January 20, 2015

School Board
Radnor Township School District
135 South Wayne Avenue
Wayne, PA 19087

Dear School Board members,

I write this letter as a Radnor parent. I also write it on behalf of a number of members of the Delaware Riverkeeper Network who have asked me to provide input on the decision to invest in more artificial turf in Radnor. The two positions are complimentary and parallel and so I write this letter in both capacities.

I write to ask you to resist the pressure to spend additional funds to expand artificial turf fields in Radnor. Your increasing investment in artificial sports playing surfaces takes from parents and children the right to engage in sports and protect their health, safety and environment at the same time. Artificial turf fields continue to raise health hazards and concerns for players. By expanding the number of artificial turf fields in the school district you are forcing families to expose themselves to hazardous risk if they want to engage in, and receive the benefits of, participating in sports in Radnor. It is simply neither right nor fair for the Radnor School Board to be making investments that take from parents and kids the ability to decide for themselves what health hazards they are willing to be exposed to if they want to participate in sports – you are forcing an unfair choice, play sports or protect your health, but you are not allowed to have both.

Synthetic turf is generally made with rubber from waste tires. Recycled rubber varies considerably in its chemical composition, even when from the same manufacturer.[1]

Hazardous substances found in tires may persist in the environment including polycyclic aromatic hydrocarbons (PAHs), phthalates and certain metals. These substances may be bioaccumulative, carcinogenic, reprotoxic, mutagenic and/or endocrine disrupting.[2]

- Most PAHs are persistent, bioaccumulative and carcinogenic.[3]

[1] T. Kallqvist, Norwegian Institute for Water Research (NIVA), Environmental Risk Assessment of Artificial Turf Systems, December 2005, p. 7.
[2] KEM, Swedish Chemicals Agency, Facts: Synthetic Turf, April 2007.

DELAWARE RIVERKEEPER NETWORK
925 Canal Street, Suite 3701
Bristol, PA 19007
Office: (215) 369-1188
fax: (215)369-1181
drn@delawareriverkeeper.org
www.delawareriverkeeper.org

- Phthalates are generally used as solvents and plasticisers in plastics. Phthalates are not chemically bound to the rubber and as a result can leach from the infill material.[4]
- Phenols likewise are not chemically bound to the rubber and so can leach. Phenols too are persistent and bioaccumulative and can have long-term effects on the environment.[5]
- Among the metals found in tires that may be of concern are zinc, lead, copper, chromium and cadmium. While zinc and copper are essential for living organisms, when absorbed at high levels they become harmful. Lead can affect reproduction, development of the nervous system leading to poor cognitive development, and is a particular threat to fetuses and young children. Chromium is carcinogenic and mutagenic. Cadmium is toxic to humans and if taken in can contribute to poor liver and kidney function, as well as osteoporosis. [6]

The environmental implications of artificial turf continues to be unsettled.
I have written previously about the potential for environmental impacts from artificial turf. Unfortunately there has not been much progress in the research necessary to settle the questions one way or another about the potential for environmental harm. When the school district decided to construct artificial turf fields at the high school it did so with a commitment that it would try to conduct its own research to help advance the need for finding answers to this question by carrying forth its own monitoring effort on the impacts of its installed fields. But the commitment to create a committee and conduct this research was never honored. And so the questions about environmental impacts of artificial turf remain.

The research into potential health affects from artificial turf has seen some advancement. New analysis by the scientific community and regulatory agencies support the need for continuing concern regarding the health impacts of artificial turf. Given that children are much more susceptible to the adverse impacts of chemical exposures and excessive temperatures, this research makes clear that you have an obligation not to invest in any more turf at this time.

(A summary of my previous comments on the research into environmental impacts of artificial turf is provided below.)

Excessive heat continues to be a primary concern for those that play on artificial turf.
Extreme heat is a health concern – high surface temperatures found on artificial turf fields can contribute to physiological stress and cause "serious heat-related illnesses".[7] Heat stress, heat stroke and burns are all of concern. In fact, the "New York City Department of Health and Mental Hygiene recognizes excessive surface temperatures as the most important health concern associated with infilled synthetic turf." [8] Studies document that the surface temperature on artificial turf is dramatically increased as compared to surrounding land uses including asphalt – so much so that it is a genuine health threat for players.

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[3] KEM, Swedish Chemicals Agency, Facts: Synthetic Turf, April 2007.
[4] KEM, Swedish Chemicals Agency, Facts: Synthetic Turf, April 2007.
[5] KEM, Swedish Chemicals Agency, Facts: Synthetic Turf, April 2007.
[6] KEM, Swedish Chemicals Agency, Facts: Synthetic Turf, April 2007.
[7] T.J. Serensits, A.S. McNitt, D.M. Petrunak; Human health issues on synthetic turf in the USA, Dept of Crop and Soil Sciences, The Pennsylvania State University, IMechE Vol 225 Part P: J. Sports Engineering & Technology, Jan 6, 2011.
[8] T.J. Serensits, A.S. McNitt, D.M. Petrunak; Human health issues on synthetic turf in the USA, Dept of Crop and Soil Sciences, The Pennsylvania State University, IMechE Vol 225 Part P: J. Sports Engineering & Technology, Jan 6, 2011.

Concerns regarding the excessive temperatures range from the implications for players who are already exerting themselves playing in such excessively high temperatures, to the implications for burns when players or pedestrians come into contact with the hot surfaces, to the implications for small children who may come into contact with the extremely hot surfaces during non-sporting events. Research has also concluded that the "heat transfer from the surface to the sole of the individual's foot" could contribute to physiological stress of players. [9]

In a 2002 study it was found that "the surface temperature of the synthetic turf was 37° F higher than asphalt and 86.5° F hotter than natural turf." [10] A study published in the Journal of Health and Physical Education and Recreation showed "surface temperatures as much as 95 to 140 degrees Fahrenheit higher on synthetic turf than natural turf grass when exposed to sunlight." [11] Random sampling at Brigham Young University identified temperatures ranging from 117.38 to 157 degrees on artificial turf while neighboring natural grass areas were in the range of 78.19 to 88.5 degrees Fahrenheit. "Two inches below the synthetic turf surface was 28.5° F hotter than natural turf at the surface."[12] Another study comparing temperatures on artificial turf temperatures with air temperature found that artificial turf ranged from 58 to 75 degrees hotter than measured air temperature.[13] And yet another study considering found ranges of 155.3 to 173.4 degrees on the turf fields when air temperatures were in the 76 degree range; and 104.2 to 159.3 degrees when air temperatures were in the 77 degree range. [14]

Research has not found good solutions for the excessive heat levels of turf. Irrigation of excessively hot artificial turf surfaces only provides cooling benefits for about 20 minutes. [15] While irrigation provides cooling for the synthetic turf, in one seminal study lowering the temperature from 174° F to 85° F, after only 5 minutes the temperature quickly rose again to 120°F; after 20 minutes it rose to 164°F.[16] In another important body of work by Penn State, it was found again that irrigation is only successful in reducing temperatures for about 20 minutes, with a rebound to within 10 degrees of the pre-irrigation temperature within 3 hours. [17] The use of white crumb rubber as the infill does not resolve the heat issue. [18] In fact, according to Penn State as part of a study which looked at various color options for infill and temperature, "[w]hile marketing materials may claim lower surface temperatures, no scientific reports exist that substantiate such claims."[19]

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[9] T.J. Serensits, A.S. McNitt, D.M. Petrunak; Human health issues on synthetic turf in the USA, Dept of Crop and Soil Sciences, The Pennsylvania State University, IMechE Vol 225 Part P: J. Sports Engineering & Technology, Jan 6, 2011.
[10] Dr. C. Frank Williams and Dr. Gilbert E. Pulley, Synthetic Surface Heat Studies, Brigham Young University.
[11] SportsTurf Managers Association, A Guide to Synthetic and natural Turfgrass for Sports Fields, Selection, Construction and Maintenance Considerations.
[12] Dr. C. Frank Williams and Dr. Gilbert E. Pulley, Synthetic Surface Heat Studies, Brigham Young University.
[13] T. Sciacca, The Thermal Physics of Artificial Turf, January 2008.
[14] Penn State's Center for Sports Surface Research, Synthetic Turf Heat Evaluation – Progress Report, January 2012.
[15] T.J. Serensits, A.S. McNitt, D.M. Petrunak; Human health issues on synthetic turf in the USA, Dept of Crop and Soil Sciences, The Pennsylvania State University, IMechE Vol 225 Part P: J. Sports Engineering & Technology, Jan 6, 2011.
[16] Dr. C. Frank Williams and Dr. Gilbert E. Pulley, Synthetic Surface Heat Studies, Brigham Young University.
[17] T.J. Serensits, A.S. McNitt, D.M. Petrunak; Human health issues on synthetic turf in the USA, Dept of Crop and Soil Sciences, The Pennsylvania State University, IMechE Vol 225 Part P: J. Sports Engineering & Technology, Jan 6, 2011.
[18] T.J. Serensits, A.S. McNitt, D.M. Petrunak; Human health issues on synthetic turf in the USA, Dept of Crop and Soil Sciences, The Pennsylvania State University, IMechE Vol 225 Part P: J. Sports Engineering & Technology, Jan 6, 2011.
[19] Penn State's Center for Sports Surface Research, Synthetic Turf Heat Evaluation – Progress Report, January 2012.

Natural grass, by comparison, provides a natural cooling affect and helps to dissipate heat from neighboring developed areas.[20] "The temperature of natural grass rarely rises above 85 degrees Fahrenheit, regardless of air temperature." [21]

The heat impacts of artificial turf need to be considered in the context of today's changing climate. Global climate change is expected to dramatically increase the number of days over 100 degrees communities in our region experience. Depending on how aggressively global warming gasses are reduced in coming years, communities nearby Philadelphia will begin to experience in the range of 10 days (in lower emission scenarios) to 30 days (if higher emission scenarios continue to prevail) over 100 degrees.[22] By later in this century seasonable temperatures are projected to rise 6°F to 14°F in summer (depending again on emission reductions achieved in the future). [23] Educators and decisionmakers selecting artificial turf based on its long-term viability and community impacts should consider the affect of global climate change to magnify the heat impacts of artificial turf.

The impacts of inhalation or ingestion of chemicals as the result of playing turf continues to be a concern for those playing on artificial turf.

Direct human exposure to the hazardous substances contained in the rubber in-fill of artificial turf is believed to occur via three pathways: inhalation, skin contact, and/or ingestion including by children who come into contact with the material.[24]

In 2011, research conducted for the New Jersey Department of Environmental Protection began investigation into the potential for players on artificial turf fields to be exposed to lead, chromium, arsenic and cadmium as a respirable/inhalable aerosol.[25] In air samples collected from the turf during various levels of activity, researchers detected arsenic, cadmium, chromium and lead, all metals with known human toxicity. [26] "The findings of this study, although limited in scope, raise some concerns with regard to the potential hazards that may exist for individuals and in particular children who engage in sports activities on artificial turf fields." [27] The research demonstrated that activity by players on the fields could suspend contaminated particulates into the air that could be inhaled. "The findings show that both inhalable PM [particulate matter], as well as inhalable lead (when present) are resuspended from even minor physical activity on an artificial surface. These data therefore indicates that human exposure from lead-containing artificial turf fields is not just limited to

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[20] James B. Beard & Robert L. Green, The Role of Turfgrasses in Environmental Protection and Their Benefits to Humans, J. Environ Qual. 23:452-460 (1994).
[21] SportsTurf Managers Association, A Guide to Synthetic and natural Turfgrass for Sports Fields, Selection, Construction and Maintenance Considerations.
[22] Union of Concerned Scientists, Confronting Climate Change in the U.S. Northeast ● New Jersey, 2007.
[23] Union of Concerned Scientists, Confronting Climate Change in the U.S. Northeast ● New Jersey, 2007.
[24] Environment & Human Health, Inc., Artificial Turf, Exposures to Ground-Up Rubber Tires, 2007.
[25] S.L. Shalat, Sc.D., "An Evaluation of Potential Exposures to Lead and Other Metals as the Result of Aerosolized Particulate Matter from Artificial Turf Playing Fields, Final Report", submitted to NJ Department of Environmental Protection, July 14, 2011.
[26] S.L. Shalat, Sc.D., "An Evaluation of Potential Exposures to Lead and Other Metals as the Result of Aerosolized Particulate Matter from Artificial Turf Playing Fields, Final Report", submitted to NJ Department of Environmental Protection, July 14, 2011.
[27] S.L. Shalat, Sc.D., "An Evaluation of Potential Exposures to Lead and Other Metals as the Result of Aerosolized Particulate Matter from Artificial Turf Playing Fields, Final Report", submitted to NJ Department of Environmental Protection, July 14, 2011.

dermal, but also to inhalation route of exposure."[28] The three potential avenues for lead from artificial turf are the blades of artificial grass, the pigment used for the field markings and lines, and the infill material. Even studies that have not found exposure levels to lead high enough to be of concern in the context of the study conducted are careful to point out: "some health scientists believe that *any* Pb [lead] is harmful to children's neurocognitive development, and that *no* new Pb should be added to their surroundings"[29] and that "…physicians should be aware of synthetic turf as pone potential source of exposure for young children. Health officials investigating elevated blood lead in children should also be aware of synthetic turf as a potential source of lead exposure."[30]

Furthermore, a 2008 study that looked at a variety of contaminants associated with artificial turf did find that the lead present in the rubber granules, while at low levels, was "highly bioaccessible" to synthetic gastric fluid used in in their research. This study also found a "slightly worrisome" level of chromium in an artificial turf fiber sample and "high bioaccessible fractions of lead in both synthetic gastric and intestinal fluids.[31]

In October 2006 and January 2007, respectively, two sites in New York where synthetic turf has been used (the large, 3 year old, Parade Ground in Brooklyn; the relatively small 5 month old Sara D. Roosevelt Park in Manhattan) were analyzed. This testing found PAHs at hazardous levels (as per New York standards) at each of the sites. At both sites dibenzo (a.h)anthracene, a probable human carcinogen, was found at hazardous levels, with two other PAH forms, both possible human carcinogens, found at hazardous levels at the Parade Ground site. A 2008 study also found that the rubber granules found in artificial turf fields had PAH levels above health-based soil standards, that there was "low" but not "no" bioaccessibility, and that while levels appear to decline over time this can be altered by the fact that new rubber can be added periodically to compensate for the loss of infill material.[32] Additional research is needed into the pathways by which these substances may be absorbed into the bodies of children and athletes via skin contact, ingestion or other pathways[33] - but the need for additional research does not displace the concerns raised by these findings.

A study by the California Office of Environmental Health Hazard Assessment (OEHHA) summarized 46 studies that identified 49 chemicals which are released from tire crumb. Of the 49, "seven of the chemicals leached from tire shreds were carcinogens. OEHHA calculated a cancer risk of 1.2 in 10 million based on a ***one-time*** ingestion of the tire crumb rubber over a lifetime."[34] While there are

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[28] S.L. Shalat, Sc.D., "An Evaluation of Potential Exposures to Lead and Other Metals as the Result of Aerosolized Particulate Matter from Artificial Turf Playing Fields, Final Report", submitted to NJ Department of Environmental Protection, July 14, 2011.

[29] J. Zhang, I. Han, L. Zhang, W. Crain, "Hazardous Chemicals in synthetic turf materials and their bioaccessibility in digestive fluids," Journal of Exposure Science and Environmental Epidemiology (2008)

[30] G. Van Ulirsch et. al, Evaluating and Regulating Lead in Synthetic Turf, Commentary, Environmental Health Perspectives, Vol 118, No. 10, Oct. 2010.

[31] J. Zhang, I. Han, L. Zhang, W. Crain, "Hazardous Chemicals in synthetic turf materials and their bioaccessibility in digestive fluids," Journal of Exposure Science and Environmental Epidemiology (2008)

[32] J. Zhang, I. Han, L. Zhang, W. Crain, "Hazardous Chemicals in synthetic turf materials and their bioaccessibility in digestive fluids," Journal of Exposure Science and Environmental Epidemiology (2008)

[33] Rachel's' Democracy & Health News #992, Hazardous Chemicals in Synthetic Turf, Follow-up Analyses, April 12, 2007.

[34] Environment & Human Health, Inc., Artificial Turf, Exposures to Ground-Up Rubber Tires, 2007 citing California Office of Environmental Health Hazard Assessment (OEHHA), Evaluation of Health Effects of Recycled Waste Tires in Playground and Track Products, January, 2007.

limited studies which assert that recycled tire crumb are stable in the gastrointestinal tract and that therefore this is not a pathway for exposure, there are other studies which contradict these findings.[35]

Concerns have been raised about the potential implications of recycled tire in-fill for individuals with latex allergies and that inhalation could result in a systemic response, as opposed to a contact response.[36]

While, "the status of the information about human exposures to recycled tire crumb rubber in-fill … is not sufficient to determine the safety of the use of the product in situations that involve continuous episodes of human exposure;" [37] "the available information is sufficient and strong enough to raise plausible questions with respect to acute toxicity for susceptible persons, and for cancer risks."[38]

Chrysene, a PAH and carcinogen, was found to be ingested as the result of hand-to-surface-to-mouth transfer from playground surfaces made with recycled tires. Assuming playground use for an 11 year period (from age 1 to 12) there was found to be an increased cancer risk of 2.9 in one million (2.9×10^{-6}). This risk is greater than the general cancer risk gauge of one in one million ($1X10^{-6}$).[39] This research would seem to suggest that repeat exposure over time to the chemicals released from artificial turf increases the associated increase in cancer risk.

The hot temperatures are also a concern for exposing players to dangerous toxins. As well explained by a well cited petition to the Consumer Product Safety Commission for rulemaking: "When tires are shredded and pulverized, their surface area increases exponentially, as does the particulate and gas yield from the tire material. Since tires are made of very harmful materials, including 24 gases found to be harmful to humans, carbon black, (a carcinogen which makes up 30% of tires), latex, benzothiazoles, phthalates, lead, mercury, cadmium, zinc and many other known toxins, when the fields heat up, they become increasingly dynamic. Of primary concern is the interaction of particles and gases, 'because when particles adsorb onto the surface of gases, they become 10-20 times more toxic than the materials themselves.' The fields yield continuously, but become more dynamic and more toxic as they heat up."[40]

Concerns for increased head injuries and bacterial infections as the result of playing on turf are justified.

There is great concern that the increased level of abrasions and burns which result from playing on an artificial turf field as compared to natural grass increases the pathways by which bacterial infections, such as MRSA (methicillin-resistant staphylococcus aureus), can enter the body. As explained in a 2011 Penn State study, "It is important to note that synthetic turf is more abrasive than natural turf grass and, as a result, breaks in the skin are more common, creating a pathway for infection when in

[35] Environment & Human Health, Inc., Artificial Turf, Exposures to Ground-Up Rubber Tires, 2007.
[36] Environment & Human Health, Inc., Artificial Turf, Exposures to Ground-Up Rubber Tires, 2007.
[37] Environment & Human Health, Inc., Artificial Turf, Exposures to Ground-Up Rubber Tires, 2007.
[38] Environment & Human Health, Inc., Artificial Turf, Exposures to Ground-Up Rubber Tires, 2007.
[39] Office of Environmental Health Hazard Assessment, Evaluation of Health Effects of Recycled Waste Tires in Playground and Track Products, January 2007. Note -- the 1.2 in 10 million cancer risk found in the OEHHA study was considered by the authors to be an acceptable level of risk as it falls below the general cancer risk gauge of one in one million ($1X10^{-6}$).
[40] Petition for a Rulemaking on Surface Heat from Artificial Turf, Submitted by PEER to Consumer Product Safety Commission, Sept 6, 2012.

contact with an infected surface." [41] There are studies to indicate that turf burns may be facilitating infection by acting as a pathway for infection.[42] Study has found that turf burns increased the risk of infection regardless of the type and timing of care provided the burn. [43]

Older turf fields have been found to have higher microbial populations, as well as higher levels in the higher traffic areas such as the sidelines, thereby suggesting to researchers that microbial populations can accumulate in synthetic turf over time.[44]

Concussions (formally described as Mild Traumatic Brain Injury or MTBI) resulting from sports has, according to the US Centers for Disease Control, reached "epidemic proportions."[45] "'Mild' head traumas, and especially a series of such minor concussions can have long term, negative effects on cognitive function." [46] Study has documented that artificial turf increases the risk of MTBI over natural turf, approximately doubling that risk, as well as causing a greater degree of trauma.[47] According to study, artificial turf presents a 5 times greater risk of the more severe head injury than natural turf, although it is still unknown the particular characteristics of the two surfaces that cause the difference in head injury incidence. [48] Only 31% of the playground surfaces made of recycled tires tested in one research study passed the California State mandated Head Impact Criterion (HIC) of ≤1,000. In this same study 100% of the playground surfaces made of wood chips passed the same standard. [49]

Environmental Impacts previously documented.
While it seems well recognized that there is a limited level of assessment and investigation into the environmental impacts associated with artificial turf, a growing body of scientific analysis is documenting a concerning level of environmental threat and harm and is further demonstrating the need for more research regarding artificial turf and its ramifications for the environment.

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[41] T.J. Serensits, A.S. McNitt, D.M. Petrunak; Human health issues on synthetic turf in the USA, Dept of Crop and Soil Sciences, The Pennsylvania State University, IMechE Vol 225 Part P: J. Sports Engineering & Technology, Jan 6, 2011.
[42] A High Morbidity Outbreak of Methicillin-Resistant *Staphylococcus aureus* among Players on a College Football Team, Facilitated by Cosmetic Body Shaving and Turf Burns, study conducted 2004 for Connecticut Dept of Public Health, Student Health Services of Sacred Heart Univ, Centers for Disease Control and Prevention, Minnesota Dept of Public Health, Los Angeles County Dept of Health Svces; Dr. S.V. Kazakova et.al., A Clone of Methicillin-Resistant *Staphylococcus aureus* among Professional Football Players, The New England Journal of Medicine, Vol 352:468-475 No. 5, Feb. 3, 2005.
[43] A High Morbidity Outbreak of Methicillin-Resistant *Staphylococcus aureus* among Players on a College Football Team, Facilitated by Cosmetic Body Shaving and Turf Burns, study conducted 2004 for Connecticut Dept of Public Health, Student Health Services of Sacred Heart Univ, Centers for Disease Control and Prevention, Minnesota Dept of Public Health, Los Angeles County Dept of Health Svces.
[44] J.J. Bass, D.W. Hintze, (2013) "Determination of Microbial Populations in a Synthetic Turf System," Skyline – The Big Sky Undergraduate Journal, Vol. 1, Iss. 1, Art. 1.
[45] Dr. M. Shorten, J.A. Himmelsbach, BioiMechanica, Sports Surfaces and the Risk of Traumatic Brain Injury citing the US Centers for Disease Control.
[46] Dr. M. Shorten, J.A. Himmelsbach, BioiMechanica, Sports Surfaces and the Risk of Traumatic Brain Injury.
[47] Dr. M. Shorten, J.A. Himmelsbach, BioiMechanica, Sports Surfaces and the Risk of Traumatic Brain Injury.
[48] Dr. M. Shorten, J.A. Himmelsbach, BioiMechanica, Sports Surfaces and the Risk of Traumatic Brain Injury. See also K.M. Guskiewica, N.L. Weaver, D.A. Padua, W.E. Garrett Jr., Epidemiology of Concussion in Collegiate and High School Football Players, Sep-Oct 2000 & Does the Use of Artificial Turf Contribute to Head Injuries, The Journal of Trauma-Injury, Infection and Critical Care, Oct 2002 for the finding that artificial turf increases the level of injury in comparison to natural grass fields.
[49] Office of Environmental Health Hazard Assessment, Evaluation of Health Effects of Recycled Waste Tires in Playground and Track Products, January 2007. Please note that in this study 32 recycled tire playground surfaces were tested as compared to only 5 wood chip playground surfaces.

The Connecticut Agricultural Experiment Station conclusively found four compounds which out-gassed and leached into water from synthetic turf rubber crumb under ambient temperatures:

- Benzothiazole (a skin and eye irritant),
- Butylated hydroxyanisole (a "recognized carcinogen, suspected endocrine toxicant, gastrointestinal toxicant, immune toxicant, neurotoxicant, skin and sense-organ toxicant"),
- n-hexadecane (a severe irritant) &
- 4-(t-octyl) phenol ("corrosive and destructive to mucous membranes").[50]

As rubber degrades it can leach toxic substances which can contaminate soil, plants and aquatic ecosystems.[51] Study has concluded that the use of tires in artificial turf has the potential to pollute our environment with PAHs, phenols and zinc[52] and that runoff from an artificial turf field draining to a local creek can pose "a positive risk of toxic effects on biota in the water phase and in the sediment."[53] Other metal contaminants found to leach from tire crumb rubber include zinc, selenium, lead and cadmium.[54] Zinc has also been shown to leach from the artificial turf fibers.[55] Extreme temperatures or solvents are not needed to release these metals, volatile organic compounds or semi-volatile organic compounds from the rubber in-fill of artificial turf into the air or water – release takes place in ambient air and water temperatures.[56]

"Runoff with high Zn [zinc] from synthetic turf fields may produce adverse effects to plants and aquatic life. This is of particular concern given that the leaching rate of Zn [zinc] from rubber granules can be up to 20 times greater than the leaching rate of Zn from agricultural applications of manure and pesticides."[57] Leaching of substances as the result of surface water runoff from precipitation has, by some researchers, been predicted to be the greatest risk for the environment from artificial turf.[58] Study shows there is a risk of local effects for aquatic and sediment dwelling organisms in impacted water courses.[59] Recycled rubber, and associated leachate, has been found to contain a variety of metals (including lead, cadmium, copper, mercury and zinc), as well as organic

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[50] The Connecticut Agricultural Experiment Station, Examination of Crumb Rubber Produced from Recycled Tires, August 2007; Environment & Human Health, Inc., Artificial Turf, Exposures to Ground-Up Rubber Tires, 2007.

[51] Quoting Dr. Linda Chalker-Scott, Washington State University -- Turfgrass Resource Center, Facts About Artificial Turf and Natural Grass; T. Kallqvist, Norwegian Institute for Water Research(NIVA), Environmental Risk Assessment of Artificial Turf Systems, December 2005, p. 17.; Connecticut Agricultural Experiment Station, Examination of Crumb Rubber Produced from Recycled Tires.

[52] T. Kallqvist, Norwegian Institute for Water Research(NIVA), Environmental Risk Assessment of Artificial Turf Systems, December 2005, p. 5; T. Edeskar, Lulea University of Technology, Technical and Environmental Properties of Tyre Shreds Focusing on Ground Engineer Application, 2004 as cited in KEM, Swedish Chemicals Agency, Facts: Synthetic Turf, April 2007.

[53] T. Kallqvist, Norwegian Institute for Water Research (NIVA), Environmental Risk Assessment of Artificial Turf Systems, December 2005, p. 6.

[54]Environment & Human Health, Inc., Artificial Turf, Exposures to Ground-Up Rubber Tires, 2007.

[55] T. Kallqvist, Norwegian Institute for Water Research (NIVA), Environmental Risk Assessment of Artificial Turf Systems, December 2005, p. 17.

[56] Environment & Human Health, Inc., Artificial Turf, Exposures to Ground-Up Rubber Tires, 2007.

[57] J. Zhang, I. Han, L. Zhang, W. Crain, "Hazardous Chemicals in synthetic turf materials and their bioaccessibility in digestive fluids," Journal of Exposure Science and Environmental Epidemiology (2008)

[58] T. Kallqvist, Norwegian Institute for Water Research (NIVA), Environmental Risk Assessment of Artificial Turf Systems, December 2005, p. 5; NIVA (The Norwegian Institute for Water Research), Evaluation of the Environmental Risks of Synthetic Turf, 2005; KEM, Swedish Chemicals Agency, Facts: Synthetic Turf, April 2007.

[59] T. Kallqvist, Norwegian Institute for Water Research(NIVA), Environmental Risk Assessment of Artificial Turf Systems, December 2005, p. 5; NIVA (The Norwegian Institute for Water Research), Evaluation of the Environmental Risks of Synthetic Turf, 2005, as cited by KEM, Swedish Chemicals Agency, Facts: Synthetic Turf, April 2007; KEM, Swedish Chemicals Agency, Facts: Synthetic Turf, April 2007

pollutants such as PAHs, phthalates, 4-t-octylphenol and iso-nonyphenol.[60] The leaching of zinc has been determined to be of major environmental concern.[61] The leaching of zinc increases as the rubber infill weathers over time,[62] it is likely this is the same for other contaminants. While Zinc contributes the most risk, phenols (specifically octylphenol) and PAHs are also of concern.[63] Of the organic compounds at issue, Octylphenol represents the greatest risk, and possibly could occur at levels where hormone disrupting effects are a concern.[64] The varying content of tires makes this threat a moving target.

The Norwegian Institute for Water Research has determined that it is "appropriate to perform a risk assessment which covers water and sediments in watercourses which receive run-off from artificial turf pitches."[65]

While recycled rubber is a greater source of pollution, newly manufactured rubber also contains level of hazardous substances; in the case of zinc and chromium the levels of recycled and newly manufactured rubber are comparable.[66]

It is predicted that chemicals leaching from synthetic turf materials occurs slowly, and as a result the environmental harms may take place over many years.[67]

Leaching may not be the only source of water contamination from artificial turf. As the artificial turf is used there is a level of "erosion" that takes place and can result in fine particles that could be carried to local waterways. This source of contamination needs study.[68]

The synthetic grass fibers can also be a significant source of pollution, particularly zinc, albeit significantly lesser amounts leach from the synthetic grass than the rubber infill.[69]

When talking about the use of ground rubber as a supplement to planting soils the North Carolina Department of Agriculture and Consumer Services sent out a notice identifying the risk that zinc leaching from the rubber causes a decline in plant growth "directly attributable to zinc toxicity."[70]

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[60] T. Kallqvist, Norwegian Institute for Water Research (NIVA), Environmental Risk Assessment of Artificial Turf Systems, December 2005, p. 7.
[61] INTRON, Environmental and Health Risks of Rubber Infill, rubber crumb from car tyres as infill on artificial turf, February 9, 2007.
[62] INTRON, Environmental and Health Risks of Rubber Infill, rubber crumb from car tyres as infill on artificial turf, February 9, 2007.
[63] NIVA (The Norwegian Institute for Water Research), Evaluation of the Environmental Risks of Synthetic Turf, 2005, as cited by KEM, Swedish Chemicals Agency, Facts: Synthetic Turf, April 2007.
[64] T. Kallqvist, Norwegian Institute for Water Research (NIVA), Environmental Risk Assessment of Artificial Turf Systems, December 2005, p. 17.
[65] T. Kallqvist, Norwegian Institute for Water Research (NIVA), Environmental Risk Assessment of Artificial Turf Systems, December 2005, p. 8.
[66] Byggforsk, SINTEF Building and Infrastructure, Potential Health and Environmental Effects Associated with Synthetic Turn Systems, 2004, as referenced in KEM, Swedish Chemicals Agency, Facts: Synthetic Turf, April 2007.
[67] T. Kallqvist, Norwegian Institute for Water Research(NIVA), Environmental Risk Assessment of Artificial Turf Systems, December 2005, p. 5; NIVA (The Norwegian Institute for Water Research), Evaluation of the Environmental Risks of Synthetic Turf, 2005, as cited by KEM, Swedish Chemicals Agency, Facts: Synthetic Turf, April 2007.
[68] T. Kallqvist, Norwegian Institute for Water Research (NIVA), Environmental Risk Assessment of Artificial Turf Systems, December 2005, p. 18.
[69] Byggforsk, SINTEF Building and Infrastructure, Potential Health and Environmental Effects Associated with Synthetic Turn Systems, 2004, as referenced in KEM, Swedish Chemicals Agency, Facts: Synthetic Turf, April 2007.

A Case Study conducted by a group of "physicians and public health professionals working with the U.S. Environmental Protection Agency's Region Pediatric Environmental Health Specialty Unit" found that they could not secure the research and information necessary to establish the safety in use with children of tire crumb used as playground surface.[71] "The use of recycled tire crumb products on playgrounds has had little health investigation. The major unresolved concern is the potential for latex allergy with short-term dermal exposure." [72] "No published information is available specifically regarding exposure to crumb rubber constituents from use of the product on playgrounds." [73]

Analyses conducted at the Environmental and Occupational Health Sciences Institute of Rutgers University found the crumb rubber from artificial turf to contain high levels of PAHs, as well as zinc and arsenic.[74] PAHs found to be contained in the crumb rubber "were above the concentration levels that the New York State Department of Environmental Conservation (DEC) considers sufficiently hazardous to public health to require their removal from contaminated soil sites. It is highly likely that all six PAHs are carcinogenic to humans." [75] "The analyses also revealed levels of zinc in both samples that exceed the DEC's tolerable levels." [76] The researchers associated with these findings were careful to state "We want to emphasize that the findings are preliminary. PAHs in rubber might not act the same way as in soil, and we do not yet have information on the ease with which the PAHs in these rubber particles might be absorbed by children or adults -- by ingestion, inhalation, or absorption through the skin. However, the findings are worrisome. Until more is known, it wouldn't be prudent to install the synthetic turf in any more parks." [77]

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[70] M. Ray Tucker, Agronomist, Ground Rubber: Potential Toxicity to Plants, Media Notes for North Carolina Growers, North Carolina Dept of Agriculture & Consumer Services, April 1997.

[71] M.E. Anderson et al, A Case Study of tire Crumb Use on Playgrounds: Risk Analysis and Communication When Major Clinical Knowledge Gaps Exist, Environmental Health Perspectives, Vol 114, No. 1, January 2006.

[72] M.E. Anderson et al, A Case Study of tire Crumb Use on Playgrounds: Risk Analysis and Communication When Major Clinical Knowledge Gaps Exist, Environmental Health Perspectives, Vol 114, No. 1, January 2006.

[73] M.E. Anderson et al, A Case Study of tire Crumb Use on Playgrounds: Risk Analysis and Communication When Major Clinical Knowledge Gaps Exist, Environmental Health Perspectives, Vol 114, No. 1, January 2006.

[74] Junfeng Zhang, professor and acting chair, Department of Environmental and Occupational Health, the School of Public Health, the University of Medicine and Dentistry of New Jersey and Rutgers University & William Crain, professor of psychology at The City College of New York, president of Citizens for a Green Riverside Park, Hazardous Chemicals in Synthetic Turf, 2006, analyses conducted at at the Environmental and Occupational Health Sciences Institute of Rutgers.

[75] Junfeng Zhang, professor and acting chair, Department of Environmental and Occupational Health, the School of Public Health, the University of Medicine and Dentistry of New Jersey and Rutgers University & William Crain, professor of psychology at The City College of New York, president of Citizens for a Green Riverside Park, Hazardous Chemicals in Synthetic Turf, 2006, analyses conducted at at the Environmental and Occupational Health Sciences Institute of Rutgers.

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One Norwegian assessment/presentation reported that "recycled rubber was the major source of potentially hazardous substances. An exposure scenario where the runoff from a football field is drained to a small creek showed a positive risk of toxic effects on biota in the water phase and in the sediment. The risk was mainly attributed to zinc, but also for octylphenol the predicted environmental concentrations exceeded the no environmental effect concentration."[78] The hazardous leaching could result in local environmental effect.[79]

Conclusion

In conclusion, the precautionary principle would dictate that you take no additional action to expand artificial turf in Radnor Township – it is a threat to the health and safety of the children and their environment. Until the science is well settled, to take steps to increase artificial turf, thereby forcing children who want to participate in sports to be forced to expose themselves to its potential hazards, is a violation of your obligation to make decisions that ensure the present and future safety and health of the kids of Radnor.

Respectfully,

Maya K. van Rossum
the Delaware Riverkeeper and Radnor Township Parent

[78] Dr. Christine Bjorge, Norwegian Institute of Public Health, Artificial turf Pitches – an assessment of the health risks for football players and the environment, Presentation at the ISSS Technical meeting 2006, Dresden.
[79] Dr. Christine Bjorge, Norwegian Institute of Public Health, Artificial turf Pitches – an assessment of the health risks for football players and the environment, Presentation at the ISSS Technical meeting 2006, Dresden.