infill completes its life or fails? How will landfill managers and environmental stewards respond to the physical load? The end of life and the recurrent failures have and will impact individuals, schools, and families and community budgets.

Direct contamination of stormwater system with tens of tons of crumbs, particulate, and leachates (particularly zinc), is a likely violation of Clean Water Act requirements. However, there are no filters approved for general use that effectively filter zinc out of stormwater. Thus, the zinc leached from these fields is being dumped into streams, rivers, and waterways across the country.

The decades-long, ongoing release of tons of tire crumb and other field material and leachate into local stormwater systems with no controls or scrutiny, remains unaddressed. These school contamination issues certainly have an impact on children even when off the playing surface. In addition to the steady toxic exposure of vulnerable children to these highly variable toxic combinations, there are serious, possibly irrevocable downstream contamination in the adjacent sediment, drainage areas and beyond.

Adjacent soil, buildings, including schools, neighborhoods, stormwater systems, aquatic environments and entire communities are being contaminated with many thousands of tons of the pulverized waste tire and plastics material, a situation which will likely require extensive, expensive and difficult clean up. The costs to communities and taxpayers is not included in any industry study we have found thus far. Environmental biomonitoring and environmental impact testing is needed.

#### **15. Basic environmental responsibility points**

We are aware that the CPSC may not have specific authority to rule on environmental impact aspects of these issues. However, looking at the whole picture of this children's product use impacts, and because we all own the public easements and stormwater systems that receive drainage from these fields, we include these points for consideration.

Rainwater and irrigation runs through the field material (estimated at 50 tons of plastic carpet, and about 370 tons of pulverized tire crumb and other infills). These waters transport multiple leachates and pieces of many substances directly into surrounding soils, and stormwater systems.

Zinc is found at levels that exceed federal limits for aquatic safety. In an area with 50 inches of rainfall each year, a single soccer field experiences about 2.3 million gallons of rainwater each year that runs through the material and into the stormwater system. In 10 year life of a field, that is of course, 23 million gallons.

In that runoff, and in shoes, bags and gear, tire crumb/particulate loss into the environment is estimated between 10-30 tons over life of a tire crumb field... or even more for other types of fields (coconut/cork infill recharge is 40% over 10 years, per Field Turf/Geofill brochures.) So, if 12,000 fields are already installed, and no federal requirements for leachate or particulate mitigation or even measurement of levels is in place, we can assume that 240,000,000 tons of

synthetic material is already in or soon to be in local stormwater systems and municipal sewage systems (via residential use, ie washing machines and sinks).



No enforcement of the Clean Water Act statutes has been imposed yet, to our knowledge, despite known high zinc levels in runoff leachates. That means, there is valid concern that currently have 12,000 streams, ponds, easements and stormwater features contaminated with multiple tons of small particulate, tire crumbs, plastic particulate, metal leachates and whatever else is used in the fields. Downstream costs of killing 12,000 local streams is incalculable, and is not borne by the industry that profitably sells tire crumb fields to schools, playgrounds, preschools and parks where children can reasonably be expected to come into contact with the field or surface.

**All used fields go back to landfill, an ironic shift of a huge contamination problem from initiating landfill or tire depository, to school play surfaces, then to the landfills in the states where the fields are installed.** The vast majority of landfills receiving these fields are managed by municipalities who are likely ill-equipped or unaware of the need to conduct toxicity due diligence on the issues presented by this used material, and accordingly may not direct it appropriately.

CalRecycle website and consultant studies boast about their ability to “divert” or redirect the 40,000,000 waste tires they receive each year to new sources, such as athletic fields. Their website, <http://www.calrecycle.ca.gov/Tires/> states:

“California is faced with the significant challenge of diverting or safely managing more than 44 million reusable and waste tires generated each year. It is estimated that fewer than 25,000 waste tires remain in stockpiles throughout California. These stockpiles pose a potential threat to public health, safety, and the environment.”

Vendors are paid by state programs to remove/redirect the stockpile of used tires and “repurpose” them. Sadly, when the tires are made into another “product”, protections from their toxic impacts apparently vanish under the 2008 RCRA law. Though CalRecycle is to be commended for actively investigating the feasibility of non athletic field use, and non children’s product use of those waste tires (like traintrack vibration stabilizers and asphalt road compounds), **the release of the enormous quantity of carcinogenic and harmful material found in tires into new markets means their carcinogenic material is also being spread, across**

**state lines at times, to unsuspecting communities and vulnerable groups, like children, with many unintended and untracked consequences.**



## **16. Conclusion**

SHPFC asks the Commission to recognize that for enforcement purposes, an individual health assessment is neither required nor useful. Rather, CPSC has only to direct these manufacturers to obtain approved testing and to submit the results to the Commission.

Failing this, tire crumb fields and playgrounds will continue to be used and new ones will be installed. In the absence of CPSC action to enforce the CPSIA lead limits, millions of children will predictably be in close, frequent physical contact with these products, often in high heat and over years. This is precisely the use to which manufacturers intended their product to be put, and it is the use over which CPSC has been given regulatory and enforcement authority.

The CPSC has the authority to recognize the heavy use of these products by children, and to direct appropriate enforcement of lead standards, to prevent further exposure of children to synturf fields and playgrounds.

## **APPENDICES**

- A. Artificial Turf: Chemical Analysis, Metal Analysis, Yale University, 2015
- B. Ferraro Law Firm Letter to Martha's Vineyard School District, 2016
- C. Safe Healthy Playing Fields Coalition Annotated Bibliography on Tire Crumb in Artificial Turf Fields, 2017
- D. Government & Industry Generated Reports re: Synthetic Athletic Fields and SBR Tire Crumb Exposures (a review of the most often cited studies on athletic synthetic turf health risks), 2016

- E. Conflicts of Interest Identified within Artificial Turf Studies, Recommendations for Studies with Little or No Conflicts of Interest, and Other Data, including Media Coverage of Artificial Turf, 2016
- F. PEER Filings: Asks for Children’s Product Designation and Regulation; Asks for Action Based on Heat Injury, 2012-2015
- G. Liberty Tire MSDS: Lists Known Carcinogens, Corrosive Substances, Hazardous Substances, Health Impacts from Ingredients in Tire Crumb, 2013
- H. HB883 Hearing, Ways and Means Committee of the Maryland General Assembly, Testimony from FieldTurf, Inc. that Confirms Lead in Fields, 2016
- I. Examples of Direct Marketing of Tire Crumb Fields to Children’s Schools and Sports Centers
- J. Safe Healthy Playing Fields Coalition Tables on Amount of Tire Crumb in 12,000 Fields, and Runoff Quantities from Fields in Top 50 Metropolitan Service Areas (Top Cities), 2016
- K. Amy Griffin’s List Spreadsheet and Pie Charts, 2017
- L. List of Football Players with Cancer Who Played on Synthetic Turf, 2016
- M. Synthetic Turf/Tire Playground Melted Cleats, Heat Stroke and Skin Injuries: Abrasions, 2nd-3rd Degree Burns, 2016
- N. Synthetic Turf/Tire Playground Temperatures, 2016
- O. Sierra Club Letter to the University of Maryland Regarding Synthetic Turf, 2016
- P. Mount Sinai Children’s Health Center Letter to Public; Warns Schools That Tire Crumb Fields Present Unacceptable Risks, 2016
- Q. Flyer, Paper, Information about Plant-Based Infills (PBI): Cork, Coconut and Corkonut Infills, 2017