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VIA EMAIL
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RE: Synthetic Turf Laboratory Testing and Analysis Summary Report Martha's Vineyard Regional High School (MVRHS)

The Horsley Witten Group, Inc. (HW) reviewed the report titled *Synthetic Turf Laboratory Testing and Analysis Summary Report* prepared by Tetra Tech and dated February 26, 2021 (the "Tetra Tech Report"). Based on our review of the laboratory results and Tetra Tech's interpretation of the risk associated with these results, we believe the material testing was conducted appropriately and that there is little risk associated with human contact. The data indicate select semi-volatile organic compounds (SVOCs), select metals and select per and polyfluoroalkyl substances (PFAS) were, in general, detected at background levels or for comparative purposes, below risk-based soil and groundwater standards. Some of these compounds are likely to leach from the turf components into the underlying groundwater, however the leachable amounts are difficult to quantify with any certainty. HW offers the following comments on testing methods, results, and conclusions:

Testing Methodology

PFAS testing, precursor analyses, and the related regulatory standards for risk assessment are part of an evolving science. While the evaluation methods are becoming more widely practiced, the application of these procedures to the specific turf system for the MVRHS project should be regarded at this time as innovative, yet imperfect. According to the Tetra Tech Report "*[s]ince there are limited regulatory standards and standardized testing methods for an environmental evaluation of the components of synthetic turf systems, the implemented approach utilized available soil-based regulatory standards and laboratory analysis methods. However, these materials are not soils, and limitations therefore exist in this evaluation as described herein. Nevertheless, it is our opinion that the evaluation has value and provides a reasonable assessment of potential human health and environmental impacts associated with the proposed synthetic turf field system*." HW agrees with this statement and adds that groundwater risk-based standards were also utilized for the evaluation of the leachate generated by the turf system. It is understood that the leachate will not be directly consumed by individuals or discharged into a surface water body, but rather could affect the underlying groundwater quality.

The Tetra Tech reports compares the laboratory results of direct extraction of the Greenfield USA Iron Turf Ultra Green, Brock USA BrockFill, Brock USA YSR Shockpad, MAPEI Ultrabond and Reynolds 775 (collectively called the "turf components" see Table 1) to a reasonable selection of the following state and federal soil standards and background levels:

- The Massachusetts Contingency Plan (MCP) Method 1 S-1/GW-1 and S-1/GW-3 standards. These standards consider risk of dermal contact and incidental ingestion/inhalation exposures to oil and/or hazardous materials (OHM) by adults and children over a lifetime as well as the potential leaching to drinking water and surface water.
- The Environmental Protection Agency (EPA) risk-based Regional Screening Levels.
- Background levels of metals and polycyclic aromatic hydrocarbons (PAHs) in soil prepared by the Massachusetts Department of Environmental Protection (MassDEP).
- Background levels of Per and polyfluoroalkyl substances (PFAS) in Vermont shallow soil prepared by the University of Vermont and the Vermont Department of Environmental Conservation.
- The Consumer Product Safety Act, USC 1278a that regulates certain hazardous materials in consumer products.

For the purposes of this memo, the soil and background levels described above will be collectively referred to as the "comparison values". The laboratory testing was completed by Alpha Analytical of Westborough, Massachusetts and total fluorine (TF) and total organic fluorine (TOF) analysis was conducted by their subcontractor Galbraith Laboratories, Inc.

Table 1. Turf Components Tested

Component	Description
Greenfields USA Iron Turf Ultra Green (referred to as the "turf carpet")	Turf carpet that human receptors will come into direct contact with. It is reportedly comprised on polyethylene, polypropylene and polyester. Rainwater will infiltrate through this material and will ultimately discharge to the subsurface.
Brock USA BrockFill (referred to as the "BrockFill")	The infill material that is placed on top of the turf carpet. Human receptors will have direct contact with this material. It is reportedly comprised of wood particles with no coatings or plastic additives. Rainwater will infiltrate through this material and will ultimately discharge to the subsurface.
Brock USA YSR Shockpad (referred to as the "Shockpad)	Padding layer installed below the turf carpet. Once the turf carpet is installed, the Brock USA YSR Shockpad will not be assessable by direct contact with human receptors under normal usage. Rainwater will infiltrate through this material that will ultimately discharge to the subsurface.
MAPEI Ultrabond (referred to as "Ultrabond")	Reportedly fast-set, urethane adhesive used to seam and direct bond the turf carpet. According to the Tetra Tech Report, "it is unlikely human receptors would come into direct contact with this material during normal use of the field". Rainwater will infiltrate through this material that will ultimately discharge to the subsurface.
Reynolds 775 (referred to as the "pellet glue")	Pellet glue product for logos and reportedly limited information about it was available for review. According to the Tetra Tech Report, "[c]onsidering the application of this product as part of the synthetic turf field, it is unlikely that human receptors would come into direct contact with this material during normal use of the field. Rainwater will infiltrate through this material that ultimately discharge to the subsurface.

The Tetra Tech Report evaluates the risk associated with impacts to groundwater, surface water and volatilization to indoor air from the turf components. This was completed by conducting a Synthetic Precipitation Leaching Procedure (SPLP) Analysis. The SPLP results are a potential estimate of the

concentration of OHM that may leach from the turf components to the underlying groundwater. The SPLP test results were compared to the following:

- The MCP Method 1 GW-1 standard which are protective of current and future drinking water sources. The GW-1 standards consider ingestion, inhalation, and dermal absorption of OHM in groundwater water.
- The MCP Method 1 GW-2 standard which evaluates the potential of vapors of OHM to impact indoor air.
- The MCP Method 1 GW-3 standard which evaluates potential discharge of OHM to surface water.
- The EPA risk-based Regional Screening Levels for tap water.
- The EPA Maximum contaminate Levels.

For the purposes of this memo, the groundwater standards described above will be collectively referred to as the "comparison values".

Results

As indicated in the Tetra Tech Report, the laboratory reporting limits (RL) for several of the turf component samples were elevated due to sample matrix interference. Sample matrix interference indicates that certain components in the sample beyond those of interest effect the ability of the lab to quantify the components of interest. A typical method for the laboratory to overcome matrix interference is to dilute the sample. Dilutions allow the laboratory to get a clearer picture of the analytes of interest but also increase the laboratory RL. The RL is the smallest concentration that the laboratory can report, and it is based on analyzing a series of standards and the generation of a calibration curve for the laboratory instrument used to analyze the sample. In some situations, the laboratory RL exceeds one or more of the comparison values or no comparison value exists at all. The laboratory data was also reported to the laboratory method detection limit (MDL) to achieve lower detection limits. The MDL is based on a statistical calculation and is below the calibration curve. In this situation, the laboratory data is qualified with a "J" flag indicating the concentration is an estimated value that is below the RL.

Tables 2 and 3 provide a simplified summary of samples where compounds were detected and exceedances of the comparison values were reported. Actual values are summarized in the Tetra Tech report (see Tables 1-4). Several compounds were detected, but most were below applicable comparison values. Of these, the BrockFill resulted in an SVOC and TOPA exceedance of the comparison values during the solids analysis.

Table 2. Solids Analysis

Sample	Semi-volatile organic compounds (SVOCs)	MCP 14 Metals	Per and polyfluoroalkyl substances (PFAS)	Total Oxidizable Precursor Analysis (TOPA)	Total Fluorine/Total Organic Fluorine
Turf Carpet	Detected but below applicable comparison values	Detected but below applicable comparison values	Detected but below applicable comparison values	Detected but below applicable comparison values	Detected but below applicable comparison values

Sample	Semi-volatile organic compounds (SVOCs)	MCP 14 Metals	Per and polyfluoroalkyl substances (PFAS)	Total Oxidizable Precursor Analysis (TOPA)	Total Fluorine/Total Organic Fluorine
BrockFill	Detected and exceeds at least one comparison value	Detected but below applicable comparison values	Detected but below applicable comparison values	Detected and exceeds at least one comparison value	Not detected by the laboratory
Shockpad	Not detected by the laboratory	Detected but below applicable comparison values	Not detected by the laboratory	Detected but below applicable comparison values	Detected but below applicable comparison values
Ultrabond	Not detected by the laboratory, elevated reporting limits due to matrix	Detected but below applicable comparison values	Detected but below applicable comparison values	Detected but below applicable comparison values	Detected but below applicable comparison values
Pellet Glue	Not detected by the laboratory, elevated reporting limits due to matrix	Detected but below applicable comparison values	Not detected by the laboratory	Detected but below applicable comparison values	Detected but below applicable comparison values

Table 3. Synthetic Precipitation Leaching Procedure (SPLP) Analysis

Sample	SVOCs	MCP 14 Metals	PFAS
Turf Carpet	Detected but below applicable comparison values	Detected and exceeds at least one comparison value	Detected but below applicable comparison values
BrockFill	Detected but below applicable comparison values	Detected but below applicable comparison values. One or more elevated reporting limits	Detected but below applicable comparison values
Shockpad	Not detected by the laboratory	Detected and exceeds at least one comparison values	Detected but below applicable comparison values
Ultrabond	Not detected by the laboratory	Detected but below applicable comparison values. One or more elevated reporting limits	Detected but below applicable comparison values.
Pellet Glue	Not detected by the laboratory	Detected but below applicable comparison values. One or more elevated reporting limit	Not detected by the laboratory

Tetra Tech evaluated the SPLP results to determine if the mass of contaminants generated from the field leachate during a 100-year storm event or from annual precipitation would generate enough OHM to create a MCP Reportable Quantities release. We concur with the approach and results of this evaluation, which indicate that based on the concentration of OHM obtained from the SPLP analysis, the mass of OHM in the leachate will not create a MCP Reportable Quantities release. TF, TOF and TOPA analysis were not analyzed for SPLP and a theoretical leaching analysis of these contaminants was not included. Similar theoretical calculations for TF/TOF are likely to result in significant overestimates that would be difficult to support. To our knowledge, SPLP testing on TOPA is uncommon and would likely represent a new testing protocol with inherent limitations.

Conclusions

1. Based on the results presented in the Tetra Tech Report, various SVOCs (except phenol), metals, PFAS (except TOPA PFHpA), TF and TOF have been detected in the field components at concentrations consistent with background and/or below the applicable comparison values. We agree with the report conclusion that the overall risk to human health through a direct contact exposure with the field components is de minimis.
2. Phenol was detected above the MCP Method 1 S-1/GW-1 standard but SPLP testing confirmed that the leaching concentration was significantly less than the GW-1 standard. As such, the leaching of phenol was not identified as a significant risk in the Tetra Tech Report.
3. PFHpA TOPA was detected above the MCP Method 1 S-1/GW-1 standard. SPLP TOPA analysis was not conducted (this is a technique that based on our experience, is uncommon). As such, the potential leachability to groundwater is unknown and no clear risk-based conclusion can be drawn. No theoretical leaching calculations were included in the Tetra Tech Report. The presence of PFHpA TOPA indicates that there is evidence that PFAS precursors exist in the materials and could form into one of the six regulated PFAS compounds. It is likely that a theoretical leaching value would result in significant overestimates that would be difficult to support.
4. Based on the SPLP results presented in the Tetra Tech Report, various SVOCs, metals and PFAS will potentially leach from the turf components into the underlying groundwater. Antimony was the only analyte that leached at a concentration exceeding a risk-based comparison value (although TOPA, TF or TOF SPLP testing was not conducted). Tetra Tech concluded that the estimated mass of antimony released to stormwater would be insufficient to result in detectable concentrations in groundwater downgradient from the proposed field above the comparison standards. HW does not disagree with this conclusion, although any potential release should be discussed by the community.
5. Currently, over 4,000 PFAS compounds are known to exist and the current laboratory methods only include a small subset of 24. MassDEP currently regulates six of the PFAS compounds in groundwater at 20 parts per trillion. The detection of TOF indicates that PFAS related compounds beyond the list of 24 are potentially present in the materials tested. For comparison purposes, the sum of TOF for all tested material is 117 parts per million (one part per million equals 1,000,000 parts per trillion). It is unclear how much if any of the TOF could leach into the underlying groundwater. No theoretical leaching calculations were included in the Tetra Tech Report, and as indicated above, a theoretical leaching value would result in significant overestimates that would be difficult to support. It is reasonable to expect more PFAS compounds will be added to the list of regulated compounds in the future.
6. To determine if the leaching of contaminates into the underlying groundwater would result in a quantity that exceeds the MassDEP Reportable Quantity, a leaching calculation was conducted for each analyte that was detected by the SPLP analysis. The calculations used SPLP analytical data to predict the quantity of contaminants that would leach during a 100-year storm event and a year's worth of precipitation. Based on the calculation, a MassDEP Reportable Quantity would not be generated. Based on the calculations provided in the Tetra Tech Report, the total estimated mass of OHM that could be discharged to the underlying groundwater in one year is approximately 31.5 pounds. It should be noted that this calculation does not include TF, TOF or TOPA values since theoretical leaching calculations were not included in the Tetra Tech Report.

Recommendations

From a toxicology perspective, the analytical data supports the Tetra Tech conclusion that the field is safe to play on. For groundwater, we know there will likely be leachable compounds from the field, but the significance of this impact is uncertain. Estimates of detectable compounds other than TOPA and TOF indicate contributions are likely insignificant. While many questions were answered by this testing, two analytical tests produced results that are inconclusive. Based on our review of the testing results and conclusions, we offer MVC the following recommendations for consideration:

1. Given the detection of TOF, it is likely that PFAS related compounds beyond the list of 24 are present in the materials tested. Unfortunately, the science is too young to offer clear guidance to MVC on the PFAS-related risk associated with TOF levels, the efficacy of theoretical leaching calculations, or predictions of TOF contributions to exceedances of future PFAS standards. Our recommendation is that MVC acknowledge that both the TOF analysis and the TOPA detection indicate a currently unquantifiable potential for PFAS contamination as part of the decision-making process. This issue should be evaluated within the context of other unknown PFAS contributions (or other contaminants) expected from a natural grass field or, frankly, any other development activities within a groundwater protection district.
2. While additional testing could be performed (i.e., leaching analysis of TOPA and TOF) we don't think it will provide the definitive data desired to better inform a decision on the approved use of a synthetic field.
3. If the synthetic field is installed, include PFAS testing in the proposed groundwater wells installed downgradient from field.

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