Summary of the Health Risk Assessments of Synthetic Turf Fields

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I. Introduction:

The use of synthetic field turf or grass on athletic and recreational fields has increased significantly over the last 40 years primarily because of their durability and low maintenance. However, agency reports and published literature have heightened the public awareness of the potential health risks associated with the chemical constituents present in these synthetic fields.

Synthetic fields have been installed in many athletic and playing fields throughout New York, the United States, and the world. NYC alone has 136 synthetic turf fields of which 99 are crumb rubber infill type.

The crumb rubber infill consists of recycled, chipped/pulverized, used automobile tires primarily made styrene butadiene rubber (SBR). This layer of chipped crumb rubber comprises the lower layer of the field turf. The tire crumbs are roughly the size of coarse grains of sand and generally are spread two- three inches thick over the field surface and packed between ribbons of green polyethylene fibers used to simulate grass. The crumb rubber added to the grass layer provides extra padding, serve as a ballast to hold the carpet down, and keep the grass upright.

Crumb rubber granules contain a variety chemicals typically found in manufactured rubber: metals, semi-volatile organic chemicals (SVOC) including polycyclic aromatic hydrocarbons (PAH), and volatile organic chemicals (VOC). The difference between these two types of organic chemicals (SVOCs and VOCs) is the relative vapor pressure of the chemicals – SVOCs have lower vapor pressures and therefore are not as volatile as VOCs or may even be solids at ambient temperatures. Examples of metals contained are zinc, iron, manganese, barium, lead, and chromium). The VOCs include: naphthalene, acetone, toluene, and methyl ethyl ketone. SVOCs include: benzothiazoles, aniline, phenol, and nitrosoamines.

The VOC and SVOC organic chemicals are the main constituents of concern because their potential carcinogenic risks.

These chemicals may be released into the air space and therefore into the breathing zones of users, especially on hot days when turf surface temperatures may be elevated. In addition, crumb rubber may contain certain amounts of particulate matter (dust) and metals, which may become airborne during play and athletic activities. Crumb rubber may also be further reduced in size (dust) and concentration (off-gassing) by mechanical abrasion and wear that comes with the use of these fields.

Since around 2000, numerous investigations and scientific studies have published volumes of data based on the extensive testing and sampling of the air space above these fields as well as the chemical analysis of the underlying materials, notably the crumb rubber and plastic turf grass blades.

The US Environmental Protection Agency (EPA), NY State Department of Environmental Conservation (NYS DEC), the Consumer Product Safety Commission (CPSC), the Centers for Disease Control and Prevention (CDCP), State and City Departments of Health (NY DOH, NYC DOH, NJ DOH, CT DOH), many independent research and development agencies, academic institutions, and of course, the Synthetic Turf Council have contributed to the body of scientific evidence associated with numerous synthetic field turfs installed throughout the United States.

It should also be noted that depending on the origin, type, age, and wear history of the tire, a significant variation in the chemical concentrations of each constituent in the crumb rubber infill in the same location of the same field was observed. The heterogeneity of these samples has created significant quantitative analysis and data interpretation challenges.

II. Summary of Published Findings from Synthetic Field Turf Sampling and Testing

A. Bioaccessibility and Risk of Exposure

That many chemical substances are toxic cannot be denied. However, one must distinguish between toxicity and hazard or risk of exposure. Toxicity is the inherent property of a chemical, which does not present a hazard – only a potential hazard. The existence of a hazard requires the simultaneous presence of a toxic substance, contact with a human host, and assimilation into the host via exposure pathways of inhalation, ingestion or dermal absorption.

One of the recent advances in risk assessment is the determination of the degree of human exposure for a given chemical concentration in the environment by that amount of the chemical which is soluble in human biological fluids, and therefore bioavailable to the host by assimilation into the bloodstream via digestive tract, sweat pores, or lung tissue.

Studies have been conducted which measure the maximum concentration of a specific analyte or target chemical that is soluble in laboratory prepared synthetic biofluids. These chemically prepared biofluids simulate the pH and chemical composition of sweat, digestive juices, and lung fluid and are more representative of an individual's

overall potential dose than the total extraction alone. These are called in-vitro bioaccessibility (IVBA) studies or measurements.

Therefore, the total concentration of SVOCs, VOCs, and metals **contained** in the sample of crumb rubber are determined by the analytical extraction methods of solvent or nitric acid dissolution but the **quantity that could be potentially assimilated** by the host was determined by the amount of analyte that dissolved in the prepared biofluids that were documented to be functional analogs of actual biological fluids, that is via IVBA measurements. The biofluids represent exposure by ingestion, inhalation, or dermal contact. After the target chemical is "captured" by the appropriate biofluid, it is then analyzed directly in the biofluid matrix. These values tend to be less than the amount of total extractable contaminant analyzed by solvent or nitric acid dissolution and more relevant to hazard risk assessment.

B. General Trends in Past Studies

Virtually all the studies to date have in common practically the same conclusions for the distribution of organic compounds and metals in the air space above the field. Both VOCs and SVOCs (and especially the PAHs) found in air above the fields were either at the same concentrations as the local background samples or higher than the background but below the detection limits across the three biofluids. Metals were detectable but at concentrations for which human health risk was considered low.

One study showed that for the products and fields tested, exposure to infill and artificial turf was generally minimal, with the possible exception of lead for some of the fields tested. This latter discrepancy is primarily due to the wide variations in the lead measurements from sample to sample.

Another reason for anomalously high lead concentrations is that another source of lead besides the crumb rubber is from the lead coloring agent used to impart the bright green color to the turf grass blade. The lead chromate from the grass blades can produce very high total extractable lead concentrations – one sample yielded 4400 mg/kg of lead and 820 mg/kg of chromium that exceeded the NJ DEP soil cleanup levels of 400 mg/kg and 20 mg/kg, respectively. The total extractable lead concentrations reported in the EPA study in 2009 ranged from 2.4 to 700 mg/kg for green blades from most of the fields sampled. However, only a portion of these concentrations were found to be bioaccessible.

Synthetic turf fields installed in the early 2000s especially those made of nylon fibers contained very high extractable lead concentrations. More recently field turfs fabricated from polyethylene fibers have lower lead and chromium contents but this

depends on the manufacturer and year of manufacture. The bioaccessibility concentration further depends on the degree of silica encapsulation (if present).

The presence of high lead and chromium levels in new turf material reinforces the need to independently check new fiber materials before purchase and installation. Furthermore, pressure has been placed on the field turf industry to ban this type of coloring agent. As the turf material degrades from weathering, the fibers tear and more lead could be released. To minimize this weathering effect, some manufacturers have encapsulated the lead chromate turf blades with an amorphous silica coating, which they claim reduces both the chemical leachability and biological availability of the constituents. Tests show that the chromate moiety is inactive in in-vitro assays. The assertion is that the lead chromate even if released and airborne, may not be bioavailable in human biological fluids and therefore has negligible toxicity.

All the published data show that the major contributors to cancer risk are not clearly field-related in either outdoor or indoor fields. The risk assessment indicators found cancer risks to be only slightly above minimal levels at outdoor and indoor fields, indicating that cancer risks are not elevated into a range of public health concern.

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