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**WORKING TITLE:
A REVIEW OF THE POTENTIAL
HEALTH AND SAFETY RISKS FROM
SYNTHETIC TURF FIELDS**

Prepared for

**New York City Department of Health
and Mental Hygiene**
New York, NY

Prepared by

TRC
Windsor, Connecticut

March 2008

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TRC Proposal (or Project) No. XXXXX-XXX
March 2008

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EXECUTIVE SUMMARY

1. Background and Purpose of Review

Synthetic turf fields have been installed in many athletic and playing fields throughout New York City (NYC), the United States and the world. The NYC Department of Parks and Recreation (DPR) began installing synthetic turf playing fields in 1997 with a total of 118 installations completed at the time of this report. An additional 91 synthetic turf fields are either planned or under construction around the five boroughs. One particular type of synthetic turf field includes an infill material of crumb rubber made from recycled waste tires. These synthetic turf fields are used in NYC parks because they have many advantages over natural grass, dirt and asphalt fields for certain types of activities. They:

- provide even playing surfaces
- have padding that helps prevent injuries
- need no watering or mowing
- use no fertilizers or pesticides
- can be used year-round and in most weather
- do not need to be closed to protect or re-sod grass
- last a long time with little maintenance

The infill-type synthetic turf fields in NYC parks contain several layers, including:

- A bottom layer composed of geotextile.
- Middle layers composed of broken stone with plastic perforated pipe for drainage and rubber padding for shock absorbance.
- A top layer composed of carpet with soft, flexible plastic grass.
- Crumb rubber infill made from recycled tires added to the 'grass' layer which provides extra padding to serve as a ballast to hold the carpet down and keep the grass upright. Sand is sometimes mixed with the crumb rubber.

Recent concern about the potential for exposure to chemicals found in the crumb rubber, also known as ground rubber, prompted NYC DPR to request assistance from the NYC Department of Health and Mental Hygiene (DOHMH). In response to this request, the NYC DOHMH undertook an intensive literature review focused on the potential health effects for people who use artificial turf fields and to identify gaps in what is known about these potential health effects. With a grant awarded by the New York

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Community Trust, DOHMH contracted a private consultant, TRC Environmental, Inc., to lead this review.

This report includes an assessment of the available literature and is divided into four main sections. The Executive Summary provides a brief overview of the findings of this report. Section I covers the chemical composition of the crumb rubber infill and develops a list of chemicals of potential concern (COPCs). Section II covers the potential for exposure to and human health effects from the COPCs. Section III is a review of the physical health effects associated with synthetic turf systems, including the risks for physical injury, heat-related illness, burns and infections with Methicillin Resistant *Staphylococcus Aureus* (MRSA). A summary of the reviewed articles is included as an appendix under the relevant section headings.

People may theoretically be exposed to COPCs from the crumb rubber infill in several possible ways. Crumb rubber, or the dust generated from crumb rubber, can be accidentally ingested by placing fingers in the mouth or not washing hands before eating and after playing on the fields. Dust can be breathed in from playing on the field, and vapors that volatilize from the turf can also be inhaled. Some COPCs may potentially also be absorbed through the skin by direct contact. Therefore, these three routes of exposure were considered in determining the potential for exposure.

2. General Findings

Components of Crumb Rubber

Crumb rubber used in synthetic turf systems is made from recycled waste tires. These contain several COPCs. Studies have found that crumb rubber contains polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), benzothiazole, and certain metals. Studies have also shown that phthalates, alkylphenols and benzene may become bonded to tires during their use. All of these chemicals have been detected in direct analyses of crumb rubber if vigorous extraction methods are used. Since these chemicals are used during the tire

manufacturing process, or are present in the environment while the tires are in use, their presence in the crumb rubber would be expected.

Potential Health Risks Associated with Synthetic Turf Fields

A number of human health risk assessments have been conducted to evaluate exposure to the constituents in crumb rubber. These risk assessments have been primarily conducted by state agencies, consultants and industry groups. These assessments are based upon quantitative measurement of the chemicals from various forms of tires (scrap tire, shreds, tire crumb rubber, recycled tire flooring, etc) from either leachate studies (from the literature or laboratory studies) or ambient air testing followed by conservative, screening risk assessment techniques. Health risk assessments have been conducted evaluating ingestion, dermal contact, and inhalation. Although each risk assessment was conducted using distinct assumptions and evaluated different concentrations of COPCs in crumb rubber, a health risk as a result of ingestion, dermal or inhalation exposure was not identified for crumb rubber exposure.

Based upon a review of the available literature, it appears that inhalation may be the primary route of exposure for contact to chemicals in crumb rubber. This is particularly the case since most air measurements conducted to document COPC emissions from synthetic turf fields were performed for indoor synthetic turf halls. Studies evaluating oral and dermal exposures used surrogate concentrations for exposure and a number of assumptions pertaining to ingestion rates, dermal contact rates, bioavailability, etc., and thus these evaluations are a theoretical conservative estimate of exposure and risk. Similar to the oral and dermal risk assessments, each of the inhalation risk assessments used conservative estimates of exposure and maximum concentrations of indoor air contaminants and showed no risk to human health.

Due to the distinct physical characteristics of synthetic turf systems, there has also been concern over potential adverse health effects not related to chemical exposure. The potential physical health effects associated with synthetic turf systems include heat-related illnesses, burns, injuries and infections.

Heat-Related Illness - Research focused on heat-related health effects because of observation that synthetic turf systems have higher surface and ambient air temperatures than grass and asphalt playing surfaces. This increase in temperature of the turf system may contribute to a local “heat island” effect, a phenomenon in which the absorption of heat by impervious surfaces increases surrounding ambient air temperature.

Physical Injuries - Concerns over the potential for increased injuries associated with the use of synthetic turf systems have led to a number of studies to evaluate any differences in injury rates, injury types, and lost time between synthetic and natural turf materials. These studies have shown either no major differences in the incidence, severity, nature or cause of injuries sustained on natural grass or synthetic turf by men or women, or that injury rates are similar but that the type of injury varies between the two surfaces.

3. Data Gaps and Potential Areas for Additional Studies

Certain knowledge gaps associated with exposure to synthetic turf fields have been identified and include:

- Consistent test methods for determining the chemicals in crumb rubber made from different source materials and from different processing techniques. Additional studies could be performed to determine the variability of infill material, including analyses of crumb rubber that is manufactured using mechanical grinding versus crumb rubber manufactured using cryogenic processing, and analyses of crumb rubber produced from different sources.
- Identification of alternate infill products with potential to lower heat island effect.
- Outdoor air concentrations of COPCs at synthetic turf fields on both newly installed and older fields. Most of the data generated have been from indoor turf halls. Air concentrations of COPCs and particulate matter could be measured above outdoor synthetic turf fields to give more representative data related to use of synthetic fields in urban parks. Measurements taken on a hot, calm (no wind) day would represent a worst case scenario.

- Background concentrations of the COPCs in New York City air and soils. In order to interpret any findings related to COPCs in crumb rubber, it would be important to characterize these background concentrations as many of the COPCs present in crumb rubber are also present in urban air and soils. This information would provide some context to the measured concentrations of COPCs from crumb rubber.

4. Conclusions

The concentration of COPCs found in crumb rubber varies depending on the type of crumb rubber, the method of extraction used for analysis, and the media measured (crumb rubber, air, leachate). However, in this review, a health risk was not identified as a result of ingestion, dermal or inhalation exposure to crumb rubber. Although a number of data gaps and research avenues have been identified, the data gaps have been addressed in these assessments by using conservative exposure parameters and maximum detected concentrations of the COPCs in the evaluation of the health risk of crumb rubber.

The primary health concern with the use of artificial turf fields is the potential for causing physical health effects associated with heat stress and dehydration, which are potential risks for children playing in any hot environment. It is recommended that DPR staff, coaches, athletic staff, field users, and parents be made aware of the potential for heat-related illnesses, how to recognize heat-related symptoms and how to prevent them on all playing surfaces and locations.

Going forward, the NYC DPR should continue to hold their suppliers and vendors to high standards when purchasing synthetic turf systems. The NYC DPR should also work to incorporate the latest best practices as new technologies in synthetic turf become available.

1.0 INTRODUCTION

1.1 Background and Purpose of Review

Synthetic turf fields have been installed in many athletic and playing fields throughout New York City (NYC), the United States and the world. The NYC Department of Parks and Recreation (DPR) began installing synthetic turf playing fields in 1997 with a total of 77 installations completed at the time of this report. An additional 23 synthetic turf fields are either planned or under construction around the five boroughs. One particular type of synthetic turf field includes an infill material of crumb rubber made from recycled waste tires. These synthetic turf fields are used in NYC parks because they:

- provide even playing surfaces
- have padding that helps prevent injuries
- need no watering or mowing
- use no fertilizers or pesticides
- can be used year-round and in most weather
- do not need to be closed to protect or re-sod grass
- last a long time with little maintenance

The infill type synthetic turf fields in NYC parks contain several layers, including:

- A bottom layer composed of plastic sheeting.
- Middle layers composed of crushed stones with plastic tubing for drainage and rubber padding for shock absorbance.
- A top layer composed of plastic mesh with soft, flexible plastic grass.
- Crumb rubber infill made from recycled tires added to the 'grass' layer to provide extra padding and keep the grass upright. Sand is sometimes mixed with the crumb rubber.

Recent concern about the potential for exposure to chemicals found in the crumb rubber, also known as ground rubber, prompted NYC DPR to request assistance from the NYC Department of Health and Mental Hygiene (DOHMH). In response to this request, the DOHMH undertook an intensive literature review focused on the potential health effects for people who use artificial turf fields and to identify gaps in what is known about these potential health effects. With a grant awarded by the New York Community Trust, DOHMH contracted a private consultant, TRC Environmental, Inc., to lead this review.

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chemicals of potential concern (COPCs). Section II covers the potential for exposure to and human health effects from the COPCs. Section III is a review of the physical health effects associated with synthetic turf systems, including the risks for physical injury, heat-related illness, burns and infections with Methicillin Resistant *Staphylococcus Aureus* (MRSA). A summary of the reviewed articles is included as an appendix under the relevant section headings.

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1.2 Scope of Work

1.2.1 *Literature Search*

An extensive literature search was conducted for information regarding synthetic turf fields and the crumb rubber that makes up the infill material. Internet search engines were utilized for finding information regarding the chemical composition of crumb rubber. Because they were the primary available sources, industry documents, technical specifications, technical presentations, research studies by European agencies and on-line publications were evaluated. Literature searches for potential health effects, both due to chemical exposure and physical effects were conducted on the National Library of Medicine's MedLine database and the Toxicology Data Network (ToxNet). Relevant articles were obtained from local universities. Hundreds of documents were reviewed for this project, and approximately 100 are cited in this document.

1.2.2 *Key Questions*

The project was designed to address the following:

1. Characterize the components of the material used to make synthetic turf fields in NYC and other relevant locations.

2. Identify COPCs in materials used in synthetic turf, COPC concentrations in crumb rubber used as infill, and variability of chemical composition among different batches” of the synthetic materials; other environmental sources and background levels of identified COPCs in NYC.
3. Cite laboratory methods that have been used to characterize/extract crumb rubber to determine chemical composition. List of advantages and disadvantages of these methods.
4. Research impact of environmental factors such as ultraviolet (UV) rays, temperature/humidity, rain, air pollution, and usage on synthetic turf material over time.
5. Identify potential pathways of exposure for people using synthetic turf fields.
6. Describe child and adult usage patterns on synthetic turf fields, especially type(s) of activities, estimated duration and frequency of the activities.
7. Describe potential biomarkers indicative of exposure to specific substances.
8. Identify guidance levels to evaluate COPC levels in crumb rubber; identify limitations or adjustments of existing soil guidelines.
9. Characterize the impact of temperature on synthetic turf fields; compare to other types of surfaces used in NYC parks, such as asphalt and grass.
10. Describe potential health effects, such as heat-related illness and dermal injury, on users of synthetic turf fields; provide recommendations to address these potential health effects.
11. Identify techniques for measuring heat effects from synthetic turf fields.
12. Describe benefits of using synthetic turf fields, including increased access to playing fields.