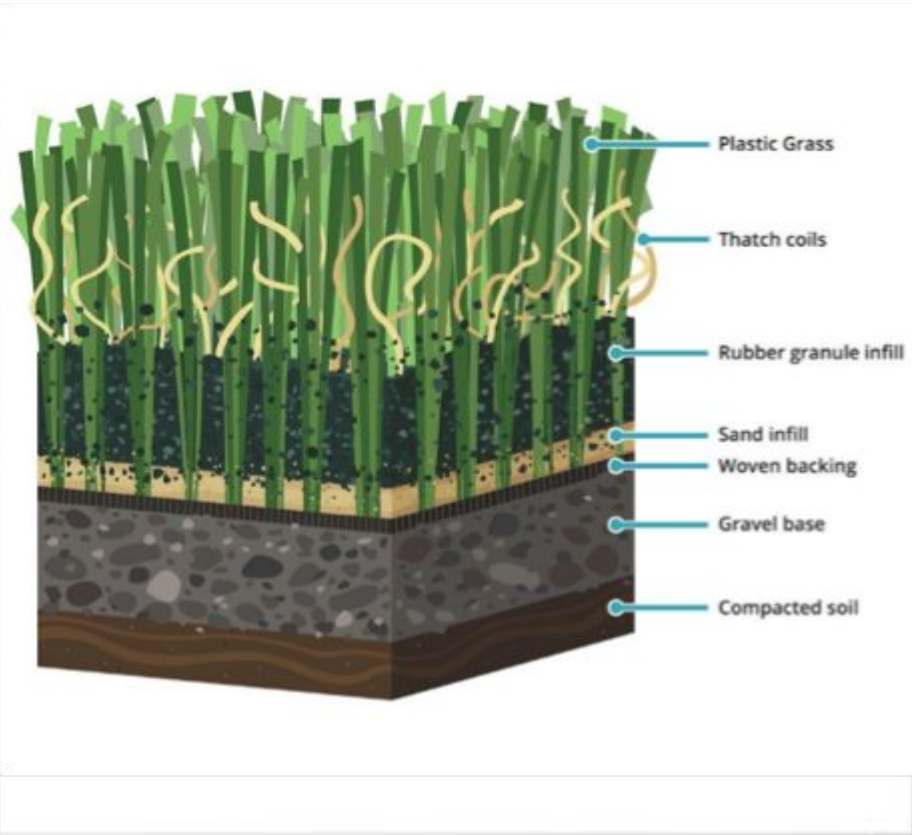
What Everyone Should Know about Synthetic Turf

What is Synthetic Turf?

Average field-
80,000 square feet (>2 Acres)

= 40,000 pounds of
plastic backing and blades

= 400,000 pounds of
infill (tire waste, silica sand, or
other infill material)



DISPLACING Grass and soil which would otherwise filter pollutants and oxygenate air.

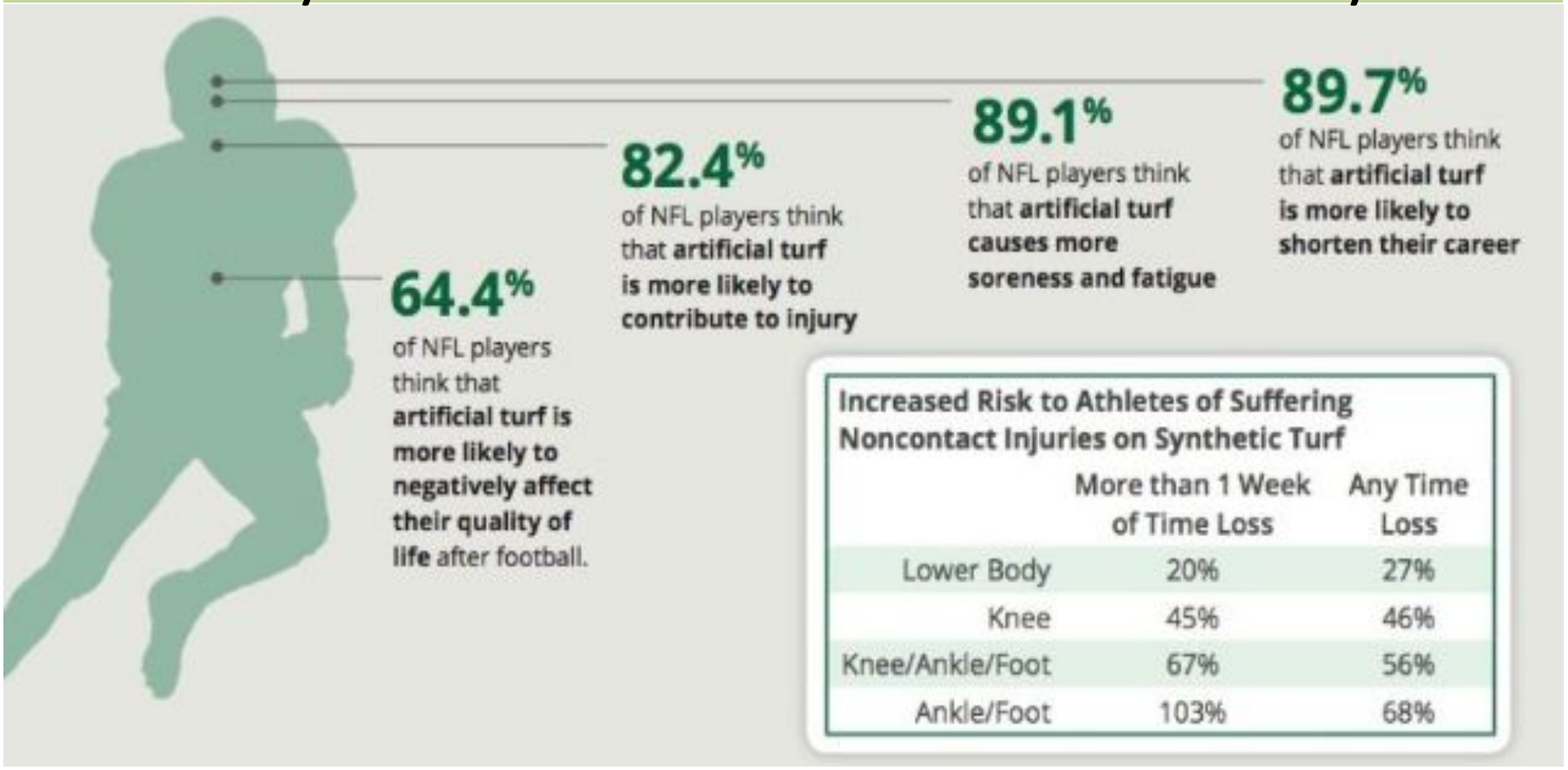
The product is made of fossil fuels and contributes to climate change.

Overview – Key Concerns

- **What artificial turf means for athletes:**
  - More **injuries**: joint (esp. ACL/PCL), concussion, and turf burn
  - More **toxic exposure** from dozens of known dangerous toxins
  - More **heat**-related disability and death

- **What it means for the community and environment:**
  - **Equity** and inclusion: heat islands, chemical pollution
  - Microplastic and nanoplastic **pollution** of soil & water
  - Volume of **waste**: Burden on landfills; unrecyclable; high cost for hauling & tipping fees at legal facilities
  - **Contribution to climate crisis**: From its carbon footprint from extraction and processing, to installation that displaces a grass field that cools, infiltrates, and sequesters carbon; plus replacement and disposal – over and over again.

Synthetic turf is dangerous to athletes. The NFL Players Assoc has called for grass fields for years - *since 1976* - for athlete safety



Jeff Miller VP of Public Affairs, NFL: "NFL owners now replace their synthetic fields more frequently– every two years – to reduce injury." That is not an option for schools and parks. 14 of 30 stadiums are synturf. The Ravens play on grass, except one indoor field.

Graphic: 1977 Final Report of US House of Representatives Select Committee on Professional Sports.

Years of studies consistently find higher injury rates on synturf

- The NFL has run two large 4-year studies of all 32 teams, showing that athletes suffer more injuries on artificial turf. The Ravens' lead orthopedic surgeon has testified repeatedly in Annapolis about the **synturf industry mischaracterization of NFL's data.**.

- A 2022 study in the leading sports injury medical journal re-examined the NFL & NCAA studies to reassess their validity and identify trendlines. Conclusion: "The available body of literature suggests a **higher rate of foot and ankle injuries on artificial turf**, both old-generation and new-generation turf, compared with natural grass."

  Of the few articles reporting higher injury rates on natural grass, the report states "... all of these studies received **financial** support from the **artificial turf industry**." (emphasis added)

10-yr NCAA study confirms: Significantly higher injury rates on synthetic turf

Based on 3,009,205 NCAA football athlete exposures over 10 years:
3X PCL and 1.63X ACL injury rates), American Journal of Sports Medicine

Injury from hardness - Gmax

Testing Gmax: Is it done by a 3rd party or a maintenance contractor? How often?

- **Gmax 200 gives no safety buffer = Risk of skull fracture/life-threatening head injury**
- 199 is NOT safe! **Industry recommends 165, down from 175**
- Grass fields are typically 90 to 120 depending on moisture
- Most synturf warranties require **1 test/year**; easy to 'cheat'
- NFL runs Gmax tests before **EVERY game**.

Maintenance determines safety – and requires money and staff to continually groom, clean, magnet-sweep, sanitize, and to replenish and redistribute infill:

- Infill too deep? Uneven traction, inconsistent footing, muscle-strain, more falls.
- Too thin? Excessive hardness, risk of concussion; joint compression. Also causes plastic carpet damage, blade breakage & loss. About 15% of concussions are from helmet-to-surface (not helmet-to-helmet). Thinner infill means harder hits.
- Adding, distributing and cleaning infill require special equipment and training. Failure to do so leaves fields unsafe and may violate warranty terms.
- In addition, blood, sweat, snot, spit, vomit, animal feces, etc., must be manually removed from artificial turf, while they break down on grass.

Injury from Turf Burns

- Synthetic turf is uniquely abrasive and results in gashes, wounds, and lacerations.
- These deep and painful abrasions can become infected and frequently cause permanent ,disfiguring scarring.

Turf burns create physical *and* toxic risk

Open wounds: Risk of MRSA. Also direct pathway for synturf's many toxic substances into bloodstream

Many Leagues Choose Grass for Athlete Safety

- FIFA – The international governing body for professional soccer now requires all tournaments to be on natural turf, following a lawsuit by women's teams which were relegated to artificial turf.

- In addition, professional and elite soccer players' contracts across Europe specifically exclude play on artificial turf.

- MLB – Only 5 out of 30 professional baseball stadiums contain artificial turf. Most teams that previously used synthetic turf have gone back to natural grass.

Synturf Microplastic Sources: Plastic Carpet Fibers Disintegrating

What about the infill?



Common synthetic infills, left to right:

- “NikeGrind” - Shredded synthetic shoe waste
- “Tire Crumb” - Granulated waste tires
- “Enviro-Fill” - Plastic-coated grains of sand

All generate massive ongoing microplastic pollution

Different Infills, Same Problems

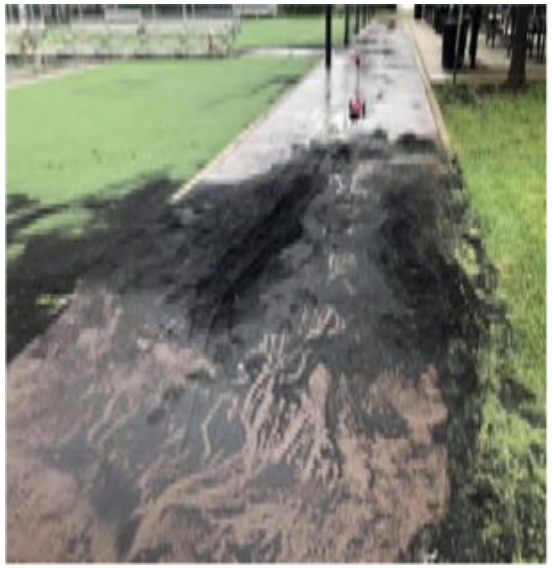
Each infill comes with its own problem, but all are hot and migrate constantly off-field. Newer infills have unproven performance and uncertain supply or cost profile.

- **Tires:** Used tire crumb is the **hottest** and **most toxic** –and the most common
- **Other plastics:** Shoe manufacturing waste, plastic-coated sand are nearly as hot as tire
- **Plant-based infills: Cork, nut-shell, pine, rice etc.,** are Goldilocks products: Too dry and the field is dusty and slippery; footing shifts and piles up. Too wet and fields get sticky and clumpy. In freezing temps they can form hard clumps.
- **Zeolite:** A family of volcanic rock that includes cat litter; very dusty and high skin injury rates.
- **Silica sand** Artificial turf carpets are held down with hundreds of tons of silica sand, resulting in constant generation of silica dust known to be carcinogenic when inhaled.

Regardless of infill type or color, artificial turf will be increasingly unusable in climate crisis heatwaves. Water-cannon irrigation interrupts play, changes field conditions, delays other games —and fields just return to original temp within 20 min.

Industry estimates infill loss of
1 - 5 tons per field, per year.
If ignored, fields are too hard and plastic carpet is damaged; if replaced, cost of materials and grooming rises.





Infill Washouts Following Storms; Rising Frequency Expected

Rice husk blend clogging track & field drainage; pine infill washed onto track

When infill is too low, plastic blades are easily damaged = shedding & breakage

Tires Are Hazardous Waste.
Why Aren't They Hazardous on the Field?

What is cushioning that plastic green field?

According to the renowned Mount Sinai Children's Environmental Health Center:

"...styrene and butadiene, …principal ingredients of the synthetic rubber used for tires in the United States. **Styrene is neurotoxic** and reasonably anticipated to be a **human carcinogen. Butadiene is a proven human carcinogen** that has been shown to **cause leukemia and lymphoma.** Shredded and crumb rubber also contain lead, cadmium, and other metals known to damage the developing nervous system." (Feb. 2016)

- **Children's developing bodies and brains are especially sensitive to toxic substances and they are closer to the ground.**
- **Children absorb toxins by inhalation, ingestion, and contact.**
- **Toxic exposures are often cumulative and synergistic.**

Undisclosed Toxins in Synthetic Turf

Plastic Synturf Carpet:

Hormone disrupting chemicals, neurotoxins, immune system disruptors, carcinogens,

Such as:

- phthalates,
- anti-oxidants,
- plasticizers,
- heavy metals in pigments (lead, Cadmium..)
- PFAS chemicals

Tire Crumb:

Over 300 toxins including:

- Fine particles- carbon black
- Neurotoxins (e.g. lead)
- carcinogenic hydrocarbons + aldehydes,
- hormone disrupting phthalates,
- volatile organic compounds (VOCs)
- Benzothiazoles (sensitizers, irritants, potential carcinogens)
- aquatic toxins such as
  - zinc
  - recently identified 6PPD highly toxic to salmon (other fish?)

Sources: EPA 2009, 2016; Vasilou et al, Yale; University of Washington and many others

Selected Toxins in Synturf Carpet & Infill

inhalation, ingestion, skin abrasions

Toxin	**Tire Infill Known Effects-**
Butadiene, styrene , Polycyclic aromatic hydrocarbons (PAHs)	carcinogenic, (e.g.stomach, blood and lymphatic cancers) Damage to central nervous system, headache, fatigue, weakness, depression Hearing and vision loss, peripheral neuropathy, loss of concentration
Lead	NO SAFE LEVEL- accumulates--brain/ nervous system damage and behavioral problems Hypertension and kidney cancer Gastrointestinal issues and fertility problems
Benzene	Inhaled. Harms bone marrow and decreases red blood cells leading to anemia Excessive bleeding, adverse impact to the immune system Known carcinogen, especially leukemia
Toxin	**Plastic Grass:**
PFAS	NO SAFE LEVEL- accumulates. *1-38 pounds of PFAS in a single field carpet system.* Liver damage and reduced immunity Severe birth defects for children Thyroid, kidney, bladder, testicular, prostate and colon cancer

Phthalates- - Hormone disruption leading to obesity, fertility problems and more

Harmful effects of exposures accumulate over time
Exposure to a mix of chemicals is more harmful than exposure to a single chemical

All Synturf Contains Cancer Causing PFAS

- All synturf grass samples from EVERY major manufacturer tested positive for PFAS (*University of Notre Dame*).
- Synthetic Turf Council testified before CA legislature (and manufacturers such as Shaw say) that **synturf cannot be made without PFAS.**
- A 2020 Swedish study: Up to **38 lbs of PFAS per field**.
- PFAS danger is so great EPA proposed 4 PPT in drinking water. 8.34 lbs. per trillion gallons = 1 PPT, which is like a drop in an olympic-size swimming pool.
- PFAS also contaminate groundwater. Many communities rely on wells and reservoirs for all their needs.
- New evidence shows PFAS in water that didn't contain it prior to field installation.
- PFAS chemicals cause 75% of active duty firefighters to die of occupational cancer – not fire!

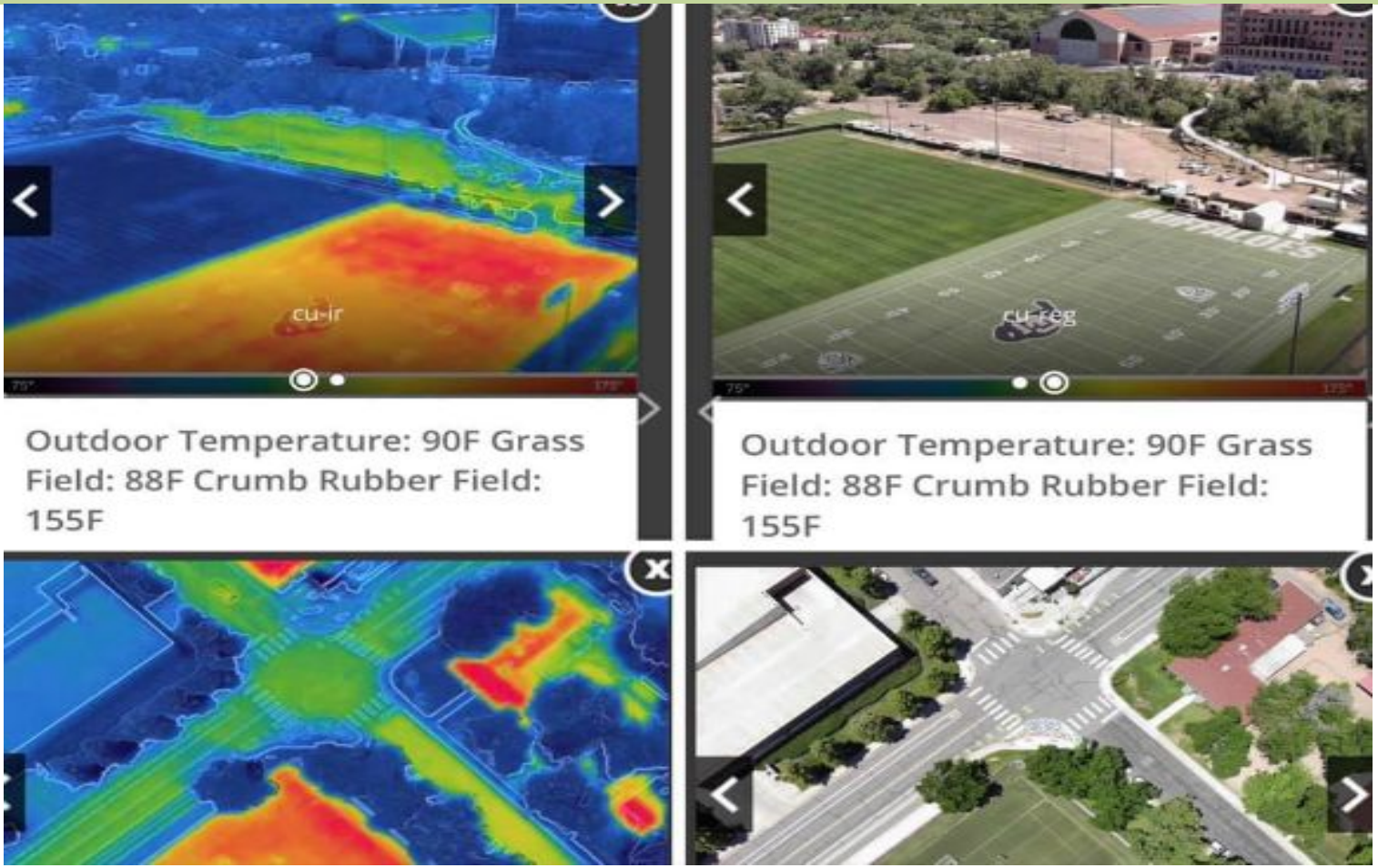
Rapidly Growing Regulatory Oversight of PFAS

- Maryland has joined attorneys general from more than two dozen states in suing PFAS manufacturers for PFAS contamination.
- State Legislation: MA bill to block spending on synturf with PFAS, NY has banned PFAS in carpeting including synturf with CA to follow, Maine PFAS reporting, NC limits PFAS in streams and rivers, etc.
- EPA Regulation:

PFAS contamination is another urgent public health and environmental threat facing communities across the United States, with significant potential equity and environmental justice implications. EPA has created a cross-Agency Council on PFAS, staffed by senior policy and technical experts, to coordinate and accelerate a whole-of-Agency response to this crisis and leverage partnerships with other Federal agencies. The Council is charged with developing a strategic roadmap and identifying actions the Agency should take in the next five years to maximize the use of existing authorities and scientific capacity to research, restrict, and remediate PFAS. EPA will publish a proposed PFAS National Primary Drinking Water Regulation. EPA will also begin PFAS monitoring under the Unregulated Contaminant Monitoring Rule and conduct occurrence analyses in FY 2023 through 2025. In addition,

Source: FY 2022-2026 EPA Strategic Plan, October 1, 2021

Dangerous Heat



90F day: Grass temp is 88F, synturf is 155F
Hot enough to melt sneakers and burn skin!

Dangerous Heat

- Highest synturf temperature published in research paper: 200° F (93° C) on 98° F (37° C) day. **Artificial turf generates excessive heat regardless of the infill.**

- Synturf air temp at child chest/head height is regularly 130-140 degrees. Children are more vulnerable to deadly heat stroke and less likely to speak up.

- Natural grass rarely exceeds 100 degrees due to transpiration
  - Commonly 75° to 85° F (25° to 35° C) even on warmest days
  - Usually less than air temperature and even cools ambient air on and around field

- Bands and many athletes wear heavy gear on fields. WV high school band and staff collapsed in the heat sending 37 to 3 hospitals.

- Exertional heat stroke can be lethal: UMD's Jordan McNair had a core body temp of 106F (in *May*) leading to state legislation, $3.5M+ lawsuit, and new federal legislation

- Sports Illustrated Oct 2022 cover story: *With Hotter Temperatures Come More Football Deaths - And Black HS Players Are Disproportionately Affected*, specifically mentions heat due to artificial turf.

Equity and Inclusion

- **Synthetic turf always creates a heat island, but its impact is even more harmful for lower-income areas** where homes may not be air-conditioned. Many already have higher temps due to more development, fewer trees and less green space.

- **Synturf adds toxic load to overburdened children who already have exposure to higher rates of pollution based on where they live.** Children inhale toxic VOCs just playing on the field and their families have similar exposure while sitting nearby.

- **Children are uniquely susceptible to the health effects of environmental hazards**.
  - Proximity to the ground
  - Eat, drink, and breathe more per pound of bodyweight
  - Rapid development
  - These environmental hazards add up for children and families who are underrepresented and/or who live in underserved communities

Free State PTA Position

SCHOOL INFRASTRUCTURE - Free State PTA supports:

- Reducing exposure to known harmful substances, including lead and PFAS, in home, play, and school environments by testing and remediating in paints, plumbing, drinking water, athletic fields, and play surfaces.
- Implementing shaded outside areas and reducing heat stroke risk by using more natural surfaces as we experience climate change.

Environmental Sustainability

- Promoting the Green Schools program.
- Reducing plastic use and promoting healthy environments by using natural playing surfaces, natural grass fields and installing filtered water bottle filling stations.
- Recycling should be promoted in all areas of the school to include recycling of office, classroom, and dining materials.

Synthetic Turf Pollution

Infill and plastic grass start contaminating communities immediately, every day..

Synthetic Turf Pollution

- Blades and turf infill begin to migrate off-site immediately upon installation: A field may lose roughly 20 tons of toxic infill in 8 yrs.

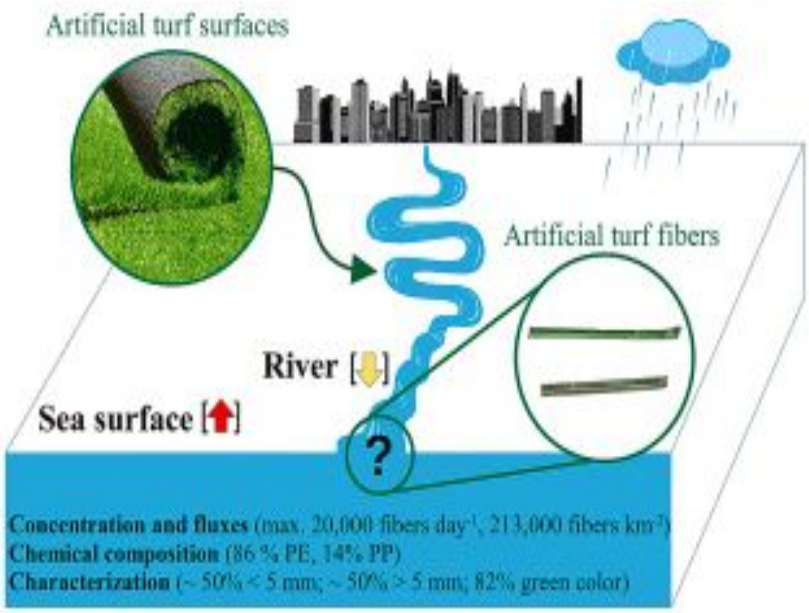
- Plastic debris goes everywhere:
  - Homes: May be consumed by young children and pets
  - Environment: Contaminates soil and disrupts soil ecology (worms, ants, beetles, ground bees, soil microbes)

- PFAS in the 2 acres of plastic grass immediately starts contaminating the soil and groundwater nearby. Municipal water authorities and communities that rely on wells are not equipped to remove PFAS from drinking water supplies.

Synthetic Turf Pollution

And into streams, rivers, and oceans…

- Recent Spanish peer-reviewed study in *Environmental Pollution*, 15% of plastics in river and oceans are from plastic turf.
- Chinese study showed 12%.
- On land and in water, these microplastics are deadly when consumed by birds, fish, whales and countless other wildlife.



Recycling Myth:
How Many Synturf Fields Have Been Recycled?
"The Answer is None."

After well over a decade of assurances from industry that thousands of fields would be recycled and facilities were opening throughout the U.S.:

Testimony from Martha's Vineyard, MA Hearing, March 2021.

MV Commissioner:

"Can you tell me any fields that have been recycled that are in the United States and where they went and how many have been taken out?"

TenCate Representative, Mark Curran:

"The answer is none."

The Myth of Recycling Synturf

- There is no synturf recycling facility in the U.S. TenCate has no facility under construction. ReMatch has failed to build in PA-DEP violations.
- No evidence any US field has ***ever*** been recycled in any country
- ReMatch in Denmark is the sole known operational recycling facility, the plastic carpet/grass is recycled (10%) with limited utility.
- Shipping truckloads of Maryland synturf out of state is cost prohibitive. Shipping across oceans to another country-absurd! Carbon footprint?
- Zembla: The Turf Mountain Documentary (Netherlands) https://www.youtube.com/watch?v=Y5o3J7uy4Tk
- Shipping a field elsewhere to be dumped is not recycling.

So Where Does Old Synthetic Turf Go?

Turf that was later dumped in Baltimore county

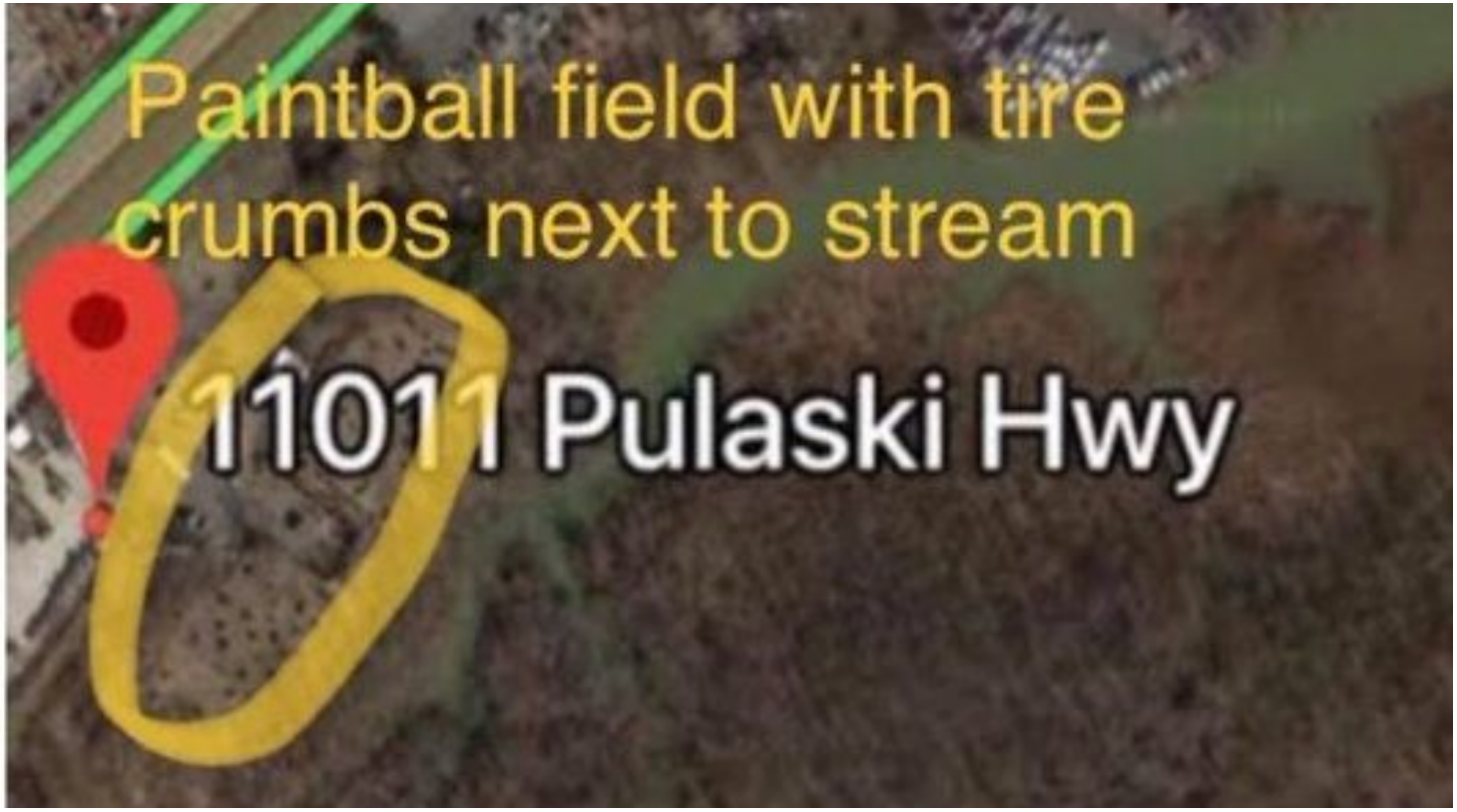
Turf dumped in Albemarle Co. VA

Under the best case scenario, synthetic turf has a life of just 8-10 years. Each time a field is replaced, it generates 440,000+ pounds of waste in a county where our sole landfill is overburdened.

A used tire is classified as waste and is regulated for public and environmental protection. But if 20k-40k tires are ground up and spread on a field as infill, they can later be dumped nearly anywhere (farm fields, woods, near streams, etc.).

Trucks have no debris containment as they transport the material.

Dumped Synturf: White Marsh near Bird River



Synturf is frequently dumped on private property where it contaminates the soil, groundwater, and watershed resources.

Synturf Disposal: Turf Dumps

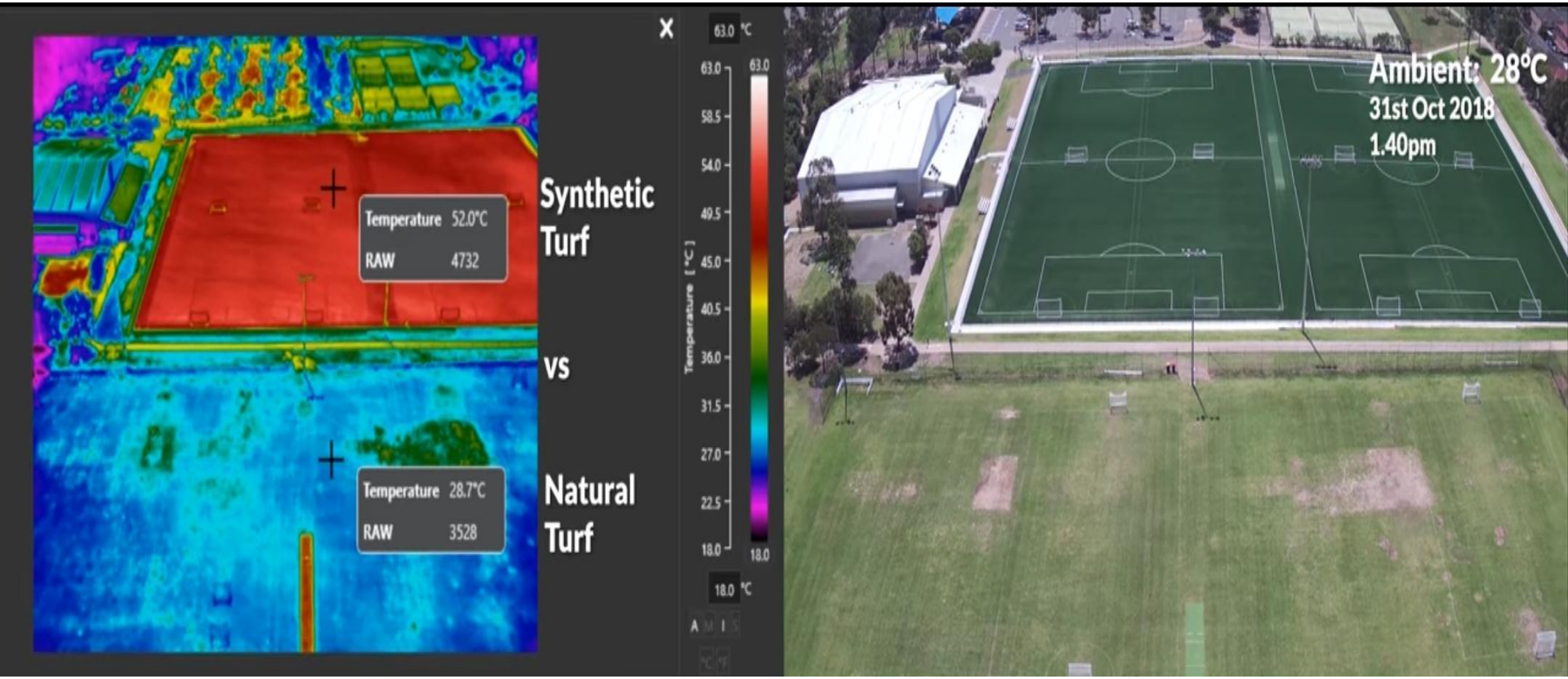
Waste with harmful chemicals dumped anywhere and everywhere.
Billions of pounds of waste across the country.

There is a solution-GRASS!

Black mulch | Synthetic | Asphalt | Natural turf

This synthetic field is 40 degrees hotter than grass

Synthetic turf reaches 125.6 F / 52.0C versus grass temperature at 82.4 F / 28.7 C



There is a solution: A well-engineered, well-maintained grass field

- People look at a natural turfgrass field in poor condition and think the only option is synthetic turf.
- A good natural turfgrass field is cheaper than synthetic turf to install and more cost-effective than synturf over time. Maintenance costs are not much different.
- Successful turfgrass fields require engineering and site-specific inputs – like a synthetic field gets automatically.
- Turfgrass: Proper site prep and drainage, plus soil amendment, suitable sod-grass, and maintenance by trained professionals with expertise.
- Did you know synturf requires grooming, infill replacement, disinfection, watering to cool and hydrate, and significant maintenance and testing? Failure to maintain will void the warranty, leaving the owner on the hook for premature replacement.

Synthetic turf needs replacement every 8-10 years. Will you get $500K to $1.3M every 8-10 years, per field?

Current Turfgrass Technology

Costs (Eight year lifespan):

Properly Designed Natural Grass Fields vs Synthetic

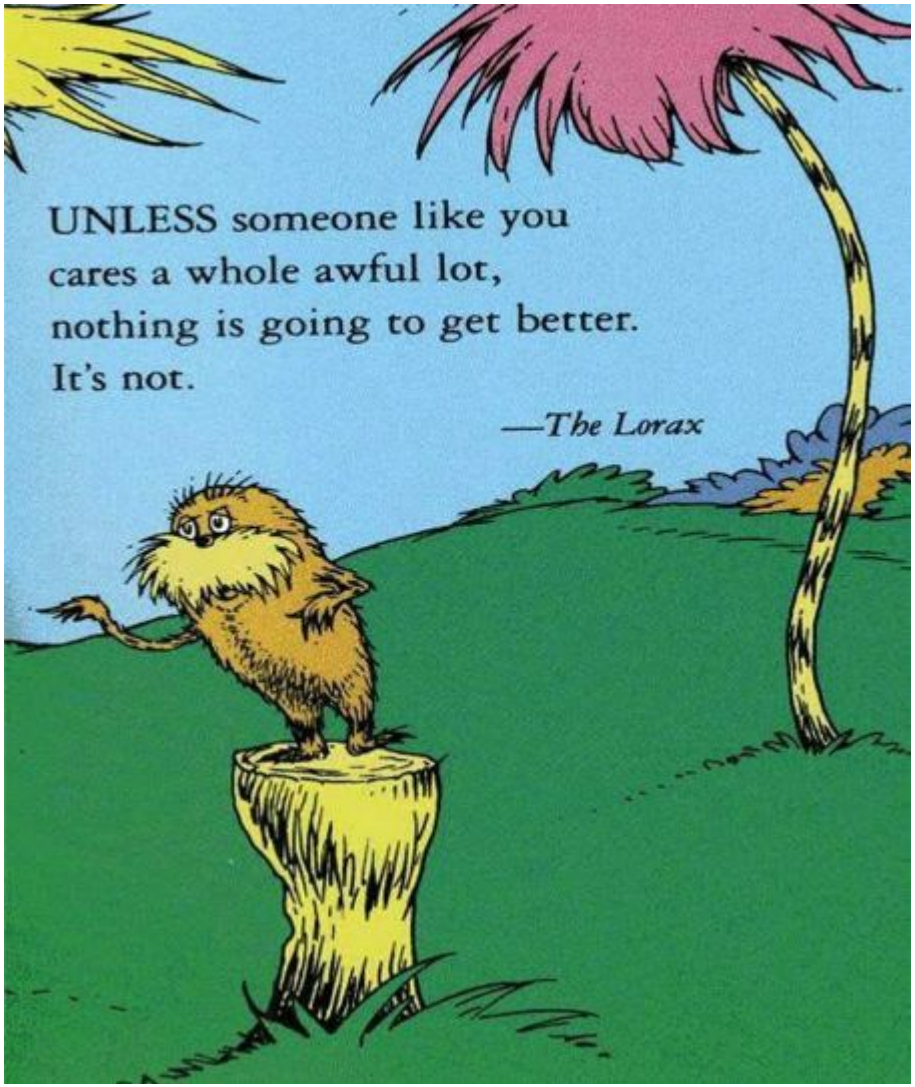
Natural turfgrass field 380'x225', 85,500 sf consisting of modified soil, drainage, irrigation and sod.

Capital Expenses		
Field construction, sand-based soil, irrigation, engineering, sod, etc.		$400,000
Replace 30,000 sf of sod down the middle of the field (2x/yr).	$60,000/yr x 8 years	$480,000
Strip sod from field, clean off organic layer over drainage lines, re-grade, and sod. Work recommended twice over 8 years.	$125,000 x twice	$250,000
Maintenance Expenses		
Yearly maintenance includes topdressing, fertilization, weed control, aerification.	$15,000/yr x 8 years	$120,000
	Eight year total cost	**$1,250,000**

Synthetic turf field 380'x225', 85,500 sf consisting of standard construction, engineering, stormwater, permitting, stone base, drainage, irrigation and artificial turf (eight year life span)

Capital Expenses		
Engineering, base, construction, irrigation system, carpet, infill, etc.	Average	$1,000,000
Maintenance Expenses		
Annual maintenance - grooming, disinfection, etc.	$6,000/yr x 8 years	$48,000
Yearly cleaning with Gmax testing	$3,500/yr x 8 years	$28,000
Add 10 tons of rubber every 4 years	$10,000 x twice	$20,000
Complete field replacement at 8 years		$400,000
	Proper disposal	*$400,000*
	Eight year total cost	**$1,896,000**

You Make the Choice for Our Children



Questions

For each of these: What warnings are given to communities? Are warnings posted prominently onsite and online?

- **Heat**: What are the protocols for monitoring field temp in county regulations or within the school district?
- **Injury:** Who is conducting Gmax testing, how often, and to what standard? Are injuries, concussions and turf burns reported?
- **Toxicity**: Are parents informed of toxins in the field? re players instructed to bathe immediately after play, and to carefully clean infill from cars, homes, clothes, shoes and equipment?
- **Funding**: How are fields funded, for capital and operating budgets?
  - Who manages the RFP process? Do RFPs call for including natural turf proposals?
  - Is the county using Project Open Space Funds for its fields?

Resources:

- Surface Temperature of Synthetic Turf, Penn State's Center for Sports Surface Research https://www.google.com/search?q=penns+state+heat+on+synthetic+turf&rlz=1C5CHFA_enUS925US925&oq=penns+state+heat+on+synt&aqs=chrome.1.69i57j33i10i160l4j33i299l2.9286j1j15&sourceid=chrome&ie=UTF-8

- Williams CF, Pulley GE. Synthetic surface heat studies. Provo (UT): Brigham Young University; 2002. Available from: https://aces. nmsu.edu/programs/turf/documents/brigham-young-study.pdf. Accessed March 2019.

- McNitt AS, Petrunak D. Evaluation of playing surface characteristics of various in-filled systems, Published at Penn State Extension, Department of Crop and Soil Sciences. November 2010. Available from: https://extension.psu.edu/evaluation-of-playing-surface-characteristics-of-various-in-filled-systems#section-26

- ESPN, Sources: Maryland OL Jordan McNair showed signs of extreme exhaustion. Available from: http://www.espn.com/college-football/story/_/id/24343021/jordan-mcnair-maryland-terrapins-died-heatstroke-team-workout.

- The dark side of artificial greening: Plastic turfs as widespread pollutants of aquatic environments https://www.sciencedirect.com/science/article/pii/S0269749123010965

- Reynolds, Casey, PhD. Natural Grass and Synthetic Turf Injury and Research https://sportsfieldmanagementonline.com/2020/01/03/natural-grass-and-synthetic-turf-injury-research/11008/

- Incidence of Knee Injuries on Artificial Turf Versus Natural Grass in National Collegiate Athletic Association American Football: 2004-2005 Through 2013-2014 Seasons, Am J Sports Med. 2019 May;47(6):1294-1301. doi: 10.1177/0363546519833925. Epub 2019 Apr 17. https://pubmed.ncbi.nlm.nih.gov/30995074/

Resources (continued):

- Mt. Sinai Childrens Environmental Health Center, Wrtitten testimony to Connecticut legislature, Feb. 16 2016 https://www.cga.ct.gov/2016/KIDdata/Tmy/2016HB-05139-R000216-Sarah%20Evans,%20Icahn%20School%20of%20Medicine%20at%20Mount%20Sinai-TMY.PDF
- Maryland Chapter of the Sierra Club https://www.sierraclub.org/maryland/synthetic-turf
- University of Tennessee Critical Fall Height Impact https://twitter.com/shockedfilm/status/975814298902638593
- Turf wars: The courtroom battle over artificial turf safety may be closer than we think https://www.reuters.com/legal/legalindustry/turf-wars-courtroom-battle-over-artificial-turf-safety-may-be-closer-than-we-2023-07-05/
- With Hotter Temperatures Come More Football Deaths And Black high school players are disproportionately affected., Jon Wertheim, OCT 7, 2022, https://www.si.com/high-school/2022/10/07/football-climate-change-daily-cover
- Maryland Synthetic Turf Field- Ongoing inventory: https://www.sierraclub.org/sites/www.sierraclub.org/files/sce/maryland-chapter/Campaigns/ZeroWaste/List%20of%20Synthetic%20Turf%20Fields%20in%20Maryland%20as%20of%20April%2022%2C%202022.pdf
- Maryland Sierra Club Zero-Waste https://www.sierraclub.org/maryland/disposal-synturf-fields

Resources (continued):

Zembla: The Turf Mountain (Netherlands) https://www.youtube.com/watch?v=Y5o3J7uy4Tk

Artificial Turf "Recycling" https://www.youtube.com/watch?v=9Wndy6dLJGk

https://peer.org/areas-of-work/public-health/artificial-turf/

Sports Turf Management Association, Grass Turf Best Practices
https://www.stma.org/natural-grass-athletic-fields/

Toxic 'Forever Chemicals" Infest Artificial Turf, *The Ecology Center*.
https://www.ecocenter.org/toxic-forever-chemicals-infest-artificial-turf

Toxic PFAS Chemicals Found in Artificial Turf, *The Intercept*, confirming the presence of PFAS in old synturf dumped in MA wetlands.
https://theintercept.com/2019/10/08/pfas-chemicals-artificial-turf-soccer/.

Dr. Greg Guyton, Ravens orthopedic surgeon testimony March 5, 2020 Opposing open space funding of for synturf due to injuries.
http://mgaleg.maryland.gov/mgawebsite/Committees/Media/false?cmte=app&clip=APP_3_5_2020_meeting_1&ys=2020rs

Jeff Miller, NFL VP on NFL synturf replacement.
https://www.nbcsports.com/nfl/profootballtalk/rumor-mill/news/report-nfl-data-shows-number-of-non-contact-injuries-were-almost-the-same-on-grass-turf-in-2021

Resources (continued)

Rodgers, Bethany, Turf recycler hit with environmental violations as it works to open PA plant ,*Bucks County Courier Times* April 2, 2023. https://www.phillyburbs.com/story/news/environment/2023/03/20/pa-officials-say-turf-recycler-is-violating-environmental-laws/69995371007/

Testimony Martha's Vineyard, MA Hearing, March 2021. Artificial Turf 'Recycling' A Decade-Long Deception. https://www.youtube.com/watch?v=9Wndy6dLJGk

WV Marching Band: https://www.wtrf.com/news/parents-and-students-react-to-band-members-overheating/1423706673

Artificial grass in parks as a potential new threat for urban bird communities 26 July 2022, https://www.cambridge.org/core/journals/bird-conservation-international/article/artificial-grass-in-parks-as-a-potential-new-threat-for-urban-bird-communities/55B131F50206D3DD485A57DE975C120C

4-16-23: PFAS research out of Sweden, February 2020 - Jeffrey Gearhart. Gearhart Presentation 16 Apr 2023, Arlington, MA. Dr. Jeff Gearhart, The Ecology Center, MI. https://www.youtube.com/watch?v=Z3OYx2axnlw