

Testimony of Ann M. Catino

Attorney, Halloran & Sage LLP

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Public Hearing, February 16, 2016

Committee on Children

Proposed Bill No. 5139

My name is Ann Catino, I am an attorney, and I chair the environmental and land use group at the law firm of Halloran & Sage in Hartford. I am here today to testify regarding Bill No. 5139, An Act Concerning the Use of Recycled Tire Rubber at Municipal and Public School Playgrounds. Thank you for the opportunity to provide the Committee with comments.

I have been representing clients for over 25 years in the area of environmental and land use law, including proponents of a variety of projects seeking permits from Connecticut Department of Energy and Environmental Protection and local land use commissions, including planning and zoning and wetlands agencies. My clients include private sector interests, municipalities and, in certain instances, the State of Connecticut.

Today, I want to talk to you about the issues involving the use of crumb rubber and synthetic turf on playgrounds and athletic fields. I currently represent the Town of Hamden which is in the midst of permitting its second synthetic turf athletic field. It had one synthetic turf football field for over 13 years, which last year it replaced after receiving all approvals and permits. Now it is seeking to replace its baseball field, which is adjacent to it, and to transition the baseball field to a multipurpose field to accommodate soccer, lacrosse and field hockey as well as baseball. At this time, all sports have been and will continue to use the one synthetic turf field (or the teams are bussed elsewhere) and only baseball plays on a grass field. Scheduling, maintenance and providing proper attention to the students is a real issue. The Town has received approvals for the new synthetic turf baseball field from inland wetlands and the zoning board of appeals. It is currently in the public hearing stage at the planning and zoning commission.

At the Town Planning & Zoning Commission hearing, parents of the Hamden students supported the transition of the grass field to the synthetic turf field with recycled-tire infill. Several had done their own research, and had concluded that the fields are both safe and needed.

Please know, first of all, that Hamden (not unlike other municipalities) would not be proposing this field if it wasn't convinced that it is safe for the student athletes and others. Hamden has relied on the results of 29 scientific studies and reports analyzing the constituents of crumb rubber, ranging from studies conducted by countries like Canada, Norway, France, and Italy to universities, and various states, including several studies by and in the State of Connecticut. These studies show that these materials are safe. I am attaching a summary of the conclusions of these studies to my testimony.

It bears remembering that in each of the 2008 and 2009 sessions of the General Assembly, there was a flurry of similar bills, none of which passed. A 2008 bill required the Connecticut Agricultural Experiment Station (CAES) to conduct a study of the toxicity of artificial turf fields, and evaluate the effects on air quality, water quality and human health. Then-Attorney General Blumenthal testified in support of the bill. While the bill was never passed, funding was ultimately found for four Connecticut state agencies (University of Connecticut Health Center, CAES, DEP, and DPH) to develop and implement comprehensive studies. Our own State toxicologist, Dr. Gary Ginsberg, together with Brian Toal from DPH, did extensive research; published *three* peer-reviewed articles in prestigious scientific journals, and concluded: "BASED UPON THESE FINDINGS, THE USE OF OUTDOOR AND INDOOR ARTIFICIAL TURF FIELDS IS NOT ASSOCIATED WITH ELEVATED HEALTH RISKS."

There exists today not one peer reviewed study that demonstrates that recycled rubber in playgrounds or in playing fields harms the health of children or others. There is no reliable support for the extreme measure for a moratorium. The results of numerous and extensive scientific studies conducted by governments and universities over the years should not be discounted. The municipalities should not be so disenfranchised who have spent time carefully reviewing and researching the issue.

Importantly, the State of California, among other states, has *considered and rejected* a moratorium on crumb rubber and rubber mulch. Instead, as I speak, California is in the midst of an almost \$3 million dollar study to further characterize these materials. And, at the federal level, there are plans to spend another one million dollars to do the same. So far, *all* of the

evidence generated and reviewed by states and the federal government has not indicated any reason to ban recycled tires from use in playgrounds.

In fact, studies have shown that with regard to heavy metals, specifically lead, recycled tires contain *much smaller* concentrations of this heavy metal than are typically present in ordinary soil at playgrounds throughout the State.

I should also note two other experts in this field, Dr. Tuncer Edil and Dr. Laura Green. Dr. Edil in 2008 provided testimony on the bill that was under consideration by the Environment Committee. He was a faculty member at the Department of Civil and Environmental Engineering at University of Wisconsin-Madison and a licensed professional engineer. He had done his own independent research on the issue that was funded by the State of Wisconsin, and concluded that artificial turf with crumb rubber infill is safe. Dr. Edil also focused on the overwhelming number of studies that have already been done to the tune of millions of dollars, all of which conclude the product is safe. Interestingly enough, during Senate discussion on the bill, Senator Meyer was asked what his recommendation would be to those Connecticut municipalities that currently have artificial turf fields under consideration. He stated that he didn't think that the studies that existed so far indicated a sufficient alarm, and that the state should not impose any sort of moratorium on their use.

So, here we are 7 years later. We have the studies performed here in Connecticut and many more studies conducted since 2008 as evidenced by our summary. All these peer reviewed studies lead to the same conclusion, which was reaffirmed by DPH in 2015. During 2015, Dr. Laura Green, a well-known toxicologist, also analyzed these issues and commented on the work performed by EHHI. I'm attaching her letter dated June 29, 2015. By way of background, Dr. Green holds a B.A. with honors from the Department of Chemistry at Wellesley College (1975) and a Ph.D. from the Massachusetts Institute of Technology (1981). She is a board-certified toxicologist, who served on the part-time faculty of MIT, teaching environmental toxicology, for 25 years. She is co-author of the text, *In Search of Safety: Chemicals and Cancer Risk*. Dr. Green has been retained by schools and municipalities to advise them on the health aspects of synthetic turf athletic and recreation facilities, and by turf companies concerned about whether

recycled tires are or are not safe. In that context, she has performed extensive reviews and analyses of *all* of the relevant evidence – that is, data and other information supplied *both* by industry and by its opponents.

In Dr. Green's letter you will see clearly the outstanding issues associated with claims about the health significance of chemicals in tires, and about the results of a preliminary, incomplete, unpublished, and un-peer-reviewed set of tests conducted in a laboratory at Yale. Dr. Green makes several points about these tests. Let me mention four of them.

1. The tests used methylene chloride – which is paint stripper – which aggressively and unrealistically stripped chemicals from vulcanized rubber – which is otherwise essentially inert. Obviously, this IS NOT A RELVANT OR RELIABLE MEANS OF ASSESSING HOW MUCH RUBBER MULCH IIN PLAYGROUNDS MIGHT BECOME ABSORBED INTO THE SKIN OR INGESTED.
2. The results were reported in entirely non-quantitative terms. There was no indication of the *concentrations* of the compounds, and no attempt to define levels or exposure through contact. Thus THERE IS NO WAY, clearly, TO JUDGE THE DEGREE TO WHICH ANY EXPOSURE MIGHT BE RISKY.
3. Of the chemicals that were detected in the methylene chloride, 8 chemicals were sporadically identified and were labeled as “probable” carcinogens. BUT NONE OF THESE 8 CHEMICALS IS ACTUALLY CATEGORIZED THIS WAY BY THE EPA, the International Agency for Research on Cancer, OR the US National Toxicology Program.
4. THE TESTS FAIL ENTIRELY TO SHOW THAT RECYCLED TIRES CAUSE CANCER, POSE A SIGNIFICANT RISK OF CANCER, OR ARE ACTUALLY HARMFUL IN ANY REAL WORLD SETTING AT ALL.

Overall, then, experts such as Dr. Edil and Dr. Green, our own expert State toxicologist, Dr. Gary Ginsberg, and literally dozens of expert, published, serious scientists have concluded that recycled tire products pose no significant risk to the health of children or others.

Municipalities should be able to make their own decisions for their own playgrounds and athletic fields. A moratorium is not needed or appropriate in light of the evidence.

You have heard, or will hear, emotionally charged commentary decrying the use of synthetic turf on athletic fields and playgrounds. However, please ask yourself – where is the science that

supports the studies? As you may know, synthetic turf has been used for decades. What reliable evidence have the opponents to these fields and playgrounds presented to support their claims? NONE. Do they have peer reviewed studies? NO. Do they have actual evidence of environmental or health harm? NO. (And, although widely reported, the reports of cancer in soccer goalies in Washington is not based upon any scientific study; it is anecdotal information by the soccer coach's own admission.) While more study can always be done – and is being done – there is no basis for imposing a moratorium on recycled tires.

Although the bill should not pass, I do have two observations about the bill itself. First, the bill right now appears limited to “playgrounds” as specifically defined in 22a-66m. There is no reason to expand the bill to include athletic fields. Second, any municipal project underway, whether under contract or not, should be permitted to proceed. I would expect that many projects may be in the permitting stage, or are out to bid, and the municipality has expended significant resources to get to that point. Excluding only projects that have not yet gone to contract does a disservice to municipalities who may already be engaged in a lengthy permitting and bid process.

In closing, I suggest to you that the municipalities should be permitted the flexibility to make the decisions that they determine are appropriate for, and in the best interest of, their own towns based upon both their own needs and the known science. Good public policy must be based on good evidence. Our State has a long and distinguished tradition of assessing risks to health and the environment based on good science, not innuendos. We should not abandon that tradition now.

THANK YOU.

**OVERVIEW OF THE TOWN OF HAMDEN/HAMDEN BOARD OF
EDUCATION SUBMISSIONS**

CONNECTICUT STUDIES:

1. Scott G. Bristol and Vincent C. McDermott on behalf of Milone & MacBroom, Inc., "Evaluation of the Environmental Effects of Synthetic Turf Athletic Fields," dated December 1, 2008.

SUMMARY: For this study, twenty air samples were collected above and around two synthetic turf playing surfaces in Connecticut. The study was designed and conducted to specifically evaluate the possible presence of benzothiazole, 4-(tert-octyl) phenol, and volatile nitrosamines in air above recently installed outdoor, crumb rubber in-filled synthetic turf playing surfaces. This study determined that under favorable conditions for vapor generation, "no detectable concentrations of volatile nitrosamines or 4-(tert-octyl) phenol existed in the air column at a height of four feet above the tested synthetic playing surfaces or in the air either upwind or downwind of the fields." *Id.* at 16. The study also determined that "benzothiazole, a common compound used in the manufacturing of rubber and plastics, was present at a very low concentration directly above one of the two fields sampled. This compound was not detected at the second of the two fields sampled nor was it detected in any of the upwind or downwind locations at either field." *Id.* Researchers attributed the low finding of benzothiazole at one of the fields to the fact that the field had recently been groomed, thereby bringing significant quantities of crumb rubber nearer to the surface of the field. *Id.* at 16-17.

2. The Connecticut Academy of Science and Engineering, "Committee Report: Peer Review of an Evaluation of the Health and Environmental Impacts Associated with Synthetic Turf Playing Fields," Prepared for the Connecticut Agricultural Experiment Station (CAES), the Connecticut Department of Environmental Protection (DEP), the Connecticut Department of Public Health (DPH), and the University of Connecticut Health Center (UCHC), dated June 15, 2010.

SUMMARY: From 2008 to 2010, four Connecticut state agencies, CAES, DEP, DPH and UCHC, completed an evaluation of the health and environmental impacts associated with artificial turf fields containing crumb rubber infill, and each issued a preliminary report. Thereafter, the Connecticut Academy of Science and Engineering (CASE) assembled a nine member expert panel to review the technical aspects of these preliminary reports. CASE issued its peer reviewed report on June 15, 2010, and thereafter the four other state agencies issued their final reports in July 2010, incorporating the comments made by CASE (see #'s 4, 5). Note that the results of these

individual reports were subsequently incorporated into the studies listed at # 3, 4 and 5. In its peer review report, CASE concluded that based on a review of all the reports, “there is a limited human health risk.” *Id.* at 8. The CASE report strongly refuted DPH’s draft “headline” that “[r]esults indicate cancer risks slightly above de minimis levels for all scenarios evaluated.” According to CASE, DPH’s conclusion is “far too conservative (i.e., overstates the risks) and is unsupported by the actual data.” *Id.* The CASE report details why the DPH report “systematically overstates the risks of [artificial turf fields] by overstating exposures, by including improbable contaminants, and by using non-standard estimates of cancer potency and ventilation,” and that it included the risk because it recognized a “contaminant that is almost certainly not actually off-gassing from the crumb rubber.” *Id.* at 10. The CASE report concludes that DPH’s “headline” is almost certain to “become the focus of media reports and will unnecessarily frighten parents as well as school and municipal supervisors. Parents may be motivated to withdraw their children from beneficial athletic activities, and schools and towns will consider the financially wasteful removal of existing fields. This would be an unfortunate result, one that would likely pose greater risks to the welfare of Connecticut than the continued use of outdoor [artificial turf fields].” *Id.* In short, the CASE peer review committee “strongly urge[d] DPH to revise its risk assessment...with appropriate cautions.” *Id.*

3. Gary Ginsberg et al., “Benzothiazole Toxicity Assessment in Support of Synthetic Turf Field Human Health Risk Assessment,” *Journal of Toxicology and Environmental Health, Part A: Current Issues* 74:17, 1175-1183, dated July 28, 2011.

SUMMARY: This report provides toxicity information for a human health risk assessment involving Benzothiazole (BZT) detected at five fields in Connecticut. BZT has been the primary rubber-related compound found in synthetic turf studies. This toxicity assessment provided information that was used for a further human health risk assessment (see # 4).

4. Gary Ginsberg et al., “Human Health Risk Assessment of Synthetic Turf Fields Based Upon Investigation of Five Fields in Connecticut,” *Journal of Toxicology and Environmental Health, Part A: Current Issues* 74:17, 1150-1174, dated July 28, 2011.

SUMMARY: This study was undertaken by researchers at the Connecticut Department of Public Health, the University of Connecticut Health Center, Connecticut OSHA, the Connecticut Department of Environmental Protection, Clark University (Massachusetts), and the Wisconsin State Laboratory of Hygiene. Researchers investigated emissions associated with four outdoor and one indoor synthetic turf field located in Connecticut that used crumb rubber. Sampling and analysis was conducted for a wide range of VOC, SVOCs, rubber-related SVOC, lead, and particulate matter (PM₁₀). Personal monitoring devices were attached to soccer players while actively playing. Soccer was also played at a grass field to serve as a background data source for the personal monitors. The study concluded that “[c]ancer and noncancer risk levels were at or below de minimis levels of concern.” *Id.* at 1150. While the study found that the main contributor was benzothiazole, the study nevertheless concluded that based on the findings, “outdoor and

indoor synthetic turf fields are not associated with elevated adverse health risks.” *Id.* The study concluded that these results are “consistent with the findings from studies conducted by New York City, New York State, the U.S. Environmental Protection Agency (EPA), and Norway, which tested different kinds of fields and under a variety of weather conditions.” *Id.*

5. Nancy J. Simcox et al., “Synthetic Turf Field Investigation in Connecticut,” *Journal of Toxicology and Environmental Health: Part A: Current Issues* 74:17, 1133-1149, dated July 28, 2011.

SUMMARY: This study was undertaken by researchers at the University of Connecticut, the Connecticut Department of Public Health, the Connecticut Department of Environmental Protection, Clark University (Massachusetts), and the Wisconsin State Laboratory of Hygiene. The purpose of the study was to characterize the concentrations of VOCs, SVOCs, rubber-related chemicals such as benzothiazole, and particulate matter in air at synthetic turf crumb rubber fields. Both new and older fields were evaluated under active use conditions. Researchers investigated emissions associated with four outdoor and one indoor synthetic turf fields that used crumb rubber, and one grass field. For VOCs and SVOCs, researchers used both personal sampling gauges attached to persons playing on the fields as well as stationary samplers. The study found that while the personal air concentrations were higher on outdoor turf than on grass for some VOCs, the concentrations of VOC detected with stationary on-field area samplers were generally similar to background samples. The study concluded that “[t]he personal sampling results indicate that players and/or the sampling equipment may be contributing to the concentrations of VOC detected in the personal samplers.” *Id.* at 1141. For PAHs, stationary samplers were used. The study concluded that at the outdoor fields, “PAH were generally found at low concentrations.” *Id.* at 1143. As for particulate matter, the study concluded that “PM₁₀ concentrations were generally greater in background locations,” and that “[t]here were no cases either outdoors or indoors where the PM₁₀ result was greater on turf than in the background samples.” *Id.* at 1145-46.

6. Memorandum from Brian Toal and Gary Ginsberg of the Connecticut Environmental and Occupational Health Assessment (CT DPH), to Local Health Departments and Districts, “Recent News Concerning Artificial Turf Fields,” dated January 20, 2015.

SUMMARY: This memorandum was issued to local health departments and districts in Connecticut in response to a then recent news story (from EHHI) that potential cancer risks are associated with artificial turf fields as predicted by CASE (see # 2). The memorandum summarizes the 2010-2011 study undertaken by several Connecticut agencies, including the CT DPH, which was peer-reviewed by CASE (see #2). The 2010-2011 study covered carcinogens, and had concluded that there was “very little exposure of any substances, carcinogenic or not, in the vapors and dust that these fields generate under active use, summer conditions,” and thus the study concluded that there was no elevated cancer risk associated with artificial turf fields. *Id.* at 2. After concluding that the recent news story “does not constitute epidemiological evidence,” the memorandum concludes that “the CT DPH[’s] position expressed in 2011 at the

conclusion of the Connecticut study, that outdoor artificial turf fields do not represent an elevated health risk. remains unchanged." *Id.*

OTHER STUDIES:

7. Detlef A. Birkholz et al., "Toxicological Evaluation for the Hazard Assessment of Tire Crumb for Use in Public Playgrounds," *Journal of the Air & Waste Management Association* 53:7, 903-907, dated July 2003.

SUMMARY: This study was undertaken by researchers at Enviro-Test Laboratories in Alberta, Canada, the Alberta Centre for Injury Control and Research, and the Department of Public Health Sciences at the University of Alberta. Researchers designed a comprehensive hazard assessment to evaluate and address potential human health and environmental concerns associated with the use of tire crumb in playgrounds. Human health concerns were addressed using conventional hazard analyses, mutagenicity assays, and aquatic toxicity tests of extracted tire crumb. An exposure assessment was performed to address the potential health risks to children playing in facilities where tire crumb is used and the study concluded that there was "little potential for an exposure sufficient to cause adverse health effects in children." *Id.* at 906. The study further concluded that "ingestion of small amounts of tire crumb by small children will not result in an unacceptable hazard of contracting cancer." *Id.*

8. Norwegian Institute of Public Health and the Radium Hospital, "Artificial Turf Pitches – An Assessment of the Health Risks for Football Players," dated January 2006.

SUMMARY: The study looked at a number of worst case scenarios based on information concerning the use of "halls" (indoor facilities utilizing synthetic turf fields). They looked at football (soccer) matches and training sessions, frequency and duration of use, physiological parameters (skin surface area, inhalation volumes during exertion and body weight), and analyses (content in rubber granulate, airborne dust/PM10 and VOC). Exposure calculations were performed for adults, juniors, older children and children based on measurements of VOC, airborne dust, concentrations of chemicals in recycled rubber granulate and leaching from the granulate. The study concluded that based on "the exposures which have been calculated in connection with the use of indoor halls with artificial turf in which recycled rubber granulate is used, there is no evidence to indicate that the use of such halls causes an elevated health risk." *Id.* at 34. The study further concluded that "[t]he estimated Margins of Safety (MOS) also gives no cause for concern." *Id.* at 33. The study also concluded that "[w]orst case calculations based on air measurements carried out by [the Norwegian Institute for Air Research] and exposure values from the Norwegian Institute of Public Health indicate that training in sports halls does not cause any increased risk of leukemia as a result of benzene exposure or any elevated risk as a result of exposure to polycyclic aromatic hydrocarbons." *Id.* at 34.

9. Dr. Robert Moretto, ADEME, "Environmental and Health Assessment of the Use of Elastomer Granulates (Virgin and from Used Tyres) as Filling in Third-Generation Artificial Turf," dated 2007.

SUMMARY: This report was the product of roughly two years of scientific research, with studies undertaken by the French Research Network and the leading public and private bodies in the field within France. The Institut National de l'Environnement Industriel et des Risques (France) (INERIS) evaluated the potential ecotoxicological risk from drainage water and health risks associated with gaseous emissions from outdoor synthetic turf fields, and concluded that “percolates are compatible with the water resource quality requirements” and “the health risks associated with the inhalation of VOC and aldehydes emitted by artificial surfaces on pitches in outdoor situations present no actual cause for concern as regards human health.” *Id.* at 11, 22.

10. Dr. U. Hofstra, “Environmental and Health Risks of Rubber Infill, Rubber Crumb From Car Tyres as Infill on Artificial Turf,” dated February 9, 2007.

SUMMARY: The aim of this study was to formulate conclusions on the potential environmental and health risks of the use of rubber infill from shredded car tires on artificial turf fields. This study was based on a literature review and an independent experimental investigation involving the sampling from 14 artificial turf fields of various ages. The report evaluated potential health risks associated with swallowing (ingesting), inhalation, and skin contact. The report concluded that “there is no significant health risk for football [soccer] players due to the presence of rubber infill from used car tyres on artificial turf pitches.”

11. Charles Vidair et al., Office of Environmental Health Hazard Assessment, “Evaluation of Health Effects of Recycled Waste Tires in Playground and Track Products,” Prepared for the California Integrated Waste Management Board, dated January 2007.

SUMMARY: In response to the California Integrated Waste Management Board’s need to better understand the potential health risks to children using outdoor playground and track surfaces constructed from recycled waste tires, the Office of Environmental Health Hazard Assessment (OEHHA) conducted a study evaluating these surfaces for the release of chemicals that could cause acute toxicity in children following ingestion or dermal contact, including exposure due to hand-to-mouth contact. A chronic exposure scenario (70 years) was also evaluated. OEHHA is a specialized department within the California Environmental Protection Agency with responsibility for evaluating health risks from environmental chemical contaminants. The study concluded that it was “unlikely that a one-time ingestion of tire shreds [by a 33 pound three year old] would produce adverse health effects. Seven of the chemicals leaching from tire shreds in published studies were carcinogens, yielding a 1.2×10^{-7} (1.2 in ten million) increased cancer risk for the one-time ingestion described above.” *Id.* at 1. The study stated that “[t]his risk is well below the di minimis level of 1×10^{-6} (one in one million), generally considered an acceptable cancer risk due to its small magnitude compared to the overall cancer rate.” *Id.* at 1.

12. Elizabeth Denly et al., TRC, “A Review of the Potential Health and Safety Risks from Synthetic Turf Fields Containing Crumb Rubber Infill,” Prepared for New York City Department of Health and Mental Hygiene, dated May 2008.

SUMMARY: The NYC Department of Parks and Recreation requested assistance from the NYC Department of Health and Mental Hygiene to conduct a study on the potential exposures and health effects related to synthetic turf fields. A grant was awarded by the New York Community Trust, which allowed the state agencies to hire an outside consultant, TRC, to assist with this study. TRC concluded that there were eleven human health risk assessments identified that evaluated exposure to the constituents in crumb rubber. According to TRC, “[a]ll had a similar conclusion: exposure to [chemicals of potential concern] from the crumb rubber may occur, however the degree of exposure is likely to be too small through ingestion, dermal or inhalation to increase the risk for any health effect.” *Id.* at ES-3.

13. State of New York Department of Health, “Fact Sheet: Crumb-Rubber Infilled Synthetic Turf Athletic Fields,” dated August 2008.

SUMMARY: This fact sheet was developed by the New York State Department of Health in order to “assist people in making decisions about installing or using [crumb rubber infill on] synthetic turf athletic field[s].” *Id.* at 1. Based on a review of the literature available on crumb rubber and crumb rubber infilled turf fields, the New York State Department of Health concluded that “ingestion, dermal or inhalation exposures to chemicals in or released from crumb rubber do not pose a significant public health concern.” *Id.* at 5.

14. Ly Lim and Randi Walker, on behalf of the New York State Department of Environmental Conservation, “An Assessment of Chemical Leaching, Releases to Air and Temperature at Crumb-Rubber Infilled Synthetic Turf Fields,” dated May 2009.

SUMMARY: From the Spring of 2008 to the Fall of 2008, the New York State Department of Environmental Conservation conducted a series of studies to assess some potential impacts from the use of crumb rubber as infill material in synthetic turf fields. The study focused on several areas of concern, including the potential for environmental impacts of chemicals into surface water and groundwater. The study concluded that while zinc has the potential to be released above groundwater standards or guidance values, “[a]n analysis of attenuation and dilution mechanisms and the associated reduction factors indicates that crumb rubber may be used as an infill without significant impact on groundwater quality, assuming the limitations of mechanisms, such as separation distance to groundwater table, are addressed.” *Id.* at 1. The study evaluated potential human exposures including inhalation, dermal contact and ingestion. Chemical releases from the surface of the fields to the air from two different synthetic turf fields were evaluated during ambient conditions that were selected to maximize potential emissions. The study concluded that the chemicals in the air at both fields “do not raise a concern for non-cancer or cancer health effects for people who use or visit the fields,” and that “[o]verall, the findings do not indicate that these fields are a significant source of exposure to respirable particulate matter.” *Id.* at 3.

15. Charles Vidair, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, “Chemicals and particulates in the air above the new

generation of artificial turf playing fields, and artificial turf as a risk factor for infection by methicillin-resistant Staphylococcus aureus (MRSA): Literature review and data gap identification,” dated July 2009.

SUMMARY: OEHHA reviewed the published literature on whether, among other things, synthetic turf fields using crumb rubber emit levels of chemicals or particulates into the air and cause illness when inhaled, and, whether these fields infect athletes with *S. aureus* (MRSA). This report concluded that based on testing, “[n]o MRSA has been detected in any indoor or outdoor natural or artificial turf field,” and that it “seems unlikely that the new generation of artificial turf is itself a source of MRSA.” *Id.* 6, 42. The report estimated inhalation exposure projected over a 70 year lifetime and determined there is a “low risk for such health effects due to inhalation exposures in soccer players.” *Id.* at 33.

16. Office of Environmental Health Hazard Assessment Pesticide and Environmental Toxicology Branch, “Safety Study of Artificial Turf Containing Crumb Rubber Infill made from Recycled Tires: Measurements of Chemicals and Particulates in the Air, Bacteria in the Turf, and Skin Abrasions caused by Contact with the Surface,” Prepared for the California Department of Resources Recycling and Recovery, dated October 2010.

SUMMARY: OEHHA conducted a study to determine whether outdoor artificial turf fields containing crumb rubber infill release significant amounts of VOCs or fine (respirable) particulates of aerodynamic diameter less than 2.5 microns (PM_{2.5} and associated metals) into the air, and, if so, whether the levels are harmful to the health of persons using the fields. The study concluded that that “PM_{2.5} and associated elements (including lead and other heavy metals) were either below the level of detection or at similar concentrations above artificial turf athletic fields and upwind of the fields,” and that “[n]o public health concern was identified.” *Id.* at 2. The study further concluded that “[t]he large majority of air samples collected from above artificial turf had VOC concentrations that were below the limit of detection.... All exposures were below health-based screening levels, suggesting that adverse health effects were unlikely to occur in persons using artificial turf.” *Id.* Lastly, the study concluded that “[t]here was no correlation between the concentrations or types of VOCs detected above artificial turf and the surface temperature.” *Id.*

17. Bill Wycko, Environmental Review Officer, “Beach Chalet Athletic Fields Renovation: Draft Environmental Impact Report,” Prepared for City and County of San Francisco, San Francisco Planning Department, dated October 2011.

SUMMARY: This environmental impact report analyzes potential environmental effects associated with a proposed renovation project that would, among other things, replace grass fields with synthetic turf in Golden Gate Park. Part of the study provides an assessment of the perceived public concern over the potential health issues associated with the use of crumb rubber in synthetic turf fields. The report summarizes, among others, the 2010 California OEHHA report (see #16 above), which had concluded that “there is no public health concern related to particulate matter or heavy metals associated

with particulate matter at the synthetic fields.” *Id.* at IV.H-11. Ultimately, the proposed renovation project was approved and four full-size synthetic turf soccer fields were constructed using crumb rubber infill.

18. Dr. Paul J. Lioy and Dr. Clifford Weisel of the Environmental and Occupational Health Sciences Institute, “Crumb Infill and Turf Characterization for Trace Elements and Organic Materials,” Prepared for the New Jersey Department of Environmental Protection, dated October 31, 2011.

SUMMARY: This study was undertaken to evaluate hazardous chemicals within crumb infill and associated synthetic turf. The study included a quantification of the bio-accessibility of hazardous chemicals found in the crumb infill and associated turf product from both newly purchased materials and in-use fields of different ages. Bioaccessibility studies were conducted for inhalation, dermal and ingestion routes of entry. Synthetic lung, sweat and digestive fluids were analyzed for trace metals, PAHs, and scanned for semi-volatile compounds. The study concluded that “[o]verall the metals, PAHs and semi-volatile compounds found all classes of materials to be at very low concentrations.” *Id.* at 2. The study also concluded that “[f]or the compounds that have known hazard the levels in the biofluids were below standards for soil cleanup so no formal risk assessment is currently recommended.” *Id.*

19. T. J. Serensits et al., “Human Health Issues on Synthetic Turf in the USA,” Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology, dated June 13, 2011.

SUMMARY: This study was undertaken by several scientists at the Department of Crop and Soil Sciences at the Pennsylvania State University. Among other things, the study surveyed 20 infilled synthetic turf fields in order to determine whether infilled synthetic turf fields potentially harbour *S. aureus* bacterium (MRSA). The study concluded that while “microbes exist on synthetic turf surfaces, the number was low compared with those on natural turf grass.” *Id.* at 5. The study further concluded that “[n]o colonies isolated from any crumb rubber or fiber samples tested positive for *S. aureus* via selective media, Gram stain, or latex agglutination tests,” which the researchers concluded was “not surprising” because the surface temperatures of the turf fields often exceeds the temperature range for the growing of *S. aureus* bacteria. The researchers also noted that the indoor synthetic turf surfaces contained low numbers of microbes. The authors theorized that the true cause of the low numbers of colonies may be due to the low moisture content. *Id.* at 5-6. In short, the study concluded that concern that infilled synthetic turf harbours and provides a breeding ground for *S. aureus* bacteria is simply “unwarranted.” *Id.* at 7.

20. Joost G. M. van Rooij et al., “Hydroxypyrene in Urine of Football Players after Playing on Artificial Sports Field with Tire Crumb Infill,” International Archives of Occupational and Environmental Health 83: 105-110, dated September 25, 2009.

SUMMARY: In this study, “football players” (the equivalent of American soccer players) played on an artificial turf field for 2.5 hours. They had intensive skin contact with rubber infill. All urine of seven nonsmoking football players was collected over a 3-day period, the day before the sporting event, the day of the sporting event, and the day after the sporting event. Urine samples were analyzed in order to assess the exposure of soccer players to PAHs. The study concluded that the “uptake of PAH by football players active on artificial grounds with rubber crumb infill is minimal. If there is any exposure, then the uptake is very limited and within the range of uptake of PAH from environmental sources and/or diet.” *Id.* at 1. In short, researchers concluded that the PAH uptake from rubber crumb infill is of “no major concern.” *Id.* at 109.

21. Tirziana Schiliro et al., “Artificial Turf Football Fields: Environmental and Mutagenicity Assessment,” *Archives of Environmental Contamination and Toxicology* 64:1-11, dated September 25, 2012, Study Financed by Department of Sport and Recreation of the City of Torino, Italy.

SUMMARY: This study was conducted on six different artificial turf fields in Torino, Italy, and two atmospheric meteorological-chemical control stations in an urban center belonging to the Environmental Protection Regional Agency of Piedmont, Italy. The aim of the study was to develop an environmental analysis drawing a comparison between artificial turf fields and urban areas relative to concentrations of particles (PM₁₀ and PM_{2.5}) and related PAHs, aromatic hydrocarbons (BTXs), and mutagenicity of organic extracts from PM₁₀ and PM_{2.5}. The study concluded that “[o]n the basis of environmental monitoring, artificial turf football fields present no more exposure risks than the rest of the city.” *Id.* at 1. The study further concluded that “[t]he concentration of BTX on the monitored football fields was constant and comparable with urban levels or at least reflects a normal situation relative to the urban pollution source of motor vehicles.” *Id.* at 9. Also, “[t]he concentration of PAHs on the monitored football fields, both PM₁₀ and on PM_{2.5}, were comparable with urban levels.” *Id.* In short, the study concluded that “[n]o significant differences were found between artificial football fields and urban sites. No differences were found between artificial football fields and “natural” football fields. There would not be any more risk on an artificial turf football field than there would be in the rest of the city.” *Id.* at 10.

22. Ho-Hyun Kim et al., “Health Risk Assessment for Artificial Turf Playgrounds in School Athletic Facilities: Multi-Route Exposure Estimation for Use Patterns,” *Asian Journal of Atmospheric Environment*, Vol. 6-3, Pages 206-221, dated September 2012.

SUMMARY: This study selected 50 schools from urban areas that had artificial turf fields using crumb rubber in order to conduct a health risk assessment to investigate multi-route exposures (inhalation, ingestion and dermal). To better distinguish health risk assessment exposure scenarios, the ratio of elementary, middle and high schools were considered before final selection. The study concluded that “[t]he excess cancer (ECR) risk of carcinogens was shown to be 1×10^{-6} in most users for the worst exposure scenario.” *Id.* at 206. In children with pica (the most extreme exposure group), the study concluded that “the ECR was expected to be as high as 1×10^{-4} , showing the low risk

level of carcinogens.” *Id.* Note that pica is an eating disorder characterized by the compulsive ingestion of non-food items such as soil, metal, sand and glass. In short, the study concluded that “no direct health risk was found in using artificial turf playgrounds.” *Id.* at 219.

23. Cardno ChemRisk, “Review of the Human Health & Ecological Safety of Exposure to Recycled Tire Rubber found at Playgrounds and Synthetic Turf Fields,” Prepared for Rubber Manufacturers Association, dated August 1, 2013.

SUMMARY: This study evaluated the health and ecological risks associated with the use of recycled tire rubber in playgrounds and athletic fields. In doing so, this study reviewed the available literature on the issue, including “studies from both advocates and opponents to the use of recycled tire materials.” *Id.* at i. After “[a]n examination of the weight of evidence across all of the available studies,” the report concluded that “adverse health effects are not likely for children or athletes exposed to recycled tire materials found at playgrounds or athletic fields. Similarly, no adverse ecological or environmental outcomes from field leachate are likely.” *Id.*

24. Brian T. Pavilonis et al., “Bio-accessibility and Risk of Exposure to Metals and SVOCs in Artificial Turf Field Fill Materials and Fivers,” National Institute of Health, dated December 11, 2014.

SUMMARY: A compressive study was done to evaluate potential exposures from playing on artificial turf fields and associated risks to trace metals, SVOCs, and PAHs, by examining typical artificial turf fibers, different types of infill, and samples from actual fields. Three biofluids were prepared including lung, sweat and digestive fluids from children and adults to investigate inhalation, ingestion and dermal contact potential routes of exposure. The study concluded that PAHs were “routinely below the limit of detection across all biofluids.” *Id.* at 1. The study further concluded that “[t]he SVOCs identified based on library matches of their mass spectra were not present in toxicological databases evaluated and many are ubiquitous part of consumer products.” *Id.* at 10. The study also concluded that “the metal concentrations measured in field samples indicate that the risk would be *de minimus* among all populations expected to use artificial turf fields.” *Id.* at 10.

25. Memorandum to Paul F. Dawson from Cindy Baumann, P.E., entitled “Tabor Academy – Synthetic Turf Athletic Field Evaluation,” dated March 13, 2014.

SUMMARY: The Town of Marion, Massachusetts, contracted with CDM Smith (a full-service engineering and construction firm) to evaluate the potential water quality impacts of the use of a synthetic turf field that was installed on the Tabor Academy campus. CDM Smith removed and tested a piece of the synthetic field using a synthetic precipitation leaching procedure. The results from the synthetic precipitation leaching procedure testing were all well below industry standards. *Id.* at 5. Water samples were also collected from the field underdrain outfalls during four different rain events in order to determine if the synthetic turf field may be contributing excess metals to stormwater

runoff. Both the athletic field and water samples were tested for arsenic, cadmium, chromium, lead, mercury, and zinc and were compared to criteria from the U.S. EPA for freshwater aquatic life and drinking water. Based on this sampling, the memorandum concludes that “stormwater runoff from the athletic field is not a source of pollutants/contaminants that would pose a threat to the harbor.” *Id.* at 7.

26. Memorandum from Laura C. Green to Report Responder for the CPSC entitled, “Comment on CPSC Report #20150608-22F81-2147431268, Assessment of the Risk of Cancer Posed by Rubber Mulch Used in Playgrounds,” dated June 29, 2015.

SUMMARY: Laura C. Green, Ph.D. is a certified toxicologist, who authored *In Search of Safety: Chemicals and Cancer Risk*. She serves on the editorial board of the journal, *Human and Ecological Risk Assessment*, and has served as a peer reviewer for several other scientific journals, the US EPA, ASTDR and other agencies. Dr. Green has reviewed the laboratory analysis (or excerpts thereof) conducted for EHHI by Yale. After looking at the actual data, Dr. Green concluded that EHHI’s hypothesis that turf causes cancer was unsupported by reliable evidence. She notes that (1) it has not been published or peer reviewed (nor even written up as an unpublished manuscript); (2) the summary results are entirely non-quantitative – there is no indication of concentrations, levels of exposure or doses that are available to children or others; (3) the method of extraction using methylene chloride is not a relevant or reliable means of assessment for determining dermal absorption; (4) none of the eight chemicals they detected are categorized as “probable carcinogens” by any authoritative body like the International Agency for Research on Cancer, the US National Toxicology Program or the US EPA. Nor are they detected consistently in all samples; (5) the two chemicals that are reported as causing cancer in humans (butadiene and benzene) were not detected by EHHI. After examining the EHHI’s theory and the evidence, Dr. Green concluded that “the evidence on crumb rubber and rubber mulch does not suggest, let alone demonstrate, that rubber mulch poses a significant risk to the health of children or others.” *Id.* at 13.

27. Letter from Michael K. Peterson et al., “Evaluation of Human Health Risks for Synthetic Field Turf,” to George Kosovich, Assistant Superintendent, Programs & Community Investments, Verdant Health Commission, dated May 26, 2015.

SUMMARY: Two scientists and toxicologists at Gradient, an environmental and risk sciences consulting firm, reviewed the publically available data related to the use of artificial turf fields. Based on this review, these scientists concluded that “the chemical levels found in FieldTurf SBR and GeoTurf infill do not present a risk to people playing on or using the fields with these products.” These conclusions are consistent with those of multiple regulatory agencies that have evaluated the risk from artificial turf products in general (*e.g.*, CalOEHHA, 2007; New York City Department of Health and Mental Hygiene, 2009; US EPA, 2009; Connecticut Dept. of Public Health, 2010; CalOEHHA, 2010).” *Id.* at 1.

28. Letter from Suzanne K. Condon, Executive Office of Health and Human Services, Bureau of Environmental Health for the Commonwealth of Massachusetts, to Stephanie Bacon, Health Agent for the Office of Board of Health, dated March 23, 2015.

SUMMARY: Suzanne K. Condon, Associate Commissioner at the Bureau of Environmental Health for the Commonwealth of Massachusetts reviewed the existing scientific literature on health concerns related to the use of crumb rubber infill material for artificial turf fields, and concluded that “the scientific literature continues to suggest that exposure opportunities to artificial turf fields are not generally expected to result in health effects.” *Id.* at 6.

29. D. Michael Johns, Ph.D., Winward Environmental LLC, “Initial Evaluation of Potential Human Health Risks Associated with Playing on Synthetic Turf Fields on Bainbridge Island,” undated.

SUMMARY: Dr. Michael Johns was asked to review the available scientific literature and publications on crumb rubber in synthetic turf fields in order to provide an opinion on the potential risks to human health to children and teenagers that play on these fields and the risks to the environment that may result from precipitation runoff collected from the fields. This research concluded that “the balance of the studies reviewed indicate that human health risks from playing on synthetic turf fields is minimal, even though low concentrations of some chemicals have been demonstrated to leach from the tire crumb, or volatilize as vapor.” *Id.* at 10.

Memorandum

To: Report Responder for the CPSC



From: Laura C. Green, Ph.D., D.A.B.T.

Date: June 29, 2015

Subject: Comment on CPSC Report #20150608-22F81-2147431268
Assessment of the risk of cancer posed by rubber mulch used in playgrounds

As a toxicologist, I have been asked by Rubberecycle (a company that manufactures, among other products, rubber mulch for playgrounds) to comment on CPSC Report #20150608-22F81-2147431268. This CPSC Report provides the following comment and request made by Dr. Debra Lay, Principal of the Jonesport Elementary School, in Jonesport Maine:

There have been a few reports lately about rubber mulch causing cancer in children. We have rubber mulch on our playground and we are interested in getting accurate information in order to make an informed decision on whether we should remove this substance. Please advise.

As explained below, I have examined the relevant evidence, and have found that rubber mulch is neither known nor reasonably expected to cause cancer, and is otherwise safe for use in playgrounds. I know of no reason that this mulch should be removed from the playground at Jonesport Elementary School.

Reports of cancer in soccer players and other athletes who play on synthetic turf fields

To begin, I note that there are no reports that rubber mulch causes cancer (either in children or others). I believe that Principal Lay may be referring instead to news reports of a *possibly* elevated incidence of cancer among soccer players who play (at least some of their games) on synthetic turf fields, some of which are "infilled" with crumb rubber.



Laura C. Green, Ph.D., D.A.B.T., Consulting toxicologist
106 Sumner Road, Brookline, Massachusetts 02445
617-835-0093 laura.green@alum.MIT.edu

In particular, in May of last year, a Seattle, Washington TV station broadcast a story, "Toxic Turf? UW coach draws connection between turf and cancer." The TV story noted:

University of Washington assistant soccer coach Amy Griffin sees a troubling connection between the turf and cancer among soccer players. Griffin [said] . . . that 13 players from the state of Washington were all diagnosed with rare types of cancer. Of those 13, 11 were goalkeepers. Griffin can't say why goalkeepers are getting cancer but she wonders if it could be caused by the crumb rubber, a kind of filler in turf fields. . . . 'Everyone says it's just a coincidence and kind of walks away, but the ratio of goalkeepers to field players is 15 to 1, 16 to 2, and I know plenty of goalkeepers that have cancers and I don't know many field players,' Griffin said . . .

Other news reports followed, with additional cancers reported; but, to my knowledge, no systematic or scientific study of these cases has been performed or published.

For example, in February of this year, the nonprofit group, Environment and Human Health, Inc. (EHHI; at http://www.ehhi.org/turf/cancer_cases_grow_0115.shtml), reported:

Cancer cases among student athletes playing on synthetic turf continue to grow

Amy Griffin, Assistant Women's Soccer Coach at the University of Washington, has been keeping a list of athletes who have developed cancer after playing on turf fields containing waste tires.

So far she has identified 126 athletes, 109 of which are soccer players, 10 were football players, and six were field hockey and lacrosse players, who have developed different forms of cancer.

The reported cancers are:

- 51 lymphomas*
- 19 leukemias*
- 10 Brain*
- 9 Testicular*

*9 Sarcoma
6 Thyroid*

The rest are rare forms of cancer.

It is important to note the predominance of lymphomas and leukemias. 1,3 butadiene is connected to lymphoma and benzene is connected to leukemia. Both of these chemicals are present in rubber tires.

What is *not* known regarding these cancers in soccer players

As noted above, these cancer-cases have not been reported on in any scientific journal, and no details have been reported – we do not even know if the reports are completely accurate. We do not know, for example, the ages, sexes, or races of any of the cases, nor do we know the specific forms of leukemia, lymphoma, or other cancer-type for any individual soccer-player. Nor do we have any idea the extent to which any of these athletes have played on fields containing “waste tires”, nor how “waste tires” is here defined.

Lacking this information, it is not possible to determine whether these cases constitute an actual cluster — that is, whether, as a group (and exactly what group is being examined is unclear), they have experienced a significantly larger incidence of cancer-cases than would be expected, based on rates in the general population. EHHI notes a “predominance of lymphomas and leukemias,” but these are among the most common types of cancer that develop in children and adolescents (Ward *et al.*, 2014), and so are not necessarily noteworthy.

Moreover, although cancers in young people (I am assuming, but do not know, that most of these 126 cases are in relatively young athletes) are not common, in 2014 in the U.S., almost 16,000 children and adolescents (from 0 to 19 years of age) were expected to have been diagnosed with some form of cancer (Ward *et al.*, 2014). Thus, learning about many cancer diagnoses in adolescents (again, I am assuming that most of these cases are among adolescents) would be entirely expected.

Suppose that these 126 cases do represent a cluster — that there are indeed significantly more cases of cancer among soccer players and other young athletes than one would “expect.” Does this mean that the cluster has an identifiable cause? In fact, no. As explained below, a great



many cancer clusters have been evaluated in great detail, and for almost none has a cause ever been found.

Results of prior investigations of cancer clusters

For several reasons, unusual coincidences of cancers among groups of younger people are noteworthy, and many of these have been extensively investigated. However, exhaustive study of such clusters in young people has never established an environmental or other exogenous cause: these clusters appear to be due instead to randomness (Caldwell, 1990; Gawande, 1999; Trumbo, 2000; Connecticut Department of Health, 2012).

Here, for example, is what noted epidemiologist Glynn Caldwell (1990) wrote toward the end of his long career:

Beginning in 1961, the Centers for Disease Control investigated 108 cancer clusters and reported the findings in Epidemic Aid Reports. The clusters studied were of leukemia (38%), leukemia and lymphoma (30%), leukemia and other cancer combinations (13%), and all other cancer or combinations (19%). These clusters occurred in 29 states and five foreign countries . . . Eight different data collection methods were used, often in combinations, and four types of laboratory methods on four different specimen types. Although 14 different categories of associations were reported, no clear cause was found for any cluster.

A priori, then, an apparent association between playing soccer (or other sports) on synthetic turf fields and risk of leukemia and lymphoma may be reported, but that does not mean that the association is causal, as opposed to coincidental.

Of course, some clusters of cancer in communities *are* due to shared environmental and carcinogenic exposures, so one cannot and should not over-generalize.

For example, clusters of skin cancer (and other diseases) have been repeatedly reported among groups of people who drink water that has been (naturally) contaminated with high concentrations of arsenic, and this is because such exposures are genuinely carcinogenic (IARC, 1980). Similarly, clusters of lung cancer and of mesothelioma occur in communities plagued by



naturally large amounts of erionite (a mineral similar to asbestos) in local rocks and soils, and, again, these associations are known to be causal (IARC, 1987).

Importantly, however, no community-based cluster of any of the cancers *at issue here* has been found to have an identifiable, external, chemical cause.

Another reason to doubt an external, chemical cause for adolescent cancers is this: the type of leukemia prevalent in childhood (namely, acute lymphocytic leukemia, or ALL), lymphomas, and brain tumors are *not known to be caused by cigarette smoking* (IARC, 2004). Of course, cigarette smoke is the most chemically complex and important cause of cancers of several tissues and organs (not only the lung) in the U.S. (Surgeon General's Report, 2014; IARC, 2004). Since chronic exposure to such a potent mixture of carcinogenic chemicals does not cause the cancers at issue, then on what reliable basis could it be suggested that the much smaller doses of some of the same chemicals (potentially) emanating from rubber particles could cause these cancers? I can think of none.

Some salient features of lymphomas, leukemias, and other cancers that occur in adolescents

As noted above, EHHI reports that of the 126 cases of cancer in athletes, 51 are cases of lymphoma. Lymphomas are not uncommon cancers: in 2014, more than 760,000 Americans were diagnosed with a form of lymphoma (Leukemia & Lymphoma Society, 2015). Indeed, among adolescents who develop cancer, lymphomas are *the most common type* (IARC, 2008). Interestingly, dogs are also prone to developing lymphoma, with some breeds more likely to develop this cancer than other breeds (Teske, 1994).

I would note that there are many different types of lymphomas, and these vary substantially with regard to their prevalence, genetic pre-dispositions, other risk-factors, and clinical courses (Swerdlow *et al.*, 2008; Morton *et al.*, 2014). (This is one reason that the lack of detail about these cases in athletes makes causal interpretations impossible). As suggested by the patterns of lymphomas in dog-breeds, and in some human families, some lymphoma-types have a strong genetic component (Bassig *et al.*, 2015); while others appear to be due to the significant alterations in the immune systems of people (i) infected with H.I.V., (ii) afflicted with various autoimmune diseases, or (iii) on immunosuppressant drug-therapies (Cáceres *et al.*, 2010; Liang *et al.*, 2014). Although many hypotheses have been raised and investigated, to date, no community-based exposures have been established to cause lymphoma (IARC, 2008).



Leukemias also vary according to type, prevalence, etiologies, and clinical courses (Jandl, 1996). Although not specified by EHHI, as noted above, I suspect that most of the leukemias in the soccer players (at least, in the younger players) are the type known as acute lymphocytic leukemia (ALL). This is important because ALL — as opposed to a major leukemia-type in adults, namely acute myelogenous leukemia (AML) — is *not* known to be caused by overexposures to chemicals, such as benzene, nor by chronic exposure to the chemicals present in cigarette smoke (IARC, 2004).

More generally, no type of cancer in adolescents is known to be caused by overexposure to chemicals. Instead, many of these cancer-cases are known or believed to occur spontaneously, or to be caused by factors common to us all (Lynch, 2010; Matés *et al.*, 2012; Tomasetti *et al.*, 2013; Tomasetti and Vogelstein, 2015). Some cases of cancers in adolescents appear to be due to infections with viruses such as Epstein-Barr virus (EBV); and some are apparently due to inherited genetic mutations (IARC, 2008).

EHHI's causal hypothesis with regard to crumb rubber (and rubber mulch) and cancer

Turning back to EHHI's apparent hypothesis with regard to rubber and cancer, I begin by noting that tires are industrial products made with various potentially hazardous chemicals; and that although tires *per se* are essentially inert, crumbled or shredded tires can release small amounts of various chemicals. In particular, synthetic rubber products tend to have a distinctive smell, caused primarily by release of trace amounts of volatile amines and organic sulfur compounds (Ambelong, 1963). These compounds are more odorous than they are toxic, and they are certainly not known or reasonably expected to pose a risk of cancer, regardless of the level of exposure.

EHHI suggests, however, that two other chemicals (i) emanate at significant concentrations from rubber and (ii) might pose a significant risk of cancer.

As quoted above, EHHI writes:

It is important to note the predominance of lymphomas and leukemias. 1,3 butadiene is connected to lymphoma and benzene is connected to leukemia. Both of these chemicals are present in rubber tires.



These statements are misleading in several ways. First, there is nothing surprising about a “predominance of lymphomas and leukemias” among young people: as noted above, these are the most common cancers in adolescents. Indeed, it would be striking if these cancer types were *not* prevalent in any random group of adolescents with cancer.

Second, the implication that crumb rubber (and/or rubber mulch) is a significant source of people’s exposures to the chemicals 1,3-butadiene and benzene is simply incorrect. It is true that 1,3-butadiene is *used* to make synthetic rubber (for tires and other products), but it is also essentially all *used up* in this process, in that it reacts with another chemical, styrene, to form a stable polymer, styrene-butadiene rubber. This stable polymer is no more a significant source of exposure to 1,3-butadiene than, say, a thoroughly baked cake is a significant source of exposure to raw eggs.

Nor would tires be expected to contain anything more than perhaps trace amounts of benzene. While it is the case that some tire building-machine operations rely on solvents that do contain small amounts (less than 1%) of benzene, there is neither evidence nor reason to maintain that tires would absorb, retain, and then release any significant amounts of benzene.

It is not surprising, then, that studies of ambient air in contact with crumb rubber in-filled synthetic turf fields have reported either (i) no detectable concentrations of 1,3-butadiene or benzene, or (ii) only the very low-level concentrations found in air throughout suburban and urban environments (Dye *et al.*, 2006; Norwegian Pollution Control Authority, 2006; Moretto, 2007; Denly *et al.*, 2008; Lim and Walker, 2009; Li *et al.*, 2010; Schilirò *et al.*, 2012). As noted by researchers Schilirò *et al.* (2012), for example, “On the basis of environmental monitoring, artificial turf football fields present no more exposure risks than the rest of the city.” Their conclusions were based on measurements in ambient air of benzene and the related compounds, toluene and xylenes, as well as on measurements of inhalable particles (in the size ranges of PM₁₀ and PM_{2.5}) and of polycyclic aromatic hydrocarbons (PAHs).

Third, as just suggested, all of us are exposed to very small amounts of both 1,3-butadiene and benzene via ordinary outdoor (and indoor) air, every day. This is because both chemicals are present in the exhaust from automobiles and from several other common sources. However, the evidence that benzene can cause leukemia (and again, only AML, and not ALL of childhood, and not lymphoma) does not come from these common, low-level, environmental exposures, but instead from massive exposures experienced by workers inside poorly ventilated factories,

prior to the institution of modern industrial hygiene (Graham *et al.*, 1988). It is entirely misleading to conflate these genuinely dangerous, historical, occupational settings with any outdoor environments, even on heavily trafficked roads, for example, let alone on playing fields or on playgrounds surfaced with rubber mulch.

Finally, although EHHI claims that 1,3-butadiene “is connected to lymphoma,” in fact it, like benzene, is known to cause leukemia (AML) and not lymphoma; and, again, it is known to do so in over-exposed factory workers (Delzell *et al.*, 1996), but not known to do so in the public at large, which routinely experiences vastly smaller, environmental exposures.

Theoretical risks of cancer from crumb rubber in-filled synthetic turf fields

Because some potentially carcinogenic chemicals are present in crumb rubber (as they are in ordinary dirt and other media), several studies have sought to estimate the degree of theoretical health-risk associated with these chemicals. Although these studies have focused primarily on crumb rubber, they are relevant for rubber mulch as well.

For example, Van Rooij and Jongeneelen (2010) studied young-adult male soccer players following intensive contact with crumb rubber-infilled synthetic turf. The researchers sought to determine whether this contact would lead to increased exposures to polycyclic aromatic hydrocarbons (PAHs). The researchers found that it did not. They concluded, “If there is any exposure, then the uptake is very limited and within the range of uptake of PAH from environmental sources and/or diet.” This was the case despite the fact that the athletes “had black residue of crumb dust on knees, hand palms and elbows . . . [confirming] that skin contact had occurred to dust of the tire crumb rubber.”

A recently published study from New Jersey’s state medical school (The Robert Wood Johnson Medical School) provides additional information. In particular, Pavilonis and colleagues (2014) subjected samples of both new and turf field-aged crumb rubber to extractions with solutions of synthetic sweat, synthetic lung fluid, and synthetic digestive fluid. They analyzed the types and amounts of chemicals that appeared in these synthetic biofluids, and then assessed whether children’s and adults’ exposures to these chemicals would be risky. Their data indicated that health risks to children and adults from extensive contact with crumb rubber ranged from none to negligible. Small amounts of potentially carcinogenic metals were detected in the crumb rubber-extracts, but the theoretical lifetime risks associated with these



were all less than one in one million, and, *per* the authors, “therefore risk was considered negligible.”

Earlier scientific studies and health risk-assessments have reported similar results. For example, in 2003, Birkholz and colleagues published their study, “Toxicological evaluation for the hazard assessment of tire crumb for use in public playgrounds.” Aggressive extraction of crumb rubber and testing of that extract revealed no significant toxic or mutagenic activity. (Mutagenic activity is an *in vitro* surrogate for ability to initiate cancer). Based on these and other results, the authors wrote, “We conclude that the use of tire crumb in playgrounds results in minimal hazard to children and the receiving environment.”

In 2006, the Norwegian Institute of Public Health published their report, “Artificial turf pitches – an assessment of the health risks for football players.” These researchers focused on indoor fields, because this is the setting in which air emissions would be much more concentrated, relative to outdoor fields. The investigators reported:

Worst case calculations based on air measurements carried out by NILU [Norwegian Institute for Air Research] and exposure values from the Norwegian Institute of Public Health indicate that training in sports halls does not cause any increased risk of leukaemia as a result of benzene exposure or any elevated risk as a result of exposure to polycyclic aromatic hydrocarbons.

On the basis of the exposures which have been calculated in connection with the use of indoor halls with artificial turf in which recycled rubber granulate is used, there is no evidence to indicate that the use of such halls causes an elevated health risk. . . . It has been concluded that exposure to benzene and PAHs in the quantities in which they have been measured in the halls will not cause any increased risk of cancer in people using the halls.

In 2007, the Dutch researcher Hofstra published his report, “Environmental and Health Risks of Rubber Infill. Rubber Crumb from Car Tyres as Infill on Artificial Turf.” His analysis was based on an extensive review of prior studies, as well as on the generation of new test data from fresh and weathered samples of rubber infill. Hofstra wrote:

Based on the available literature on exposure to rubber crumb by swallowing, inhalation and skin contact and our experimental investigations on skin contact

we conclude that there is not a significant health risk due to the presence of rubber infill for football players on artificial turf pitch with rubber infill from used car tyres.

Finally, the Connecticut Department of Public Health (CT DPH) has published three peer-reviewed studies of synthetic turf fields (Ginsberg *et al.*, 2011a and 2011b; Simcox *et al.*, 2011), and recently (January 20, 2015) issued a memorandum to local health departments and districts in the State. In this, CT DPH (2015) affirms its "position that outdoor artificial turf fields do not represent an elevated health risk." The Department notes:

. . . CT DPH finds no scientific support for a finding of elevated cancer risk from inhalation or ingestion of chemicals derived from recycled tires used on artificial turf fields. . . . federal and state authorities have taken seriously the concerns that artificial turf fields may present a health risk due to contaminants in recycled rubber. The best way to investigate these concerns is via an exposure investigation. Studies conducted in Connecticut and elsewhere have shown a very low exposure potential, less than from typical outdoor sources of air pollution. The current news reports of a list of soccer players with cancer does not constitute a correlation or causality and thus raises a concern that currently lacks scientific support. Thus, the CT DPH position expressed in 2011 at the conclusion of the Connecticut study, that outdoor artificial turf fields do not represent an elevated health risk, remains unchanged.

Data from a recent, unpublished study by EHHI at Yale University

Earlier this month, EHHI (at http://www.ehhi.org/turf/new_study_jun2015.shtml) posted this press release:

New Study – Many carcinogens found in Yale analysis of crumb rubber infill and playground mulch surfacing

North Haven, Conn., June 11, 2015—Environment and Human Health, Inc. (EHHI), an organization of physicians and public health professionals, is releasing its study done at Yale University showing that the analysis found 96 chemicals in the rubber tire infill used in synthetic turf and

rubber tire mulch used as surfacing in toddler playgrounds.

Of the 96 chemicals detected – a little under a half have had NO toxicity assessments done on them for their health effects - therefore nothing is known about them. The other half have had SOME toxicity testing done on them - but even many of those chemicals had incomplete toxicity testing and therefore all health effects are not fully known. Of the half that have had toxicity assessments, 20% are probable carcinogens. . . .

Comments on the EHHI/Yale study

For many reasons, the EHHI/Yale study does not demonstrate that rubber mulch or crumb rubber pose a significant risk of cancer (or other diseases).

First, the study has not been published (or released in any complete form) nor, to my knowledge, has it been peer reviewed. In fact, contrary to the press release, the study does not appear to have been written up in even an unpublished manuscript. At my request, Nancy Alderman of EHHI was kind enough to supply me with a summary of some of the methods and a spreadsheet of the results to date: I have attached these materials to this memorandum.

Second, as far as I can tell, the summary results presented are entirely non-quantitative: there is no indication of the concentrations of any of the detected chemicals, let alone is there any attempt to assess levels of exposure or doses potentially received by children or others playing on or near rubber mulch or crumb rubber. Accordingly, there is no way to judge *the degree to which* any such exposures might be risky. Since all of us eat, drink, breathe, and otherwise contact at least trace levels of many carcinogens daily, it is crucial to be quantitative when assessing cancer-risks (and then acting wisely upon those assessments). Absent at least semi-quantitative estimates of risk, informed judgments simply cannot be made.

Third, according to the summary of the study-methods, the chemicals were detected in methylene chloride extracts of a mixture of ground and unground crumb rubber or rubber mulch — but methylene chloride extraction is not a relevant or reliable means of assessing how rubber mulch in playgrounds might become solubilized or otherwise release chemicals that could then be absorbed across a child's skin, for example, or across a child's digestive tract (were he or she to ingest some rubber). For purposes of human health risk assessment, instead



of using a non-biological solvent such as methylene chloride, one should use simulated sweat or simulated gastric fluid, as was used in the published, peer-reviewed study by Pavilonis *et al.*, 2014, for example, cited above.

Fourth, EHHI reports that eight of the chemicals detected in the methylene chloride extracts of at least one of the nine samples of mulch are “probable carcinogens” (there were another five samples of “infill” that are not considered here) — but none of these eight chemicals is so categorized by authoritative bodies, such as the International Agency for Research on Cancer (IARC), the U.S. National Toxicology Program (NTP), or the U.S. Environmental Protection Agency (EPA). Moreover, not one of the putative “probable carcinogens” is consistently detected in the samples of mulch.

For example, EHHI lists pyrene (detected in seven of the nine samples) as a carcinogen, but no rodent bioassays of pyrene are in fact positive; and, *per* U.S. EPA, “Overall, the database for pyrene is substantial, and the weight of evidence suggests that this PAH is not carcinogenic” (EPA-635-R-08-012A). Not surprisingly, then, neither IARC nor NTP lists pyrene as either a known or a probable human carcinogen (See <http://www.cancer.org/cancer/cancercauses/othercarcinogens/generalinformationaboutcarcinogens/known-and-probable-human-carcinogens#> for complete lists of carcinogens compiled by IARC and NTP).

Similarly, EHHI lists heptadecane (detected in one of the samples) as a carcinogen, but no rodent bioassays indicate that heptadecane is carcinogenic, and it is not listed as a carcinogen by either IARC or NTP. EHHI lists phthalamide as a carcinogen, but the NTP bioassays for phthalamide yielded negative results in male and female rats and mice, and it is not listed as a carcinogen by either IARC or NTP.

And EHHI lists 9,10-dimethylanthracene, fluoranthene, phenanthrene, 4-(1,1,3,3-tetramethylbutyl)-phenol, and 1-methylpyrene as carcinogens; but, again not one of these five chemicals is listed as a carcinogen by either IARC or NTP.

Finally, I would note that the chemicals butadiene and benzene were *not* detected in this EHHI/Yale study. Recall that these two chemicals are indeed established causes of cancer in humans, and that EHHI had hypothesized that both are present — and presumably bioavailable — at significant concentrations in crumb rubber and rubber mulch. I would add that the elevated temperatures used to dry and to analyze the samples would likely have obscured the

presence of either compound, but it remains the case that the causal hypothesis raised by EHHI has yet to be supported by actual data or other reliable evidence.

Overall, then, the evidence on crumb rubber and rubber mulch does not suggest, let alone demonstrate, that rubber mulch poses a significant risk to the health of children or others. As such, I believe that Principal Lay can rest assured that the mulch in her playground has not put her students at risk of developing cancer.

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Laura C. Green, Ph.D., D.A.B.T., Consulting toxicologist
106 Sumner Road, Brookline, Massachusetts 02445
617-835-0093 laura.green@alum.MIT.edu