SAN FRANCISCO RECREATION AND PARK DEPARTMENT

Synthetic Playfields Task Force
Findings and Department Recommendations

REPORT TO
SAN FRANCISCO RECREATION AND PARK COMMISSION

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I. Executive Summary

In the last decade, the demand and popularity of synthetic turf fields has risen dramatically with the development of new turf technologies. Municipalities, schools, universities and professional sports teams worldwide have installed over 3,500 new-generation synthetic turf fields.

In 2004, a independent study commissioned by the Recreation and Park Department (the 2004 Recreation Assessment) found that San Francisco faced a significant playfield deficit. In order to meet standard player to playfield ratios, and meet existing demand, San Francisco would need to add 35 soccer fields and 30 baseball/softball fields. This research confirmed the every day experience of RPD staff; overwhelming demand for playfield time, coupled with limited maintenance resources, had resulted in many of the fields becoming run-down.

In an effort to find a long-term solution to address these demand and maintenance challenges, the Department installed synthetic turf at two city fields. From an operational and recreation programming perspective, the fields were a success, and in 2006, the Department formed a partnership with the City Fields Foundation to renovate additional playfields with synthetic turf.

The widespread adoption of these synthetic turf fields –as well as the significant variation in available synthetic turf products – has resulted in a heightened, and appropriate, level of scrutiny regarding the environmental and health impacts of synthetic turf materials. At this point, no scientific consensus exists on this topic. Any municipality interested in exploring these issues has had to develop its own "due diligence" process to discuss and debate the meaning, legitimacy, and relevance of the available scientific research.

SFRPD began by consulting the city's Department of Environment (SFE) and Department of Public Health (DPH). After consulting with colleagues in their respective fields and reviewing available research, neither department recommended a moratorium on playfields in San Francisco. Both departments identified legitimate questions and issues that would require further research. The Department of Environment specifically urged the use of a criteria-driven site selection process. These criteria, in keeping with the philosophy of the Precautionary Principle, should strive to maximize the benefits of the synthetic turf technology while actively limiting potential risks.

SFRPD staff requested the opportunity to further explore these issues and concerns with the public. On March 26, 2008 the San Francisco Recreation and Park Commission (Commission) established the Synthetic Playfields Task Force (Task Force) to review, discuss, and vet existing scientific research on synthetic turf playfields.

The Task Force was asked to achieve three key objectives:

1. Identify primary environmental and health concerns related to synthetic turf materials.
2. Synthesize the scientific research available and discuss relevance to San Francisco playfields.

3. Provide feedback to inform Department recommendations and a course of action to the Commission.

It is important to clarify that the Task Force did not explore or compare the operational, recreational, or maintenance benefits of synthetic turf and natural turf. This discussion had occurred as part of the Commission's initial deliberations regarding the installation of synthetic turf. Rather than revisit the earlier deliberation, the Task Force was asked to focus their efforts on gathering and synthesizing scientific data not available during the Commission's initial discussions on synthetic turf.

The task force identified 11 environmental and health issues of public concern, and for which there was thought to be readily available research. Study teams, comprised of subject matter experts and park users, were assigned to review the research on each issue, synthesize the findings, discuss strengths and weaknesses of the research, assess the relevance of the research to San Francisco's playfields implementation, and, identify suggestions and recommendations for Department staff to make to the Commission.

The Task Force's thoughtful, constructive suggestions and recommendations are described throughout this report. At the final meeting of the Synthetic Playfield Task Force, members asked that staff emphasize the following Task Force recommendations to the Commission:

- **Explore synthetic turf infill alternatives to SBR rubber.** Task Force members urged the Department to seriously investigate and explore the use of alternate infill materials to SBR rubber. Available alternatives exist that contain organic material, and/or more post-consumer recycled content.
- **Meet with the California Environmental Protection Agency (Cal EPA) and SFDPH to determine feasibility of conducting further studies on ingestion exposure.** RPD should, in consultation with Cal EPA and SFDPH, determine the need for a study on risks associated with ingestion exposure, and identify opportunities to collaborate if deemed necessary.
- **Use a criteria-driven site selection process.** The criteria utilized to select field sites should be expanded to reflect task force suggestions for avoiding potential risks, and focus on maximizing the known health, environmental, and recreational benefits of the synthetic turf fields.
- **Do not purchase synthetic turf products with lead.** The US Consumer Product Safety Commission recently completed their evaluation of various synthetic athletic fields. The evaluation states that polyethylene fields did not release amounts of lead that would be harmful to children; nonetheless, different field products contained varying amounts of lead. The Task Force urged the Department to purchase those products with the lowest lead content possible.

Department staff, in response to these and other issues and suggestions raised by the task force, have also crafted a set of recommendations to the Commission on how to improve the synthetic turf implementation process. These recommendations are described in summary in Section II of this report.

This report presents a summary of the process, proceedings, and deliberations of the Task Force and final Department recommendations to the Commission for improving synthetic turf playfield renovations.

The Department recognizes and appreciates the diligence of the Task Force and the value of their research and discussions about synthetic turf. With the Commission's approval, the Department is prepared to implement the recommendations in this report and continue our efforts to expand recreation opportunities for our many park users.

II. Summary of Recreation and Park Department Staff Recommendations

During the Task Force's discussion, Task Force members made many thoughtful suggestions on how the Department could address many of the public's environmental and health concerns. In response, Recreation and Park Department staff developed the following recommendations to improve implementation of the Playfields Initiative.

These recommendations are outlined below. They are organized by implementation phase, beginning with one-time action items, and continuing through to actions that will be executed for each playfields project.

IMMEDIATE IMPLEMENTATION

Post Task Force Action (Program)

Immediate action items with conclusion

1. The Department should review, and if necessary, revise language in permit documents to emphasize good hygiene, such as washing hands after playing, and practicing standard first aid for skin wounds to prevent infection, regardless of the type of turf.
2. The Department should install signage at renovated fields with health and safety guidelines for players. *(completed fields)*
3. Although the Department does not believe that antimicrobial agents are needed on fields, staff should reevaluate this additive option with both the Health Department and the PUC to determine if there is a net benefit.
4. The Department should conduct or participate in field temperature testing at existing synthetic turf fields in San Francisco. *(one time test process)*
5. The Department should monitor a leachate study currently underway at Stanford University.
6. The Department should work with CalEPA to develop one-time air quality tests on a subset of existing synthetic turf fields.
7. The Department should continue to track CalEPA's studies of particulates, which may be underway in the next year or two.
8. The Department should conduct or participate in tests of field stormwater runoff to determine the presence and potential levels of zinc and other possible contaminants. *(on existing fields)*

Immediate action items with continued monitoring

9. The Department should continue to review literature and new studies as they become available.
10. The Department should contact the NCAA to see if they are planning to publish injury data associated with use of synthetic turf using the information from their injury tracking system.

11. The Department should request MSDS sheets from turf vendors, which provide data on flammability testing and consult the fire department on product literature. The Department should continue to monitor performance and reliability of companies with new rubber free infill alternatives.
12. The Department should examine alternative infill products that do not contain zinc.
13. The Department should continue to increase access and play time on athletic playfields to promote physical activity among children, youth and adults.
14. The Department should continue to request feedback from user groups using new products rather than relying on manufacturers for quality and performance information. New York and New Jersey are leading the way, and the Department will know more about performance, playability, safety, and longevity of new products within the next three years.
15. The Department should work with SFE staff to continue encouraging turf manufacturers to initiate and implement end-of-product-life recycling programs.
16. The Department should search for turf companies that use post-consumer recycled content in their material.

Field Selection Process (Program)

1. As part of the Department's evaluation of future fields, identify opportunities to convert asphalt play space into synthetic turf.
2. Work with the Director of the Natural Areas Program to assist with site selection, including field selection criteria.
3. The Department should not install synthetic turf fields in areas of parks that are prone to flooding.

PROJECT RECOMMENDATIONS (Implemented for each playfield site)

Planning (Project)

1. The Department should continue its standard practice of submitting each project to the Planning Department for general plan review as well as a California Environmental Quality Act (CEQA) review.

Design Development (Project)

1. The Department should consult with native landscaping specialists to plant native, drought tolerant and wildlife-friendly trees, shrubs, and groundcover around renovated playfield sites as appropriate.
2. With all new synthetic turf projects, the Department should provide appropriate landscape and irrigation improvements to all impacted areas surrounding the field.
3. The Department should request MSDS sheets from turf vendors, which provide data on flammability testing and consult the fire department on product literature. The Department should continue to monitor performance and reliability of companies with new rubber free infill alternatives.
4. The Department should not purchase field products that contain hazardous levels of lead.
5. When purchasing new turf projects, RPD should request full material composition disclosures and share them with DPH and SFE for feedback.

Construction Documents (Project)

1. If the stormwater runoff meets drinking water standards, the Department should recharge it into groundwater, if feasible. If the water does not meet drinking water standards, the Department should collect runoff for discharge into the sewer system, where it will be treated appropriately.
2. Immediately following storm events, any stormwater discharge should be managed on site to support efforts to manage the City's overall storm water system.
3. All synthetic turf fields should be installed above the water table and feature state of the art drainage systems.

Construction (Project)

1. The Department should install signage at renovated fields with health and safety guidelines for players. *(new projects)*

On-going Tasks (Program)

1. The Department should conduct or participate in tests of field stormwater runoff to determine the presence and potential levels of zinc and other possible contaminants.
2. The Department should examine alternative infill products that do not contain zinc.
3. The Department should continue to increase access and play time on athletic playfields to promote physical activity among children, youth and adults.
4. The Department should continue to request feedback from user groups using new products rather than relying on manufacturers for quality and performance information. New York and New Jersey are leading the way, and the Department will know more about performance, playability, safety, and longevity of new products within the next three years.
5. The Department should work with SFE staff to continue encouraging turf manufacturers to initiate and implement end-of-product-life recycling programs.
6. The Department should search for turf companies that use post-consumer recycled content in their material.

III. Additional City Department Recommendations: Department of Public Health (DPH) and Department of the Environment (SFE)

RPD's General Manager Yomi Agunbiade asked San Francisco's Department of the Environment (SFE) and Department of Public Health (DPH) to review the scientific research and data available on issues of concern to the public, assess risks associated with these issues, and make recommendations to the Department.

SFE began its study of synthetic turf in June 2006, with a focus on determining if brominated flame retardants were present in synthetic turf materials. SFE continued compiling reports, reviewing research, and interviewing professional colleagues on the subject, and published reports in October, 2007, that summarized the findings of their past and current research.

Neither SFE nor DPH found an unacceptable or imminent risk that warranted a moratorium on synthetic turf installation in San Francisco; both SFE and DPH made recommendations to eliminate, avoid, or reduce potential and/or unknown risks during the implementation of the Playfields Initiative.

San Francisco Department of Environment Findings

The Precautionary Principle guides SFE's review and evaluation of the environmental impacts of city programs and initiatives.

It is important to note that the Precautionary Principle does **not** advocate the avoidance of any and all potential environmental risks.

The Principle does advocate for a public process in which the benefits of an action or technology are weighed against potential risks. The deliberation that occurs should explore and assess available alternatives for comparative risks, related financial and resource costs, and other immediate and long-term consequences.

In keeping with the basic tenets of Precautionary Principle, in January 2008 San Francisco Department of the Environment (SFE) issued a letter making the following *key conclusions*:

1. SFE recognizes potential environmental advantages and disadvantages from synthetic turf use.
2. SFE recognizes that human health risks are minimal from exposure to the crumb rubber infill used with synthetic turf products, according to the OEHHA study[1]. SFE recommended a precautionary approach to assessing these risks due to the lack of established reference doses for some ingredients.

[1] In January 2007 the California Office of Environmental Health Hazard Assessment (OEHHA) published three studies for the California Integrated Waste Management Board (CIWMB) that evaluated rubberized matting used in playgrounds. The CIWMB needed to gain a better understanding of the potential health risks to children using outdoor playground and track surfaces made of recycled waste tires. In addition to an evaluation of toxicity, OEHHA also tested the playground surfaces for their ability to attenuate fall-related impacts and the potential of the rubberized surfaces to impact the local environment. CIWMB manages a grant program to promote markets for recycled-content products derived from waste tires in California. The OEHHA study found no evidence that rubberized matting used in playgrounds, a material similar in composition to synthetic turf infill, would cause danger or harm to human health or the environment.

3. SFE is concerned that there is currently no system available to recycle used synthetic turf, even though most of the products are composed of polyethylene, an easily recyclable plastic.
4. SFE recommends that RPD specify the use of recycled content materials in the manufacturing of artificial turf.
5. SFE recognizes the potential for aquatic toxicity from synthetic turf leachate, but also notes that leachate concentrations will not approach levels of concern in normal installations above water table.
6. There are several other potential health-related issues related to synthetic turf that are outside the scope of their review, including differences in sports injuries on synthetic turf vs. natural turf, and the potential for spreading methicillin-resistant Staphylococcus aureus (MRSA) among players.

San Francisco Department of the Environment Recommendations:

1. Create transparent selection criteria for determining which playing fields will have synthetic turf installed. These criteria should include the selection of sites that are not prone to flooding.
2. Confine installations of synthetic turf to the sites where its other benefits are maximized.
3. Due to the need for information regarding potentially toxic constituents, require full ingredients disclosure from manufacturers.
4. If hand-to-mouth exposure by children can be reasonably expected, post signs reminding parents to wash children's hands after play.
5. Due to concerns over end-of-life disposal, require that synthetic turf vendors guarantee take back of the product at end of life, and provide documentation that the product is recycled.
6. Pursuant to the ordinance regarding the use of recycled content materials in Public Works construction, SFE recommends that post-consumer recycled content materials be specified in the manufacturing of all components comprising artificial turf.
7. Do not permit the use of disinfectants on synthetic turf areas without full review by the Department of Public Health.
8. Obtain comments from the San Francisco Public Utilities Commission on both the potential water conservation benefits and the leaching concerns associated with synthetic turf products.
9. Obtain comments from the DPH Environmental Health Section on the human health risks discussed above.

San Francisco Department of Public Health Findings

In a February 2008 draft memorandum, SFDPH summarized their review of several reports, studies, and documents relevant to assessing the potential for health risk associated with artificial turf.

SFDPH concluded that the OEHHA study was a reliable and unbiased report which could be used as a primary basis for decision-making, and that its conclusions were supported by several other local, state and international government agencies that have considered the potential health risks associated with artificial turf fields.

In addition to the OEHHA report, SFDPH also reviewed the Environmental and Human Health, Inc (EHHI) report. SFDPH identified some potential biases in that report's methodology, and noted that the EHHI report does not assess the value of the information gathered with respect to likely exposure scenarios.

DPH's *conclusions and recommendations* were as follows:

> *"At this time SFDPH does not recommend a moratorium on the continued installation and use of artificial turf playfields in San Francisco. It may be helpful to perform air monitoring on artificial turf playfields in San Francisco during hot weather to help further assess relevant exposures to users in the breathing zone.*
>
> *We will continue to stay apprised of emerging research, to communicate with our expert colleagues and to follow national and international regulatory and legislative developments. We are committed to identifying and evaluating important research or policy developments in a timely manner to determine if there is good cause to reconsider this assessment."*

IV. Task Force Process and Proceedings

The Recreation and Park Commission established a 16-member Synthetic Playfields Task Force, and on May 6, 2008 the Department finalized the Task Force membership roster. Staff provided all members with a briefing binder that included national and international research, studies and media clippings including several of the references described in section IV of this report. The Department also created Web page archives to ensure public access to all Task Force proceedings including the member roster; briefing binder contents; research and publications; meeting agendas, transcripts, audio, presentations and notes; and contact information for the Department's Planning Director.

The archive can be found on the City of San Francisco Web site at the following address: http://www.parks.sfgov.org/site/recpark_page.asp?id=77040

Composition of Task Force

To facilitate a thorough and well-informed discussion, the Commission established the following "seats" for the task force:

- Five (5) Subject Matter Experts to offer expertise on:
  - Climate change and recycling policy
  - Public health impacts and risks (e.g. physical health, respiratory disease, etc.)
  - Water quality and conservation
  - Toxicity of synthetic turf materials
- One (1) seat from the Park, Recreation and Open Space Advisory Committee (PROSAC)
- Two (2) seats to represent citywide park policy and advocacy organizations
- Two (2) seats to represent park and field users
- Two (2) seats to represent park "neighbors"
- Two (2) seats to represent schools and other youth serving organizations

The public was invited to apply for seats on the Task Force and Commissioner David Lee selected the Task Force members.

Refer to Appendix A for the final member roster including 16 members and five (5) subject matter expert alternates.

Objectives and Proceedings

The Task Force was created with three main objectives:

1. Identify primary environmental and health concerns related to synthetic turf materials.
2. Synthesize the scientific research available and discuss relevance to San Francisco playfields.
3. Provide feedback to inform Department recommendations and a course of action to the Commission.

After reviewing and discussing background information, studies and news articles concerning synthetic turf materials, Task Force members formed study groups around the following topics of concern:

- **Bacteria/Staph Infection**
- **Climate Change and Heat Island Effects**
- **Ecosystem**
- **Injuries**
- **Material Composition: Overall Chemical Composition and Flammability**
- **Material Composition: Air Quality/Off Gassing**
- **Material Composition: Ingestion – Inhalation of Turf Product Materials**
- **Material Composition: Lead**
- **Obesity**
- **Turf Products: Alternative Field Products**
- **Turf Products: Recyclability**

The Task Force primarily addressed potential public health, safety and environmental risks. However, one study group subject, obesity, refers to the need and benefits of athletic playfields, especially in underserved neighborhoods, to help combat alarming obesity trends among children and youth.

The following section presents:

1) Each topic of concern including a short summary of the issue for background and context
2) Names and affiliations of study group member(s)
3) A brief summary of research considered by the study group
4) Summary of findings by study group

The Department wrote summaries of each issue area to convey the information in a digest format. Appendix B provides a master list of studies consulted by the Task Force study groups. Appendix C provides a list of acronyms found in this report. The complete and unedited versions of the study group reports are found in Appendix D.

A. Bacteria/Staph Infection

Summary of Issue and Concern

According to the federal Centers for Disease Control and Prevention (CDC), staphlyococcus aureus bacteria are one of the most common causes of skin infections in the United States. Most of these skin infections are minor and can be treated without antibiotics. However, these bacteria also can cause serious infections. MRSA (methicillin-resistant Staphylococcus aureus) is a type of Staphylococcus aureus bacterium that is resistant to common antibiotics.

Individuals who play high-contact sports or who are at high risk of abrasions and skin-to-skin contact, such as football players, may have a greater risk of acquiring skin infections, depending on whether or not they practice proper wound care and hygiene after playing.

Public concerns around the relationship between synthetic turf and bacterial infections are two fold: 1) does synthetic turf cause more and/or serious skin abrasions, and 2) is there a greater risk of bacteria growing on synthetic turf as opposed to other materials in the environment?

Study Group

June Weintraub, San Francisco Department of Public Health
Bruce Cohen, Athletic League
Richard Lee, San Francisco Department of Public Health

Research Considered

The study group referred to the February 2008 draft memo by SFDPH (summarized in section IV on page 11) that included a section discussing the potential risk of MRSA infection in relation to playfields. The memo was developed in consultation with Dr. Erica Pan, an SFDPH physician with considerable expertise in MRSA epidemiology. Dr. Pan emphasized that MRSA is not a problem on grass or synthetic turf because people get these infections from skin contact, open sores and contact with other people. To prevent infection, the Department of Public Health recommends proper wound care.

The SFDPH draft memo states that "MRSA is now a common disease in the community, primarily spread from skin to skin contact, and we are not aware of evidence that suggests artificial turf as a vehicle of infection. Any type of skin breakdown, including "turf burns," may provide a portal of entry for infection thus in order to prevent MRSA or other infection, athletes and children should practice standard wound care in the event of turf burn, regardless of the type of turf on which the injury occurs."[2]

The study group found that little literature exists on the presence of bacterial growth on synthetic turf fields; however, of the research available, no data suggests that synthetic turf itself is a source of human pathogenic bacteria. One relevant study, by Penn State's Department of Crop and Soil Science. looked at bacterial populations in natural turf, synthetic turf, and other

[2] Weintraub, J., Lee, Richard. "Artificial Turf Playfields." Draft Memo to Recreation and Park Department, February 6, 2008

environmental surfaces. The study concluded: "there are generally lower numbers of total microbes present in the infill or fibers of the synthetic turf systems tested compared to natural turf grass root zones and Staphylococcus aureus bacterium were not found on any of the playing surfaces. Staphylococcus aureus bacterium were found on towels and other devices used by athletes. "[3]

In June 2008, Dr. June Weintraub contacted Dr. Marilyn Felkner, who has worked on MRSA issues in her role as epidemiologist for the state of Texas. Dr. Felkner communicated plans for an environmental study planned for Fall 2008. A new turf surface will be cultured before any play occurs, and then throughout a football season. They expect to collect about 150 samples, and though they are not doing any evaluation of an association with disease occurrence, the study will provide helpful information about the prevalence of staph and MRSA on the playing surface.

Summary of Findings by Study Group

Bacteria are ubiquitous in individuals and in the environment, and the study group did not find evidence that there is any greater risk to the public health from bacteria growing on a synthetic field versus bacteria found elsewhere in the environment. Any type of skin breakdown, including "turf burns," may provide a portal of entry for infection. To prevent infection, individuals should practice standard wound care in the event of any type of turf burn, natural or synthetic.

Study Group Recommendations

As with natural grass playfields, synthetic turf fields should be cleaned of litter and debris on a routine basis. The Department should: 1) Monitor future research about whether disease-causing bacteria grow on synthetic turf materials, and how long the bacteria would be expected to survive in the outdoors on synthetic turf. 2) Consider whether disinfectant should be used periodically to allay concerns about molds, fungus, and other bacteria.

B. Climate Change and Urban Heat Island Effects

Summary of Issue and Concern

The Intergovernmental Panel on Climate Change defines climate change as “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere.” Changes in atmospheric concentrations of greenhouse gases and aerosols, land cover and solar radiation all affect climate dynamics. There is very high confidence in the scientific community that human activities have caused accelerated warming. Human activities that affect climate warming include: fossil fuel burning (such as vehicle emissions), deforestation, and animal ranching, which produces methane gas, another greenhouse gas. Internationally and nationally, there is significant public attention on ways to reduce human impacts and reduce our “carbon footprint” since the biggest concern is the increase of carbon dioxide emissions from fossil fuel combustion.

[3] McNitt AS, Petrunak D, and Serensits T. A Survey of Microbial Populations in Infilled Synthetic Turf Fields. Pennsylvania State University Department of Crop and Soil Sciences. 2008. http://cropsoil.psu.edu/mcnitt/microbial/index.cfm

Urban heat islands are created when natural areas are replaced by impervious surfaces like rooftops and asphalt, which absorb heat during the day, and continue to do so after the sun sets. Synthetic turf materials are also impervious, and surface temperatures are higher than natural grass.

Urban heat islands were identified as a concern because they might lead to an increase in the demand for energy for air conditioning, intensify air pollution due to increased heat, and increase heat-related health problems. In recent years there has been a popular movement to create "living roofs" such as the one nearing completion on the new California Academy of Sciences museum in Golden Gate Park, to lessen the heat island effect caused by standard roofing material.

Study Group

Chris Geiger, San Francisco Department of the Environment
Chloe Good, Neighborhood Parks Council

Research Considered

In relation to global climate change, the study group consulted several sources and found a potential model for projecting carbon dioxide (CO2) impact in a study by the Athena Institute. Melissa Capria, the San Francisco Department of the Environment Climate Change Coordinator, reviewed the results of this study. The group noted that the Athena Institute model does not include some considerations for weighing the differences between natural and synthetic turf.

To study the potential impacts synthetic playfields might have on the local urban heat island effect, the group looked at a New York presentation on mitigating the effects of heat islands and a NASA Earth Observatory study that reported local effects for California urban areas.

Summary of Findings by Study Group

Climate Change Issue: The study group concluded that if the Athena Institute model is correct and broadly applicable to synthetic turf, it strongly suggests that the use of synthetic turf should be minimized and confined to the sites where its other benefits are maximized. It also highlights the need to recycle synthetic turf when it needs to be replaced.

Other factors to consider in looking at climate impacts of artificial turf versus grass scenario would be:

1. Emissions associated with fuel used in mowing/maintenance equipment.
2. Water usage and associated energy used for pumping.
3. Loss of soil sequestration benefit in the artificial turf scenario.
4. Emissions associated with pesticides and fertilizer in the grass scenario.
5. Any emissions associated with disposal of waste in either scenario (it is unclear whether grass clippings are being composted which would address this issue in that scenario).
6. Vehicle emissions associated with increased use of the fields.
7. Energy used for lighting the fields at night if they were not lighted before.
8. On the adaptation to climate change impacts side - ability to absorb stormwater.

9. The urban heat island affect

Heat Island Issue: In areas of San Francisco, extended periods of intense sunlight could potentially raise the field temperatures to a level that can contribute to the urban heat island effect. With the numerous microclimates in San Francisco, some neighborhoods would be impacted greater than others. For example, heat island effects would be a greater concern on the eastern side of San Francisco compared to western neighborhoods, which experience cooler temperatures and less sunlight due to fog.

Study Group Recommendations

Due to increased carbon dioxide emissions and heat absorption of synthetic turf when compared to natural grass, the use of synthetic turf should be balanced against the benefits, criteria should be developed for selecting suitable installation sites, impacts can be reduced through offsets, site selection should maximize its benefits, and, if possible, recyclable turf should be used to reduce overall emissions compared to virgin material.

Synthetic turf fields reach much hotter temperatures than natural turf during hot summer days. While this may not be a problem in the generally cool San Francisco climate, the city might consider specifically monitoring field temperatures if a heat wave occurs to determine whether play should be suspended.

C. Ecosystem

Note: The study group did not prepare a formal written summary. The Task Force discussed this issue during the June 11, 2008 meeting, and the transcript is available in the Web site archive noted in Section V.

Summary of Issue and Concern

Task Force members raised concerns that the removal of grass playfields would adversely impact the local ecosystem.

Study Group

Arleen Navarret, San Francisco Public Utilities Commission
Matt Fuller, Audubon Society

Research Considered

The study group did not find independent studies that specifically addressed this topic in relation to synthetic playfields. However, they found one study commissioned by the King County Water and Land Resources Division in Seattle that looked at the water quality of synthetic turf runoff. The researchers found that the runoff had no effect on the test organisms and met all state and federal water quality standards.

Summary of Findings by Study Group

The study group could not find relevant studies to reference.

In the absence of any specific data on this issue, the study team summarized their concerns regarding potential ecological impacts from the installation of synthetic turf.

The study team noted that habitat fragmentation can lead to a loss of biodiversity. Habitat fragmentation occurs when development interrupts wildlife migration corridors and disrupts reproductive behaviors. San Francisco has a number of ecologically sensitive parks, as well as several federally endangered or threatened species.

To date no negative effects to the local ecology have been observed in the vicinity of any artificial turf field in San Francisco.

Study Group Recommendations

When considering sites for field renovations with synthetic turf, the Department should consider sensitive species occurring in parks. One suggestion was to consider the installation of turf on a case-by-case basis. For example, consider the difference between the ecological impacts of removing existing grass versus asphalt for replacement with a synthetic field.

The study group also recommended that the Department conduct an environmental or biological assessment prior to selecting a particular site.

D. Injuries

Summary of Issue and Concern

While San Francisco athletes have reported that the city's uneven natural grass athletic fields have led to many sprained ankles, Task Force members were interested in finding research studying the potential for injury on grass turf versus natural turf. In addition, before the new-generation of synthetic playfield technology, artificial turf fields did not have materials, such as rubber, to absorb shock and impact.

Study Group

Jeanne Darrah, Garfield Square Park User
Dr. Robert Harrison, UCSF Occupational and Environmental Health

Research Considered

Most of the studies found by the study group compared the potential for injury on artificial and natural turf for football players. One study looked at young female soccer players and found that the risk of acute injures was the same on both natural and synthetic turf. Other studies related to football injuries suggested that there may be slightly more injuries on synthetic turf. At the same time, while synthetic turf injuries were less frequent, natural grass injuries were more serious head, clavicle and knee injuries.

Summary of Findings by Study Group

The study group found that injury rates appear to be most closely related to the type of sport and no significant differences were found for injuries on artificial turf when compared to well-maintained natural turf. However, two studies found more skin abrasions on artificial turf, which could contribute to infections if not properly cared for with first aid.

Only about four studies were located comparing injury rates on the new generation of artificial turf fields to rates on natural turf. Injury rates were generally comparable, although in some cases the numbers of injuries may have been too low to detect real differences. The NCAA has an injury tracking system that may provide valuable data on this topic in the future.

Study Group Recommendations

The study group did not recommend additional action. However, they noted that the Department should stay apprised of future studies that look at injury rates related to baseball.

E. Material Composition: Overall Chemical Composition and Flammability

Summary of Issue and Concern

Much of the confusing information in the public arena relates to concerns about the materials that make up turf and their risk to public health and the environment. Most of the synthetic turf fields contain crumb rubber infill along with padding and drainage systems.

Polyaromatic Hydrocarbons (PAHs) are present in car exhaust, smoke, urban soil, charbroiled foods and food, particularly seafood. Volatile Organic Compounds (VOCs) are released into the air from gasoline, paint, building materials and many other sources. At much higher levels, PAHs and VOCs can cause serious health effects. Studies to date have found the presence of PAHs and volatile organic compounds VOCs in the crumb rubber but not at levels that are dangerous to humans. Several studies have concluded that health effects are unlikely from exposure to the levels of chemicals found in synthetic turf. Crumb rubber can also contain small amounts of heavy metals, which are discussed below and in sections G. H. and I.

The concern about flammability arose because Task Force members and members of the public did not feel confident in the information available on the flammability of the turf. They did not think the tests run by manufacturers took into consideration the possibility of vandalism. One person referred to vandalism that ruined a synthetic field in the Bay Area city of Richmond. In this incident, the vandals drove a vehicle into the middle of the field and set it on fire, burning the car and the turf underneath and around it.

Study Group

Chris Geiger, San Francisco Department of the Environment
Paul Ledesma, San Francisco Department of the Environment

Research Considered

The study group reviewed two 2007 studies commissioned by the San Francisco Department of the Environment titled, “Synthetic Turf Versus Natural Turf for Playing Fields” and “Occurrence

of Bromine, Lead, and Zinc in Synthetic Turf Components" by Philip Dickey, Staff Scientist, Washington Toxics Coalition. The studies were prepared to help the Department of Environment evaluate synthetic turf products.

The study group also researched relevant scientific literature and public reports, and made requests for information from various manufacturers on 22 synthetic turf products (12 manufacturers). In addition, they referred to the 2007 Office of Environmental Health Hazard Assessment (OEHHA) study evaluating the health effects of recycled waste tires in playground and track products for the California Integrated Waste Management Board.

Summary of Findings by Study Group

Predominant materials used in synthetic turf are fibers (polyethylene or nylon), infill (silica sand, cryogenic or ambient rubber, and backing material (polyurethane, polypropylene, various foams). Two turf products reviewed contain lead, possibly to act as a color fixative. The presence of lead in those products would not present a significant risk to field users because it is inaccessible in padding or other layers below the turf. Bulk materials contain various additives that may or may not be problematic. Rubber, for example typically contains some zinc, around 20% naphthenic/aromatic oil, and various other compounds. Plastics may contain brominated flame retardants, and PVC vinyl may contain a host of plasticizers and stabilizers such as lead and phthalates.

Testing by the Washington Toxics Coalition showed that brominated flame retardants are not present in the brands tested, except for a small amount in the shock pad of one product. Tests also showed significant lead in two products, especially in the nylon thread (encapsulated inside the polyethylene yarn). From a risk perspective, if the lead is inaccessible the risk is negligible. Therefore the presence of lead in padding or other layers below the turf may not be a concern for users of the turf. However, a precautionary principle approach to purchasing would seek to avoid products containing lead (i.e., nylon products). Zinc was present in infill materials, as expected.

A more complete review of flammability issues is desirable, although the flash point (the temperature at which a material will initially ignite) and autoignition data suggest that the hazard is minimal. The spread of flames was slow in two known playground fires involving loose-fill crumb rubber, and no one was injured. Both fires were intentionally started by juveniles who used matches, paper, and wood to ignite the crumb rubber.

For fiber used in synthetic turf, some manufacturers cite their products' passage of ASTM D 2859 Flammability (Pill test). This test relies on a point ignition source that might understate flammability hazards from arsonists. Most manufacturers claim that their product is nonflammable.

Given the incidents of fires in playgrounds with surfaces of shredded tires and in artificial turf fields with rubber infill, these artificial turf fields should be considered potentially flammable.

Study Group Recommendations

Choose turf products that are free of lead, since it is apparently not essential. Minimize the potential for zinc hazards through site selection and maintenance (i.e., no standing water) and choose infill materials that do not contain zinc, when feasible.

In addition, the Recreation and Park Department should consider obtaining an opinion or review of the flammability of synthetic turf from the San Francisco Fire Department.

F. Material Composition: Off Gassing

Note: The study group did not prepare a formal written summary. There is significant overlap with the issue areas summarized in sections E. and G. The Task Force discussed this issue during the May 29 and June 11, 2008 meetings. The transcripts are available in the Web site archive noted in Section V.

Summary of Issue and Concern

Preliminary testing conducted by the Connecticut Agricultural Experiment Station at the request of a nonprofit advocacy group EHHI discussed in Section IV showed that volatile organic compounds are released into the air (called off-gassing) from rubber pellets made from ground-up rubber tires, a fill material for several new-generation synthetic turfs (see sections E. and G.). While they did not find VOC levels to be a risk to human health, they suggested that additional studies should be conducted.

Study Group

Charlie Vidair, Office of Environmental Health Hazard Assessment (OEHHA)
Michael Vestel, Rolph Playground Neighbor

Research Considered

The group referred to the 2001-2003 Building Material Emissions Study conducted by the California Department of Health Services (DHS); J. C. Broderick & Associates air measurements above outdoor synthetic football fields in two high schools in New York State; a Norwegian Institute for Air Research study that measured the air over an indoor synthetic field; the Moretto study performed for the artificial turf industry; and also, the National Institute for Public Health and the Environment (Netherlands) study of the air over four outdoor soccer pitches made from synthetic turf.

Summary of Findings by Study Group

The group did not consider the level of off-gassing adverse to human health based on the studies they reviewed. They noted that the DHS study measurements were only taken from indoor flooring, and with products containing recycled tires, the emissions will vary since it is not a virgin material. The indoor study recommended that, prior to installation, products with odors and significant VOC emissions should off-gas in dry, well-ventilated space for 14 calendar days to allow for reasonable dissipation of odors and emissions prior to delivery to a project site.

There have been few studies that analyzed the air above these fields for volatile chemicals and particles. The largest study was performed in Norway. Calculations based on the measured levels of chemicals and particles suggested that adverse health effects would not occur in players using these fields, although significant uncertainties remained (i.e., not all chemicals identified and the absence of health-based screening levels for many chemicals and particles).

Study Group Recommendations

Determining if the recycled tire infill is a pollution source and health risk in the outdoors requires further research. It is suggested such experiments be performed at local San Francisco artificial turf installations such as Garfield Park. Such experiments should be done to mimic use by children as they are closest to the source (measured at child height, say 32 inches). Similarly, the sampling should be done both during use (running, etc.) and close to where the re-suspension will take place (e.g. close to the athlete's breathing zone). Measurements on hot and cold days should be performed.

G. Material Composition: Ingestion – Inhalation of Turf Product Materials

Summary of Issue and Concern

The three possible routes of exposure to chemicals are inhalation, ingestion, and skin absorption. Associations have been found between day-to-day inhalable particulate air pollution and an increased risk of adverse health outcomes related to risk to heart and lung health. While large particles are filtered through the nose and throat and do not cause problems, particles less than 10 microns (1/10th the diameter of coarse hair) in diameter (called PM10 and PM2.5) have strong relationships to adverse health effects. In the United States, health risk assessments follow PM10 and PM2.5 for regulating emissions. Ingestion and skin contact is a concern because small children are known to eat or mouth objects in their environment. Older youth and adults who come into contact with crumb rubber might inadvertently ingest or have skin contact with crumb rubber or from field dusts.

In January 2007 the California Office of Environmental Health Hazard Assessment (OEHHA) published three studies for the California Integrated Waste Management Board (CIWMB) that evaluated rubberized matting used in playgrounds. The CIWMB needed to gain a better understanding of the potential health risks to children using outdoor playground and track surfaces made of recycled waste tires. The OEHHA study researched each potential exposure pathway by conducting a literature search, an experiment to mimic the gastric environment of a young child exposed by ingestion, and by conducting an experiment to mimic chronic hand-to-surface-to-mouth activity. OEHHA found no evidence that rubberized matting used in playgrounds, material similar in composition to synthetic turf infill, would cause danger or harm to human health through ingestion, inhalation, or by skin contact.

Study Group

Charlie Vidair, Office of Environmental Health Hazard Assessment (OEHHA)
Michael Vestel, Rolph Playground Neighbor

Research Considered

The study group reviewed the OEHHA playground study and EHII study referenced above, other international and national studies by public agencies, and a study conducted by the turf manufacturers (also see section F.).

Task force member Michael Vestel also compiled extensive resources on the linkages between particulate matter and health outcomes; these references are included in the summary he prepared on this topic located in the Appendix.

Summary of Findings by Study Group

Adverse health effects were not expected from the exposure scenarios as modeled in each published study, either via inhalation or ingestion. When specifically analyzing tire shreds used as playground safety surfacing, which were which were found to emit thirteen metals and eleven organic chemicals in an indoor setting, a low risk of adverse health effects was calculated for a scenario of a one-time ingestion of 10 grams of shreds by a child. Exposure modeling suggests the identified chemicals would not cause health effects via inhalation in outdoor applications; however, most low-level chemicals were not identified and so could not be evaluated for health effects. Chemical release by rubber crumb used in synthetic fields is likely to be greater since the surface area/weight of rubber crumb is greater than that for rubber shreds.

The group could not find data on the concentrations of many of the chemicals released in outdoor settings. One study, by RIVM (Netherlands) did examine the air above four outdoor soccer pitches for the presence of nitrosamine, a known carcinogen. RIVM concluded that nitrosamines do not pose a health hazard to the users of the synthetic turf pitches.

However, to fully and accurately assess the potential for human health toxicity, accurate measurements of particulate matter, specifically PM10, PM2.5 and ultra fine particles are required. These measurements will provide the comparative data necessary to determine if a significant pollution risk exists due to the level, and/or chemical composition, of the particulate matter associated with outdoor synthetic turf.

Currently, the literature does not address this, though it does for indoor particulates from artificial turf.

Study Group Recommendations

The study group identified the current gaps in research and made recommendations for how the methodologies of several studies could be improved to yield more conclusive outcomes. In addition, determining if the recycled tire infill is a pollution source and health risk in the outdoors requires further research. As noted in the preceding section, it is suggested such measurements be performed at local San Francisco artificial turf installations such as Garfield Park. Such experiments should be done to mimic use by children as they are closest to the source (measured at child height, say 32 inches). Similarly, the sampling should be done both during use (running, etc.) and close to where the re-suspension will take place (e.g. close to the athlete's breathing zone). Measurements on hot and cold days should be performed.

H. Material Composition: Lead

Note: The study group did not prepare a formal written summary. There is overlap with the issue areas summarized in sections E. and G. The Task Force discussed this issue during the June 11, 2008 meeting. The transcript is available in the Web site archive noted in Section V.

Summary of Issue and Concern

According to the Centers for Disease Control, in general, children less than 6 years old are more likely to be affected by lead than adults because of increased contact with lead sources in the environment, including lead contaminated house dust and soil. Children also absorb lead more easily. Children's developing nervous systems are also more susceptible to the adverse health effects of lead including developmental delay and behavioral problems.

Study Group

Jeanne Darrah, Garfield Square Park User
Dr. Robert Harrison, UCSF Occupational and Environmental Health

Research Considered

June 18, 2008 Centers for Disease Control and Prevention (CDC) Public Health Advisory on the Potential Exposure to Lead in Artificial Turf submitted by email to the Department.

Summary of Findings by Study Group

The New Jersey Department of Health and Senior Services NJDHSS provided CDC information on limited sampling they conducted of athletic fields in New Jersey and commercial products. The results indicated that artificial turf made of nylon or nylon/polyethylene blend fibers contain lead at levels that may be a potential health concern. Artificial turf fields made with only polyethylene fibers contain very low levels of lead according to their tests.

Information provided by NJDHSS to CDC and Agency for Toxic Substances and Disease Registry (ATSDR) indicates that some of the fields with elevated lead in either dust and/or turf fiber samples were old, used frequently, weathered and visibly dusty. The CDC stated that these factors should be considered when evaluating the potential for harmful lead exposures from a given field.

The CDC also emphasized that although turf testing has been limited to the state of New Jersey, no cases of elevated blood lead levels in children have been linked to artificial turf on athletic fields in New Jersey or elsewhere.

Because it is unclear whether all artificial turf contains lead at this time, CDC and ATSDR only recommend testing artificial turf fields that appear worn or weathered. NJDHSS has asked the United States Consumer Product Safety Commission (CPSC)[4] to investigate this potential

[4] Since the study group shared its findings, the CPSC has issued the findings of its investigation. These may be accessed through their website at http://www.cpsc.gov/cpscpub/prerel/prhtml08/08348.html

problem and CDC and ATSDR are currently waiting for information from CPSC to help guide future public health recommendations and actions.

Study Group Recommendations

The study group recommends that RPD not purchase nylon[5] turf and choose lead-free products.

I. Obesity

Summary of Issue and Concern

Adults and children in California and across the country are facing alarming rates of obesity with a decline in physical activity. A July 2008 press release by The National Institute of Child Health and Human Development (NICHD) announced the conclusion of a long-term study that found a sharp drop in activity levels of American children between age 9 and age 15. NICHD wrote, "helping American children maintain appropriate activity levels is a major public health goal requiring immediate action."

Study Group

Jeanne Darrah, Garfield Square Park User
Dr. Robert Harrison, UCSF Occupational and Environmental Health

Research Considered

The group's findings were largely based on scientific studies and scientific opinions including: "Promotion of physical activity in children" by Floriani and Kennedy of the UCSF Dept. of Family and Healthcare Nursing; "Physical Activity Among Adolescents, When Do Parks Matter?" by Babey et al.; "Contribution of Public Parks to Physical Activity" by Cohen, et al.; and "Physical Activity and Neighborhood Resources in High School Girls" by Pate, et al. The group also reviewed The Trust for Public Land's 2005 publication, "Healthy Parks, Healthy Communities, Addressing Health disparities and Park Inequalities through Public Financing of Parks, Playgrounds, and Other Physical Activity Settings." The Trust for Public Land has publicized the issue of obesity and the potential for physical activity offered by parks to improve the health of youth and low income communities.

Summary of Findings by Study Group

According to the Trust for Public Land, low income communities of color have reduced access to community-level physical activity settings. Research has shown that physical activity is an effective strategy for obesity intervention (Floriani). Teens reporting no access to safe parks are more likely not to engage in any physical activity compared to teens with such access (Babey). Living close to a park is a critical determinant of park use and physical activity in low- income and minority communities (Cohen). The highest expenditure of energy was associated with soccer fields, playgrounds, basketball, tennis and volleyball courts as opposed to dog play areas, picnic shelters, baseball fields and open-space areas (Cohen). Female adolescent girls were more

[5] RPD has not purchased nylon turf. All synthetic field materials in use are polyethylene-based.

likely to engage in physical activity where there were multiple activities at one site, the site was well lighted and clean and safe (Pate).

In addition, after reviewing New York Department of Recreation and Parks data, the group also found that New York City is experiencing 28% more use time on artificial turf fields when compared to grass fields.

Study Group Recommendations

Consider focusing the installation of artificial turf fields in high density areas of the city and where natural turf maintenance is not feasible due to field overuse.

J. Turf Products: Alternative field products

Summary of Issue and Concern

In recent years, several new synthetic turf products have come to market. While a new alternative might prove to be the best available technology at some time in the future, today not enough is known about the alternatives, including their playability, performance over time, safety, recyclability, and the reliability of new vendors without a track record.

Study Group

Mollie Ward Brown, Parks Trust Board Member and Dan Mauer, RPD

Research Considered

The study group considered interviews and product information collected by Dan Mauer from numerous turf manufacturers over the last two years, searched the Internet for alternative products and manufacturers, and contacted other municipalities and schools to inquire about field types and experiences.

Summary of Findings by Study Group

According to RPD's Dan Mauer, the turf industry is an extremely volatile market and there are many companies emerging and failing on a regular basis. One turf manufacturer estimated that there are approximately 45 companies in the market selling turf products or individual components.

All turf companies appear to have similar product types with minor variations to their systems to distinguish their product lines. These variations include differences in fiber design and profile, length, or combination of fiber material (polyethylene/nylon), backing design, infill type and sub turf pads and drainage systems.

Most turf companies use all rubber (typically a polymer rubber called styrene-butadiene rubber or SBR or, in some cases, recycled tires) or a combination of rubber and sand as their primary infill product. Although there are alternative infill products available, most companies believe that rubber is the best infill product on the market because it has been field tested and proven

for performance. The goal of alternative infill products on the market is to address the concerns about SBR rubber (leaching, off-gassing, heat island).

All fiber material is made of either polyethylene or nylon or a combination of the two. Backing material is made of various layers of geo textile fabric layers with various binding and gluing styles. Some turf companies that use no infill or alternative infill products require a resilient backing material to prevent compaction as well as to meet fall attenuation requirements called GMAX[6] (a measure of the peak forces likely to be inflicted on the head as a result of impact from a fall). Currently, there appears to be only one company that has indicated that they have an active recycling component/program associated with their turf product. Further evaluation is required.

Study Group Recommendations

It is important to research and investigate all viable material options by requesting feedback from other users as well as examine the companies that provide the material and installation services. The Department should request Material Safety Data Sheet (MSDS) for products to compare safety or potential hazards.

Although it is important to pick the most appropriate material for the need, other variables related to vendor choice should be considered in the selection process including vendor fiscal status, experience, location, continued customer service, warranty, and recycling programs. Because the synthetic turf industry is changing rapidly to meet the needs of consumers, decisions made on new companies and products should be well researched to make sure that the Department receives and delivers the best product and service to park users. In addition, the Department should gather user feedback on alternative turf products from other municipal user groups.

K. Turf Products: Recyclability

Summary of Issue and Concern

Synthetic turf fields are expected to have a lifetime of 12+ years. Once they are worn down and require removal, the material will need to be landfilled, unless an alternative solution is identified.

Study Group

Paul Ledesma, San Francisco Department of the Environment
Robert Watkins, Labor – Local 261

[6] Refer to American Society for Testing and Materials (ASTM) F355 Standard test method for shock-absorbing properties of playing surface systems and materials, and F1936 Standard specification for shock-absorbing properties of North American football field playing systems as measured in the field.

Research Considered

Interviews with synthetic turf manufacturers and distributors provided by Dan Mauer, RPD.

Summary of Findings by Study Group

End-of-life issues are both an economic and environmental concern. Disposal costs are expected to increase significantly in the next decade. According to the City of Larchmont, California, when an 80,000 sq. ft. field required replacing, it created 400 tons of debris that the city needed to manage.

Currently, there appears to be only one company in the industry that recycles this material at the end-of–life. However, several manufacturers are developing programs to both reclaim turf and use materials containing post-consumer content in new products. Other interviewees expressed varying degrees of understanding of recycled content materials. All expressed a willingness to commit their companies to end-of-life recycling for their products.

Study Group Recommendations

Choose vendors willing to guarantee that turf materials will be recycled to the highest and best use. Procure turf materials containing post-consumer content when possible and select those materials pursuant to Ordinance 53-07 (Public Works – Use of Recycled Materials). Continue to negotiate and create pressure on manufacturers to innovate and use post-consumer content in the manufacturing of synthetic turf.

L. Water Quality

Summary of Issue and Concern

Some of the materials found in synthetic turf contain heavy metals and known carcinogens, including zinc, lead, cadmium, and mercury. Because it is well known that these compounds can leach into water, the Study Group members sought to understand the current scientific knowledge concerning the quantity, toxicity, and longevity of these harmful chemicals that could potentially leach into the groundwater and environment.

Study Group

Ellen Levin, San Francisco Public Utilities Commission
Steve Hagler, Neighbor

Research Considered

The Study Group reviewed 22 studies and papers, including several that identified heavy metals and known carcinogens associated with synthetic turf, several that measured the amount of heavy metals in turf leachate, several that documented the concentrations of leachate over time, and several that measured the area affected by leachate.

Summary of Findings by Study Group

Studies reviewed show that concentrations of heavy metals in leachate from synthetic turf and/or materials used in synthetic turf (i.e. crumb rubber from recycled tires, tire shreds, etc.)

can exceed national and state water quality standards[7][8][9][10] (zinc up to 14x the national standard in one test), however the concentrations decreased to safe standards after a few months.[11][12][13][14] It should be noted that these tests were performed in the laboratory and not under natural conditions, which may alter results.

Additional studies found that toxic substances that leached were very localized and did not affect a large area.[15][16] It was emphasized that, while there may be some water quality impairment from metals, PAHs, and toxics, these impacts pale in comparison to the leaching of tire scrap storage in landfills.

The Study Group found that more evidence is needed about the resultant environmental effects of artificial turf leachate. Because of this unknown, the Study Group found that turf leachate risks could be lessened by locating synthetic fields in locations that do not flood and by lining the fields so that leachate could be collected and diverted into the wastewater system, allowing it to be processed by the City's wastewater treatment facilities. The Study Group also discussed the possibility of installing turf only after leachate concentrations have declined to lower levels.

Study Group Recommendations

The Study Group identified several recommendations related to water quality issues associated with synthetic turf. Primarily, limiting the materials containing heavy metal in the synthetic turf would avoid water quality concerns entirely. In the event that it is not possible to avoid such materials, there are several actions that should be considered in installing synthetic turf. They are presented below:

- Avoid leachate from infiltrating the groundwater basin by collecting it and retaining it, particularly during storm events, for eventual discharge to the City's sewer system; or

- Request (from manufacturer) or perform leachate tests on synthetic turf to determine if the leachate meets drinking water quality standards before allowing it to infiltrate the groundwater basin. If the leachate does not meet drinking water quality standards, avoid groundwater infiltration until studies can be performed to understand any potential

[7] "Examination of Crumb Rubber Produced from Recycled Tires." Department of Analytical Chemistry at the Connecticut Agricultural Experiment Station.
[8] "Environmental Risk Assessment of Artificial Turf Systems." Norwegian Institute for Water Research 2005.
[9] Preliminary Artificial Turf Leachate Study, Santa Clara Valley Water District.
[10] "Coordinated Laboratory and Field Investigation of the Impact of Artificial Turf Leachate on Groundwater and Surface Water Quality." Cheng and Reinhard, Stanford University
[11] "Field Study of Water Quality Effects of Tire Shreds Placed Below the Water Table." Dana N. Humphrey, Lynn E. Katz.
[12] French National Institute for Industrial Environment and Risks (INERIS)
[13] "Toxicological Evaluation for the Hazard Assessment of Tire Crumb for Use in Public Playgrounds." J Air and Waste Management Association.
[14] "Environmental and Health Assessment of the Use of Elastomer Granulates as Infill in 3rd-Generation Artificial Turf." Robert Moretto, EEDEMS.
[15] "Evaluation of Health Effects of Recycled Waste Tires in Playground and Track Products." California Office of Environmental Health Hazard Assessment, Jan 2007
[16] "Assessing the Health and Environmental Impact from the Use of End-of-Life tire Rubber Crumb as Artificial Turf in Sports Arenas." ALS Laboratory Group.

impacts on groundwater quality. If the study results indicate that groundwater quality will not be impacted, infiltration may be appropriate. This action should be followed in consultation with the SFPUC and DPH.

V. Key Findings and Department Recommendations

The conversation about synthetic turf is occurring, in part, because the modern generation of synthetic turf is new and evolving. Like all new technologies, it is under scrutiny, which will hopefully result in continued product improvement. As described in Section III, subject-matter experts from San Francisco's Department of the Environment and Department of Public Health provided important recommendations for improving the playfield renovation program. Following those recommendations, Task Force members and members of the public raised additional questions and made key recommendations to the Department. These findings helped the Department to formulate recommendations for improving the playfield renovation projects. Those recommendations are provided in Table 4.

Table 4: Department Recommendations for each Issue Area

Issue Area	Department Recommendations
A. Bacteria/Staph Infection	1. The Department should review and revise language in permit documents to emphasize good hygiene, such as washing hands after playing, and practicing standard first aid for skin wounds to prevent infection, regardless of the type of turf. 2. The Department should install signage at renovated fields with health and safety guidelines for players. 3. Although the Department does not believe that antimicrobial agents are needed on fields, staff should reevaluate this additive option with both the Health Department and the PUC to determine if there is a net benefit.
B. Climate Change & Heat Island Effects	1. The Department should conduct or participate in field temperature testing at existing synthetic turf fields in San Francisco. 2. As part of the Department's evaluation of future fields, identify opportunities to convert asphalt play space into synthetic turf.
C. Ecosystem	1. Work with the Director of the Natural Areas Program to assist with site selection, including field selection criteria. 2. The Department should consult with native landscaping specialists to plant native, drought tolerant and wildlife-friendly trees, shrubs, and groundcover around renovated playfield sites as appropriate. 3. With all new synthetic turf projects, the Department should provide appropriate landscape and irrigation improvements to all impacted areas surrounding the field. 4. As part of the Department's evaluation of future fields, identify opportunities to convert asphalt play space into synthetic turf. 5. The Department should continue its standard practice of submitting each project to the Planning Department for general plan review as well as a California Environmental Quality Act (CEQA) review.

Table 4: Department Recommendations for each Issue Area	
Issue Area	**Department Recommendations**
D. Injuries	1. The Department should continue to review literature and new studies as they become available. 2. Contact NCAA to see if they are planning to publish anything ont his topic using the data from their injury tracking system.
E. – H. Material Chemical Composition	1. The Department should continue to review literature and new studies as they become available. 2. The Department should request MSDS sheets from turf vendors, which provide data on flammability testing and consult the fire department on product literature. The Department should continue to monitor performance and reliability of companies with new rubber free infill alternatives. 3. The Department should not purchase field products that contain hazardous levels of lead. 4. The Department should conduct or participate in sampling to test existing San Francisco synthetic turf fields for lead. 5. The Department should conduct or participate in tests of field stormwater runoff to determine the presence and potential levels of zinc and other possible contaminants. 6. If the stormwater runoff meets drinking water standards, the Department should recharge it into groundwater, if feasible. If the water does not meet drinking water standards, the Department should collect runoff for discharging into the sewer system, where it will be treated appropriately. 7. Immediately following storm events, any stormwater discharges should be managed on site to support efforts to manage the City's overall storm water system. 8. The Department should examine alternative infill products that do not contain zinc. 9. The Department should monitor a leachate study currently underway at Stanford University. 10. The Department should work with CalEPA to develop one-time air quality tests on a subset of existing synthetic turf fields. 11. The Department should continue to track CalEPA's studies of particulates, which may be underway in the next year or two. 12. The Department should not install synthetic turf fields in areas of parks that are prone to flooding. 13. All synthetic turf fields should be installed above the water table and feature state of the art drainage systems. 14. When purchasing new turf projects, RPD should request full material composition disclosures and share them with DPH and SFE for feedback.

Table 4: Department Recommendations for each Issue Area	
Issue Area	**Department Recommendations**
I. Obesity	1. The Department should continue to increase access and play time on athletic playfields to promote physical activity among children, youth and adults.
J. - K. Turf Products: Alternative Field Products and Recyclability	1. The Department should continue to request feedback from user groups using new products rather than relying on manufacturers for quality and performance information. New York and New Jersey are leading the way, and the Department will know more about performance, playability, safety, and longevity of new products within the next three years. 2. The Department should work with SFE staff to continue encouraging turf manufacturers to initiate and implement end-of-product-life recycling programs. 3. The Department should search for turf companies that use post-consumer recycled content in their material.

VI. Conclusion

Throughout the proceedings, Task Force members were very thoughtful and provided an invaluable service to the Department and San Francisco residents. The group's proceedings led to a comprehensive record of legitimate concerns and relevant research. Multiple perspectives from scientists, subject matter experts and community members allowed for a diverse public forum and the synthesis of new information that has emerged over the last three years, especially in the last year. The recommendations in this report will improve the playfield renovation program and the Department's progress toward ensuring adequate opportunities for youth and adults to play field sports in San Francisco.

VII. Acknowledgements

The Recreation and Park Department wishes to thank the Synthetic Playfield Task Force members for their time and contributions. This Task Force reflected an experimental approach – bringing together subject matter experts, park users, and neighbors – to discuss and explore an extremely complicated topic. The success of this effort is largely due to the open-minded curiosity, seriousness of purpose, and enthusiasm of Task Force members that ensured a thoughtful and constructive conversation.

We thank and acknowledge the following individuals who participated in or contributed to the Task Force and the development and review of this report.

CCSF Department of Public Health
- June Weintraub
- Richard Lee

CCSF Department of Environment
- Chris Geiger
- Debbie Raphael
- Paul Ledesma

California EPA, Office of Environmental Health Hazard Assessment
- Charles Vidair

San Francisco Public Utilities Commission
- Paula Kehoe
- Ellen Levin
- Arleen Navarret

UCSF Environmental and Occupational Health Division
- Dr. Robert Harrison

Task Force Community Participants
- Bruce Cohen
- Jeanne Darrah
- Matt Fuller
- Chloe Good – Neighborhood Parks Council
- Steve Hagler
- Mary Lipian
- Michael Vestel
- Mollie Ward Brown – San Francisco Parks Trust
- Robert Watkins - Local 261, Recreation and Park Department
- David Weiss

Task Force Project Team

- Melinda Gable
- Dawn Kamalanathan
- Claire Lachance
- Dan Mauer
- Christine Sculati

Recreation and Park Commission

- Larry Martin, President
- Jim Lazarus, Vice President
- Gloria Bonilla
- Tom Harrison
- David Lee
- Meagan Levitan
- Michael Sullivan

Mayor of San Francisco

- Honorable Mayor Gavin Christopher Newsom

In addition, the Department would like to extend its thanks and appreciation to those members of the general public who provided comments during Task Force proceedings.

Appendix A: Task Force Members

Task Force Members by Name, Affiliation, and Seat

1) Chloe Good, Neighborhood Parks Council, Citywide Advocacy
2) Mollie Ward Brown, San Francisco Parks Trust, Citywide Advocacy
3) Matt Fuller, Audubon Society, Citywide Advocacy
4) Robert Watkins, Labor - Local 261, Labor
5) Debbie Davidson, Rossi Park, Neighbor
6) Steve Hagler, Rossi Park, Neighbor
7) Michael Vestel, Rolph Playground, Neighbor
8) David Weiss, Rossi Park, Neighbor
9) Jeanne Darrah, Garfield Park, Park User
10) Bruce Cohen, Athletic League, Park User
11) Mary Lipian, Park, Recreation and Open Space Advisory Committee (PROSAC), PROSAC
12) Charles Vidair, Office of Environmental Health Hazard Assessment (OEHHA), Subject Matter Expert
13) June Weintraub, SF Department of Public Health, Subject Matter Expert
14) Debbie Raphael, SF Department of Environment, Subject Matter Expert
15) Paula Kehoe, SF Public Utilities Commission, Subject Matter Expert
16) Dr. Robert Harrison, USCF Environmental and Occupational Health, Subject Matter Expert

Subject Matter Expert Alternates

1) Richard Lee, Department of Public Health
2) Chris Geiger, Department of Environment
3) Arleen Navarret, San Francisco Public Utilities Commission
4) Ellen Levin, San Francisco Public Utilities Commission
5) Paul Ledesma, SF Environment

Appendix B: Master List of Studies Consulted by Task Force

Bacteria/Staph Infections

1. Begier EM, Frenette K, Barrett NL, Mshar P, Petit S, Boxrud DJ, Watkins-Colwell K, Wheeler S, Cebelinski EA, Glennen A, Nguyen D, Hadler JL; Connecticut Bioterrorism Field Epidemiology Response Team. 2004. A high-morbidity outbreak of methicillin-resistant Staphylococcus aureus among players on a college football team, facilitated by cosmetic body shaving and turf burns. Clin Infect Dis. 39(10):1446-53.
2. Benjamin HJ, Nikore V, Takagishi J. 2007. Practical management: community-associated methicillin-resistant Staphylococcus aureus (CA-MRSA): the latest sports epidemic. Clin J Sport Med. 17(5):393-7.
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Ecosystem

Note: The study group did not prepare a formal written summary. This issue was discussed by the Task Force during the June 11, 2008 meeting, and the transcript is available in the Web site archive noted in Section V.

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4. EHHI study of rubber crumb samples heated in small glass vials.
5. California Integrated Waste Management Board (CIWMB) study of tire-derived indoor flooring: flooring off-gassed in environmental chambers.
6. Norwegian Institute of Public Health risk assessment
7. OEHHA playground study in which shredded tires were digested overnight in a solution that mimicked the gastric environment.
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2. Promotion of physical activity in children, Floriani and Kennedy UCSF Dept. of Family and Healthcare Nursing, SF, CA, Current Opinion in Pediatrics 2008
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Turf Products: Alternative Field Products

1. Interviewed and solicited product information from numerous turf manufacturers over the last two years.
2. Searched the internet for alternative products and manufacturers
3. Contacted other municipalities, schools to inquire about field types

Turf Products: Recyclability

1. Interviews with synthetic turf manufacturers and distributors. See Dan Mauer for complete list of vendors and manufacturers interviewed.

Appendix C: List of Acronyms

ADA	American Disability Act
CAES	Connecticut Agricultural Experiment Station
CalEPA	California Environmental Protection Agency
CCSF	City and County of San Francisco
CDC	Centers for Disease Control and Prevention
CEQA	California Environmental Quality Act
CIWMB	California Integrated Waste Management Board
DPH	San Francisco Department of Public Health
EHHI	Environment and Human Health Inc.
EPA	United States Environmental Protection Agency, also USEPA
MRSA	Methicillin-resistant Staphylococcus Aureus
MSDS	Material Safety Data Sheet
OEHHA	California Office of Environmental Health Hazard Assessment
PAH	Polycyclic aromatic hydrocarbon
PM	Particulate matter
PROSAC	Park, Recreation and Open Space Advisory Committee
RPD	San Francisco Recreation and Park Department
SFE	San Francisco Department of the Environment
UV	Ultraviolet
VOC	Volatile organic compound

Appendix D: Use of Synthetic Turf on San Francisco Playfields

2004 Recreation Assessment Report

In 2004 the Department commissioned an independent comprehensive assessment of the recreation needs of San Francisco residents and their perceptions of facility conditions. The first of its kind in the history of the Department, the assessment provided tools for precise planning and prioritization of capital projects based on the level of public demand for specific park facilities and activities.

Key Finding of the 2004 Recreation Assessment

Deficit of playfields in San Francisco

- » *30 Baseball/softball fields*
- » *35 Soccer fields*

The community assessment process revealed that many park users felt that several recreation facilities were deteriorating and unsafe. Furthermore, specific to baseball/softball fields and soccer fields, the report's authors found the current inventory of playfields to be much lower than national guidelines. Considering local demand and population density, the assessment recommended a ratio of fields to population that would require adding 30 ball fields and 35 multi-use/soccer, either by developing new sites or redeveloping current areas. Table 1 summarizes these findings.

Table 1: Field Deficit in San Francisco

Facility Type	2004 Inventory	2004 Service Level/person	National Service Level/person	Consultant Recommended Standard	Deficit based on Consultant Recommended Standard
Baseball/softball	66 fields	1 field/11,640	1 field/5,000	1 field/8,000	Need 30 fields
Soccer	41 fields	1 field/18,735	1 field/5,000	1 field/10,000	Need 35 fields

Background on SF Recreation and Park Synthetic Turf Fields

In 2003, the Recreation and Park Department installed San Francisco's first synthetic turf fields at Franklin Square Field in the Mission and Youngblood Coleman Field in the Bayview. Franklin Square was originally renovated with Bermuda grass turf in 1996, but the grass field could not endure the continuous and heavy use by the soccer community. Similarly, demand at Youngblood Coleman ran down the grass field, leaving a hard dirt playing surface. The Department installed artificial turf to withstand the heavy use and prevent closures. Since re-opening with synthetic turf playing surfaces, the fields have remained extremely popular and have increased play capacity throughout the year.

The success of the artificial turf athletic fields at Franklin Square and Youngblood Coleman led the Department's Turf Manager to assess the benefits of renovating additional fields with synthetic turf to increase the quality and capacity of sports fields in San Francisco. In 2005, the Turf Manager prepared a comparative analysis between artificial and natural turf athletic fields

finding that the city would save on annual maintenance costs, increase play capacity, and reduce the potential for injuries due to holes, uneven surfaces, and mud. From an environmental perspective, the Turf Manager concluded that there were several advantages to using synthetic turf over grass turf because it does not require herbicides, chemical fertilizers, paint, and mowing by gas-powered equipment. He also recognized two potential disadvantages: unknowns about any potential toxicity of the materials and end-of-life disposal concerns for the turf material, which does not biodegrade.

In February 2006 the Recreation and Park Department signed a Memorandum of Understanding with City Fields Foundation forming a public-private partnership to renovate several athletic facilities throughout San Francisco under the Playfields Initiative.

Since 2006, the Department has successfully completed additional field renovations in high-need neighborhoods including Franklin Square (lights, fencing and landscaping only) and Garfield Square in the Mission District, Silver Terrace Playground near the Bayview neighborhood, and South Sunset in the Outer Sunset. The soccer fields at Crocker Amazon Playground in the Excelsior are currently being renovated with synthetic turf. Using a new generation of synthetic turf, the parks' sports fields are overhauled with new irrigation, drainage, foundation, artificial turf, goals and backstops, bleachers, garbage cans, signs, field lights, and American Disability Act (ADA) improvements to pathways and restrooms.

The Police Department has also supported individual playfield renovations for their potential to reduce criminal activity by removing dilapidated structures and adding field lights to improve visibility and safety within and around the parks.

The synthetic turf field renovations and associated park improvements are also helping San Francisco conserve water. According to the San Francisco Public Utilities Commission (PUC) billing data, water use at Silver Terrace has decreased by about 3,000 gallons per day since the turf renovation at that location.

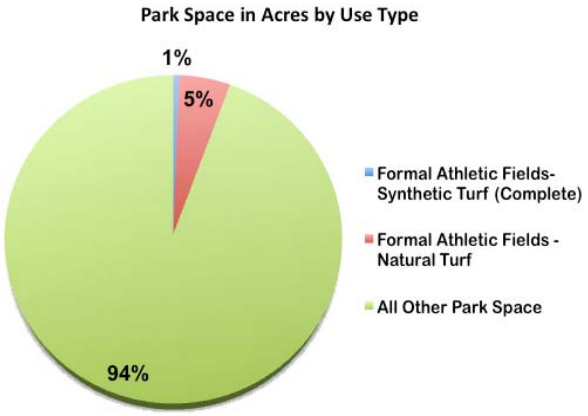
Play capacity has substantially increased at all the Recreation and Park fields renovated with artificial turf, greatly benefiting the youth and athletes who use these fields for practice, pick-up games and league games.

Capacity increases are the result of 1) the reconfiguration of facilities to add additional fields in the play space (soccer only), 2) no closures due to rainouts or field overuse, and 3) the addition of lights for nighttime play. According to a joint analysis by Recreation and Park and the City Fields Foundation, the recent renovation projects at Garfield Square, Franklin Square, Crocker Amazon, Silver Terrace and South Sunset Playground would result in a 175% increase in play capacity. Prior to renovation, the facilities' play capacity was 15,625 hours per year. After renovation, annual soccer play capacity increased to 42,960 hours, a net gain of 27,335 hours. (*Note that these estimates assume the added benefit of additional fields and play space for soccer games, which can be played simultaneously. However, when fields are used for baseball or softball, this capacity estimate would be lower because those sports cannot be played simultaneously with soccer.*)

Table 2 and the following graphic summarize the area of athletic fields renovated through 2008 compared to the area of other grass fields and park space owned by the city and managed by the Department. With the completion of Crocker Amazon later this year, the acreage of synthetic turf will be approximately 1% of all park space. Natural grass athletic fields represent 5%, and other park space occupies 94%.

Table 2: Field Renovations and Total Recreation and Park Owned Park Space

Park Area	Acres	Percent
Formal Athletic Fields - Synthetic Turf (rounded)	20	1%
Franklin Square	*1.87*	
Garfield Square	*0.89*	
Silver Terrace Playground	*3.06*	
Youngblood-Coleman Playground	*2.53*	
South Sunset	*2.23*	
Crocker Amazon	*9.36*	
Formal Athletic Fields - Natural Turf (rounded)	177	5%
All Other Park Space	3,303	94%
Total Park Space City Wide	**3,500**	**100%**



Appendix E: Study Group Summaries

Synthetic Playfields Task Force
May 23, 2008
Bacteria

Considered by Task Force Members:
June Weintraub
Bruce Cohen
Richard Lee

1. Bacteria in general

Relevant Research and Main Findings:
A literature search did not return any environmental studies that looked at the bacterial colonization of synthetic fields. On the other hand, there is a whole body of research on the microbial environment of soils and grass. (Yao et al, 2006; Dell et al, 2007; Kenna, 2001)

In the absence of literature on bacterial growth on synthetic turf playfields, we attempted to find analogous environments that could inform our understanding of the risk. Although there is some research on the microbial environment of wrestling mats, these are not exposed to sunlight, and wrestling involves considerably more direct skin-skin contact between participants than soccer or base/softball. We looked carefully at two wrestling mat manuscripts with opposing results--one did not find evidence of skin disease causing fungi known as dermatophytes (Kohl et al, 2000) and one did (Hedayati et al, 2007). Although Hedayati and colleagues did find evidence of dermatophytes, they did not have control samples and were unclear on what, if any, cleaning procedures were used before and after wrestling uses.

Jumping off from the wrestling mat analogy, we looked for literature on playfields (natural or synthetic) as a risk factor for any communicable disease (dermatologic or other) in athletes, but found little that is relevant. There is some literature on occurrence of tetanus, and one outbreak of wound infection that occurred after a "mud football" tournament in Australia (Vally et al, 2004). These were associated with natural and not synthetic playing environments.

Relevance to San Francisco synthetic playfields
Bacteria are ubiquitous in individuals and in the environment, and we have not found evidence that there is any greater risk to the public health from bacteria growing on a synthetic field versus that found elsewhere in the environment.

We reviewed the photos of some of the fields that appeared to show mold or decaying organic matter. We don't see any benefit to culturing the material for bacteria, as any sample, whether from artificial or natural surface, is likely to have bacteria growing on it.

This is likely to be a maintenance issue rather than a health issue. As with natural grass playfields, synthetic turf fields should be cleaned of litter and debris on a routine basis. Public concern about bacterial infections should be considered in establishing policy on field maintenance, including whether periodic use of disinfectant is warranted.

2. MRSA (methicillin-resistant Staphylococcus aureus)

Relevant Research and Main Findings:
The draft memo from SFDPH (February 2008) included a statement on MRSA risk. The statement is based on review of the current medical literature as well as consulting with the MD in the SFDPH Communicable Disease Control and Prevention group who deals specifically with MRSA for SFDPH.

A summary of much of the relevant literature was recently published (Cohen, 2008). There are several case series that look at this particular issue. The problem with case series is that the outbreaks occur in groups without any variability in their exposure to synthetic turf. That is, since everyone in the case series is exposed to artificial turf, there's no way to know if the incidence would be greater or less in a comparable "unexposed" group that is not exposed to artificial turf.

In addition to the Cohen review, we identified a good review article on Community Acquired MRSA transmission that had a focus on sports settings (Benjamin et al, 2007). The article points out that "there is little scientific evidence regarding the risk of acquiring CA-MRSA through fomite transmission" which affirms that there is not much specific data that shows MRSA is or is not a concern specific to any particular playing field surface.

Turf Burns: Because turf burns pose a point of entry for MRSA, if there is increased risk of turf burns with artificial turf compared to natural turf, this could be part of the causal pathway to MRSA infection. Although one study reported that turf burns were associated with a seven-fold increase in risk of MRSA in an outbreak, the study also notes that cases with turf burns had also used a poorly maintained whirlpool, and since all of the players used artificial turf, it is not possible to assess the risk associated with the playing surface. (Begier et al, 2004). Another study found that most of the participants on a particular football team had turf burns, so even though most of the cases of MRSA infection had turf burns, a higher proportion of the people who didn't get MRSA also had turf burns (Kazakova et al., 2005).

Relevance to San Francisco synthetic playfields
We have not found evidence that changes the SFDPH conclusion stated in the 2/2008 memo:

> *"In addition, we have considered the question of whether there is any increased risk of MRSA infection associated with these playfields. MRSA is now a common disease in the community, primarily spread from skin-to-skin contact, and we are not aware of evidence that suggests artificial turf as a vehicle of infection. Any*

type of skin breakdown, including "turf burns," may provide a portal of entry for infection thus in order to prevent MRSA or other infection, athletes and children should practice standard wound care in the event of turf burn, regardless of the type of turf on which the injury occurs."

3. Next questions:

(1) We are still looking for general information on how pathogenic bacteria grow on polyethylene or related plastics, and how long pathogenic bacteria would be expected to survive in the outdoors on a polyethylene surface.

(2) We should consider whether disinfectant should be used periodically to allay concerns about molds, fungus, and other bacteria.

4. References

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Vally H, Whittle A, Cameron S, Dowse GK, Watson T. 2004. Outbreak of Aeromonas hydrophila wound infections associated with mud football. Clin Infect Dis. 38(8):1084-9.

Yao H, Bowman D, Shi W. 2006. Soil microbial community structure and diversity in a turfgrass chronosequence: Land-use change versus turfgrass management. Applied Soil Ecology. 34:209-218.

Environmental/Health Concern: Climate change and heat island effects

Relevant Research (list/identify articles, studies, etc.)	1) Meil, J and L Bushi. undated. *Estimating the required global warming offsets to achieve a carbon neutral synthetic field turf system installation.* Athena Institute. Results reviewed by Melissa Capria, Climate Change Coordinator, SF Dept. of the Environment 2) Dickey, Phillip. 2007. Synthetic turf versus natural turf for playing fields. Report commissioned by SF Dept. of the Environment. 3) McNitt, Andrew S. and Dianne Petrunak. "Evaluation of Playing Surface Characteristics of Various In-Filled Systems." Pennsylvania State University, Department of Crop and Soil Sciences. 2006. 4) Williams, C. Frank, and Gilbert E. Pulley. "Synthetic Surface Heat Studies", Brigham Young University, 2002.
Main Findings?	1)FINDINGS - CLIMATE CHANGE: 55.6 tons CO2/10 year period emitted for synthetic turf, and more if it is not recycled. Compared to -16.9 tons/10-years for natural turf. Evidence of heat island impacts from synthetic turf. 2) RELIABILITY OF DATA: *Athena Institute Study* - Thorough report and plausible model but CO2 impact of landfill disposal is not considered (synthetic turf). Decomposition of grass clippings would add to the CO2 impact of natural turf; this was not considered either. Factors to consider in looking at climate impacts of artificial turf vs. grass scenarios: 1. Emissions associated with fuel used in mowing/maintenance equipment. 2. Water usage and associated energy used for pumping. 3. Loss of soil sequestration benefit in the artificial turf scenario. 4. Emissions associated with pesticides and fertilizer in the grass scenario. 5. Any emissions associated with disposal of waste in either scenario (presumably the grass clippings are being composted which would address this in that scenario) 6. Vehicle emissions associated with increased use of the fields. 7. Energy used for lighting the fields at night if they were not lighted before. 8. On the adaptation to climate change impacts side - ability to absorb stormwater. 9. The urban heat island affect, although this is not such a significant issue for us in our current climate it may important as things heat up. 3) FINDINGS - HEAT ISLANDS: Initial results showed that the surface temperature of the synthetic field was, on average, 39 degrees higher than the natural turf and 8 degrees higher than asphalt. At its hottest point, the synthetic turf was 86.5 degrees hotter than grass. The study also found that cooling the synthetic turf with water had very little effect on its temperature. Similar results were found by researchers at Penn State, who examined the surface temperatures of several different brands of synthetic turf. On FieldTurf, the difference between surface and air temperatures was 37 degrees. 4) RELIABILITY OF DATA: Did not completely assess.
Is this concern relevant to and/or significant forSan Francisco synthetic playfields? (given conditions, materials, typical uses)	CLIMATE CHANGE - RELEVANT. San Francisco has committed itself to ambitious goals for reducing climate change impacts. If the Athena Institute study is correct and broadly applicable synthetic turf, it strongly suggests that, unless the greenhouse gas emissions can be offset, the use of synthetic turf should be minimized and confined to the sites where its other benefits are maximized. It also highlights the need for recyclable synthetic turf. HEAT ISLANDS - RELEVANT. It seems clear that there the synthetic turf does absorb considerably more heat; however, this may not be important in San Francisco's mild climate except during exceptionally hot spells.
Next Questions? What do we still need to know/ understand?	No further information needed. We know that synthetic turf will have undesirable climate change and heat island effects. These need to be balanced against the benefits, and suggest that criteria should be developed for selecting suitable installation sites. A larger scale, life-cycle analysis comparing synthetic and natural turf impacts is desirable, but this is well beyond the scope of this task force, and is not essential for the current decisions being made.

Environmental/Health Concern: Urban Heat Island Effect

Relevant Research (list/identify articles, studies, etc.)	1. Rosenzweig, Cynthia. "Mitigating New York City's Heat Island with Urban Forestry, Living Roofs, and Light Surfaces," Columbia University and Hunter College, New York, NY; and W. Solecki, L. Parshall, S. Gaffin, B. Lynn, R. Goldberg, J. Cox, and S. Hodges. Presented 31 Jan. 2006. <http://www.greenroofs.com/research_links.htm> 2. NASA Earth Observatory. Richard Medina, University of Utah and Bill Patzert, NASA Jet Propulsion Laboratory <http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=17616> 3. McNitt, Andrew S. and Dianne Petrunak. "Evaluation of Playing Surface Characteristics of Various In-Filled Systems." Pennsylvania State University, Department of Crop and Soil Sciences. 2006. <http://cropsoil.psu.edu/mcnitt/infill7a.cfm>
Main Findings?	1. Urban heat islands are created when softscape natural areas are replaced by impervious surfaces like rooftops and asphalt, which absorb heat during the day, and continue to do so after the sun sets. Urban heat islands can result in an increase demand for energy for air conditioning, intensify air pollution due to increased heat, and increase heat-related health problems. Urban Heat Island mitigation strategies to reduce temperatures include increasing vegetation in urban areas according to a study conducted in New York City. 2. A NASA study attributes the large increase of average temperature of southern California to urbanization and suburbanization, which then creates Urban Heat Islands. However, San Francisco's temperature increase over the second half of the 20th century (1950-2000) is the same as surrounding rural areas to the south and east. 3. Synthetic turf temperatures are higher than natural grass. The temperature can be reduced by about 15 degrees Fahrenheit with watering, but the effect is short term (about 200 minutes) in central Pennsylvania where the study was con
Is this concern relevant to and/or significant for San Francisco synthetic playfields? (given conditions, materials,	In many areas of San Francisco extended periods of intense sunlight could potentially raise the field temperatures to a level that can contribute to urban heat island effect. With the numerous micro-climates in San Francisco, some neighborhoods would be impacted greater than others. For example, urban heat island effect would be a greater concern when installing a synthetic turf field in the eastern side of San Francisco as opposed to the Western neighborhoods.
Next Questions? What do we still need to know/ understand?	Is there research on the urban heat island effect in San Francisco's different micro-climates?

San Francisco Synthetic Playfields Task Force
Potential Damage to Ecosystem Subgroup

- Few conclusive studies
  - Woodside Elementary (2006): creek runoff
  - King County Water and Land Resources Division in Seattle, Washington by AMEC Environmental, Inc.: runoff from 2 field turf fields had no effect on toxicity to the test organisms and met all State and Federal water quality standards.
  - Potential Health And Environmental Effects Linked To Artificial Turf Systems
    - The Norwegian Building Research Institute 2004
  - Need for transparency
  - Need for environmental assessment

- New York City Audubon Opposition by (see attached)

- Removal of grass

Investigation of the effects of waste tires and **tire rubber** on soil, water, and air under various conditions or combinations of conditions –

CA Integrated Waste Management Board and US Dept. of Energy

Analyte	**Value in 1990**	**Value in 1991**
pH	7.7	7.7
Alkalinity (mg/l)	533	705
Barium (µg/l)	210	350
BOD (mg/l)	14	70
Calcium (mg/l)	170	340
Chloride (mg/l)	400	1400
COD (mg/l)	170	560
Conductivity (µohm/µm)	-	5150
Iron (mg/l)	0.05	0.7
lead (µg/l)	<3	22
Magnesium (mg/l)	150	390
Manganese (µg/l)	270	3200
Sodium (mg/l)	230	200
Sulfate (mg/l)	140	450
Total Solids (mg/l)	2000	4630
Zinc (µg/l)	46	540
Hardness (mg/l)	1100	2500

http://209.85.173.104/search?q=cache:Ki2r05qXFDUJ:www.ciwmb.ca.gov/Publications/Tires/43296029.doc+a+study+of+the+leaching+of+tire+rubber+department+of+commerce&hl=en&ct=clnk&cd=3&gl=us

Estimating the Required Global Warming Offsets to Achieve a Carbon Neutral Synthetic Field Turf System Installation, by Jamie Meil and Lindita Bush.

- A study conducted by the Athena Institute, Merrickville, Ontario, estimated the greenhouse gases (GHG) emitted during the life cycle of the synthetic turf system as opposed to a natural grass surface. The study also determined the number of trees to be planted to achieve a 10-year carbon neutral synthetic turf installation.
  For a 9,000 square-meter facility a 10-year period, the research showed a total CO2 emission of 55.6 tons. An Amercian football field (53.3 yards wide times 100 yards long minimum, without end zones and sidelines) is larger than an acre; and acre is equal to 4,047 square meters or 4,840 square yards. The GHG emissions offset was estimated at -72.6 tons. According to the U.S. Department of Energy estimate (1998), a medium growth coniferous tree, planted in an urban setting and allowed to grow for 10 years, sequesters 23.2 lbs of carbon, equivalent to 0.039 metric ton CO2. The tree planting offset requirements to achieve a 10-year carbon neutral synthetic turf installation was estimated to be 1861 trees.

Potential Health And Environmental Effects Linked To Artificial Turf Systems

The Norwegian Building Research Institute 2004

The total concentrations of zinc and PAH in the recycled rubber granulates exceed the Norwegian Pollution Control Authority's normative values for most sensitive land use. The concentrations of dibutylphthalate (DBP) and diisononylphthalate (DINP) exceed the PNEC values for terrestrial life taken from the EU's programme for risk assessment. The concentration of isononylphenol is above the limits specified for cultivated land in the Canadian Environmental Quality Guidelines.

The leachate from the recycled granulates contain zinc, polycyclic aromatic hydrocarbons (PAH), phthalates and phenols. The concentration of zinc indicates that the leachate water is placed in the Norwegian Pollution Control Authority's Environmental Quality Class V (very strongly polluted water), but is lower than the permissible zinc concentration in Canadian drinking water. The concentration of anthracene, fluoranthene, pyrene and nonylphenols exceed the limits for freshwater specified in the Canadian Environmental Quality Guidelines. An expanded risk assessment with an analysis of possible spreading paths and changes in leaching properties over time is necessary to determine the degree to which the concentrations of zinc, anthracene, fluoranthene, pyrene, phthalates and nonylphenols in the leachate are actually harmful to people and the environment.

The recycled rubber granulates give off a significant number of alkylated benzenes in gaseous form. Trichloromethane (sample 1) and cis-1,2-dichlorethene (sample 5) were also found.

Cadman Plaza letter

December 16, 2005
Commissioner Adrian Benepe
New York City Parks & Recreation
Central Park Arsenal
830 Fifth Avenue
New York, NY 10021

Dear Commissioner Benepe:

New York City Audubon is a grassroots community that protects wild birds and habitat in the City, improving life for all New Yorkers. Representing over 10,000 members in the five boroughs, I urge you to oppose the use of artificial turf in downtown Brooklyn's Cadman Plaza Park and instead support the restoration of the Park's natural lawn.

Cadman Plaza Park is one of only a few large grassy areas in downtown Brooklyn. We are concerned that the replacement of this large lawn with artificial turf, in this area and in the city as a whole, will have a detrimental effect on the amount of food available to birds and other wildlife, including insects and other small creatures. We believe that a living, breathing park is of tremendous value not only to wildlife, but also for the many residents of downtown Brooklyn. It provides people with an opportunity to relax and enjoy a respite from the busy urban pace. For this reason, we strongly believe that the restoration of the large lawn should be a top priority. While artificial turf represents an easy solution for Cadman Plaza, we believe it would do a disservice to local residents and wildlife. We strongly urge you to abandon the artificial turf option, and focus instead on making the necessary improvements to the grassy areas.

Thank you for your attention to this important matter.

Sincerely,
E.J. McAdams
Executive Director

Environmental/Health Concern: Injuries

Jeanne Darrah and Robert Harrison
June 10, 2008

Relevant Research:

1. Comparison of the incidence, nature and cause of injuries sustained on grass and new generation artificial turf by male and female football players, Part 1: match injuries
Colin W. Fuller, Randall W. Dick, Jill Corlette, and Rosemeary Schmalz
British Journal of Sports Medicine, May 2008

2. Comparison of the incidence, nature and cause of injuries sustained on grass and new generation artificial turf by male and female football players, Part : training injuries
Colin W. fuller, Randall W. dick, Jill Corlette, and Rosemeary Schmalz
British Journal of Sports Medicine, May 2008

3. Risk of injury in elite football played on artificial turf versus natural grass: a prospective two-cohort study
J Ekstrand, T Timpka, M Ha¨gglund
Br. Journal of Sports Medecine, Sept. 2006

4. Risk of Injury on artificial turf and natural grass in young female football players
Kathrin Steffen, Thor Elnar Andersen and Roland Bahr
British Journal of Sports Medicine, May 2008

5.Incidence, Causes and Severity of High School Football Injuries on Field Turf Versus Natural Grass: A 5-year Prospective Study, Meyers and Barnhill
American Journal of Sports Medicine, Oct., 2004

6. Injuries to High School Football Athletes in California
Ramirez, et al. The Am. Journal of Sports Medecine, Bol. 34, No. 7

Findings:

These are comparative studies between artificial and grass turf.
1 & 2 & 3. In the Fuller research they monitored thousands of hours of soccer training and match play time for injuries. They found no major differences between the incidence, severity and nature or cause of training and match injuries sustained on new generation artificial turf and on grass by either men or women.

4. In the Steffen study of young women (which I think is particularly relevant as there is a sport and age match) they found that among young female football (soccer) players the risk of acute injures was the same. There may be more twisted ankles, but the findings were not statistically significant enough to draw these conclusions.

5. There were slightly more injuries on artificial turf, but they were more minor injures. Natural turn had more serious head, clavicle and knee injuries.

6. This was more of a 2 year study on high school football in general and not about artificial turf injuries. It shows that there is a very high injury rate in high school football players—25 out of 100 for the life of the study. There were higher incidence of injuries on artificial turf—they thought because the football cleats were getting stuck in the turf and the players should wear soccer cleats and not football cleats.

5 & 6. Both indicated more skin abrasions on artificial turf, which could contribute to infections if there were more bacteria present.

Relevant for SF?

1 & 2 & 3. Yes because our fields are used primarily for soccer and baseball

4. Yes, because these are younger athletes playing soccer.
The problem with comparative studies is that the grass fields are well maintained in these studies, whereas in SF they typically are not and do not provide a very even playing surface which also contributes to injures.

5&6. I really don't think these are relevant because we are not building football fields and football is so dangerous compared to soccer and baseball. I would not worry too much about the skin abrasions because there was not a significant increase in skin abrasions in the soccer studies.

Next Questions:

It would be nice to have a baseball study.

It is clear from the relevant studies that there is not a huge difference in injuries between artificial turf and natural turf.

Environmental/Health Concern:
Chemical Composition & Flammability

Relevant Research (list/identify articles, studies, etc.)	1) Dickey, Phillip. 2007. Synthetic turf versus natural turf for playing fields. Report commissioned by SF Dept. of the Environment. 2) Phillip. 2007. Occurrence of bromine, lead and zinc in syhthetic turf components. Report commissioned by SF Dept. of the Environment. 3) 2006-07. Requests for information from various manufacturers on 22 synthetic turf products (12 manufacturers) by SF Dept. of the Environment. 4) Office of Environmental Health Hazard Assessment. 2007. Evaluation of health effects of recycled waste tires in playground and track products. Contractors report to the California Integrated Waste Management Board.
Main Findings?	FINDINGS: 1) Listed in detail in reference #1 above. Predominant materials used are (fibers) polyethylene or nylon, (infill) silica sand, cryo-rubber, 'Nike Grind' (ground Nike shoes), (backing material) polyurethane, polypropeylene, various foams. 2) Bulk materials above contain various additives that may or may not be problematic. Rubber, for example typically contains at least several percent zinc, around 20% naphthenic/aromatic oil, and various other compounds. Plastics may contain brominated flame retardants, and PVC vinyl may contain a host of plasticizers and stabilizers such as lead and phthalates. 3) Testing (reference #2) showed that brominated flame retardants are not present in the brands tested, except for a small amount in the shock pad of one product. Tests did show significant lead in two products, especially in the nylon thread (contained inside the polyethylene yarn). From a risk perspective, if the lead is inaccessible the risk is negligible. Therefore the presence of lead in padding or other layers below the turf may not be a concern for users of the turf. However, a precautionary principle approach to purchasing would seek to avoid products containing lead. Zinc was present in infill materials, as expected. In high concentrations this can pose aquatic toxicity issues.
	4) Flammability (reference #4): "Tire shreds have a reported flash point of 582º F, higher than some other materials used for architectural purposes such as wood, paper, foam, and fabric. The flash point is the temperature at which a material will initially ignite, and the temperature to support continuing combustion (fire point) is even higher. When crumb rubber is combined with a binder, the binder may control the flammability of the resulting product if the binder has a lower flash point. Flame propagation was slow in two known playground fires involving loose-fill crumb rubber, and no one was injured. Both fires were intentionally started by juveniles that used matches, paper, and wood to ignite the crumb rubber." For fiber used in synthetic turf, some manufacturers cite their products' passage of ASTM D 2859 Flammability (Pill test). This test relies on a point ignition source that might understate flammability hazards from arsonists. Most manufacturers claim that their product is nonflammable. Flash points for polyethylene yarn are listed as >600 degrees F, with autoignition temperatures
Is this concern relevant to and/or significant forSan Francisco synthetic playfields? (given conditions, materials, typical uses)	RELEVANT: Lead is an ingredient that appears only in two of theproducts, probably as a color fixative. Although it may not pose a significant risk to users, San Francisco can choose products that are free of lead, since it is apparently not essential. All-polyethylene fibers are generally preferable due to issues of recyclability. If tire rubber cannot be avoided by the use of other infill materials, then zinc hazards should be minimized through careful site selection (i.e., no standing water), in keeping with the OEHHA findings.
Next Questions? What do we still need to know/ understand?	1) Which products are lead-free? This information could inform future purchasing decisions. For purposes of the Task Force work, however, we have already established that there are lead-free alternatives. 2) A more complete review of flammability issues is desirable, although the flash point and autoignition data suggests that the hazard is minimal. We may want to obtain an opinion from the SF Fire Department on this issue.

The body of literature relevant to tire based particulate matter is largely based on particulate matter (PM) pollution [2-10] associated with vehicular traffic on roads. Many studies look at the wear characteristics of tires and the health problems associated with particulate matter from tire wear. The concentration and chemical makeup of such particulate matter must be determined directly from artificial turf fields to make an accurate assessment of its impact on health.

Described below are the three primary sizes of particulate matter and their general, well documented impacts on health. The chemical contribution to health impact are discussed followed by the health impacts of tire based particulate matter. The indoor study on artificial turf with a focus on particulate matter is discussed next. Finally, future directions are suggested.

Particulate Matter as a pollutant – tutorial

Associations have been found between day-to-day inhalable particulate air pollution and increased risk of various adverse health outcomes, including cardiopulmonary mortality and respiratory health problems [2-4, 11]. While large particles are filtered through the nose and throat and do not cause problems, particles less than 10 microns (1/10th the diameter of coarse hair) in aerodynamic diameter (PM10 and PM2.5) have strong relationships to health effects [5-7, 11]. In the US, PM10 and PM2.5 are adopted for regulatory purposes.

PM10

Thoracic particles, (PM10, aerodynamic diameter <10 μm) and coarse particles (PM10-2.5, between 10 μm and 2.5 μm) tend to be related to acute airway symptoms because the settle in the bronchi and lungs and cause health problems. A relevant example is the study showing [12] fluctuations in PM10 levels related to acute respiratory hospital admissions in children, to school and kindergarten absences, to decrements in peak flow rates in normal children, and to increased medication use in children and adults with asthma [12].

Dockery and Pope reviewed the epidemiologic literature for similar adverse effects. They estimated increased mortality and morbidity associated with each 10-$\mu g/m^3$ increase in daily mean PM10 exposure. The total mortality was observed to increase by 1% for each 10-$\mu g/m^3$ increase in PM10. Perhaps more relevant, they demonstrated respiratory mortality increased by 3.4% and cardiovascular mortality increased by 1.4% for each 10-μg/m3 increase in PM10. Furthermore, hospital admissions and emergency department visits increased approximately 1% for all respiratory complaints, and 2% to 3% for asthma. Exacerbation of asthma increased by about 3%, as did lower respiratory symptoms. Small decreases in lung function, approximately 0.1%, have also been observed. This review suggests that the epidemiologic studies of adverse morbidity measures are coherent with the mortality studies showing quantitatively similar adverse effects of acute exposures to particulate pollution [12].

PM2.5

Fine particles (PM2.5, aerodynamic diameter <2.5 μm) tend to be associated with cardiovascular disease [6] and asthema [13] because they penetrate ino the gas-exchange regions of the lungs. This is because the PM is deposited in the alveolar region of the lung where the adsorption efficiency for trace elements is 60-80% [13]. PM2.5 can thus affect lung physiology, especially if the particles contain biologically available toxic metal [13].

Two studies below give a basis on which to assess the safety for particulate matter (PM2.5) generated by artificial turf fields, albeit not in the context of it chemical composition:

For example, Pope, et al. assessed the relationship between long-term exposure to fine particulate air pollution and all-cause, lung cancer, and cardiopulmonary mortality [11]. Based on an ongoing prospective mortality study, which enrolled approximately 1.2 million adults in 1982 the study showed a significant association of health effects to PM2.5. **Each 10-μg/m^3 elevation in fine particulate air pollution was associated with approximately a 4%, 6%, and 8% increased risk of all-cause, cardiopulmonary, and lung cancer mortality, respectively.** Dominici, et al. [14] estimated risks of cardiovascular and respiratory hospital admissions associated with short-term exposure to PM2.5 in 11.5 million Medicare enrollees (>65 years). They investigated hospital admissions for cerebrovascular, peripheral, and ischemic heart diseases, heart rhythm, heart failure, chronic obstructive pulmonary disease, and respiratory infection, and injuries as a control outcome. There was a short-term increase in hospital admission rates associated with PM2.5 for all of the health outcomes except injuries. The largest association was for heart failure, which had a 1.3% increase in risk per 10-μg/m3 increase of PM2.5 in the same-day.

Ultrafine particles

Ultrafine particles (<100 nm or 1/1000th the diameter of hair) may pass through the lungs and affect other organs. One notable exception to chemical composition being the modulator for PM toxicity (discussed below) may be for ultrafine particulate matter where the actual physical size may be the specific particulate property responsible for toxicity. Particles 10nm in size, for example produce more significant pulmonary inflammatory response than the when exposed to the same chemical composition or same mass as larger (e.g. fine) particles [15].

In summary, smaller particles are generally considered more toxic than larger particles, motivating the recent change to use PM2.5 and PM10 instead of exclusively PM10 for regulator purposes [14, 16, 17].

Chemical composition as a modulator for PM toxicity:

While the number of particles is important as it realtes to health effects, so to is the size, shape, **chemical composition** [2, 6] and material properties. Chemicals absorbed or adsorbed to the particles may also have different toxicological effects. It is important thus to determine both the particle concentration and size distribution as well as determine the chemical properties of the parent material to asses the effect of inhalable particles. There is ample evidence [2, 5] suggesting that specific chemical properties of PM link with biological response. For example, it has been observed that coarse and fine particles of PM were greater in generating inflammatory mediators compared to carbon black, suggesting chemicals adsorbed onto the particle surface, rather than just the mere presence of the particle can be responsible for toxicity [17]. Obot, *et al.* [18] studied human alveolar

macrophages incubated with fine PM subjected to various procedures and concluded PM toxicity was dependent on the surface characteristics of the particles.

Of significant interest to this task force is evidence for toxicity of chemical constituents found in tire particulate matter. A class of carcinogens, namely, polycyclic aromatic hydrocarbons (PAH) are benzene-soluble organics which are of particular interest because of their toxicity. Li et al. used in vitro assays to show concentrated PM10 and PM2.5 induced oxidative stress in alveolar macrophages for PM which was highest in PAH [19].

Exposure limit difficulties
It has also been shown that the respiratory tract is actually more sensitive to particle number, not mass [20]. Determining the best way to express exposure limits is complex as further illustrated by Diociaiuti, *et al.* They demonstrated the effects on one studied endpoint to be greater for fine particles than for coarse particles delivered *at equal mass concentrations*. But no differences in response when exposure data were expressed in terms of *PM surface area per volume unit [16]*.

Tire Particulate Matter

The studies below discuss the chemical properties and size distribution of tire PM to enable a comparative, quantitative understanding of tire based pollution.

It has been shown that wear from tires largely impacts the particle concentration and contribute to poor environmental air quality [21]. The standard for PM10 stipulates that the daily mean concentration must not exceed 50 μg/m3 more than 35 days per year and the yearly mean can not exceed 40-$\mu g/m^3$ [7].

Chemical content of tire based PM
Analysis of tire dust or particulate matter from tires shows that it consists not only of debris from the tire but also assimilated heavy metal particles emitted from road traffic materials such as break lining and road paint [21]. For example, Fe, Cr/Pb clusters, Ti, Cr, Cu, Zn, Sr, Y, Zr, Sn, Sb, Ba, La, Ce and Pb [21].

It has been shown that zinc can be an excellent indicator of particulate matter generated by tire wear [8]. Zinc oxide is added as an activator to the vulcanizing process and give zinc concentrations of about 1% of the final rubber product. Further more, to speed vulcanization sulphur containing zinc organic accelerators are added at between 0.5 and 2 wt %. The major part of the zinc in tires is presnt as excess ZnO and ZnS. While not all the zinc can be assigned to tire wear, they showed the only significant contributor to extractable zinc in airborne particles is from tires, with the exception of engine oil. They were able to show 1290 ug of organic zinc is present per gram of tire. This number can thus be used to help determine the souce of particulate matter, especially as assigned to tire wear.

Road PM from tire particles
These studies below are helpful in yielding a comparative exposure to road tire particulate matter. Gustafsson et al. [2] used a road simulator with tires on a track to investigate PM generation from cars and truck on roads. The also investigated the inflammatory potential of the generated particles in human macrophages and epithelial cells. Chemical analysis was used to determine source (road,

tires, etc.). While the majority of wear particles were shown to be from pavement, the concentration of tire wear particles goes up for smaller particles (especially for ultra fine) as illustrated by the elevated Zn and S content which are specific to tires in the experiments. Measurements were made at **2 meters** from the simulated road when cars were driven 20km/hr in a closed room and reaching steady state concentrations. They measured 1 mg/m3 PM10 (all particles) which contained 400 ppm (0.04%) zinc, or 2-$\mu g/m^3$ of zinc. Using the above technique yields **520-$\mu g/m^3$ <u>tire</u> PM 10**. This estimates the concentration of PM due to tires is about 52% PM when compared to the road material (road stone, pavement, etc.). Gupta [13] showed that tire wear accounted for about 7% of all PM in roadside measurements when including the entire environment in a highly polluted region (Kolkata, India) at industrial sites. When looking at the number of particles directly behind a car, 100-250-$\mu g/m^3$ of 3-5 micron particles were measured and is consistent with the numbers above [4].

It is interesting to note at that the concentration of zinc goes up to 2000 ppm (0.2%) Zn for 100nm PM, indicating an increase in tire PM at the ultra fine size [2]. While the study concludes that studded tire wear pavements induced inflammation in airways and the tire and pavement type are important in determining the level of response, they did not break out the biological responses due to tire vs. pavement.

Settling time of PM

Table 1: Terminal gravitational settling velocities and settling times for particles [1].

	PM10	PM2.5	PM 100nm
Settling Velocity (cm/sec)	0.5	0.02	0.0001
Time to settle 1 meter	3.3 min	83 min.	11.5 days

The time particles are in the air is an important parameter, Table 1. One meter height is consistent with how high the rubber infill may rebound or be kicked up during use. When the large tire granules are carried into the air, they will re-suspend particulate matter (PM10, PM2.5, etc) into the air. Their persistence in the air impacts the time they are available for inhalation.

Indoor NILU study

Table 2 presents the particulate matter results from the NILU study [22] and select carcinogenic gas phase results. Of particular interest is the fact that the known carcinogen BaP is present in the PM at quantities near the maximum goal levels directed by various agencies. Both the concentration of PM together with the chemical composition indicates a concern. Results of chemical characterization of the airborne dust showed the presence of PAHs, phthalates, other SVOCs, benzothiazoles, and aromatic amines, also referenced in the NYC study [23]. Higher levels were seen in the SBR rubber air measurements than in the thermoplastic elastomer air measurements.

On average, 28% of the dust was natural latex rubber for PM10 and 45% of the dust was rubber for PM2.5. Because the average European car tire consists of 42% rubber [Section 4.3.4 of 22], the dust it was concluded the dust is from recycled tires and NOT from ambient background.

Table 2: Select PM and vapor phase statistics near recommended limits from NILU study [22] for three indoor turf halls, Valhall (Val), Ostfordhallen (Ost), and Manglerudhallen (Mang).

Pollutant	Val	Ost	Mang	Limits
PM10 ($\mu g/m^3$)[a]	32	31	40	35[b]
PM2.5 ($\mu g/m^3$)	19	10	17	20[c]
Benzo(a)pyrene[d] (ng/m^3) in PM10	0.56	0.38	1.2	1.0[e]
Benzene ($\mu g/m^3$) gas phase[f]	2.4	2.0	2.3	2.0[g]
Total PAH[h] (ng/m^3) in gas phase	364	121	174	NA

High Risks in NILU

The review [24] of the NILU study concludes 1.2 ng/m3 BaP will give a lifetime cancer risk of $\mathbf{10^{-4}}$. The review [24] dismisses this and concludes the PAH values are from surrounding air with poor support or evidence. The BaP was dissolved out of the collected particulate matter during analysis and appears to be taken in good lab practices. The review also concludes a concentration of the gas phase carcinogenic benzene of 1.7 $\mu g/m^3$, linked to leukaemia in humans, has a lifetime cancer risk of $\mathbf{10^{-5}}$. These risks are higher than the *di minimis* risk level of 1 case per one million established by OEHHA [25].

NYC study

A very recent study by NYC [23] described the SBR crumb rubber as containing several chemicals of potential concern (COPC). They discussed extraction studies above and others as illustrating crumb rubber contains polycyclic aromatic hydrocarbons (PAHs), including carcinogenic PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene,

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[a] Both PM sizes contained measurable amounts of 28 various chemicals (not including PAHs)

[b] In the EU, the recommended norm for oudoor air is 35 $\mu g/m^3$. The US standard for PM10 stipulates that the daily mean concentration must not exceed 50 $\mu g/m^3$ more than 35 days/year and the yearly mean can not exceed 40 $\mu g/m^3$[7]
Johansson C, Norman M, Gidhagen L. Spatial & temporal variations of PM10 and particle number concentrations in urban air. Environmental Monitoring and Assessment 2007;127:477..

[c] Indoor and outdoor national standard

[d] Known carcinogen and PAH; its chemical composition has been shown to be a modulator for PM toxicity

[e] 2004 EU directive for outdoor air

[f] Highest of two or three readings per hall. The lowest reading was 1.7 $\mu g/m^3$

[g] 2010 National Target

[h] The group of polycyclic aromatic hydrocarbons (PAH) measured included 40 plus chemicals

dibenz[a,h]anthracene and and indeno(1,2,3-cd)anthracene) [23, p2-7]. They also pointed out PAHs were identified in PM_{10} and $PM_{2.5}$ samples collected from indoor sports halls, i.e. the NILU study.

The NYC study concludes [23] new research is necessary to give more representative data on exposures related to urban field use. They suggested COPCs and PM should be measured at the breathing zone levels of users (specifically children due to their closer proximity to COPCs [23, p3-7]), on both newly installed and older synthetic turf fields containing crumb rubber should be. Air monitoring targets should include PAHs, VOCs, and particulate matter, and should occur during hot weather and calm wind conditions to approximate worst case exposure scenarios. In addition, background air sampling should be conducted at nearby off-field sites simultaneously, as well as natural and/or asphalt fields, in order to provide comparative data on exposures related to urban environments .

Phthalates, alkylphenols, and benzene have been found to off-gas during tire manufacturing (Cocheo et. al. 1983). In addition, studies have also shown that various chemicals such as phthalates, alkylphenols, and benzene may become bonded to tires during use (Willoughby 2006a, b). 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.

Risk levels

Risk level of 1 in 10,000 (10^{-4}) is considered the maximum acceptable risk while a risk of 1 in 1,000,000 (10^{-6}) is considered a virtual safe dose and constitutes a negligible risk. The debate [26] regarding the maximum acceptable risk should be discussed within the taskforce. While measuring risk is scientific, judging the acceptability of risk is a value judgment [27, 28] and it is unclear if 10^{-4} in San Francisco considers the identified and potential risks as acceptable. Risk levels less stringent than 10^{-6} are often due to economic or technological considerations. Regulatory agencies generally view these higher risk levels (10^{-4} ,10^{-5}) to be acceptable if there is no feasible way to reduce the risks further [25].

Future Steps

To accurately assess the potential for human health toxicity, accurate measurements of particulate matter, specifically PM10, PM2.5 and ultra fine particles are required. Currently, the literature does not address this, though it does for indoor PM from artificial turf. The indoor numbers demonstrate the source of dust is primarily from the recycled tire infill and the source strength for both the particle concentration and composition is comparable to EU and US standards for pollution, indicating the infill is a particulate matter pollution source.

Experiments suggested:

Determining if the recycled tire infill is a pollution source and health risk outdoors requires further research. It is suggested such experiments be performed at local San Francisco artificial turf installations such as Garfield Park. Such experiments should be done to mimic use by children as they are closest to the source (measured at child height, say 32 inches). Similarly, the sampling should be done both during used (running, etc.) and close to where the re-suspension will take place (e.g. close to the athlete's breathing zone). Measurements on hot and cold days should be perforemed. Hot days may increase out gassing and lead to more adsorption of chemicals on the PM;

cold days may increase PM generation due to stiffening of the rubber tire material enabling more mechanical formation of PM.

Risk assessment can then be undertaken armed with accurate concentrations and compositions of the PM. Short of outdoor data, the indoor PM data should be used to make an assessment – concluding the levels of PM and the composition therein are at or above to EU and US standards for pollution, not below. Factors such as radiant heating (sun) and low/no wind days may create scenarios where the indoor values are applicable.

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Study Concern: Will there be health effects due to inhalation or ingestion of synthetic field components?

5/29/08

Charles Vidair, OEHHA

Relevant Research

1. J. C. Broderick & Associates air measurements above outdoor synthetic football fields in two high schools in New York State.
2. Norwegian Institute for Air Research air measurements over three synthetic sports fields in indoor stadiums.
3. Moretto study performed for the artificial turf industry: assayed turf samples in sealed chambers (for volatilizing chemicals) and outdoor turf plots (for chemicals leaching in rain water).
4. EHHI study of rubber crumb samples heated in small glass vials.
5. California Integrated Waste Management Board (CIWMB) study of tire-derived indoor flooring: flooring off-gassed in environmental chambers.
6. Norwegian Institute of Public Health risk assessment using the data from #2 above.
7. OEHHA playground study in which shredded tires were digested overnight in a solution that mimicked the gastric environment.

Main Findings

1. Sixteen polycyclic aromatic hydrocarbons (PAHs) were assayed: none were detected at the minimum detection limit of 6 ug/m^3.
2. A variety of volatile organic compounds (VOCs), PAHs and small particulates (PM_{10}, $PM_{2.5}$) were identified and quantified. Many additional low-level chemicals were detected but not identified.
3. VOCs (over 112) and metals were released by the turf but no concentrations were given.
4. Identified and quantified 4 VOCs and 4 metals released by the rubber crumb into the air in the vial (VOCs) or into an aqueous solution (metals).
5. Twenty-four VOCs were identified and quantified, hundreds of other low-level VOCs were not identified or quantified.
6. Adverse health effects were not expected from the exposure scenarios modeled, either via inhalation or ingestion.
7. The tire shreds released thirteen metals and eleven organic chemicals. A low risk of adverse health effects was calculated for a scenario of a one-time ingestion of 10 grams of shreds by a child.

Significance for San Francisco

1. Suggests PAHs are not released by these outdoor fields at detectable levels.
2. Uncertain, since these fields were in indoor stadiums and the fields in San Francisco are outdoors. Outdoor fields may have lower levels of volatilizing chemicals and particulates in the air space above them due to dispersion into the atmosphere.
3. Uncertain without data on concentrations of chemicals released.
4. Concentrations may be useful for estimating whether health effects would be expected in outdoor fields.
5. Exposure modeling suggests the identified chemicals would not cause health effects via inhalation in outdoor applications; most low-level chemicals were not identified and so could not be evaluated for health effects.
6. Since these risk calculations were for fields in indoor stadiums, this suggests that health effects would not be expected for the outdoor fields being considered for San Francisco (assuming this group's analysis is correct).
7. Chemical release by rubber crumb used in synthetic fields is likely to be greater since the surface area/weight of rubber crumb is greater than that for rubber shreds.

Next Steps

1. Is the minimum detection limit of 6 ug/m^3 sufficient to rule out harmful levels of PAHs?
2. Need measurements for these chemicals and particulates from above outdoor fields.
3. If possible, get concentration data for this study.
4. Determine if health effects would be expected from estimated exposures to these chemicals.
5. If possible, locate data that identify more of the VOCs released by the tire-derived rubber.
6. Check calculations used in this risk assessment.
7. Try to extrapolate from rubber shreds to rubber crumb.

Environmental/Health Concern: Obesity

Jeanne Darrah and Robert Harrison
June 10, 2008

Relevant Research:

Policy:

1. Healthy parks, Healthy Communities, Addressin Health disparities and Park Inequalities through Public Financing of Parks, Playgrounds, and Other Physical Activity Settings, Yanez and Muzzy, October 2005 Trust for Public Lands
2. Promotion of physical activity in children, Floriani and Kennedy UCSF Dept. of Family and Healthcare Nursing, SF, CA, Current Opinion in Pediatrics 2008

Research:

3. Associations of Perceived Social and Physical Envtl Supports with Physical Activity and Walking Behavior, Addy et al. Am. Journal of Public Health, March 2004
4. Physical Activity Among Adolescents, When Do Parks Matter?, Babey et al., Am J. Prev Med, Jan. 2008
5. Contribution of Public Parks to Physical Activity, Cohen, et al. Am. Journal of Public Health, March 2007
6. Park-Based Physical Activity in Diverse Communities of Two US Cities, An Observational Study, Floyd, et al., Am J. of Prev. Med. V. 34, N. 4
7. Physical Activity and Neighborhood Resources in High School Girls, Pate, et al., Am J Prev Med. Vol. 34 No. 5
8. Places to Play: Association of Park Space and Facilities with Healthy Weight Status among Children, Potwarka, et al., J Community Health, 2008
9. Mac Arthur BART Transit Village Health Impact Assessment, Ch 6 Parks and Natural Spaces, Richardson, Jan 2007
10. Association of access to parks and recreational facilities with the physical activity of young children, Roemmich, et al. Preventive Medicine 43, 2006
11. Comaring Percei ed and Objectively Measured Access to Recreational Facilites as Predictors of Physical Activity in Adolescent Girls, Scott, et al., J of Urban Health, Vol. 84, No. 3 2007

Findings:

Adults and children in California are facing alarming rates of obesity (TPL) Low income communites of color have reduced access to community-level physical activity settings (TPL)
Physical activity is an effective strategy for obesity intervention (Floriani)
Teens reporting no access to safe parks are more likely not to engage in any physical activity compared to teens with such access (Babey)

Living close to a park is a critical determinant of park use and physical activity in low-income and minority communities (Cohen)
The highest expenditure of energy was associated with soccer fields, playgrounds, basketball, tennis and volleyball courts as opposed to dog play areas, picnic shelters, baseball fields and open-space areas. (Cohen)
Female adolescent girls were more likely to engage in physical activity where there were multiple activities at one site, the site was well lighted and clean and safe (Pate)

Relevant for SF?

Yes, because we have the same demographic data that the TPL put together for Santa Ana, California where there are pockets of high density, minority children with a lack of open space. These children are at an even higher risk of obesity than the general population.

The NY Dept. of Recreation and parks determined they have 28% more use time on fields that are artificial turf. In some areas of SF the use time is 100% more because RPD has not been able to maintain the fields. This is a significant increase in the available time for children to play.

Also, in urban areas the kids felt safer and were more inclined to go to clean well-lighted areas, which the artificial turf done by the City Fields Foundation provides.

Next Questions:

Should we focus the installation of artificial turf fields in high density areas of the city that have a lack of open space?
Should we install fields where natural turf maintenance is otherwise not feasible due to overuse of fields?

Environmental/Health Concern:
Alternative Synthetic Turf Products

Relevant Research (list/identify articles, studies, etc.)

1. Interviewed and solicited product information from numerous turf manufacturers over the last two years.
2. Searched the internet for alternative products and manufacturers
3. Contacted other municipalities, schools to inquire about field types

Main Findings?

1. Turf companies all appear to have similar product types with minor variations to their systems which distinguish their product line. These variations include differences in fiber design/profile, length, or combination of fiber material (polyethylene/nylon), backing design, infill type and sub turf pads and drainage systems.

2. Quote from one turf manufacturer who states that there are approximately 45 companies in the market selling turf products or individual components. The turf industry is an extremely volatile market and there are many companies emerging and failing on a regular basis.
3. Most turf companies use all rubber (SBR) or a combination of rubber and sand as their primary infill product. Although there are alternative infill products available, most companies believe that rubber is the best infill product on the market (tested and approved performance).
4. The goal of alternative infill products on the market is to address the concerns about SBR rubber (leaching, off-gassing, heat island, microbial growth).
5. Various Infill Materials: No Infill, SBR Rubber, SBR Rubber/Sand, Cool Fill (colored rubber), Flex Sand (rubber coated sand), EPDM, TPE, EcoFill (engineered fill), EnviroFill (sand), EcoFill (mulch), Polyolefin Plastomers, Polyolefin Elastomers
6. All fiber material is made of wither polyethylene or nylon or a combination of the two. Backing material is made of various layers of geo textile fabric layers with various binding and gluing styles. Some turf companies that use no infill or alternative infill products require a resilient backing material to meet full attenuation requirements (GMAX)

7. Only one company showed evidence that they have an active recycling component/program associated with their tur product (Mondo)

Is this concern relevant to and/or significant for SF synthetic playfields? (given conditions, mate

1. It is important to research and investigate all viable material options as well as examine the companies that provide the material and installation services.
2. Although it is important to pick the most appropriate material for the need, other variables should be considered in the selection process: fiscal status, experience, location, continued customer service, warrantee, recycling programs, etc.
3. Because the synthetic turf industry is changing rapidly to meet the needs of the customer, decisions made on new companies and products should be well researched to make sure that we receive the best product and service over time.

Next Questions? What do we still need to know/ understand?

1. Need further evaluation on new alternative turf and fill products.
2. Need to request and review MSDS sheets for all products being evaluated.
3. Need to gather user feedback on alternative turf products (other municipal user groups).

Alternative Synthetic Turf Products

Turf Manufacture	Company Location	Turf/Fiber Types	Fiber Material	Infill Types	Recycling Program	Green Technology	Local Installations	Warantee	FIFA Rated	Bio Mechanics Tests	ADA Approved	Antimicrobial Agent	Leachate Data	Field Temp Data	Off-Gas Data
FieldTurf (currenly used in SF)	Canada	Fibrillated Tape, Monofilament, Tape	Polyethylene	SBR Rubber with Sand	No	recycled tire infill that can be recycled/re-used	Yes	8 Year	Yes	Yes	Yes	No	request required	request required	request required
Sportexe (currently used in SF)	Texas	Fibrillated Tape, Monofilament, Tape	Polyethylene	SBR Rubber with Sand, SBR Rubber	No	recycled tire infill that can be recycled/re-used	Yes	8 Year	Yes	request required	Yes	No	request required	request required	request required
Mondo	Canada	Fibrillated Tape, Monofilament, Tape	Polyethylene	SBR Rubber, EcoFill	Yes	EcoFill is partially a post consumer product that can be recycled. Mondo has a recyclying program in place for turf at end of life.	Yes	8 Year	request required	request required	request required	No	request required	Yes	Yes
Italgreen	Italy	Monofilament	Polyethylene	GeoFill	No	Natural infill that can be recycled/re-used	Yes	request required	Yes	request required	request required	No	request required	request required	request required
Sprint Turf	Philadelphia	Tape, Monofiliment	Polyethylene	SBR Rubber, Cool Fill, Flex Sand	No	recycled tire infill that can be recycled/re-used, altnative infill mix to reduce heat	Yes	8 Year	request required	request required	request required	Yes	request required	Yes	request required
Astro Turf (General Sports Venue)	North Carolina	Tape, Monofiliment, Combination	Polyethylene, Nylon	No Infill, SBR Rubber	No	Bio Cell- modified polyurathane backing system using soybean based polyol in lieu of petroleum based compounds. Secondary backing uses post consumer plastic bottles	80 US fields in 2008	8 Year	No	request required	request required	Yes (turfaide)	request required	request required	request required
Desso	Europe	Fibrillated Tape, Monofilament, Tape	Polyethylene, Polypropolene	Sand, SBR, EPDM, TPE	request required	recycled tire infill that can be recycled/re-used	request required	request required	request required	request required	request required	request required	request required	request required	request required
Tiger Turf (California Ultimate Turf)	Texas	Monofilament	Polyethylene	SBR Rubber, SBR Rubber with Sand, EnviroFill	No	recycled tire infill that can be recycled/re-used	request required	8 Year	request required	request required	request required	request required	request required	request required	request required
GSE Geo Sport Surfaces	Texas	Tape	Polyethylene	SBR Rubber	request required	recycled tire infill that can be recycled/re-used	request required	request required	request required	request required	request required	request required	request required	request required	request required

Infill Options	
No Infill	EPDM
SBR Rubber	TPE
SBR Rubber with Sand	EcoFill (engineered infill)
Cool Fill (colored rubber)	EniroFill (sand)
Flex Sand (rubber coated sand)	GeoFill (mulch/cocunut husk)

Environmental/Health Concern: Recyclability

Relevant Research (list/identify articles, studies, etc.)	Interviews with synthetic turf manufacturers and distributors. See Dan Mauer for complete list of vendors and manufacterers interviewed.
Main Findings?	· The crumb rubber infill material is manufactured from 100% post consumer waste used tires. · Only some Mondo Turf infill products contain some (up to 30% post-consumer content. · According to the City of Larchmont, CA, an 80,000 sq. ft. field produced 400 tons of debris that needed to be managed. · Currently, no one in the industry recycles this material at the end-of–life. · Interviewees expressed varying degrees of understanding of recycled content materials. All expressed a willingness to commit their companies to end-of-life.
Is this concern relevant to and/or significant forSan Francisco synthetic playfields? (given conditions, materials, typical uses)	Yes, end of life issues are potentially costly for the City. Disposal costs are expected to increase significantly in the next decade. Climate change impacts of synthetic turf disposal have yet to be calculated.
Next Questions? What do we still need to know/ understand?	What are the plans of the synth turf manufacturers? Can the manufacturers increase the amount of post-consumer content?