ACTIVITAS
landscape architecture | civil engineering

HALEY ALDRICH

delivered via email
tgohlmann@bbns.org

05 April 2021

Dr. Tara S. Gohlmann
Chief Operating / Chief Financial Officer
Buckingham Browne & Nichols School
80 Gerry's Landing
Cambridge, MA 02138

Re: Field Surface Information in Regards to New Athletic Complex

Dear Dr. Gohlmann:

Activitas is an independent landscape architecture and civil engineering firm that provides outdoor athletic facility consulting services for municipal, collegiate and professional sports clients throughout the United States. We are strictly a "client side" design firm representing only the interests of our clients. We do not sell, construct or otherwise profit from the installation of synthetic turf, or other playing field systems, or any associated products and equipment. We have worked with BB&N on several projects on your campuses over the last 15 years including the original installation of Franke Field and are thrilled to continue our work with you on the New Athletic Complex in Watertown.

As your Athletic Field Consultant it is important to us that the BB&N Community are comfortable with the proposed athletic surface from a variety of perspectives that include playability, heat concerns, and human and environmental health and safety in regards to heavy metals, PAHs and PFAS/PFOS. As such we have partnered with Haley & Aldrich, an environmental and geotechnical consultant firm headquartered in Burlington, MA with multiple offices around the country, to provide technical and scientific review of available literature related to synthetic turf and its materials. Mr. Jay Peters is H&A's Risk Assessment Practice Leader with over 28 years of risk assessment expertise. Activitas and H&A have partnered many times on synthetic turf projects for public and private clients. In our collective experience, we find there is a lot of information available to the public and it is important to sort out conjecture versus information based in science. The following is a summary of synthetic turf considerations supporting why synthetic turf is an appropriate and safe choice for BB&N's New Athletic Complex.

Surface Playability

It is important to distinguish between a field meant for passive and recreational play and a field meant for high-use athletic play. The fields being proposed at BB&N's New Athletic Complex are being designed for high-use athletic play. It is anticipated that typical use of the field will be from early March through early December (approximately 40 weeks per year over three

seasons, or 13 weeks per season) and that usable hours are from 7am to 10pm with the inclusion of athletic lighting. Most likely, field use will occur from 2pm-9pm during the week and 8am-9pm on weekends. This results in approximately 793 hours of use per season of play.

Members of the Sports Turf Managers Association, the leading organization of turf-grass professionals, from Brigham Young University established a Field Wear Index that provides guidance about how much wear a field can withstand and remain in good condition in comparison to type of play and level of field maintenance. Based on the type of activity at the field, there is an Activity Wear Index (AWI) multiplier that is used. For the anticipated multi-purpose use at the site, an AWI multiplier of 2.5 is used.

Hours per Season	Multiplier	Activity Wear Index Value
793 hours/season	2.5	1,983

For natural grass surfaces, even with the highest level of maintenance (Level 5 – Heavy Maintenance, which includes completing hollow core aeration once a month; two or more deep tine aerations a year, or one deep tine aeration and one deep hollow tine aeration a year; two or more top-dressings a year; two or more over-seedings a year; and potentially repairs by sodding high use areas), recommended use per season is 401-450 AWIV, which comes out to 160-180 hours/per season. The calculated AWIV of 1,983 exceeds this amount by 440%. This means that as a natural grass surface the proposed field surface characteristics would drastically deteriorate, creating unsafe playing surfaces despite heavy maintenance. In addition, grass fields in the northeast are typically limited in usability to a mid-April to mid-November timeline and require time off following storm events to allow the field conditions to dry to alleviate field wear issues. Synthetic turf can be played upon during and directly after storm events without detrimental effects to the surface. As such it has been determined that in order to truly support both BB&N's athletic programs and to allow the proposed town-use as negotiated in the *Memorandum of Understanding By and Between the Town of Watertown and Buckingham Browne and Nichols School*, a synthetic turf surface is the appropriate field surface choice for this Athletic Complex.

The project proposes to use the same style synthetic turf product that is installed at Franke Field with the addition of a resilient underlayment (pad). The system will utilize a 2"-2.25" high polyethylene/propylene fiber carpet that is infilled with a mixture of sand and encapsulated rubber particles. This carpet and infill will be installed over a resilient underlayment, which is a prefabricated pad providing additional resiliency to the surface which helps minimize impact associated injuries on a field (e.g. concussions, shin splints, body fatigue, etc.). Similar systems have been installed locally at Harvard Stadium, Boston College's Alumni Field, Colby College, and Dexter Southfield School, among many others. Other recent projects that use traditional rubber, rather than encapsulated rubber, include Amherst College, Dartmouth College, Harvard

University, the Massachusetts Institute of Technology and UMass Amherst. Similar systems using traditional rubber also include recently installed fields in the Towns of Carver, Dedham, Lexington, Scituate, Weston and Weymouth; and the Cities of Lynn, Malden and Marlborough to name a few.

Heat Concerns

Synthetic turf fields based on their materials can at times be warmer than their natural grass counterparts. In the New England area, these discrepancies in temperatures do not typically occur until the summer months and even at that time are typically limited to peak sun hours on humid days. Cloud cover, humidity, and wind play a major part in temperature discrepancies. To the best of our knowledge, the majority of municipalities and private institutions around New England do not have a policy around closing athletic fields and it is typically dependent on the user and is a rare occurrence in New England. This applies to both natural and synthetic turf athletic fields.

Heavy Metals & PAHs

Health concerns related to crumb rubber were reignited in 2014 at the University of Washington as a result of a national news story, which first appeared on NBC and was later picked up by other outlets. The Women's Associate Head Soccer Coach became concerned that there was a link between crumb rubber and soccer players (specifically goalkeepers) that she had identified as having developed a variety of cancers within the recent past. To date, approximately 100 scientific, peer-reviewed, published studies have been performed worldwide on the potential health risk of using crumb rubber in general; with some specifically applied to its use in synthetic turf. As a result of these studies the following state, national and international agencies, governing bodies, and academic institutions have concluded that the use of crumb rubber in athletic fields does not pose a significant human health risk, including (among others) the following:

- Dutch National Institute for Public Health and Environment
- Norwegian Institute of Public Health
- EU - European Chemical Agency (ECHA)
- Connecticut Department of Public Health
- New York City Department of Health
- New York State Department of Health
- The Washington State Department of Health and researchers from the University of Washington School of Public Health

It is notable that the Washington State Department of Health, responding to the issues raised at the University of Washington, conducted a study and "concluded the number of cancer cases

among soccer players is *less than expected* based on rates of cancer among Washington residents of the same ages".

Though there is considerable Internet speculation regarding the safety of crumb rubber in synthetic turf, we are not aware of any peer-reviewed scientific study, which demonstrates a link to cancer, or even an elevated health risk. The available peer reviewed studies have found that chemicals of potential concern (COPCs) within the crumb rubber particle are chemically bound to the particle and are not bio-available through dermal contact, ingestion, or inhalation – essentially there is no way for COPCs within crumb rubber to affect a field user.

From an environmental side and in addition to peer-reviewed scientific studies, crumb rubber has been reviewed by the MA Department of Environmental Protection (MADEP) at the highest level through an adjudicatory hearing in regards to a specific project that was within Riverfront Area (Fenn School, Docket No. WET-2010-010, DEP File No. 137-1032). MADEP determined that the synthetic turf field (and all components) would "not have a significant adverse impact on the ability of the Riverfront Area to protect the interests of the MA Wetland Protection Act."

It should be pointed out that the encapsulated rubber product proposed for use on this project is providing another coating of material to further bind the rubber granule, thereby adding another layer of material preventing bio-availability of COPCs within crumb rubber.

PFAS Information

Per- and polyfluoroalkyl substances, otherwise known as PFAS, are a large family of chemicals used in a variety of manufacturing industries including carpet and clothing as it provides durable waterproof coatings. You may also see the terms PFOA and PFOS discussed, which are subsets within the PFAS family. PFAS linked to synthetic turf were raised in articles in the Boston Globe and The Intercept in 2019. Attached to this letter is a memorandum from Dr. Stephen Clough, a well-respected Senior Environmental Toxicologist, now retired, but formerly of Haley & Aldrich (colleague of Mr. Peters), and previously referenced in the Fenn School MADEP adjudicatory hearing re: heavy metals and PAHs. Dr. Clough reviewed the information provided in the articles that referenced PFAS in synthetic turf in Franklin, MA and Easton, MA. Dr. Clough's review of the information provided, as well as his knowledge and research on PFAS in general, leads him to the following points made in his memorandum:

- *"Based on research studies and what is known about the chemical composition of PFAS, dermal (skin) exposure to PFAS containing materials is not significant and thus poses a negligible human health risk. Similarly, based on the high water solubility of PFAS and low volatility, these compounds pose a negligible health risk via the inhalation exposure pathway."*

ACTIVITAS
HALEY ALDRICH

- Directly related to the articles mentioned above: *"The concentrations of PFOS in soil cited by ITRC's recent "Fact Sheets" (Table 4-2) that are protective of both human health and underlying groundwater are also much greater than the value of 0.19 ug/kg cited by the recent articles. Based on these comparisons, human health risk is negligible."*
- Directly related to the articles mentioned above: *"Based on the above information, which addresses analytical uncertainties, concentrations relative to clean background locations, potential exposure, and subsequent human health risk, one may conclude that the discovery and reporting of ultra-trace levels of PFAS in used synthetic turf appears to be overstated if not misleading."*

We encourage the BB&N Community to thoroughly read Dr. Clough's memorandum as well as review the additional information he cites in his memorandum.

Closing

Given that synthetic turf is a topic of interest in many areas around the country, literature (both peer-reviewed and non-peer-reviewed) continues to be developed. Activitas and H&A continue to review this literature as it becomes available to identify any contemporary information that may be relevant to synthetic turf projects.

At this time, no literature that we have reviewed causes us to be uncomfortable with the use of synthetic turf and we are hopeful that the BB&N Community reaches the same conclusion. The use of synthetic turf is not only safe, but among other benefits, it accommodates the intense level of field use that makes the proposed Athletic Complex use feasible.

We look forward to answering any questions you may have on the use of synthetic turf at the New Athletic Complex.

Respectfully:

ACTIVITAS

Meg Buczynski, PE, LEED AP
Principal Civil Engineer

HALEY & ALDRICH

Jay Peters, M.S. Environmental Engineering
B.S. Toxicology
Senior Risk Assessor

Attachment A: Sampling of Scientific Literature Review
Attachment B: Memorandum from Dr. Stephen Clough dated October 25, 2019

Attachment A

Review of Scientific Literature

Below is a partial list of the scientific literature that have found that artificial turf fields do not cause an adverse health risk in humans and are safe for use:

- "…it appears that the health risks for players who use artificial turf are not significant and that it is completely safe to engage in sports activities on this type of outdoor field." Beausoleil, et al (2009). https://doczz.net/doc/6464908/chemicals-in-outdoor-artificial-turf--a-health-risk-for-u...
- 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. Hazard to children appears to be minimal. We conclude that the use of tire crumb in playgrounds results in minimal hazard to children and the receiving environment." Birkholz, et al (2003). https://pubmed.ncbi.nlm.nih.gov/12880077/
- "PM2.5 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." "The large majority of air samples collected from above artificial turf had VOC concentrations that were below the limit of detection. "Fewer bacteria were detected on artificial turf compared to natural turf." California Office of Environmental Health Hazard Assessment, (2010). https://cdn.ymaws.com/sites/syntheticturfcouncil.site-ym.com/resource/resmgr/docs/ca_oehha_safety_study-vocs_a.pdf
- "Health risk assessment studies suggested that users of artificial turf fields, even professional athletes, were not exposed to elevated risks. Preliminary life cycle assessment suggested that the environmental impacts of artificial turf fields were lower than equivalent grass fields." Cheng, et al. (2014). https://cdn.ymaws.com/www.syntheticturfcouncil.org/resource/resmgr/Docs/Cheng_H._,_Environmental_Hea.pdf
- "In spite of the conservative nature of the assessment, cancer risks were only slightly above de minimis levels for all scenarios evaluated including children playing at the indoor facility, the scenario with the highest exposure. The calculated risks are well within typical risk levels in the community from ambient pollution sources and are below target risks associated with many air toxics regulatory programs. Chronic non-cancer risks were not elevated above a Hazard Index of 1." "Cancer risks are slightly above de minimis in all scenarios." Connecticut Department of Public Health (CDPH), (2010). https://portal.ct.gov/-/media/DEEP/artificialturf/DPHArtificialTurfReportpdf.pdf
- "Based on the information reviewed none of the risk assessments showed concentrations of contaminants that would be at a level of concern, even under conservative assumptions and thus it does not appear that the ingestion of tire crumb would pose a significant health risk for children or adults." Denly, et al. (2008). https://www1.nyc.gov/assets/doh/downloads/pdf/eode/turf_report_05-08.pdf

- "Cancer and noncancer risk levels were at or below de minimis levels of concern. The scenario with the highest exposure was children playing on the indoor field. Based upon these findings, outdoor and indoor synthetic turf fields are not associated with elevated adverse health risks." Ginsberg, et al. (2011). https://pubmed.ncbi.nlm.nih.gov/21797769/

- "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 an artificial turf pitch with rubber infill from used car tyres." Hofstra, U. (2007a). https://cdn.ymaws.com/sites/syntheticturfcouncil.site-ym.com/resource/resmgr/Docs/Environmental_-_risks_of_rub.pdf

- "On the basis of estimated exposure values and the doses/concentrations which can cause harmful effects in humans or in animal experiments, it is concluded that the use of artificial turf halls does not cause any elevated health risk. This applies to children, older children, juniors and adults. The estimated Margins of Safety (MOS) also give no cause for concern." Norwegian Institute of Public Health and the Radium Hospital. (2006). https://www.playguardsurfacing.com/Sustainability

- "...crumb rubber may be used as an infill without significant impact on groundwater quality...Analysis of crumb rubber samples digested in acid revealed that the lead concentration in the crumb rubber samples were well below the federal hazard standard for lead in soil...A risk assessment for aquatic life protection...found that for the three types of crumb rubber, aquatic toxicity was found to be unlikely...A public health evaluation was conducted on the results from the ambient air sampling and concluded that the measured levels of chemicals in air at the Thomas Jefferson and John Mullaly Fields do not raise a concern for non-cancer or cancer health effects for people who use or visit the fields...the findings do not indicate that these fields are a significant source of exposure to respirable particulate matter" New York Department of Environmental Conservation (NYDEC). (2009). https://www.dec.ny.gov/docs/materials_minerals_pdf/crumbrubfr.pdf

- "… these findings support the premise that while many chemicals are present in the recycled tire crumb rubber, exposure may be limited based on what is released into air or biological fluids." - EPA's Final Report Part 1 – Tire Crumb Rubber Characterization Volume 1, dated July 25, 2019. https://www.epa.gov/sites/production/files/2019-08/documents/tc_public_webinar_-_august_6_2019.pdf

TO: Patrick Maguire; Synthetic Turf Stakeholders

FROM: Stephen R. Clough, Ph.D., DABT
Senior Environmental Toxicologist

DATE: 25 October 2019

SUBJECT: Low Levels of PFAS Detected in Samples of Discarded Turf

---

Recent news articles from both the **Boston Globe** (Toxic chemicals are found in blades of artificial turf) and **The Intercept** (Toxic PFAS chemicals found in artificial turf) have reported analytical laboratory results of synthetic turf sampled for the presence of perfluorinated alkyl substances (PFAS). This information, however, is of a preliminary nature as the results having not been peer-reviewed nor have the concentrations been put into context (e.g. compared to ambient levels reported for soils in unimpacted locations).

In lieu of this information, suppliers of synthetic turf have been contacted to determine if PFAS are utilized in the manufacture of their products (PFAS is not present in recycled tires and therefore crumb rubber). Vendors and manufacturers of turf products have, in the past, stipulated that all of their products meet California Prop 65 and European REACH standards of safety. Moving forward, Activitas Inc. wants to ensure that all products used in the construction of their synthetic turf fields meet the highest levels of quality assurance and safety, which includes minimizing exposure and subsequent risk to any potentially toxic chemicals of concern.

Background. PFAS are a family of highly fluorinated alkyl compounds used in a host of commercial and consumer products to provide durable waterproof coatings. Because of the nonspecific methods used to generate thousands of different types of PFAS, little has been done in terms of understanding their fate and transport. The scientific community is therefore evolving its understanding of PFAS in the environment. PFAS are considered to be contaminants of emerging concern (CECs). CECs are chemicals that have the potential to affect human health or present an environmental risk, and either: (1) do not have regulatory cleanup or health-based standards and/or (2) regulatory standards are evolving due to new science, detection capabilities or exposure pathways. PFAS are "ubiquitous" in the environment because a) they have been used in hundreds of different consumer products (e.g. carpet, waxes, lubricants, nonstick coatings, firefighting foams, leather, etc.) for over 60 years and b) they do not degrade and tend to concentrate in wildlife. Additionally, the carbon-fluorine bond affords detection of most PFAS at infinitesimally low levels, thus allowing observation in all media: air, soil, sediment, groundwater, surface water, animals and humans. Because the amount of peer-reviewed information available on PFAS is voluminous, it is recommended the reader peruse "fact sheets" available in States that are affected by environmental releases (e.g. ITRC PFAS Fact Sheets).

Toxicity research is also evolving, and several large epidemiological studies have "linked" exposure to adverse health effects in humans following long-term drinking water exposure to PFOA and PFOS compounds. The primary exposure route that the USEPA and State regulatory agencies have identified is through consumption of PFAS in contaminated drinking water. Based on research studies and what is known about the chemical composition of PFAS, dermal (skin) exposure to PFAS containing materials is not significant and thus poses a negligible human health risk. Similarly, due to the high water solubility of PFAS and low volatility, these compounds pose a negligible health risk via the inhalation exposure pathway.

Review of Methods. While the preliminary results following the sampling and analysis of discarded turf appears to indicate that PFAS may be present in both the backing and the blades of synthetic turf, a more careful evaluation of the information from the newspaper articles has identified the following issues that may bias an uninformed reader:

- It is well documented at both the State and Federal level that cross-contamination during sampling is a very important issue and, given the ubiquity of PFAS, is a common problem in the field. Technicians need to go through meticulous training to avoid contaminating the sample with materials containing PFAS or fluorine (including gloves, clothing, sampling items, containers, notebooks, makeup, perfumes, etc.). The articles do not mention what precautions were taken in the field, and the results would be suspect if Massachusetts Department of Environmental Protection standard operating procedures were not followed.

- There is no certified method for analyzing PFAS concentrations in materials other than a US EPA method for analyzing PFAS in drinking water. Since the samples were synthetic turf and not drinking water, the methods used for analysis were likely not certified and therefore, the results are questionable. Additionally, the article incorrectly compares apples to oranges, stating "…the swatch of turf from Franklin contained 190 parts per trillion of one of the most common PFAS chemicals, well above federal safety standards for drinking water." The laboratory results from a solid "swatch" would be reported as nanograms per kilogram (ng/kg), but a standard for drinking water would be nanograms per liter (ng/L). Thus the comparison of a PFAS in a bulk sample to a drinking water advisor is misleading.

- The article noted that an additional eight samples were analyzed for total fluorine and assumed that total fluorine is an indication that PFAS is present. Total fluorine, however, is a non-specific method and thus a poor proxy for PFAS. The method can be biased by the presence of many non-PFAS compounds. For example, some anionic surfactants applied to the field drain may contain fluorine. Many consumer products also contain fluorine such as toothpaste, mouthwash and household cleaners. The presence of fluorine, therefore, does not necessarily indicate PFAS compounds are present.

Evaluation of the Analytical Results and Potential Exposure/Risk. If one assumes in good faith that the results are correct, what does a concentration of 190 parts per trillion (0.19 ug/kg) of PFOS in synthetic turf mean? A review paper by Vedagiri and Loso (Remediation Journal, 2019) identified the range of PFOS levels in soil samples taken from "ambient" or "background" locations in 21 States "with no known point source" of PFAS. In other words, samples were taken from rural, uncontaminated areas that were away from urban/suburban impacts. The range of concentrations for PFOS, which was detected in every soil sample taken in North America (N=38), was 0.018 - 2.55 μg/kg (range of PFOA was 0.059 – 1.84 ug/kg). The concentrations in the eastern U.S. are much higher (>0.184 ug/kg). Thus, a concentration of 0.19 ug/kg PFOS in a swatch of used turf falls into this uncontaminated concentration range which would be considered "clean". While synthetic turf is not soil, the fields do receive atmospheric deposition of dust which is recognized as a major PFAS transport mechanism. Moving forward, concentrations in swatches would need to approach 2.5 parts per billion of PFOS (and 1.8 ug/kg PFOA) to raise a concern in terms of categorizing used turf as a potentially hazardous material.

These authors also compared these values to a residential soil Risk Screening Level of 1,260 ug/kg which applies to both PFOS and PFOA. All the background concentrations were well below the safe soil RSL "by two to three orders of magnitude". The concentrations of PFOS in soil cited by ITRC's recent "Fact Sheets" (Table 4-2) that are protective of both human health and underlying groundwater are also much greater than the value of 0.19 ug/kg cited by the recent articles. Based on these comparisons, human health risk is negligible.

Finally, it is noteworthy to mention, based on the conclusions of US EPA's recent Synthetic Turf Research Action Plan, that bioavailability of toxic chemicals (e.g. metals, polycyclic aromatic hydrocarbons) in synthetic turf is very low (≤3%). Thus reporting "total" PFAS that would be bound up in the matrix of the turf backing or plastic blades would overestimate what an athlete would actually be exposed to following contact.

Based on the above information, which addresses analytical uncertainties, concentrations relative to clean background locations, potential exposure, and subsequent human health risk, one may conclude that the discovery and reporting of ultratrace levels of PFAS in used synthetic turf appears to be overstated if not misleading.

Activitas, Inc. will continue to monitor this important issue and strive to keep all synthetic turf products free from any potentially toxic constituents of concern. We will also provide updates on this subject as additional information becomes available.