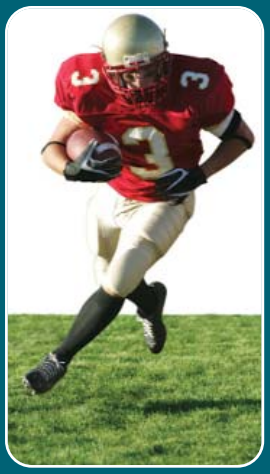
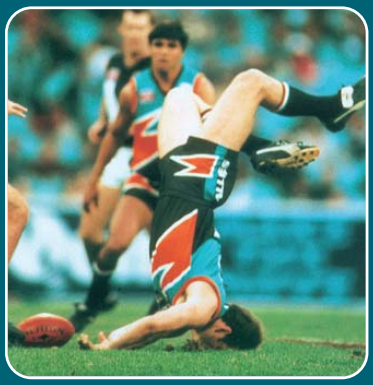
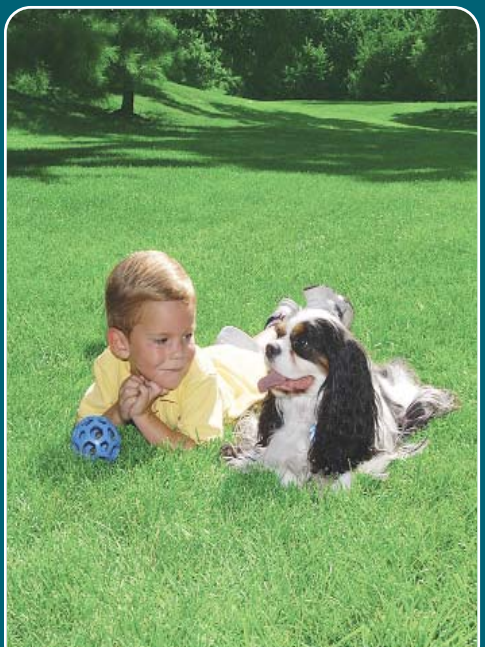


Natural Grass and Artificial Turf: Separating Myths and Facts





Published by the
Turfgrass Resource Center
www.TurfResourceCenter.org

PREFACE:

Natural Grass and Artificial Turf – Separating Myths and Facts

The intent of this publication is to present insightful information regarding the myths and facts about natural grass and artificial turf. Responsible questions about natural grass and artificial turf must be asked and answered truthfully with scientific data and facts, not with marketing materials and unsubstantiated claims. The information in this booklet is based on a literature review of scientific data, case studies and other information from industry professionals. The Turfgrass Resource Center considers this publication to be a positive step toward an honest dialogue.

Natural turfgrass playing surfaces have been used successfully for many years and there is a wealth of scientific data documenting their safety. With proper management and balanced use, natural grass fields have been proven to withstand and accommodate multiple sports team usage. While natural grass surfaces may become worn from excessive use, those portions of the fields can be easily, economically and quickly replaced. With proper management, the playability of a natural grass field, with a consistent and uniform playing surface, can be maintained year after year for a fraction of the cost of an artificial turf surface over its projected life expectancy. An entire natural turfgrass field could be replaced every year and have the worn parts of the field repaired, all at a significantly lower cost than installing and maintaining an artificial turf field.

A well maintained natural grass field may require water, fertilizer, pest management and mowing, but at significantly lower levels than often claimed by artificial turf sales people. An artificial turf field requires watering to cool the field to make it playable during warm days. What is generally omitted is the fact artificial turf fields need pesticides and disinfectants to prevent or eliminate mold, bacteria and other hazards that would otherwise be biodegraded by the natural environment of turfgrass fields. The maintenance equipment required for artificial turf fields is often underestimated. Companies produce entire lines of maintenance equipment for upkeep of artificial fields and for bringing them back to a playable condition.

While artificial turf has made improvements, artificial turf manufacturers continue attempts to simulate the exceptional playing surface that only natural grass provides. No matter what you call it – Artificial Turf, Synthetic Turf, Plastic Grass – it is a fact that artificial surfaces lack most of the benefits provided by natural turfgrass. Many athletes, coaches, parents and spectators take for granted the significant benefits of natural grass. Over 20 such benefits are listed within this booklet. These numerous benefits confirm natural grass as the best sports surface, which is why artificial turf companies try so hard to replicate its look and feel.

Companies involved in the manufacture or marketing of artificial turf acknowledge they have a responsibility to address concerns about their products; however their products have a relatively short history from which to draw any proven results. It is disconcerting that very few people question the erroneous claims of marketing firms and consider their data to be factual. More scientific research is needed to directly address reliability, longevity and the potential negative impact of artificial turf with regards to safety, health and environmental issues.

> ***"Make all fields grass to prevent injuries."***
>
> ***This is number one of five written "common responses" by 1,511 National Football League (NFL) players in a playing surface survey.***[1]

Municipalities, schools and groups are beginning to wake-up to the potential problems and negative affects involved with artificial turf. Several have placed a moratorium on its use until more of these questions have valid, scientific answers based on proven data. Parents, athletic booster clubs, schools boards, athletic directors, coaches and local officials deserve answers to help them evaluate unsubstantiated claims.

Surveys of NFL players show that most athletes prefer a natural grass playing surface and feel it is the more desirable, premium surface. The fact that others have installed artificial turf surfaces is not an acceptable reason to ignore the research and facts.

Choosing the best playing surface for our children and athletes should not be taken lightly. Anyone interested in a sustainable future should be fully informed about the benefits of natural turfgrass to our ecosystem and concerned about the potential negative impact of using synthetic surfaces.

1 National Football League Players Association 2006 NFL Players Playing Surfaces Opinion Survey, www.NFLPlayerAssociation.com

Table of Contents

Introduction

The decision of whether to install artificial turf or natural grass is one that requires serious consideration of all related science-based information. Current trends should be put aside in favor of the facts that can have short- and long-term rewards or consequences. Unsubstantiated claims, over-statements, misstatements or misunderstandings and fads should not be part of the decision-making process.

While there are situations when artificial turf might be an appropriate choice, scientific research documents the significant environmental, health and safety benefits of natural grass which should be the first consideration.

The true costs of proper installation, care and maintenance of artificial turf fields varies as widely as those of natural grass. The key word is "proper," as in whatever it takes to maintain high quality fields. The most reliable means for estimating true costs is to request a comprehensive bid proposal from artificial turf and from natural turfgrass producers, inclusive of actual costs for pre-installation field preparation, installation, post-installation care and maintenance, annual and seasonal maintenance, and repair for an extended period of time such as five or ten years.

Safety and health benefits are a major concern when selecting a sports field surface.

Decision-Makers Need to Know

To make fiscally and environmentally sound decisions regarding the potential purchase and installation of artificial turf or natural grass in their communities, decision-makers have the responsibility to consider a wide range of issues and concerns. The following information has been assembled to help them make the appropriate decision.

What Is Artificial Turf?

Artificial turf was first invented in 1965. The first synthetic turf fields were not much more than green plastic indoor-outdoor carpet. At the time, some members of the industry thought that as more teams moved to an indoor stadium, grass would not grow as well and would require a substitute.

While artificial turf today has evolved from the plastic mats of old, the "turf" is still attached to such a mat, with the fibers composed of polyethylene lubricated with silicone. A layer of expanded polypropylene or rubber granules (made mostly from recycled car tires) and sand serve as an "infill" to add shock absorbency. It is recommended that this infill be replenished and/or redistributed on a regular basis.

The advantages of artificial turf lie in its ability to withstand heavy use, even during or immediately after a rainstorm. Fields enduring high traffic situations throughout the year (particularly winter) benefit from its durability and effective drainage systems when properly incorporated into the field design. However, this is not inexpensive. The construction of the artificial turf field at Brigham Young University cost 2.5 million dollars with 1.7 million dollars of that amount spent on subsurface and drainage.[3] Artificial fields require a different type – but just as extensive maintenance protocol – as natural grass, particularly if used regularly for a multitude of sports events.

The Roll of Natural Grass in Sports

As of 2006, the majority of professional sports fields still used natural grass. In the National Football League, two-thirds of the stadiums (20 fields) used natural grass while 11 stadiums used artificial turf. Even more dramatically, only four of 30 baseball stadiums chose artificial turf.

In Europe and North America, some soccer clubs converted to synthetic turf in the 1980s, but soon converted back to natural grass when both players and spectators complained. Not only did players find the hard surface unforgiving but the bounce of the ball was affected, changing the dynamics of the games. Although

Survey questions asked of 1,511 National Football League players: [2]

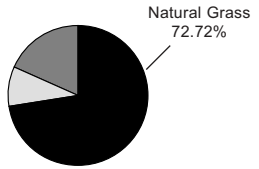
"What type of field do you prefer to play on?

Responses:

72.72 % Natural Grass

18.09% Artificial Turf

9.19% No preference



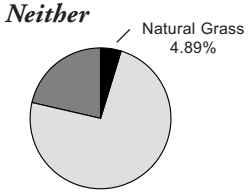
"Which surface do you think causes more soreness and fatigue to play on?"

Responses:

4.89% Natural Grass

73.87% Artificial Turf

21.24% Neither



2 "National League Players Association 2006 NFL Players Playing Surfaces Opinion Survey", *Op. cit.* Questions 8 and 2

3 C. Frank Williams and Gilbert Pulley, "Synthetic Surface Heat Studies," Brigham Young University, www.byu.edu, p 2

Grass strength is important for a successful sand based sports field.

Photo: A turfgrass stretching device used to measure grass strength

"Although many types of turf undergo university trials, there is a lack of information of the long term impact of artificial turf."

Photo: Folsom High School, Folsom, CA

the Federation International de Football Association (FIFA) allows the use of synthetic turf,* some international soccer teams absolutely refuse to play on artificial turf.

Although many types of turf undergo university trials, there is a lack of information on the long-term impact of artificial turf. While government organizations like the Department of Agriculture and the Environmental Protection Agency exist to educate users and oversee the effects of natural grass, there are no government restrictions or guidance in reference to artificial turf.

While modern artificial turf has evolved considerably, so has modern natural grass. Natural grass fields of yesterday that were often muddy, rough or simply unplayable have been replaced with modern turfgrass varieties developed for greater durability, even under heavy traffic conditions. Different types of natural grass fields are referred to throughout this document; the most modern fields have significant drainage, at least 90 percent uniform sand in the profile mix, and the best varieties of sports turfgrass.

Natural soil or native soil fields have soil compaction and drainage limitations that are overcome with the improved, soil-modified fields. Native soil fields should only be used when they are necessitated by financial limitations. For native soil fields to have any hope of providing quality turf under average traffic conditions, they must have proper pitch and adequate drainage.

A Standard of Comparison

In both theoretical and practical terms, a fair comparison between natural grass and artificial turf should include the most modern, technologically advanced fields available on both counts.

The following information examines six major considerations one should use when comparing artificial turf and natural grass: 1) safety issues; 2) cost analysis of various sports fields; 3) wear, durability and maintenance of field surfaces; 4) human safety and health issues; 5) environmental issues; and, 6) future research issues.

Part I: Sports Field Surfaces: Opinions of NFL Players and Professional Organizations

The National Football League Players Association (NFLPA) announced the results of a league-wide player survey concerning NFL club's playing surfaces. The written survey, directed by the

* FIFA's marketing department promotes artificial turf fields, recieving significant contractor fees for FIFA-approved turf fields

Board of Player Representatives, was conducted by staff members at team meetings during September through November, 2006. A total of 1,511 active NFL players from all 32 teams voluntarily filled out survey forms. This survey is conducted every two years.[4]

The survey revealed that 72.72% of the players prefer to play on a natural grass surface: 18.09% selected artificial turf; but, when playing on artificial turf, 90.85% of the players wanted the softer "infill" which causes a safer playing surface – making the artificial turf field more like a well maintained natural grass field.

The last part of the survey asked for additional comments. Number one of the five most common responses by players was "Make all fields grass to prevent injuries."

After one of the earlier NFLPA surveys related to field surfaces, former Executive Director Gene Upshaw stated: "In this survey, we have heard from the true experts on playing surfaces – the players."[6]

More details from the 2006 NFLPA survey are included throughout this report. In addition, there is information on safety and health issues related to artificial turf and natural grass in Part 4.

Synthetic Fields are Being Called Into Question All Over the World

In spite of aggressive lobbying from synthetic turf marketing groups, safety and health problems related to synthetic surfaces have caused concerns and moratoriums throughout the world. Dr. Guive Mirfendereski, editor at www.synturf.org, published the following articles: *

- The Scottish Premier League banned synthetic pitches for competition matches.
- The Italian Minister of Health found that synthetic turf fields are potentially carcinogenic (cancer producing substance).
- The Center for Disease Control and the Mount Sinai Children's Environmental Health Center issued warnings about the hazards of artificial turf.
- Norway has banned synthetic turf.
- The UEFA (Union of European Football Associations) has ordered that the 2008 European Champions League final must take place on natural grass.

4 "The NFL Players Playing Surfaces Opinion Survey," *Op. cit.*
5 Wendell Mathews, Ph.D., "Editorial Comment: A Photo Worth a Thousand Words," Turf News, November/December, 1999, p. 11
6 Wendell Mathews, *Ibid*
* Guive Mirfendereski is an attorney in private practice. He manages the website www.SynTurf.org , a public interest clearinghouse for information related to artificial turf fields.
** From "Why choose natural turf? A discussion on natural versus artificial turf for sport and leisure applications," by the European Seed Association, 2006

"Thank goodness the turf [grass] tore instead of my spinal cord! My playing career, and possibly my life, was saved by the softness of the surface." [5]

Jason Dunstall
Australian Football League

"This artificial grass was a disaster. It hurt my feet. I really hope we don't get this in the Amsterdam Arena. If this is the future, I'd better stop playing football [soccer]"**

Rafael van der Vaart
Soccer player for Ajax Amsterdam
The Netherlands

■ All seven professional baseball stadiums in development at the time of this writing will have natural grass, including Cisco Field (Oakland A's). AT&T Park has always had natural grass. Monster Park (Candlestick) returned to natural grass in 1979. Only five synthetic pro stadiums still remain; two of these will be abandoned by major league baseball in 2009.

■ The NFL Players Association repeatedly renounces synthetic turf in its biannual polls because of its tendency to aggravate injury.

■ A growing number of communities in California are opposing the installation of synthetic fields, including San Carlos, Woodside, Danville and Atherton.

■ Two stadiums were closed in New Jersey in 2008 by the recommendation of the New Jersey Department of Health after it found high levels of lead in the stadium's nylon-fiber artificial turf.

■ A Dutch investigation stated: "the leaching of zinc [from a synthetic turf surface] is a major concern."

■ South Korea's Education Ministry began investigating the safety of recycled rubber granules following student complaints of nose and eye irritation.

■ The Swedish Chemical Agency recommended that tire waste not be used in constructing synthetic turf fields because the product releases hazardous materials.

■ The non-profit organization, Environment and Human Health, Inc. (www.ehhi.org), has called for a moratorium on synthetic surfaces.

■ State legislators in California, New York, New Jersey and Minnesota have called for a moratorium.

■ The U.S. Consumer Product Safety Commission is investigating potential hazards from lead in artificial turf sports fields.

■ The Attorney General of Connecticut has called for further studies associated with risks related to artificial turf.

Crumb rubber is used in the base below the surface of the artificial turf carpet– "Inhalation of components of tire rubber or dust particles from tire rubber can be irritating to the respiratory system and can exacerbate asthma."

Dr. Joseph P. Sullivan
An Assessment of Environmental Toxicity and Potential Contamination from Artificial Turf using Shredded or Crumb Rubber*

Part 2: Cost Analysis of Various Types of Sports Fields

Since conditions and requirements vary, there is no single definitive answer or figure to describe the costs of constructing and maintaining a natural grass field or a synthetic field.

Just as natural grass sports fields have an installation cost range because of base soil conditions and their preparation, the installation cost of an artificial turf sports field can vary from basic to premium. As previously mentioned, the artificial turf field at Brigham Young University is a premium installation that cost 2.5 million dollars (of that amount, 1.7 million was spent for the subsurface and drainage system)[7]

Therefore, consulting the experiences of other field builders and users provides a method of estimating costs.

Field Construction Types and Costs

Because many factors contribute to the fields' construction costs, your sports turf manager should research recent similar construction. For further information, contact STMA (Sports Turf Management Association) at 800/323-3875.

The Turfgrass Resource Center asked Mike Kelly, a professional sports field contractor, to describe basic types of sports field installations and to give cost estimates. Mike Kelly's company installs both artificial turf fields and natural grass fields at approximately a 50-50 ratio.[8] He reported: "We construct a number of sand based fields and lay the base of a number of synthetic fields per year. The contractor's primary concern is to find what the customer needs: questions include: 1) What type of sports are played? 2) How often will the field be used? and, 3) What are the annual, local weather conditions? A high sand based field if installed correctly will play as well in the rain as in dry weather. All of the fields described in this report are based on 85,000 square feet. Costs apply to a normal high school and college sports field or a recreational facility in a city park."

Myth: ***Artificial turf saves money because of its longevity.***

Fact: ***While the factors influencing costs vary from field to field, construction costs for an artificial turf field generally far outweigh construction costs for a natural field.******

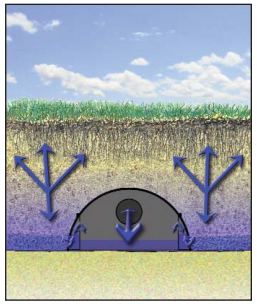
Native Soil Field: Field player performance will vary greatly on a native soil field. Some of these fields are great while others are terrible. The native soil structure and soil type will be the biggest performance factor. Seldom do we consider this an option unless the native soils are very sandy. The largest cost of this type of field is the site grading and the drainage system.

Typical cost for this type of field is **$50,000 – $150,000***

Sand Based Field: These fields are the proven performance standard for a good athletic field. A sand based field will require a uniform size and structure (medium sand, semi-angular) of sand particles. The sand percentage will be 95-99% with 1.0 to 2.5% organics. It has very little silt or very fine sand. This field will drain at approximately 10 inches or greater per hour and have

* Joseph P. Sullivan, Ph.D., "An Assessment of Environmental Toxicity and Potential Contamination from Artificial Turf using Shredded or Crumb Rubber," Ardea Consulting, March 28, 2006, page 2. This literature review was initiated by Turfgrass Producers International and is available at http://www.turfgrasssod.org/trc/index.html

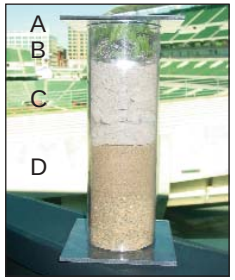
7 Williams and Pulley, "Synthetic Surface Heat Studies," Brigham Young University, *Op. cit.*
8 "The Cost of Field Construction in the Midwest," Turfgrass Resource Center, http://www.turfgrasssod.org/trc/index.html
* All costs quoted in Part 2 are United States dollars unless otherwise stated. Mike Kelly provided this information in 2008 with the understanding that—with time—decision makers must factor in inflation percentages and the price increases of materials and labor.
** The information throughout Part 2 documents this statement.



Construction profile for a sand based field. Two inch rock layer and sand to appropriate depth 12-18 inches.

Photo and information: Rehbein Excavating, Inc.

Construction profile for a synthetic field.



A: Artificial Turf Level
B: Rubber/Sand Mix
C: Rock (#57 stone)
D: Pea Gravel and/or old sand base

Photo and information: Darian Daily, Head Groundskeeper, Paul Brown Stadium, Cincinnati, Ohio

good resistance to compaction.

Typical cost of this type of field is **$250,000 – $350,000**.

Sand Based Mesh Element Field: This ReFlex Mesh Element Field is built similar to a sand based field, however it incorporates segments of polypropylene netting into the top 4 in. of the profile. The inclusion of the mesh increases pore space which gives more water and air holding capacity, increases infiltration rates, improves surface stability, decreases divots and improves the recovery time because the plants are healthier.

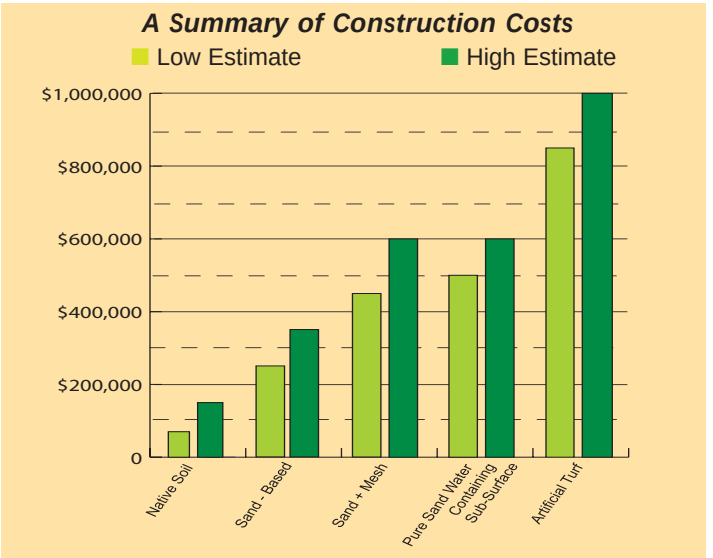
Typical cost of this type of field is **$450,000 – $600,000**

Pure Sand Based Water-Contained Sub-Surface System Field: This is a new type of natural grass field that requires less than 50 percent of the water of a normal sand based field.

Typical cost of this type of field is **$500,000 – $600,000**. (There would be an additional cost if you include Reflex mesh elements.)

Synthetic Field: Synthetic turf is filled with a ground rubber material to cushion the users of the field. The sub-base is composed of a hard, chipped rock material that will drain water freely. This is generally 6 in.-10 in. of course rock material and approximately 2 in. of fine granular chips. Please note that the carpet on synthetic fields needs to be replaced every 8-10 years. The cost of the carpet replacement is projected at $500,000+ in today's dollars.

Typical costs of these fields are **$850,000 – $1,000,000**.



Comparative Maintenance Cost

The cost estimate for a sports field must include the annual maintenance costs. This seems obvious, but there has been misinformation related to artificial turf fields. An *Athletic Turf News* article reported: "Maintaining synthetic turf systems is not as inexpensive or as 'labor free' as some people may have been lead to believe."[9] That was the "take-home message" from the Michigan Sports Turf Managers Association's (MiSTMA) Synthetic Turf Infill Maintenance Seminar held at the Detroit Lions' practice facility in Dearborn, MI. Details of maintenance costs at Michigan State University are presented below. The following information presents construction costs, plus maintenance costs. Some of the reports amortized costs over a specific period of time to give a realistic understanding of annual costs.

Artificial Turf Sports Field Maintenance Costs

The Michigan Sports Turf Managers Association sponsored a seminar titled "Synthetic Turf Infill Maintenance" held at the Detroit's Lion practice facility in Dearborn, MI. Amy J. Fouty, CSFM, athletic turf manager for Michigan State University, presented details about the cost of maintaining MSU's synthetic turf indoor three-year-old practice field. Fouty presented the following:[10]

MAINTENANCE COSTS

Total straight hourly cost $5,040
(Field only; 280 hours at $18 per hour; benefits not included)
Total supply cost.....$6,220*
Total equipment cost for the year.....$3,500
(This includes a sweeper ($1,500); a broom ($500); and, a groomer ($1,500)
Total outside contractor repairs .....$ 8,000
TOTAL cost 2004-2005 .....**$22,760**

SYNTHETIC TURF MAINTENANCE EQUIPMENT

Equipment to spray water.....$1,000 to $35,000
Sweeper ..... $1,500 to $20,000
Broom .....$500 to $3,000
Painter.....$500 to $3,000
Groomer.....$1,500 to $2,000
Cart (to tow equipment).....$2,500 to $16,000
Field Magnet.....$500 to $1,000
Rollers.....$250 to $2,000
TOTAL.....**$8,250 to 82,000**

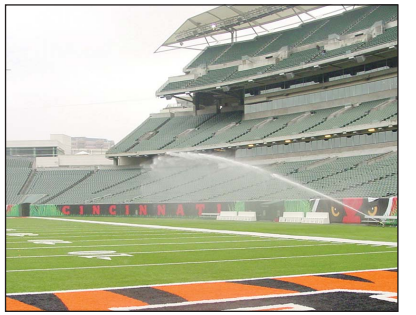


Photo: Darian Daily

Water cooling and cleaning the synthetic turf using irrigation. The field should also be treated with chemicals to eliminate bacteria and mold.

9 Lynne Brakeman, "Experts spell out the true cost of synthetic turf maintenance," *Athletic Turf News*, May 24, 2005, p.1
10 Lynne Brakeman, *Ibid*, pp 3 and 4
*Note: the supply cost summary does not include the application of crumb rubber one time a year using 10 tons as "top dressing" at $500 per ton ($5,000 dollars). Adding this figure, the summary total would be $27,760.

Comparative Guide: Equipment and Maintenance

The following is a basic comparative guide presenting a broad range of estimates. The information has been gathered by The Turfgrass Resource Center from research reports, seminar presentations, published articles, manufacturers, suppliers, and personal conversations with field contractors and field managers. Estimates are given only as a general guide. Each potential buyer must gather their own information as it relates to field type, field size, geographic location, area labor costs, amount of site work required, irrigation or water/cooling needs, and the number of estimated games or activities. The SportsTurf Managers Association's *A Guide to Synthetic and Natural Turfgrass for Sports Fields* is a good source to begin a comparative study of selection, construction and maintenance considerations.[11]

Cost of Equipment, Supplies and Labor Required for Maintaining Artificial Turf and Natural Grass:

Artificial Turf		**Natural Grass**	
Water (for cooling)	$6,000-35,000	Irrigation	$6,000-35,000
Sprayer for water application	$1,000-35,000	Equipment for irrigation	$3,000-31,000
Sweeper	$1,500-20,000	Mower	$13,000-69,000
Mechanical Broom	$500-3,000	Fertilizer Applicator	$1,000-3,000
Line Painter	$500-3,000	Painter, line	$700-3,000
Groomer	$1,500-2,000	Rollers	$2,000-4,000
Cart (for towing equip.)	$7,000-16,000	Cart (for towing equip.)	$7,000-18,500
Field Magnet	$500-1,000	Aerator	$3,500-17,000
Rollers	$250-2,000	Vacuum	$2,100-5,000
Top Dresser	$4,500-10,000	Top Dresser	$4,500-20,000
Total	**$23,250-127,000**	**Total**	**$42,800-205,500**

Annual Maintenance Required for:

Artificial Turf		**Natural Grass**	
Painting/removal (various sports)	$1,000-10,000	Painting (various sports)	$800-12,300
Top Dressing/Infill	$5,000*	Top Dressing (sand)	$0-5,400
Brushing/sweeping	$1,000-5000	Dragging	$0-200
Disinfecting/Fabric Softener	$220*	Fertilizers	$1,200-11,000
Carpet Repair (rips, joints)	$1,000-8,000*	Pesticides	$650-6,300
		Aeration	$700-960
Water Cooling	$5,000-10,000	Sod Replacement	$833- $12,500
Weeding	$500-1,000	Irrigation	$300-3,000
Total	**$13,720- $39,220**	**Total**	**$8,133- $48,960**

*Michigan State University/Brakeman, *Op. cit.*, p4

11 SportsTurf Managers Association, "A Guide to Synthetic and Natural Turfgrass for Sports Fields," www.STMA.org (Click PDF version to access complete guide of 19 pages)

Natural Grass Sports Field Maintenance Cost

The costs for maintaining a natural grass field vary based upon field type and size (native soil or one of the sand-based fields) and a number of factors listed on page 12 of this report. Costs can range from $8,000 to $49,000. The SportsTurf Managers Association's comparative study includes examples in the low range of the scale:

1. **A Denver-area native soil field** with Kentucky bluegrass and perennial ryegrass that hosts approximately 110 soccer events annually will spend between $5,500 and $8,000 per year to maintain that field (not including equipment and labor).

2. **In New York state, a high school native soil field** with perennial ryegrass and Kentucky bluegrass that hosts approximately 15 fall football games and 30 LaCrosse games in the spring will spend approximately $4,000 annually (not including equipment and labor).

3. **A Denver-area sand modified field** constructed of 90% sand and 10% peat, with four varieties of Kentucky bluegrass that hosts 35 football games and 10 other events, is between $9,000-$11,000 annually (not including equipment and labor).

Sports Field Construction and Maintenance– Researching the Total Costs

Numerous websites present comparative studies about total sports field cost. For example, the Turfgrass Information File, (TGIF) at Michigan State University has hundreds of articles related to artificial turf sports fields and natural grass sports fields.* The following are examples of research and case studies.

The SportsTurf Managers Association Guide

The SportsTurf Managers Association recently produced a guide to construction and maintenance of all field types that demonstrates the affordability of natural grass. This 19-page guide is a good beginning for a general comparative study.[12]

Synthetic Turf/infill .....$7.80-$10.75 per sq. ft. ($83.96-$115.71 per m^2)

Natural grass/sand and drainage .$6.50-$7.95 per sq. ft. ($69.97-$85.57 per m^2)

Natural grass with sand cap.....$3.50-$5.25 per sq. ft. ($37.67-$56.51 per m^2)

Natural grass with native soils .....$2.50-$5.25 per sq. ft. ($26.91-$56.51 per m^2)

Natural grass with on-site native soil .....less than $1 per sq. ft. ($10.76 per m^2)

Using SportsTurf's guide to estimate costs:

■ ***Synthetic field:***

85,000 sq. ft. X $10.75 = $913,750

■ ***Natural grass field with sand and drainage:***

85,000 sq. ft. X $7.95 = $675,750

The natural grass field is a difference of $238,000

12 SportsTurf Managers Association, "A Guide to Synthetic and Natural Turfgrass for Sports Fields," *Op. cit*
*For further reading about turf field issues and management, use the TGIF database online. Members can access directly via their organization website. Others can subscribe individually; see http://tic.msu.edu for further details.

Myth: *Artificial turf requires little maintenance, and therefore, little if any annual costs.*

Fact: *While in some cases, annual maintenance costs may be lower for artificial turf, there are still significant costs involved. Artificial turf fields still require personnel and equipment for dragging, cleaning, carpet repair and infill additions and water/cooling. When maintenance and construction costs are combined, natural grass fields generally average out to less cost per year than artificial fields.*

Information throughout Part 2 documents this statement

University of Missouri Case Study

Brad Fresenburg, a turfgrass specialist at the University of Missouri, Division of Plant Sciences, completed a comparison study of natural grass and artificial turf. Like many studies, Fresenburg found that when annual maintenance costs and installation costs were combined, natural grass fields were a better value. He calculated an annual average cost for each field type, based on a 16-year scenario:

Native soil based field $33,522
Sand based field $68,545
Sand-cap grass field $49,318
Basic synthetic field $65,846

Fresenburg notes that for the cost of installing a synthetic field, an organization could install a natural sand-cap grass field, then place the remaining money into a maintenance fund.[13]

Hidden Costs

Michigan State University Athletic Turf Manager Amy Fouty found that not only was artificial turf not maintenance free, but that maintenance costs alone were only part of the expense. Fouty's annual equipment budget varied from $8,250 to almost $82,000. The need for outside contractors to consult or train maintenance staff could cost as much as $3,000 a day, resulting in $30 to $70 per linear foot for repairs.

Unlike natural grass, artificial turf cannot regenerate and grow in or be quickly sodded to fill spots or damage marks. One university recorded an annual cost of $13,000 to repair damage and replenish the field (seam repairs – $8,000, application of crumb rubber – $5,000).[14]

On another professional field, repeated painting of an artificial field as it changed from one sport to another and back again totaled more than $100,000 in one year.

A Comparative Cost Study

Dr. A.J. Powell, a leading turfgrass agronomist with the University of Kentucky, conducted a research study to analyze costs involved with installing and maintaining both natural grass and synthetic fields.

13 Brad Fresenburg, "Synthetic turfgrass costs far exceed natural grass playing fields." (2005), Tables are available in a Power Point format.
14 Lynne Brakeman, "Experts Spell out the True Cost..." *Op. cit.*, pp 3 and 4

Contrary to others' experience, Dr. Powell felt that installing a new sand based field would actually cost more than an artificial FieldTurf construction. However, because the synthetic field would need to be replaced after approximately eight years, the long-term value favors the natural grass field. Properly installed and maintained quality natural grass remains viable for at least twice as long, exponentially increasing the costs for a synthetic field based on the need to tear up, totally remove and reinstall new artificial turf every eight to ten years or even more often.[15]

Disposal Costs

For the removal and disposal of an artificial surface, sports field managers can expect these costs to run at least $1.75 - $2.25 per sq. ft., not including transportation costs and any landfill surcharges that disposal might incur. This cost will arise in conjunction with a new field's construction, boosting the up-front costs required. Many of the modern artificial turf fields installed in the last decade will be reaching this stage in a few years, raising the awareness of these costs.[16]

Cost and Warranty Concerns: Questions to Ask

Officials making a decision about installing an artificial turf field should be prepared to ask the contractor critical questions.

The ancient Latin axiom is especially pertinent: "caveat emptor"– let the buyer beware.

The initial purchase price of an artificial surface (sports field or home lawn) is many times greater than a natural grass area; however, promoters of the artificial products maintain that tremendous costs savings will be forthcoming because of reduced maintenance costs, as well as the product's warranty.

Because many of the artificial products are relatively new and not tested over time and through use, claims about no-cost or low-cost maintenance requirements that are consistently made by promoters of artificial surfaces may prove to be highly exaggerated. Consider:

1. Will the artificial turf manufacturing and installation company provide a warranty specifying the expected life of the product?

2. Given the fact that several artificial turf manufacturing companies have gone bankrupt, will the selling firm provide a warranty bond for the life of the product, ensuring the buyer has some legitimate recourse in the event of failure?

3. What is the longest period of time the artificial field being specified has been in use (at a level of use at least as great as the area being considered)?

4. What conditions or maintenance practices will void the field's warranty?

15 Lynne Brakeman, "Natural Turf or Synthetic Turf: The Numbers Game", *Athletic Turf News*, May 21, 2005, p1
16 SportsTurf Managers Association, *Op. cit*

"The goal of this report is to present insightful questions and answers about artificial turf and natural grass based on professional knowledge, case studies and scientific data – not promotional campaigns, marketing materials and unsubstantiated claims."

5. Does a single warranty cover all aspects of the artificial field's soil base preparation, base materials, artificial turf materials, top-dressing, irrigation system, etc.; will there be separate warranties and warranty voiding conditions for each element, some of which could contravene each other?

6. What is the minimum and maximum financial investment in specialized equipment that must be purchased to maintain the artificial field at a level that will provide maximum playing conditions and maintain the warranty?

7. What level of manpower (ground crew) is required to maintain an artificial field, compared to a natural grass field? Has any crew size or man-hour requirements been reduced with the installation of an artificial turf area?

8. What level of technical training is supplied, recommended or required for the ground crew in order to properly maintain the area and the warranty conditions?

9. What are the warranty requirements or recommended processes to address each of the following repair or replacement demands of the artificial surface:

   a. Damage caused by cigarette burns? Burns to larger areas?
   b. Discoloration of areas caused by wear pattern differences?
   c. Replacement of areas caused by wear or other physical or weather-related damage?

Part 3: Problems with Wear, Durability and Maintenance of Artificial Turf

Although made of non-living synthetic materials, artificial turf cannot endure without continual maintenance and repair.

Ford Field, a synthetic turf surface, is a multi-use facility built in 2002. Home of the Detroit Lions, the venue was designed to host 120 events a year. Sports Field Manager Charlie Coffin and the field owners "were sold these fields on the basis that there would be no maintenance. That just wasn't true," says Coffin.[17]

Since the field was covered, planners decided that the field didn't need a drainage system. Contamination and erasing paint lines are now significant issues with no rainfall and nowhere for water to flow when applied.

Synthetic surfaces require: 1) additional "infill" below the artificial turf; 2) water treatment because of unacceptable high temperatures; 3) chemical treatment to disinfect against bacterial and mold growth; 4) sprays to stop static cling and odors; 5) constant monitoring of the drainage system; 6) a difficult procedure for erasing and repainting field lines; and, 7) removing organic matter.

17 Lynne Brakeman, "Experts Spell out the True Cost..." *Op. cit.*

On the other hand, natural grass can be easily and inexpensively treated to propagate self-repair because of the inherent, regenerative character of a living plant. Other natural grass benefits that help with sports field maintenance are listed beginning on page 27 of this booklet.

The following information and case studies address some of the problems associated with the wear, durability and maintenance of artificial turf.

Replenishing field's infill: Since infill needs to be replenished repeatedly over the life of a synthetic field, a new concern is discovering what became of the "old infill." How much of it ends up where? As infill is played on, some of it merely settles. Some of it breaks down, allowing part of the field to literally walk away with players after each use, stuck on their cleats, uniforms and bodies. Some of it washes away with a drainage system and even rain run-off. The extent of the effects of this "runaway" infill are still unknown.

Drainage problems below the field surface: Ford Field, mentioned earlier, was an unfortunate synthetic indoor surface installation that created problems. Since the indoor field was covered, planners decided the field did not need a drainage system. Contamination and erasing paint lines became significant issues with nowhere for water to flow when the surface needed cleaning and chemical applications to stop bacterial growth. All synthetic surfaces – whether indoors or outdoors – need a drainage system. Decision makers who are considering a synthetic surface need to ask

Synthetic/artificial sports fields are covered with a fiber carpet (polyethylene/nylon) that breaks down with time, weather and use. These photos are of a seven-year-old field in Lucchesi Park, Petaluma, CA (2008). The abrasive nature of the sand/rubber sub-structure causes seams to split and holes to form.

Unless properly treated with chemicals that disinfect, a synthetic surface can harbor bacteria and mold. Many non-professional fields are not properly cleaned or disinfected.

Photo source: http://sfparks.googlepages.com in collaboration with www.SynTurf.org

MYTH:
Synthetic fields drain water better than natural grass.

FACT:
Owners of artificial turf fields are discovering problems with the drainage systems.

specific questions about these complex systems that sometimes work incorrectly or inefficiently. Two case studies illustrate this problem:

Example 1–Brigham Young University Artificial Sports Field: When this university's synthetic field was installed, the company claimed a drainage rate of 60 inches (152 cm) per hour. A system under the artificial carpet was designed to move water from the surface into an extensive drain mat system. The drainage system made up two thirds of the overall cost of the field (in this case, US $1.7 million of US $2.5 million total costs). After installation, B.Y.U. found the surface to be hydrophobic and the undersurface poorly engineered, leading to water retention rather than drainage, with the drain mat typically seeing little or no water.

In a report by Dr. C. Frank Williams and Dr. Gilbert E. Pulley, there is an evaluation statement about the problems with the 1.7 million under-surface drainage system: "That seems like a high price to pay for something that does not work!"[18]

MYTH:
Artificial fields are more durable than natural grass fields.

FACT:
Natural grass has been cultivated to endure a wider variety of conditions than ever and has the added benefit of being capable of self-repair.

Example 2–Portage High School, Indiana: When this high school installed its artificial turf, it was "ballyhooed for its ability to handle large amounts of rain," yet ended up unplayable after the first heavy rain. Officials found that the field was not draining, nor were the sidelines. The ball would not bounce or roll due to where the water remained on the field. Coach Danny Jeftich of the opposing team noted that, "It was a hard rain, but it should've drained much faster," citing that he had observed better drainage on natural grass fields. "Last year, there was a downpour before the semi-state [finals], and it drained in 10, 15 minutes," said Jeftich in reference to the grass fields.[19]

Maintenance needs of a synthetic turf surface: The Michigan Sports Turf Managers Association (MiSTMA) sponsored a "Synthetic Turf Infill Maintenance Seminar" in May of 2005. The "take-home message" was "Maintaining synthetic turf systems is not as inexpensive or as 'labor free' as some people may have been led to believe."[20] The following are a few examples of maintenance problems:

Example 1–Cleaning and disinfecting the surface: Whether by hand or with field magnets, small objects and materials must be meticulously removed; liquids or other residues must be thoroughly cleaned and disinfected. Some common elements that field managers must cleanse or remove after events include: blood, spit, urine, vomit, food, beverages, gum, metal particles, wooden splinters and animal droppings.

Question: As chemicals and sprays are repeatedly applied and washed off, what effect do these have on the groundwater supply?

Example 2–Field lines: While an artificial surface may seem smoother, lines are not easier to apply and remove. Painting lines has been found to create problems because the paint soon spreads, leading to messy lines and unsafe, slippery conditions. Other methods for creating lines on artificial turf is to "tuft-in" colored pieces, glue in sections or stitching during manufacturing. These efforts all come at a cost to accommodate various sports such as lacrosse, soccer and football. (See photo page 17)

Example 3–Static cling: Static cling is a nuisance for synthetic turf fields and requires diluted fabric softener to be sprayed on the field. The softener also serves to retard the odor – described by some as the smell of "old tires and locker rooms" – that comes from the rubber infill. However, the application of softener can make the field slippery for players.

Part 4: Safety and Human Health Issues Related to Artificial Turf

Safety and human health issues are a major concern related to synthetic surfaces. The following information and studies raise concerns and questions that all decision-makers must take seriously. A list of pertinent questions begins on page 30.

Extreme temperatures

Artificial surfaces cannot be played on all the time. Temperatures on the surface of artificial turf can sometimes reach more than half again the air temperature causing dangerous burns, with water providing cooling only for a limited time.

Case study: University of Missouri (M.U.): Brad Fresenburg, turfgrass specialist from the University's Division of Plant Sciences, explains the danger of artificial turf is that the rubber and plastic materials used absorb more of sunlight's heat energy than natural grass, causing extraordinarily high temperatures. His observations found that on a 98° F (37° C) day, MU's Faurot Field had a surface temperature of 173° F (78° C). The temperature of the nearby natural grass was only 105° F

Photo: Infill rubber particles spilling out onto a soil surface.

Since "infill" (rubber particles and sand below the synthetic surface) needs to be replenished repeatedly over the life of a synthetic field, a new concern is discovering what becomes of the old infill material. Some of it spills out and is washed away into a drainage system, creating a growing concern about water contamination.

The danger of artificial turf is that the rubber and plastic materials used absorb more of sunlight's heat energy than natural grass, causing extraordinarily high temperatures.

Brad Fresenburg
University of Missouri

18 Williams and Pulley, "Synthetic Surface Heat Studies," Brigham Young University, *Op. cit.*
19 Jim Peters, "Field fails first test," *The Times of Northwest Indiana*, September 29, 2005
20 Lynne Brakeman, "Experts Spell out the True Cost..." *Op. cit.*

(41° C). Even at head-level, the temperature over the artificial turf was 138° F (59° C).[21]

Case study: Brigham Young University (B.Y.U.): In 2002, Brigham Young University installed artificial turf on one half of its practice field, leaving the other half a sand-based natural grass field. After observing exceedingly hot temperatures from the synthetic turf – including a case where one coach received blisters on his feet through his tennis shoes – Drs. Frank Williams and Gilbert Pulley launched a scientific comparison of the two turf types. For this study, the artificial turf area was examined as two separate fields: the football field and the soccer field.

An artificial turf surface generates exceedingly hot temperatures– one coach at the University of Missouri received heat-related blisters on his feet through his tennis shoes.

The Safety Office at BYU has set 120° F (49° C) as the maximum safe temperature that a playing surface can reach, since temperatures of 122° F (50° C) can cause skin injury in less than 10 minutes.

The field study compared not only surface temperatures, but also soil temperatures, temperatures in shade, and the cooling effects of water.

Surface temperatures of playing fields were compared with the temperatures of other common surfaces for perspective:

Table 1 Surface–Average Surface Temperature between 7:00 AM and 7:00 PM

Soccer (artificial turf)	117.38º F (47° C)	high 157º F (69° C)
Football (artificial turf)	117.04º F (47° C)	high 156º F (69° C)
Natural Grass	78.19º F (26° C)	high 88.5º F (31° C)
Concrete	94.08º F (34° C)	
Asphalt	109.62º F (43° C)	
Bare Soil	98.23º F (37° C)	

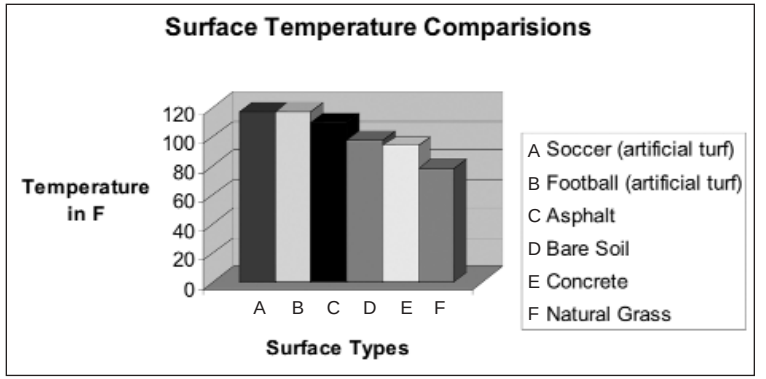
Table 2 2 inch depth–Average Soil Temperature between 7:00 AM and 7:00 PM

Soccer (artificial turf)	95.33º F (35° C)	high 116º F (47° C)
Football (artificial turf)	96.48º F (36° C)	high 116.75º F (47° C)
Natural Grass	80.42º F (27° C)	high 90.75º F (33° C)
Bare Soil	90.08º F (32° C)	

Table 3 Shade–Average Temperature between 9:00 AM and 2:00 PM

Surface Temperature of Natural Grass	66.35º F (19° C)	high 75º F (24° C)
Surface Temperature of Artificial Turf	75.89º F (24° C)	high 99º F (37° C)
Average Air Temperature	81.42º F (27° C)	

21 Brad Fresenburg, "Synthetic Turf Playing Fields, Present Unique Dangers," *Applied Turfgrass Science*, November 3, 2005. University of Missouri



Other startling observations from the study included:

- 200° F (93° C) was the highest surface temperature recorded (on artificial turf) on a 98° F (37° C) day.
- Even during Utah's cool October weather, the surface of the artificial turf reached 112.4° F (44.7° C) – 32.4° F (18° C) higher than the air temperature

When water was used to cool the surfaces of the natural grass and artificial turf, the natural grass remained cool for so long that only the artificial turf's temperature was recorded at five and 20 minutes after wetting.

Even during Utah's cool October weather, the surface of the artificial turf reached 112.4 F (44.7 C)—32.4 F higher than the air temperature.

A water application cooled the surface of the synthetic field from 174º F (79° C) to 85º F (29° C) but after five minutes the temperature rebounded to 120º F (49° C) (the limit of what BYU considers safe). After 20 minutes, the temperature rose to 164º F (73° C).[22]

Injuries: The Science of Traction and Release

Turfgrass specialist Brad Fresenburg of the University of Missouri Division of Plant Sciences explains that many injuries are due to greater levels of torque, velocity and traction found in conjunction with artificial turf. Fresenburg performed tests on Missouri's own Faurot Field showing that potential pressure on joints and bones is increased from, "the inability of a fully planted cleat-wearing foot to divot or twist out, an action that releases force."

He noted that while some might see divots or ripped-out grass from natural grass as damage, it is actually a healthy sign indicating that the surface is doing its job of yielding to the athletes' impact, being less likely to cause significant injury. And unlike artificial turf, natural grass has the ability to regenerate or be repaired relatively easily.[23]

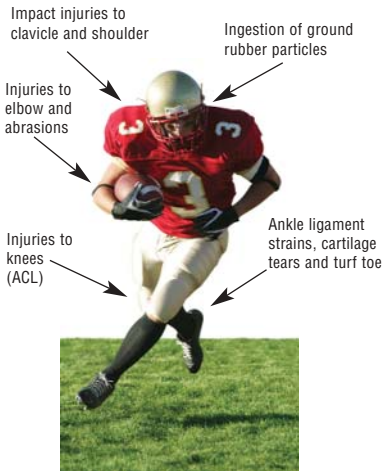
22 Williams and Pulley, "Synthetic Surface Heat Studies," Brigham Young University, *Op. cit.*
23 Brad Fresenburg, "Synthetic Turf Playing Fields, Present Unique Dangers," *Applied Turfgrass Science*, November 3, 2005. University of Missouri, *Op. cit.*

What are the health concerns related to the ingestion of ground rubber particles that takes place from sliding face-first on the surface or dropping and re-inserting a particle-covered mouthpiece onto the field?

Common Injuries on Artificial Turf

Certain types of injuries are being seen more often due directly to artificial turf and its inherent make-up and inflexibility, including:

- **Turf toe** (first metatarsophalangeal joint sprain) is a painful "jam" or hyperextension of the big toe. It occurs when the cleats of a players shoe grab the artificial turf mesh and cause an overextension of the big toe. (See illustration)
- **ACL** (Anterior Cruciate Ligament) injuries are one of the more common types. It is a sprain or rupture of the ACL. The problem is linked to shoe-surface traction which is higher on artificial turf than on natural grass.
- **Foot lock** (caused when the foot is prevented from turning, also placing stress on the knees)
- **Turf burn** part abrasion and part burn—is caused when an athlete's skin slides across artificial turf. These burns happen frequently due to the fact that athletes slide farther on artificial turf due to the lower co-efficient of friction than natural grass, particularly when wet. The sliding action in combination with the friction generates heat, producing the burn, exposing the body to infection.[24] (See page 23)
- **Heat exhaustion**
- **Concussion**



An example of Turf Toe

An example of ACL

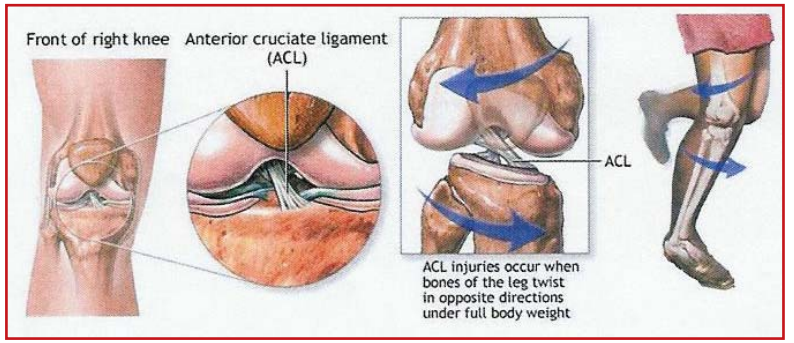


Photo Source: Medical photos are found on multiple webpages, for example: http://images.google.com/images?

24 "Why Choose Natural Turf? A discussion on natural versus artificial turf for sport and leisure applications," the European Seed Association, 2006

Good Bacteria, Bad Bacteria

Different types of bacteria serve different purposes in the world of athletic fields. Soils in natural grass fields contain helpful bacteria which naturally sanitize the surface by decomposing human body fluids, algae and animal excrements. Artificial turf lacks significant populations of these natural cleansers, leaving the job of sanitation to man-made cleansers, which then must be flushed to leave the surface safe for athletic play. But other bacteria, such as that found in sand and rubber infill of artificial turf, can cause infection and even life-threatening health problems. Because sand and artificial turf has a lower microbiological activity than soil, harmful bacteria do not have to compete with beneficial microbes that grow in turfgrass root zones, allowing the harmful bacteria to multiply to dangerous levels, creating an increased opportunity for dangerous infection. Brad Fresenburg, turfgrass specialist from the University of Missouri's Division of Plant Sciences, describes how synthetic fields are virtual breeding grounds for harmful bacteria due to the combinations of warmth, moisture, sweat, spit and blood.[25]

The Life-Threatening Danger of MRSA

In a 2005 issue of the *New England Journal of Medicine*, seven doctors reported on a research project related to Methicillin-resistant Staphylococcus aureus (MRSA) an emerging cause of infections outside of health care settings. The doctors focused on an outbreak of abscesses due to MRSA among members of a professional football team and examined the transmission and microbiologic characteristics of the outbreak strain. The report stated: "From our player survey and observational study of games and practices, we found that skin abrasions occurred frequently among players ... Players reported that abrasions were more frequent and severe when competition took place on artificial turf than when it took place on natural grass."

The report also stated: "Findings from our investigation underscore the importance of certain factors at the player level and at the team level that could have facilitated the spread of the clone in this setting. One important player-level factor was skin abrasions, or turf burns. MRSA skin abscesses developed at sites of the turf burns on areas of the skin not covered by a uniform (e.g., elbows and forearms) these abrasions were usually left uncovered, and when combined with frequent skin-to-skin contact throughout the football season, probably constituted both the source and the vehicle for transmission."[26]

***MYTH:** The new-generation artificial turf utilizes sand and rubber-based infill to minimize injuries from skids and falls.*

***FACT:** The abrasiveness of the carpet fibers above the rubber/sand infill gives the player turf burns that can open the way for infection.*

An example of skin abrasion

"Players reported that abrasions were more frequent and severe when competition took place on artificial turf..."

New England Journal of Medicine article

25 Brad Fresenburg, "Synthetic Turf Playing Fields, Present Unique Dangers," *Applied Turfgrass Science*, November 3, 2005. University of Missouri, *Op. cit.*
26 "A Clone of Methicillin-resistant Staphylococcus aureus among Professional Football Players," www.nejm.org, February 3, 2005. This study uses "clone" or "MRSA clone" throughout the text.

The report also makes several recommendations to control or prevent the spread of MRSA. The full report can be obtained at www.nejm.org (February 3, 2005).

Diagnosis: MRSA

During the 2003 football season, researchers from the CDC (Center for Disease Control) found eight cases of MRSA in five members of the St. Louis Rams. Skin scrapings proved that a turf burn from synthetic turf had provided the entry point. MRSA was then passed amongst the players in a variety of ways, such as sharing towels or using locker room facilities that were not completely disinfected. After a game with the San Francisco 49ers, some members of that team were also diagnosed with MRSA.[27]

MYTH:
An artificially created surface is more sterile.

FACT:
The materials used for synthetic turf fields and infill not only carry harmful bacteria, but trap unsanitary body fluids, opening the way for infection; chemicals used for sanitation can create additional problems.

Information throughout Part 4 documents this statement

MRSA is not a condition limited to the professional sports teams. College and high school players have been diagnosed across the country, including confirmed cases in Connecticut, Texas, Illinois and Pennsylvania.

Following this news, one synthetic turf supplier has voluntarily started to offer free, life-time decontamination services to existing customers based on the levels of bacteria found in its sand infill. The decision came after independent research commissioned by the company showed infill containing sand had 50,000 times the bacterial count as that of all-rubber infill.

Athletic Turf News reported that an officer of the company was "stunned" by the results of the study and committed to sanitation techniques which were expected to be needed monthly for each field containing the sand infill. He was also quoted as saying that the synthetic turf company would "strongly encourage others in the industry to do the right thing and follow our lead."[28]

Because bacteria genes can become resistant, care must be taken to clean fields, equipment, uniforms, towels and locker rooms to kill MRSA.

Toxicity from Rubber

Recycled rubber contains heavy metal substances such as aluminum, cadmium, chromium, copper, iron, magnesium, manganese, molybdenum, selenium, sulfur and zinc, in addition to lead that may have been absorbed into the rubber while in use as an automobile tire. Many of these can be toxic. According to Dr. Linda Chalker-Scott, a horticulturist with Washington State University, "There is no question that toxic substances leach from rubber as it degrades, contaminating the soil, landscape plants and associated aquatic systems."[29]

27 Phil Taylor, "A Menace in the Locker Room." SI.com, February 23, 2005
28 *Athletic Turf News*, March 20, 2008

Some have argued that when old tires are exposed to the elements, they become less harmful; evidence from other studies shows this thought to be incorrect. In one study, it was observed that the materials that leached out of washed, used tires were more toxic to rainbow trout than that from washed new tires.[30] The U.S. Department of Agriculture also found that when recycled tire rubber is used as garden mulch, the zinc from the rubber leaches into the soil, impairing plant growth.[31]

"There is no question that toxic substances leach from rubber as it degrades, contaminating the soil, landscape plants and associated aquatic systems."

Dr. Linda Chalker-Scott Washington State University

Breaking It Down

As synthetic fields degrade with use, the materials used break down into smaller and smaller pieces. These tiny microfibers from the field can be easily inhaled, especially when a player falls and/or slides across the synthetic surface. Many paints and metals already carry warning labels. How will the dust from these particles effect athletes and maintenance staff? One Massachusetts doctor suggests that the world could be looking at another asbestos curse down the line, complete with lawsuits that could ruin schools or public systems.[32]

Skin and Lung Effects

In his scientific review of published literature related to artificial turf, Dr. Joseph Sullivan found that the tire rubber used for infill could have damaging effects on the human body. He noted that "the most detrimental health effect resulting from direct exposure to tire rubber appears to be either allergic or toxic dermatitis." Since athletes playing on artificial turf not only come into contact with the rubber but often do so with great force (such as during a fall or tackle), the potential for skin absorption is high. It is estimated that 6% to 12% of the population is allergic to rubber in some form.

Dr. Sullivan also found that "inhalation of components of tire rubber or actual particles of tire rubber can be irritating to the respiratory system and can exacerbate asthma." Dr. Sullivan cites the basis of these concerns in studies of rubber workers in tire production, noting that these workers have been documented to suffer greater incidence of chronic cough, chronic phlegm, chronic bronchitis, shortness of breath, and tightness in the chest than unexposed workers. Again, the potential for such damaging effects is clear when one considers that athletes spend hours every week stirring up

29 Dr. Guive Mirfendereski, "Take a Pass at Fake Grass", www.SynTurf.org, March 29,2006
30 Joseph P. Sullivan, *Op. cit.*
31 Lindsey Hodel, "Gardners: Tread Lightly–Green Gazette–Rubber Mulch," *Mother Earth News,* April-May 2003
32 Dr. Guive Mirfendereski, *Op. cit.*

Dr. Sullivan's literature review found that "inhalation of components of tire rubber or actual particles of tire can be irritating to the respiratory system and can exacerbate asthma."

these minute particles while breathing rapidly during exertion.[33]

Potential Cancerous Effects

Perhaps the most frightening observation noted by Dr. Sullivan is the potential for mutagenic or cancer causing effects when people are exposed to used rubber tire particles. He notes that the exposure of human cells in lab cultures to rubber dust has proven to be toxic, and that not one but three chemicals used in tire production proved positive in tests for mutagenicity, meaning they have the potential to cause human cancer. Dr. Sullivan cites one study's results where under laboratory conditions, human cells exposed to tire debris organic extract for 72 hours demonstrated a modified physical appearance and an increase in DNA damage.

ABC News Video and CNN Report Review the Problem of Lead Content in Artificial Turf:

Artificial turf is being installed more and more on school playgrounds and athletic fields. Concerns about health hazards related to lead content in the artificial turf nylon fibers have been serious enough that fields have been closed and an investigation by the Consumer Product Safety Commission is under way. ABC News reviewed the issue in a news cast titled "Unhealthy Playing Fields." For details, see ABCNews.com (search: sportsfields)

CNN reported that New Jersey's epidemiologist, Dr. Eddy Bresnitz, said fibers and dust created through wear and weathering might become airborne, where they could be inhaled or swallowed.[34]

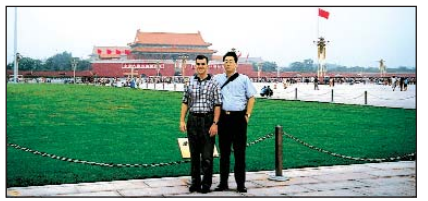
33 Joseph P. Sullivan, *Op. cit.*
34 "U.S. looking at lead levels in artificial turf," CNN.com, April 26, 2008

Part 5: Environmental and Cultural Benefits of Natural Grass

The human race lives within two environments. One is the natural environment and the other is a created society – a secondary environment superimposed upon the natural. Grasses and other green plants are important for an environmental balance. From the natural environment, societies have cultivated turfgrasses that give significant benefits to the existence, growth and welfare of lives. In this booklet the emphasis has been on natural grass benefits that affect the safety and health of those who play on athletic fields. The following sets of "before" and "after" photographs dramatically illustrate many benefits.

Set I: Tiannenmen Square, Beijing

Before: *Tiannenmen Square, the site of the 1989 riots, was originally a solid gray mass of concrete.*



After: *In 1998 the Chinese government tried to soften the hard-line anti-western view by tearing up much of the cement and installing turfgrass, giving it a more natural appeal.*

Set II: Parque Tezozomoc, Mexico

Before: *This bleak seventy acre industrial area was located in one of Mexico City's most polluted areas.*

After: *The land was used to create a park for a community of one million people. The project was finished in four years, applying ecological concepts that included large areas of turfgrass.*

Returning turfgrass areas in China. During the Communist purges in China, it was decided to eliminate symbols of capitalism. A part of the purge was to remove green lawns and cut down many trees.

The effects to the environment were both immediate and long lasting. The lack of turfgrass and shade trees caused cities to become "heat islands," where temperatures became much higher than in rural areas. Air pollution from dust and smog increased due to a lack of natural turfgrass to trap these materials.

The lack of turfgrass also increased erosion, raising levels of pollution and damaging water quality in ponds, streams, rivers and lakes. While Chinese leaders are now working with Westerners to restore the landscapes, it will take decades to re-establish an environmental balance.

However, returning turfgrass to Tiannenmen Square was not just an ecological decision – it was also a psychological decision. Turfgrass gives the Square a more user-friendly appearance – a sense of social harmony and quality of life.

The benefit of turfgrass to heal polluted areas: Parks are often the only green places left amid gray city walls. Parks offer beauty, recreation and tranquility, serving as an oasis that can be remedial and restorative to those who enter from their man-made environment. In Mexico, turfgrass played a significant role in transforming Parque Tezozomoc into a park with significant ecological and psychological benefit.

In one of Mexico City's most polluted areas, in the middle of an industrial and working-class district, was a space of seventy acres. Authorities planned a cultural and recreational open space. The area was transformed into a park for a community of one million people. The park was designed to recreate the topography and lagoons of the valley of Mexico as they were in the 15th century – a symbolic vision of the region's historical and ecological roots.

"Grass is what saves and holds the water that keeps life good and going...It keeps the falling rain from flushing away. Blades of grass take water from the air and transpire it into the ground. That works the other way around too. Because grass blades help put water back into the air so that rain can fall again." [36]

Theodore Roosevelt
President of the United States (1901-1909)

There are numerous examples of turfgrass benefits within the natural environment and the man-made, cultural environment. The following is a list of major benefits.[35]

Rainwater entrapment, retention and ground recharge: Groundwater recharge refers to the retention and use of water – especially rainwater – as it soaks into the ground surface. There is little groundwater retention when the soil surface is bare or when there are impervious surfaces such as streets, driveways, parking lots, and roofs. As a result the rate of surface runoff increases and the time that elapses before runoff decreases. A thick, healthy area of turfgrass reduces rainwater runoff to practically nothing. The turfgrass areas and the soil beneath create a near ideal medium to purify water as it leaches through the root zone and the soil into underground aquifers.

Temperature modification: People function best physically and mentally with a given range of climactic conditions. The major elements to be considered are air temperature, solar radiation, humidity, and air movement. Turfgrass plays an important role in controlling climate. Turfgrass is one of the best exterior solar radiation control ground covers because it absorbs radiation and converts it to food for growth through photosynthesis. Grass surfaces reduce temperature extremes by absorbing the sun's heat during the day and releasing it slowly in the evening.

The significance of temperature modification related to sports field surfaces – especially the extreme temperatures generated by synthetic surfaces – is discussed in this booklet beginning on page 19.

Soil building capacity of turfgrass: Topsoil takes thousands of years to develop. It is lost quickly by wind and water erosion. Turfgrasses send many fine rootlets into crevices of the soil where they grow and, as they decay, add organic matter to the soil. Grass is the most effective plant in conditioning the soil. Natural grass roots are continually developing, dying, decomposing and redeveloping. Every individual plant of Kentucky bluegrass produces about three feet of leaf growth under favorable growing conditions each year. The average lawn produces clippings at the rate of 233 pounds per 1,000 square feet a year. By leaving clippings on the lawn and by allowing them to decay, the equivalent of three applications of lawn fertilizer is made. This process builds humus, keeps soils microbiologically active and, over time, improves soils physically and chemically. Grass improves the soil by stimulating biological life and by creating a more favorable soil structure for plant growth.

Turfgrasses generate oxygen: Turfgrasses release significant amounts of oxygen into the air. Air is cleansed by plants through photosynthesis. Green plants take carbon dioxide and water and use sunlight energy in photosynthesis, producing organic compounds and releasing oxygen to the environment. "All life, with minor exceptions, is now, and forever has been, entirely dependent upon photosynthesis and the plant."[37]

Natural grasses absorb pollutants from the air: Progress has been made in upgrading our air quality but recently the levels of nitrogen oxide, sulfur dioxide and particulate matter are increasing. Plants absorb gaseous pollutants into their leaves and assimilate them, helping to clean the air and create oxygen.

Natural grass is regenerative: Natural grass can be easily and inexpensively treated to propagate self-repair because of the inherent regenerative character of the living plant.

Soil erosion control

Increased property values

Community pride and Urban heat reduction

Quality living

New drought resistant turfgrass research

35 The benefits are a summary of information from "Lawn and Sports Turf Benefits" by Dr. Eliot C. Roberts and Beverly C. Roberts, www.TheLawnInstitute.org
36 Ibid., page 12

37 Ibid., page 14

Part 6: Safety and Health Concerns: Questions Related to Artificial Turf

Health and safety are two major principles that guide many of the decisions individuals, parents, athletes, coaches and appointed or elected officials must make on a daily basis. When decisions impact children or the environment, ignorance is no excuse, neither is falling under the guile of an agenda-driven or commission-driven salesperson.

Ground tire rubber is used in some artificial fields as an impact-softening base. The toxic content (including heavy metals) of tires prohibits their disposal in landfills or through ocean dumping. Yet, this toxic material is being allowed (in large quantities) where children and professional athletes come into direct contact with it.

1. Should the presence of potentially toxic ground rubber on a sports field or home lawn be a concern to decision-makers, athletes, coaches, spectators and parents?

2. For those firms who make claims of using shredded athletic shoes, what percentage of this type of rubber is being used (if any), versus ground tire rubber?

3. What is the heavy-metal and/or toxic material analysis of the ground rubber?

4. What are the short-term and long-term health effects for athletes and spectators to the inhalation of the ground rubber dust?

5. What are the health concerns related to the ingestion of ground rubber particles that takes place from sliding face-first on the surface or dropping and re-inserting a particle-covered mouth-piece into ones mouth?

6. When additional ground tire rubber is periodically added to the field, are potential health and environmental concerns about the toxicity of this material also renewed?

Temperatures on artificial fields have been documented to be upwards of 86.5 degrees (F) hotter than natural grass fields under identical conditions. For example, at one location, when the natural grass surface temperature was 93.5 degrees (F), the measured artificial field temperature was 180 degrees (F).

1. What length of time can players of different ages (particularly the very young and/or very old) be safely exposed to this heat level?

2. If watering artificial turf reduces the field temperature, what is the length of time the temperature is reduced, and by how many degrees?

3. Does the requirement to have a field-watering system negate some of the projected cost-savings of artificial turf?

4. Although artificial fields are sold on a basis of being able to utilize the field 7 days a week, 24 hours a day, what outdoor temperature levels will cause the field to be closed because of potential health concerns to participants? Similarly, what lesser temperatures will cause participants to be so uncomfortable as to not enjoy playing on the surface?

Field sanitation that includes removal of bodily fluids (spittle, blood, sweat, vomit, urine), and/or bird or animal droppings may present a unique problem for artificial fields.

1. Will the use of antiseptic cleaners properly sanitize the area? How frequently must the field be sanitized?

2. Will the use of these sanitizing cleaners invalidate the surface's product warranty?

3. Do the sanitizing cleansers or the scrubbing process damage the artificial fibers and lessen the projected life expectancy of the product?

4. How much time, equipment and manpower must be budgeted to ensure a reasonably sanitary playing surface?

Abrasive surfaces can result in difficult-to-heal injuries, particularly in the presence of bacterial or viral pathogens.

1. What standards of abrasiveness have been established for artificial products?

2. Are parents, coaches and sports medical personnel trained to recognize the potential seriousness of abrasive wounds caused by artificial surfaces and prepared to treat them properly?

Field hardness (either too hard or too soft a surface) can result in serious chronic or immediate athletic injury.

1. What standards of artificial turf installation and maintenance have been developed to ensure field-wide, season-long uniformity and consistency, particularly when different field uses (i.e., soccer, football, marching bands, concerts, etc.) are allowed or encouraged?

2. What is the correlation between the potential for increased on-field players' speed and the incidence of serious injuries?

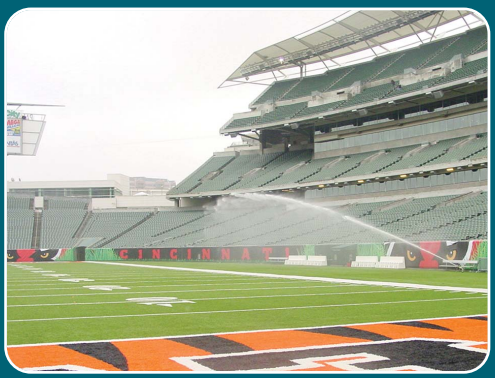
Athlete Health and Career-Longevity can be seriously jeopardized by exposure to extreme temperatures; playing on overly hard or overly soft surfaces, greater speed at point of impact (with the field or other players) and staphylococcus (staph) infections caused by parasitic bacterium present on the playing surface.

1. What specific sports injury studies have been conducted to document the safety of artificial sports surfaces?

2. What specialized equipment, particularly footwear and padding, is recommended or required to address sports injury concerns that occur frequently on artificial fields?

3. Has the health-care profession developed hydration guidelines for athletes at different ages, performing on hot artificial fields to reduce or avoid serious or even life threatening dehydration situations?

4. What field maintenance practices and disinfectants are recommended or required to address bacteria that may remain on an artificial surface?



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