Thank you for joining the webinar!

- We will begin no later than 12:02!
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- During the presentation please send any questions to *All-Entire Audience*
  - The moderator will direct questions to the presenter at the end of the webinar
  - You will also have the opportunity to ask questions during the Q&A
- A survey will be sent to all attendees following the completion of this webinar
  - **If you wish to receive continuing education credit as a Toxics Use Reduction Planner for attending this webinar you MUST correctly answer the questions posed (at least 70% correct) and submit the survey to the organizer**
  - TURI will submit the results to MassDEP, who approves CE credit
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Visit www.turi.org to learn more about the Toxics Use Reduction Institute and the work we do to help make Massachusetts a safer place to live and work

Sports Fields: Assessing the Alternatives

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Massachusetts Toxics Use Reduction Institute

TURI webinar
February 27, 2018

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Overview

- Background: Massachusetts Toxics Use Reduction Act
- Background: Tire crumb & sports turf
- Assessing alternatives
  - Artificial turf components (focus on infills)
  - Heat
  - Injuries
  - Costs
  - Natural grass
- TURI resources

Massachusetts Toxics Use Reduction Act (TURA)

The Massachusetts Toxics Use Reduction Act (TURA):

- Enacted in 1989
- Helps Massachusetts companies and communities reduce their use of toxic chemicals while promoting the competitive advantage of Massachusetts businesses.

Implementing Agencies

Massachusetts Department of Environmental Protection (MassDEP): enforcement, filings, planner certification

Massachusetts Office of Technical Assistance and Technology (OTA): On-site, confidential technical assistance

Massachusetts Toxics Use Reduction Institute (TURI): Training, Grants, Research, Alternatives Assessment, Policy Analysis, Technical Support, Laboratory, Library

Toxics Use Reduction

- Focus on inherent hazard
- Reduce toxics as a means to protect human health & environment
- Assess alternatives & avoid regrettable substitutions
- Look for efficiencies & cost saving opportunities

TURI's work on sports fields

- Organic grass management projects
- Queries from municipalities & universities
- Research: Sports turf alternatives assessment

Sports Turf Alternatives Assessment: Preliminary Results
INTRODUCTION

Massachusetts Toxics Use Reduction Institute
June 2016

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Introduction

The Massachusetts Toxics Use Reduction Institute (TURI) conducts alternatives assessments as part of its overall mission to help Massachusetts companies, communities, and municipalities identify and implement toxics use reduction options that will provide safer solutions to the use of toxic chemicals.

TURI has received numerous requests for information about artificial turf fields as an alternative to natural grass fields. In response, TURI is developing an alternatives assessment for sports turf. Preliminary sections of the assessment are being published in the order in which they are developed.

This introductory section provides background on the types of turf analyzed in this report. It also includes background information on the history of artificial turf use and existing literature that is relevant for this report. The information presented here may be updated over time as new information becomes available.

Municipalities, educational institutions and others frequently face complicated choices related to the human health and environmental effects of synthetic turf as well as a range of questions related to costs, maintenance, technical performance, and player safety. This alternatives assessment is designed to provide a compilation of key information on these issues, and is intended as a resource for decision makers.

Types of turf analyzed

This alternatives assessment report provides information on natural grass turf and synthetic turf. Within the broader category of natural grass turf, the report considers both organically managed and conventionally managed turf. Within the broader category of synthetic turf, the report considers several types of synthetic turf infill.

Organic turf. Key elements of organic land care, as applicable to turf, include the following: no synthetic pesticides, including herbicides, insecticides, or fungicides; no synthetic fertilizers; no genetically engineered organisms; building healthy soil that can support diverse soil life and cultivate healthy grass; reducing the potential for nitrogen or phosphorus pollution by limiting the amount of organic fertilizers applied and adjusting the timing of application; using good cultural practices to encourage the growth of healthy grass and reduce the need for irrigation and other inputs; and increasing diversity of plant cultivars and species where appropriate. Certain fertilizers and soil amendments are allowed; these include compost and compost teas, cover crops and green manures, and organic fertilizers that meet NOFA standards for organic lawn

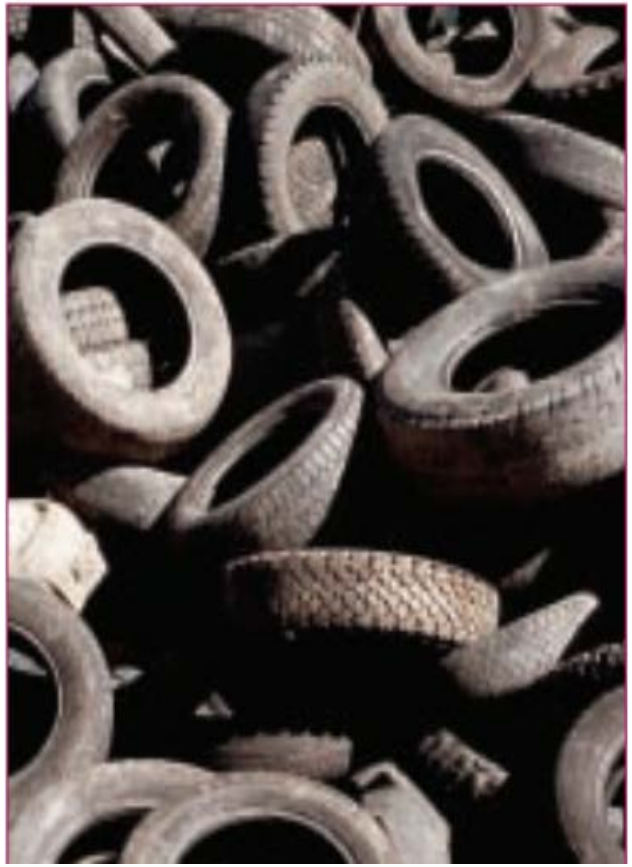
Massachusetts Toxics Use Reduction Institute – June 2016 1

Background: Tire Crumb and Artificial Turf

Source of image:
Ohio EPA

Tire Crumb

- Challenges: tire recycling
- Challenges: tire disposal
  - Restrictions on landfilling tires
- Large quantities of waste tire material
  - In 2015:
    - 49% -- tire-derived fuel
    - 26% -- ground rubber
    - 11% -- land disposal
    - 7% -- civil engineering
    - 7% -- other



Source of image: EHHI

2015 figures summarized from US Tire Manufacturers Assoc. 2017. "2015 US Scrap Tire Management Summary," https://www.ustires.org/system/files/scraptire_summ_2015_05_2017_Final_USTMA.pdf

Background: Synthetic turf

- 1964 – Synthetic turf first marketed
- 1990s – sand & rubber infill introduced
- Significant use of tire crumb
  - Tire crumb in 2015:
    - Sports surfaces – 25%
    - Playgrounds & mulch – 22%
    - Molded/extruded – 35%
    - Asphalt – 15%

2015 figures summarized from US Tire Manufacturers Assoc. 2017. “2015 US Scrap Tire Management Summary,” https://www.ustires.org/system/files/scraptire_summ_2015_05_2017_Final_USTMA.pdf

Synthetic Turf

- Elements include bottom drainage layer (stone/gravel); backing material; fibers/blades; shock absorption pad; infill
  - All materials should be researched
- Considerations include
  - Material composition
  - Releases from materials
  - Particle migration

Infill materials include:

- **Synthetic**
  - Tire crumb
  - EPDM
  - TPE
  - Waste athletic shoe material
- **Mineral- or plant-based**
  - Sand
  - Zeolite
  - Cork
  - Coconut hulls & fibers
  - Walnut hulls
- **Combinations**
  - Acrylic-coated sand

Useful concepts

- Multiple materials in a single category
- Additives
  - Can include cross-linking agents, accelerators, stabilizers, plasticizers, fillers, antimicrobials
- Thermosets vs. thermoplastics

Routes of exposure

Inhalation of off gassed chemicals and particulates

Dermal contact and absorption through the skin or open wounds

Ingestion of turf infill particles

Source: Mt. Sinai School of Medicine

Tire Crumb Infill

Tire crumb

- EPA: just over 350 chemicals or chemical categories discussed in existing literature on tire crumb
- Presence and amount of a given chemical can vary depending on the sample/field.

Tire crumb infill – Chemicals (EPA)

Category	Examples
Metals	Aluminum, arsenic, barium, cadmium, chromium, copper, lead, nickel, zinc
VOCs	Benzene, benzothiazole, hexane, naphthalene, styrene, toluene, xylenes
PAHs	Anthracene, benz(a)anthracene, fluoranthene, naphthalene, phenanthrene, pyrene
Phthalates	Benzylbutyl phthalate, di(2-ethylhexyl)adipate, di(2-ethylhexyl)phthalate [DEHP]
Other (e.g. rubber curatives)	4-tert-(octyl)-phenol, butylated hydroxytoluene

Health & environmental endpoints of interest include:

- Carcinogenicity
  - e.g. certain VOCs, PAHs
- Neurotoxicity
  - e.g. lead
- Endocrine disruption
  - e.g. phthalates
- Aquatic toxicity
  - e.g. zinc in runoff

What studies have been conducted?

- Materials characterization
- Limited exposure studies
- Risk assessments
- No epidemiological studies to date

On-going federal, state, & EU research

- Federal agencies (EPA, CPSC, ATSDR)
  - www.epa.gov/tirecrumb
  - https://www.cpsc.gov/Safety-Education/Safety-Education-Centers/Crumb-Rubber-Safety-Information-Center
- California Office of Environmental Health Hazard Assessment (OEHHA)
- Centre for Safety of Substances and Products, Netherlands – PAHs

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Other infills

EPDM

- Can be mixed with high levels of additives & oils (can be as high as a 50-50 mix); often mixed with carbon black

EPDM

- Norwegian Building Institute (NBI), 2004
  - Compared tire crumb with EPDM
  - Found lower levels of hazardous substances in EPDM, except for chromium & zinc
    - More chromium
    - Similar levels of zinc
    - Both chromium & zinc above “sensitive land use” standards
    - *Lower* levels of PAHs, phthalates, phenols
    - *Lower* level of lead
    - No PCBs

Table 4: Comparison: Recycled Rubber Granulate vs. EPDM infill (NBI 2004)			
		Recycled rubber granulate (n=3)	EPDM (n=1)
PAHs	Total PAHs	Yes (16 PAHs detected; total PAHs 51 to 76 mg/kg)	Yes (5 PAHs detected; total PAHs 1 mg/kg)
Phthalates	Phthalates – over all	Yes	Yes (lower)
	Dimethylphthalate (DMP)	No*	Yes (3.4 mg/kg)
	Diethylphthalate (DEP)	No*	Yes (1.5 mg/kg)
	Dibutylphthalate (DBP)	Yes (2.6 to 3.9 mg/kg)	Yes (1.6 mg/kg)
	Benzylbutylphthalate (BBP)	Yes (1.3 to 2.8)	No*
	Diethylhexylphthalate (DEHP)	Yes (21 to 29 mg/kg)	Yes (3.9 mg/kg)
	Di-n-octylphthalate (DOP)	No*	Yes (3.2 mg/kg)
	Diisononylphthalate (DINP)	Yes (57 to 78 mg/kg)	No data
	Diisodecylphthalate	No*	No data
Phenols	Phenols – over all	Yes	Yes (lower)
	4-t-octylphenol	Yes (19,600 to 33,700 µg/kg)	Yes (49.8 µg /kg)
	Iso-nonylphenol	Yes (9120 to 21,600 µg /kg)	Yes (1120 µg /kg)
VOCs (offgassing test)		Yes (12 detected)	Yes (4 detected, all at lower levels than the recycled rubber

TPE

- Thermoplastic elastomer
- Broad category – describes multiple materials

TPE

- Norwegian Pollution Control Study (Dye et al., 2006): compared two tire crumb fields with one TPE field (all indoor)
  - Vulcanization compounds, preservative compounds, and carbon black all present at tire crumb fields, absent at TPE field
  - Total VOCs: very high to high at tire crumb fields (exceeding recommended levels); slightly elevated at TPE field
  - PAHs: present at all fields, but lower at TPE field
  - Benzothiazole, toluene – present but lower at TPE field
  - TPE potentially preferable to tire crumb based on the chemicals examined in the study; however, the authors were not able to make a broad recommendation about TPE infill because they did not know what other chemicals it contained.

Waste athletic shoe materials

- Variety of synthetic rubbers; may also include natural rubber
- Like other products, may contain vulcanizing agents, antioxidants, colorants, stabilizers, plasticizers
- Restricted substances lists (RSLs)
- Potential allergic reactions to additives used in shoe rubber
  - Literature on shoe-related dermatitis -- chemicals used in vulcanization process are implicated in some studies

Acrylic-coated sand

- Sand
- Proprietary acrylic
- Pigment
- Antimicrobial (unspecified)
  - Example: Triclosan: GreenScreen® Benchmark 1 (“Avoid: Chemical of High Concern”)
    - Persistence, bioaccumulation
    - Acute & systemic human toxicity
    - Very high ecotoxicity
    - Chronic aquatic toxicity

Plant-based infills

- Cork
- Coconut
- Walnut shells
- May be combined with zeolite
- Questions:
  - Respiratory hazards?
  - Development of mold & dust?

Heat

- All artificial turf gets hotter than natural grass
  - 35º F to 42º F hotter than grass (NYDEC, 2009)
  - 156º F under direct sunlight (Milone & MacBroom 2008)
  - 200º F on a 98º F day (Williams & Pulley 2004)
- Heating most pronounced in the artificial grass fibers
- Choice of infill type *may* lead to some variation in the amount of excess heat
- Frequent, heavy irrigation can help to control heat to a limited extent
- Concerns: burns; heat-related illness
  - Education for coaches, other decision-makers

Injuries

- Mixed evidence on many types of injuries. Sample studies:
  - Similar rate over all, but different types of injuries (Dragoo & Braun 2010)
  - Possible decrease in incidence of the most serious injuries (Meyers & Barnhill 2004)
  - More head & neck injuries for men, fewer ankle sprains for women (Fuller et al. 2007)
- Higher incidence of skin abrasions
  - Need for vigilance re: skin infections

Other considerations

- Particle migration
- Wildlife/green space
- Ecosystem services
- Biocides

Open questions

- Lack of full information on material composition

Mt. Sinai School of Medicine: "Tips for Safer Play on Artificial Surfaces" (Selected)

- Avoid use on very hot days
- Avoid use for passive activities (e.g. sitting, picnicking)
- Monitor young children
- Clean cuts & abrasions immediately
- Shower immediately after playing on artificial turf
- Brush hair thoroughly after play
- Wash hands before eating, drinking, or adjusting mouth guard

Natural grass

- Safer alternative
  - Organically managed grass whenever possible

Costs

- In nearly all scenarios, the life-cycle cost of synthetic turf is higher than that of natural grass for an equivalent area.

Table 12: Sample Life Cycle Cost Estimate (65,625 square foot field)

	Natural		Synthetic (replacements in years 8 & 16)	
	Low	High	Low	High
Installation*	$39,000	$328,000	$295,000	$673,000
Annual Maintenance*	$4,000	$14,000	$4,000	$4,000
Annual Labor (hrs)*	250	750	300	300
Annual labor cost	$5,000	$15,000	$6,000	$6,000
Resodding (yrs 6, 11, 16)	$25,000	$45,000	$0	$0
Disposal & resurfacing & transport & landfill*	$0	$0	$557,000	$642,000
Net Present Value	$197,000	$753,000	$1,189,000	$1,676,000

***Source: SportsTurf Managers Association. [no date.] A Guide to Synthetic and Natural Turfgrass for Sports Fields. 3rd edition. Lawrence, KS: STMA. Assumptions: Hourly rate $20; interest rate 3%, disposal/resurfacing occurs in years 8 & 16; natural grass resodding in years 6, 11 and 16; conversion factor used to calculate annualized cost from NPV 0.0796. In the scenarios used here, at year 16 the field is in equally good condition as in year 1.**

Maintenance

- Artificial turf maintenance can include:
  - Fluffing, redistributing, & shock testing infill
  - Periodic static control & disinfection of materials;
  - Seam repairs & infill replacement
  - Organic matter removal
  - Watering to lower temperatures on hot days
- Natural grass maintenance can include:
  - Irrigation
  - Mowing
  - Fertilizing
  - Replacing sod

Organic land care projects supported by TURI – a few examples:

- Marblehead – Living Lawn Demonstration Project
- Townsend
- Ayer & Stoneham
- Springfield
- NOFA trainings for landscapers & homeowner

Springfield

Year 1	$1,740/acre
Year 2	$1,245/acre
Year 3	$1,110/acre


Slide provided by Chip Osborne
Estimate for a more aggressive program
Year 1 $2,000/acre
Year 2 $1,500/acre
Year 3 $1,300/acre

Field use:

*** 650 scheduled hours annually**

*** Physical Education**

*** Estimated 100 hours non-programmed use**

Martha's Vineyard – Field Fund

- Five pilot locations (West Tisbury School & town fields; Oak Bluffs School; Chilmark) – began September 2017
  - Soil testing
  - Aeration
  - Overseeding with high quality seed
  - Extra mowings (1-2 per week)
  - Fertilization (3 fields)
  - Replacement of some sprinkler heads
  - Hole filling
  - Professional consultation & project manager fees.
- Improvements at all fields
- No fields taken off line

TURI resources

www.turi.org/artificialturf

- Fact sheet
- Detailed documents on
  - Cost
  - Physical & biological hazards
  - Infills – overview
  - Infills – individual types
- Resource guide

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Athletic Playing Fields and Artificial Turf: Considerations for Municipalities and Institutions

Municipalities, universities, schools and other institutions frequently need to make decisions about maintenance and installation of athletic playing fields. This may include choosing between natural grass and synthetic turf. Factors that may be considered include cost of installation and maintenance, number of days the field can be used, likelihood of player injuries, temperature of the playing environment, and athletes' exposure to chemicals.

The Massachusetts Toxics Use Reduction Institute (TURI) at UMass Lowell has worked with municipalities and other institutions to facilitate the adoption of turf management practices that are cost-effective and preferable for human health and the environment. This fact sheet introduces some of the considerations that are relevant to evaluating natural grass and artificial turf alternatives. TURI is also developing an alternatives assessment for sports turf, which will provide a detailed assessment of these factors.

Principles of toxics use reduction

TURI's work is based on the principles of toxics use reduction (TUR). The TUR approach focuses on identifying opportunities to reduce or eliminate the use of toxic chemicals as a means to protect human health and the environment. Projects to reduce the use of toxic chemicals often have additional benefits, such as lower life-cycle costs.

Children's environmental health

People of all ages benefit from a safe and healthy environment for work and play. However, special concerns exist for children. Children are uniquely vulnerable to the effects of toxic chemicals because their organ systems are developing rapidly and their detoxification mechanisms are immature. Children also breathe more air per unit of body weight than adults, and are likely to have more hand-to-mouth exposure to environmental contaminants than adults.[1] For these reasons, it is particularly important to make careful choices about children's exposures.

Artificial turf: chemicals in infill

Artificial turf is composed of several elements, including drainage materials, support and backing materials, synthetic fibers to imitate grass blades, and an infill that takes the place of soil. A number of concerns exist regarding chemicals in the artificial grass blades and infill. Here, we briefly review issues related to chemicals in infill. Toxic chemicals such as lead are also found in the artificial grass blades in some cases.[2]

Crumb rubber infill made from recycled tires. Crumb rubber made from recycled tires, also referred to as styrene butadiene rubber (SBR) infill, is currently the most widely used type of infill. This type of infill contains a large number of chemicals that are known to be hazardous to human health and the environment. These include polyaromatic hydrocarbons (PAHs); volatile organic compounds (VOCs); metals, such as lead and zinc; and other chemicals. Some of the chemicals found in crumb rubber are known to cause cancer.[3] Because of the large number of chemicals present in the infill, as well as the health effects of individual chemicals, crumb rubber made from recycled tires is the option that likely presents the most concerns related to chemical exposures.

Other synthetic materials. Other synthetic materials used to make artificial turf infill include EPDM rubber, thermoplastic elastomers (TPE), and Nike Grind (a proprietary rubber product made from recycled athletic shoes). These alternatives are sometimes marketed as safer alternatives. Relatively little information is available on the chemicals present in, or emitted from, these infills. Preliminary information suggests that these materials do contain some hazardous chemicals, but that they may generally pose less of a concern than crumb rubber made from recycled tires.[4] There is an urgent need for more information on these alternatives.

Mineral-based and plant-derived materials. Other materials used as infill can include sand, cork, and coconut hulls, among other materials. Again, these materials are likely to contain fewer hazardous chemicals than crumb rubber infill made from recycled tires, but the materials have not been well characterized or studied thoroughly.

The Toxics Use Reduction Institute is a multi-disciplinary research, education, and policy center established by the Massachusetts Toxics Use Reduction Act of 1989.
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TURI resources

www.turi.org/artificialturf

Video: Natural Grass Organic Athletic Fields in Springfield, MA

Video: Safer Alternatives for Athletic Fields

Playgrounds – CPSC precautions to limit exposure

1. “Avoid mouth contact with playground surfacing materials, including mouthing, chewing, or swallowing playground rubber. This may pose a choking hazard, regardless of chemical exposure.
2. Avoid eating food or drinking beverages while directly on playground surfaces, and wash hands before handling food.
3. Limit the time at a playground on extremely hot days.
4. Clean hands and other areas of exposed skin after visiting the playground, and consider changing clothes if evidence of tire materials (e.g., black marks or dust) is visible on fabrics.
5. Clean any toys that were used on a playground after the visit.”

Source: https://www.cpsc.gov/Safety-Education/Safety-Education-Centers/Crumb-Rubber-Safety-Information-Center

Thank you

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