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March 23, 2015

Stephanie Bacon, Health Agent  
Office of Board of Health  
155 Village Street  
Medway, MA 02053

Dear Ms. Bacon:

Thank you for your letter of February 24, 2015, in which you requested that the Massachusetts Department of Public Health, Bureau of Environmental Health (MDPH/BEH), evaluate health concerns related to the use of crumb rubber infill material for artificial turf fields in Medway, Massachusetts. As you are likely aware, our office had previously evaluated this issue in a series of letters to the Town of Needham Board of Health in 2008, 2011, and 2013.

In response, MDPH/BEH staff have evaluated more recent information on potential exposure opportunities to artificial turf components, including crumb rubber infill, and evaluated health concerns, including cancer, in relation to exposure to such turf. Recent media reports on soccer players, particularly goalies that have played on artificial turf, and the incidence of some cancers have been expressed. These reports raised concerns about the possible association between playing on crumb rubber fields and the development of cancers, notably, non-Hodgkin's lymphoma, Hodgkin Lymphoma, and osteosarcoma. We also evaluated information you provided on the content of the specific products used in Medway. Our review is summarized below.

#### Updated Literature Review

Our previous evaluations noted that crumb rubber infill has been found to contain chemicals, including polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), and metals. We further stated that although these chemicals are in the material itself, information available at that time did not suggest significant exposure opportunities to the chemicals in the materials such that we would expect health effects. We noted that the most relevant study on this topic at the time was a study conducted by the California Office of Environmental Health Hazard Assessment (CA OEHHA).

Since that time, the CA OEHHA conducted additional evaluations of chemical concentrations in air above crumb rubber turf fields under active use (CA OEHHA 2010). Air samples were taken above fields and analyzed for VOCs and metals. Results suggested that adverse health effects were unlikely to occur from inhalation of VOCs or metals in particulates above these fields. To assess the potential for skin infections due to bacteria or to skin abrasions on these fields, tests for bacterial contamination were performed and the frequency of skin abrasions was assessed. Researchers found fewer bacteria detected on the artificial turf compared to natural turf, suggesting that the risk of infection to athletes using these fields was actually lower. However, more skin abrasions were observed in athletes using artificial turf fields than natural turf fields, and the study authors made various recommendations to help prevent skin abrasions (e.g., protective equipment or clothing) and prompt treatment of skin abrasions.

In another study, the state of Connecticut conducted air sampling at four outdoor artificial turf fields with crumb rubber infills (most relevant to Medway) under summer conditions (Simcox et al. 2011). Air measurements were taken using stationary air sampling monitoring devices as well as personal samplers (placed on people using the fields). They concluded that exposure opportunities to turf contaminants were not associated with elevated health risks and suggested that their findings were consistent with other studies available at the time. A letter prepared by the Connecticut Department of Public Health reiterates these conclusions (CTDPH 2015).

A 2014 study by researchers at the Rutgers Robert Wood Johnson Medical School in New Jersey evaluated opportunities for exposures to PAHs, semivolatile organic compounds (SVOCs), and heavy metals from exposures to artificial turf fibers and crumb rubber infills by measuring these constituents in simulated body fluids (digestive fluids, lung fluids, sweat) that represented different routes of exposure (ingestion, inhalation, dermal). This bioaccessibility study aimed to provide a better measure of the actual amount of these contaminants that might be absorbed into the body after exposure. The researchers found that PAHs were routinely below the limit of detection and SVOCs that have environmental regulatory limits to use for comparison were identified at levels too low to quantify. Some metals were detected but at concentrations at which health risks were low, with the exception of lead from the field sample collected. That sample indicated lead at levels in the simulated digestive fluids that the authors reported could result in blood lead levels above the current U.S. Centers for Disease Control and Prevention (CDC) reference value for blood lead in children (5 ug/dL). It should be noted that the lead concentration of the materials used in this study included a sample of turf fiber with a lead concentration of 4,400 mg/kg. This level contrasts with information on the Medway artificial turf components, which reportedly either contained lead at 39 mg/kg (crumb rubber infill) or had no lead (turf fibers) (see discussion later in this letter). Based on the lead result from this one field sample, the authors suggested that components of artificial turf fields should be certified for low or no lead content prior to use. Overall, however, the authors concluded that opportunities

for exposure to constituents in these fluids presented very low risk among all populations that would use artificial turf fields (Pavilonis et al. 2014).

A study conducted in 2010 in the Netherlands assessed the exposure of soccer players to PAHs after playing sports on a rubber crumb field. Urine testing in participants indicated that uptake of PAHs by the participants following exposure to artificial turf with rubber crumb infill was minimal. If there is any exposure, the authors reported, uptake is minimal and within the normal range of uptake of PAHs from environmental sources and/or diet observed in healthy individuals (van Rooij and Jongeneelen 2010).

It is probably worthwhile to also note that MDPH/BEH reviewed testing data for artificial turf for the Town of Needham, as reported in our letters of 2011 and 2013 to the Needham Board of Health. The Town of Needham contracted with an environmental testing firm to conduct environmental tests including, air measurements of volatile organic compounds taken in the laboratory and heavy metals (arsenic, cadmium, chromium, lead, mercury, selenium, zinc) content of crumb rubber materials. Our review and conclusions for that testing, did not indicate exposures of health concern.

#### Material in Medway

MDPH/BEH reviewed available information provided by the Medway Board of Health regarding the specific materials used in the Medway fields. These included the APT Gridiron turf system and Liberty Tire Recycling 10+20 BM Rubber Crumb Brantford, ON. Among the materials provided for these products were statements or test results for various constituents in these products.

APT submitted a written statement dated October 29, 2014, that reported that the APT Gridiron turf systems (essentially the grass fibers of the artificial turf) are manufactured and installed without the use of any lead or heavy metals. They reported that this included all materials used for the turf fibers and backings. No other documentation about this product, including any testing results, was provided to support this statement.

With respect to the 10+20 BM Crumb Rubber infill product, laboratory testing results were provided for this product, although it is not clear whether the testing was for the materials specifically used in turf applied in Medway. Testing was conducted for metals content as well as emissions of volatile organic compounds (VOCs). It appears that testing included the following: (1) testing for VOCs emitted into a confined air space in the laboratory after heating the product to 73 degrees F; and (2) content testing for eight heavy metals, including lead. The laboratory compared results to criteria established by the Greenguard certification program, part of Underwriters Laboratory, that uses among its criteria for certification health-based levels derived by the CA OEHHA.

Testing results for metals content of the product indicated a lead concentration of 39 mg/kg, which is less than the current Consumer Product Safety Improvement Act (CPSIA) limit of 100 mg/kg for lead in children's products (Ulirsch et al. 2010). No other metals were detected.

Test results measuring emissions off-gassing from heated material were provided in measurements that cannot be compared to any health-based standards or guidelines and thus, MDPH/BEH did not further evaluate this information. Typically, when certain products raise health concerns, health agencies review Material Safety Data Sheets (MSDS). An MSDS provides information on health risks associated with use of the product. An industry group, Synthetic Turf Council, provides a sample template MSDS for crumb rubber infill material (Synthetic Turf Council 2014). Although this sample MSDS is not specific to any particular product, it appears to be applicable to crumb rubber infill in general. In the section under "Hazardous Ingredients," the MSDS notes that the product can contain fine fibers that may cause irritation symptoms (e.g., itching, irritation of mucous membranes, eye irritation). The MSDS notes that the crumb rubber material is generally thought to be a nuisance dust.

### Concerns About Cancer Among Soccer Players

As noted earlier in this letter, some recent news reports suggested that the incidence of cancers among soccer players, particularly goaltenders exposed to artificial turf, might be atypical. These reports included many cancer types, but some focused specifically on NHL, Hodgkin Lymphoma, and osteosarcoma in three individuals. We thought it would be helpful to provide additional information on cancers in general and known risk factors for NHL, Hodgkin Lymphoma, and osteosarcoma.

### Cancer in General

Understanding that cancer is not one disease, but a group of diseases, is very important. Research has shown that there are more than 100 different types of cancer, each with separate causes, risk factors, characteristics and patterns of survival. A risk factor is anything that increases a person's chance of developing cancer and can include hereditary conditions, medical conditions or treatments, infections, lifestyle factors, or environmental exposures. Although risk factors can influence the development of cancer, most do not directly cause cancer. An individual's risk for developing cancer may change over time due to many factors and it is likely that multiple risk factors influence the development of most cancers. In addition, an individual's risk may depend on a complex interaction between their genetic make-up and exposure to environmental agents, including infectious agents and/or chemicals. This may explain why some individuals have a fairly low risk of developing a particular type of cancer as a result of an environmental exposure, while others are more vulnerable.

Cancers in general have long latency or development periods that can range from 10 to 30 years in adults, particularly for solid tumors. In some cases, the latency period may be more than 40 to 50 years. It is important to note, however, that latency periods for children and adolescents are significantly shorter than for adults.

## Hodgkin Lymphoma

Hodgkin Lymphoma is most common in young adults between the ages of 15 and 40, especially in individuals in their 20s. Among adolescents, it is the most common type of cancer.

Hodgkin Lymphoma occurs specifically in a type of B lymphocyte (or white blood cell) called the Reed-Sternberg cell while other lymphomas (non-Hodgkin's types) occur in different cells.

Established risk factors for Hodgkin Lymphoma include: exposure to the Epstein-Barr virus (EBV); a previous diagnosis of mononucleosis (mono is caused by the EBV); family history; and certain hereditary conditions (such as ataxia telangiectasia) associated with a weakened immune system. The Epstein-Barr virus is very prevalent in the general population. Even though most of us have been exposed to the virus (which remains latent in our bodies), most people do not develop mononucleosis or Hodgkin Lymphoma. EBV is thought to account for about 20% or 25% of the diagnoses of classical Hodgkin's in the US.

Higher socioeconomic status is also a possible risk factor. This is thought to be due to delayed infectious exposures in childhood.

Occupational exposures as risk factors have been studied extensively and none have emerged as established risk factors. Likewise, there is very little evidence linking the risk of Hodgkin Lymphoma to an environmental exposure, other than the EBV.

## Non-Hodgkin Lymphoma (NHL)

NHL refers to a diverse group of cancers that are characterized by an increase in malignant cells of the immune system. Each subtype of NHL may have different risk factors associated with its development. The specific cause of NHL in most individuals is unknown.

Although some types of NHL are among the more common childhood cancers, more than 95% of diagnoses occur in adults. Incidence generally increases with age, and most diagnoses occur in people in their 60s or older.

Established risk factors for NHL include a weakened immune system, associated with various medical conditions, and exposure to various viruses. An increased risk is faced by individuals taking immunosuppressant drugs following organ transplants; individuals with autoimmune disorders, such as rheumatoid arthritis and lupus; and individuals who have taken certain chemotherapy drugs for other cancers. Several viruses have been shown to play a role in the development of NHL, including the human immunodeficiency virus (HIV), the human T-cell leukemia/lymphoma virus (HTLV-1), and the Epstein-Barr virus.

Exposure to high-dose radiation (for example, by survivors of atomic bombs and nuclear reactor accidents and possibly by patients who have received radiation therapy for a previous cancer) may pose an increased risk. Some studies have also suggested that exposure to chemicals such as benzene and certain herbicides and insecticides may be linked with an increased risk of NHL. Smoking has been associated in some studies with certain types of NHL.

### Osteosarcoma

Osteosarcoma is a type of malignant bone cancer which accounts for about 2% of childhood cancers in the United States. It is the most common type of cancer that develops in bone and comprises about 66% of malignant bone tumors in children in Massachusetts. Most osteosarcomas occur in children and young adults between the ages of 10 and 30. Teenagers comprise the most commonly affected age group and are at the highest risk during their growth spurt. However, osteosarcoma can occur in people of any age, with about 10% of all osteosarcomas occurring in people over the age of 60.

Established risk factors for osteosarcoma include certain inherited syndromes (such as retinoblastoma, the Li-Fraumeni syndrome, and others) and certain bone diseases (such as Paget disease of the bone and hereditary multiple osteochondromas). Individuals with these syndromes and bone diseases have an increased risk of developing osteosarcoma. People who have received radiation treatment for a previous cancer may have a higher risk of later developing osteosarcoma in the area that was treated. Being treated at a younger age and with higher doses of radiation both increase the risk. Because the risk of osteosarcoma is highest between the ages of 10 and 30, especially during the teenage growth spurt, experts believe that there may be a link between rapid bone growth and the risk of a bone tumor. Children with osteosarcoma are often tall for their age, which supports the link with rapid bone growth. Other than radiation, there are no known lifestyle or environmental risk factors associated with osteosarcoma. Besides from these risk factors, the causes of most osteosarcomas are unknown.

### Summary

In summary, the scientific literature continues to suggest that exposure opportunities to artificial turf fields are not generally expected to result in health effects. Testing results on the crumb rubber infill indicated lead content less than CPSIA statutory limits established for children's products. For the turf fibers, APT provided a statement that this material did not have lead used in its manufacture, but no additional documentation was provided.

With respect to cancer concerns reported in media stories, it is important to note that the reports of cancers were of a wide variety of different types, each with its own set of risk factors. In addition, our staff reviewed cancer incidence data for the Town of Medway. The Massachusetts Cancer Registry (MCR) is a population-based surveillance

system that began collecting information in 1982 on Massachusetts residents diagnosed with cancer in the state. All newly diagnosed cancer cases among Massachusetts residents are required by law to be reported to the MCR within six months of the date of diagnosis (MGL, c.111, s.111B). This information is kept in a confidential database and reviewed for accuracy and completeness.

Available information on the occurrence of cancers in children living in Medway indicates no diagnoses of Hodgkin Lymphoma, NHL, or osteosarcoma have been reported to the MCR in a search of their files from 2006 to the present. Although it is possible that a very recent diagnosis may not yet have been reported to the MCR, the fact that there are no reports of such cancers is reassuring.

Although available resources cannot support MDPH conducting environmental testing of this material, we would be happy to assist the Town of Medway in developing a sampling and analysis plan as well as provide technical support in interpreting results, similar to the assistance that we provided to the Town of Needham.

As we stated in our letters to Needham officials, while available information does not indicate exposure opportunities of health concern, MDPH/BEH continues to recommend common sense ways to minimize any potential exposure to chemicals that may be contained in synthetic turf fields made of crumb rubber. MDPH/BEH suggests washing hands after playing on the field and before eating, particularly for younger children with frequent hand-to-mouth activity, and taking off shoes before entering the house to prevent tracking in any crumb rubber particles. Also, there are studies that indicate heat levels on artificial turf fields may rise as outdoor temperatures increase (New York State 2009). Thus, for protection of the players, MDPH/BEH recommends increasing hydration, taking frequent breaks, and watering down the field to cool it on hot days to prevent the potential for burns or heat stress. Finally, based on recent work in California, MDPH/BEH recommends that steps be taken to minimize the potential for skin abrasions (e.g., protective equipment) and that skin abrasions be treated promptly to prevent potential infections.

We hope this information is helpful to you and Medway residents. If you have any questions, please feel free to contact us at 617-624-5757.

Sincerely,

A handwritten signature in black ink, appearing to read "Suzanne K. Condon". The signature is fluid and cursive, with a long horizontal stroke extending to the right.

Suzanne K. Condon, Associate Commissioner  
Director, Bureau of Environmental Health

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