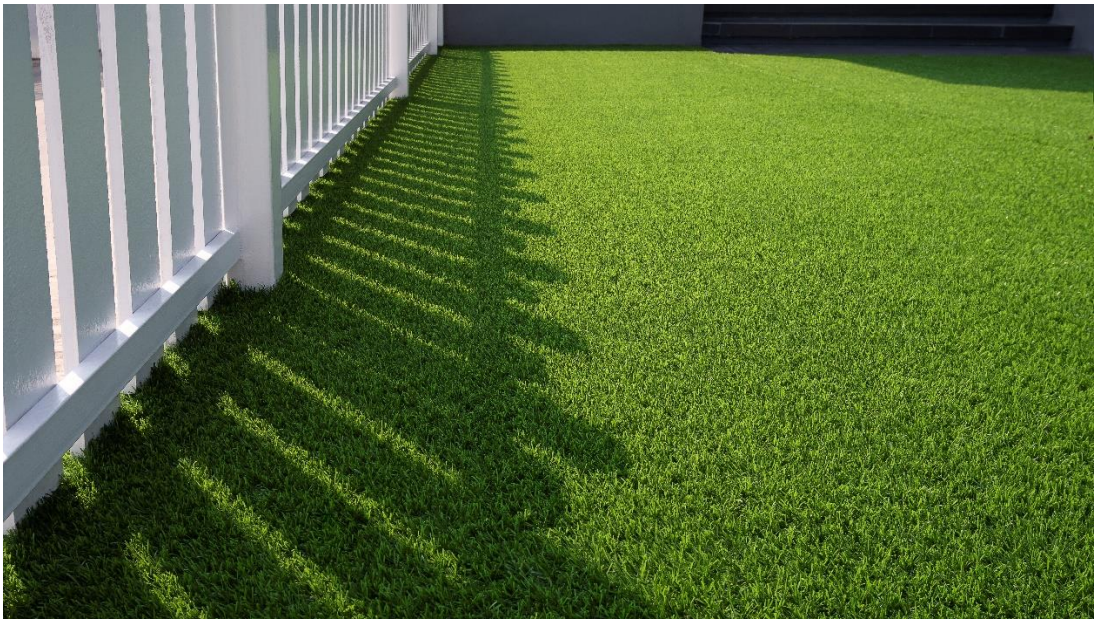
Is Artificial Turf a Beneficial Water Conservation Tool in the West?



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WESTERN RESOURCE ADVOCATES

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Introduction

Artificial turf is a landscaping alternative made of plastic that mimics the look, feel, and function of a natural grass lawn or athletic field. Artificial turf has become more popular in Colorado and the West in recent years for its ability to reduce landscape water use in the face of unprecedented drought and water security challenges; the region now accounts for 24% of the artificial turf market share in the United States, with most being used for athletic fields. In recent years, many communities across the West have mounted turf replacement programs to encourage residents to save water used on outdoor landscapes in the face of prolonged drought. Communities are also limiting the amount of high water use, non-functional turf that can be installed in new development and instead requiring landscaping alternatives. As momentum continues to grow around reducing high water use turfgrass in our communities, water conservation practitioners, land use planners, landscape professionals and community members are asking: is artificial turf a worthwhile landscaping alternative, especially for residential properties? While artificial turf may reduce landscape water demand compared to traditional cool season turf, research shows that artificial turf can also have significant environmental and economic drawbacks. This report explores the current state of the research behind the benefits and drawbacks of artificial turf as it relates to: water management, temperature impacts, lifecycle analysis, PFAS contamination, harmful chemicals, microplastic contamination, pet waste buildup, and cost. While much of the data available are from studies of artificial turf athletic fields, most findings are applicable to properties with smaller footprints as well.

Water Management

Artificial turf has gained popularity in large part for its ability to reduce outdoor water use. One study found that full-sized, 1.32 acre, natural grass sports fields can use up to 1.5 million gallons of water for irrigation per year depending on geographic location. The Synthetic Turf Council estimates that same-sized artificial turf athletic fields can save 500,000 to 1 million gallons of water per year (8.7 to 17.4 gallons/sq-ft), and that a turf lawn of 1,800 square feet can save 99,000 gallons of water per year, or about 70% of a homeowner's water bill. In the arid Western United States, the need for water conservation has been a driver of artificial turf demand. Artificial turf for residences has proven especially popular in drought-stricken California, where some areas were limited to one day of outdoor watering per week in the summer of 2022 due to water shortages.

While artificial turf companies tout water savings as a main benefit of artificial turf, this is not always the case. Studies have found that on a warm, sunny day artificial turf can measure up to 80 degrees hotter than the ambient air temperature. In one study, an artificial turf field measured 160 degrees while the ambient air temperature was 87 degrees. On an athletic playing field, one solution to this heat is to water the artificial turf. A large amount of water needs to be applied to achieve a cooling effect, and it has been found that this cooling effect lasts only minutes before temperatures rebound. Some sports arenas have attempted to solve the problem by installing misters that apply water to the turf field throughout sports events. Others find that irrigation of artificial turf improves traction and athletic

performance; one university in North Carolina going so far as to apply for a business exemption to water their artificial turf athletic fields during a drought.

An additional concern is the effect of artificial turf on groundwater recharge. Cities in California that once encouraged the replacement of natural grass with artificial turf have since changed their policies upon discovering that artificial turf can increase stormwater runoff and prevent groundwater recharge. Los Angeles offered a rebate for homeowners who replaced irrigated grass with artificial turf until 2016, when they revised their program's requirements to provide a rebate only for replacement with xeriscape landscaping. Los Angeles realized that artificial turf reduces the amount of rainwater that soaks into the ground after a storm, and that more stormwater flushed out to sea via the stormwater system.

Temperature Impacts

Artificial turf can reach temperatures up to 80 degrees higher than the ambient air temperature due to its material composition and color, as well as the color and heat retention abilities of infill materials used. This excess heat contributes to urban heat island effect in cities, as heat from the synthetic turf elevates the ambient air temperature and disperses into the local environment. One researcher found that some of the hottest areas in New York City are artificial turf fields, rivaling black colored roofs in their heat retention abilities. Research has shown that excessively hot artificial athletic fields can lead to heat stress, especially in children who are more susceptible than adults, turf burns, and the cancellation of athletic events due to unsafe playing conditions. Artificial turf heat can also be an issue when used in landscaping, as pets and children use the turf for play on warm days. Urban heat island effect can also increase the demand for energy for air conditioning, and can increase pollution as natural grass areas are removed. Natural grass absorbs the sun's heat during the day, and slowly releases it at night, contributing a cooling effect to the surrounding environment, as well as removing pollutants from the air.

The artificial turf industry has responded to temperature issues and has developed products that can repel UV rays, better disperse heat, and even mimic the evaporative cooling effects of natural grass. Some types of artificial grass have been developed specifically for areas like Arizona that have extreme high temperatures during the summer. Manufacturers claim that heat-repellent synthetic turf measures 10-20% cooler than grasses with high heat retention. Another heat reduction measure is the infill material chosen; crumb rubber and sand infill materials can contribute to extreme artificial turf temperatures due to their color and heat-retention abilities. Special infill materials have been developed that when wet with water, will slowly release the water over time, mimicking the evaporative cooling properties of natural grass and reducing the hottest temperatures by 50 degrees. Cooling technologies seem to be distributed across price points, but largely cannot match the cooling properties of natural grass or other plants.

Lifecycle Analysis

In the early 1990s, the United States had a mounting problem with the disposal of used automobile tires; they were costly to dispose of and created pest and fire hazards in landfills. It was then discovered

that discarded tire rubber could easily be recycled into small pellets to be used as "infill" to stabilize artificial turf athletic fields and lawns. The infill is now mainly used for large athletic field installations and industry experts estimate that the artificial turf industry now recycles one-twelfth of all automobile tires disposed of each year. One artificial turf athletic field can use 20,000 to 40,000 used tires as crumb rubber infill. Infill is added during installation, and as needed to replace infill that migrates out of the artificial turf area.

Artificial turf has an average lifespan of 8-10 years before an athletic field becomes worn out, or a residential lawn loses its formerly lush appearance. The Synthetic Turf Council, an artificial turf industry group, insists that artificial turf is recyclable, and that its members actively recycle the spent turf it sells. Investigative journalists and concerned citizens have documented otherwise in the Netherlands and in the United States.

The Netherlands requires artificial turf to be recycled. A few Dutch companies claim to be artificial turf recyclers; these companies accept payment to recycle spent turf and provide removal services. However, investigative journalists have found that several of these companies have no active facilities for turf recycling. The companies do not recycle the artificial turf they accept, but either hold on to it indefinitely in growing piles in municipalities with lax regulations or sell it to new customers who repurpose the turf, rather than recycle its components into new materials.

In the United States, there are no regulations that pertain to the disposal or recycling of artificial turf. Most municipalities will accept artificial turf in local landfills. Fees to dispose of large amounts of turf, such as from athletic fields, can be extremely expensive. As artificial turf owners are not held responsible for the turf at the end of its life, it is often illegally dumped, or a small fee is paid to store the turf on an abandoned lot rather than paying disposal or recycling fees. Piles of discarded turf create fire and chemical hazards, just as discarded automobile tires did in the 1990s. Although a Danish artificial athletic field recycler, Re-Match, has plans to open an artificial turf recycling facility in Pennsylvania, and has recently expanded its European operations to the Netherlands and France, life cycle concerns for end-of-life artificial turf athletic fields and synthetic residential landscaping remain an active problem the world over.

Harmful Chemicals

Artificial turf eliminates the need for pesticides, herbicides, and fertilizers that are traditionally used to maintain a lawn or sports field; the plastic turf and its base layers block the growth of weeds and pests that otherwise might invade natural grass. However, artificial turf contains many chemicals of concern. These chemicals can migrate into the surrounding environment as the plastic material degrades when exposed to heat and light. The majority of research on artificial turf focuses on athletic fields, and many specifically on the chemicals related to crumb rubber infill. Crumb rubber infill is the cheapest infill material on the market and is often used in athletic field installations. It is less likely to be used for artificial lawns, but the following research discussed can at times apply to residential installations.

The cheapest infill material on the market is crumb rubber infill made from recycled discarded tires. Crumb rubber infill is most often used for athletic fields, as it provides a durable playing surface.

However, crumb rubber infill has been found to release chemicals as it degrades. Crumb rubber infill has been analyzed and found to contain 197 carcinogenic chemicals. Alternative infill materials include EPDM rubber, TPE plastic, and recycled athletic shoe material, as well as natural materials like sand, cork, and zeolite clay. A study comparing infill materials found that almost all contain chemicals of concern, except natural infill materials, which may conversely be susceptible to mold growth, or cause negative respiratory effects. Studies have found that organic contaminants and heavy metals in crumb rubber leach into stormwater runoff, posing hazards to the surrounding environment, aquatic life, and human health. Studies have also found that Volatile Organic Compounds (VOCs) from crumb rubber infill can aerosolize during play on artificial turf athletic fields. VOCs can cause respiratory irritation and have been linked to the development of cancer.

While there are no fully conclusive studies on the human health effects of exposure to artificial turf, studies have been conducted on the effects of crumb rubber infill chemicals on earthworms, an invertebrate, and on chicken embryos, a vertebrate. Two experiments have been conducted on the effects of earthworm exposure to crumb rubber infill. The first experiment tested the effect of exposure to new crumb rubber infill, and found that after one week of incubation in contaminated soil, the exposed earthworms had noticeably lower body weight than those in clean soil. A second, similar, experiment was conducted using recycled tire crumb rubber infill. In this experiment, the exposed earthworms quickly died in a stress test, demonstrating a marked decrease in resilience to stress when exposed to chemicals in recycled tire rubber.

Another study that examined the effects of crumb rubber leachate on fertilized chicken embryos during their development process found that approximately half of the fertilized eggs exposed to the leachate developed extreme malformations, while the unexposed group developed into healthy chicken embryos.

Although no conclusive studies have been conducted on the direct effects of artificial turf on human health, anecdotal collections of statistics have raised concerns about artificial turf's potential connection to cancer development in humans. In 2013, one women's soccer coach compiled a list of 38 US soccer players who had developed cancer, mainly leukemia and cancers of the blood. Many of the players were goalies, who regularly dive into artificial turf. Health experts have been unable to reach consensus on whether artificial turf and the use of crumb rubber infill can be linked to cancer or other human health effects. Despite this lack of consensus, the presence of known carcinogens in artificial turf blades and infill and the results of the animal studies have raised alarm.

PFAS Contamination

PFAS chemicals are widely found in artificial turf because they are used in the artificial turf production process and are typically added as a coating to the grass blades as they are manufactured. The chemicals can break down and leach into the environment when exposed to heat and light after artificial turf is installed.

PFAS chemicals are also known as "forever chemicals" because they do not break down under normal environmental conditions, and can last in the environment for hundreds of years, or longer. PFAS

chemicals are also associated with negative health effects in humans and wildlife. Studies on the human health effects of PFAS chemicals have found that the chemicals bioaccumulate in human tissues and can lead to liver effects, immunological effects, developmental effects, endocrine effects, decreased fertility, cardiovascular effects, and can contribute to the development of cancers. PFAS can cause similar problems in animals and can also bioaccumulate in plants.

In 2020, one New Hampshire community attempted to purchase PFAS-free artificial turf to minimize exposure risks. The community tested the turf they had been sold, and found that it did contain PFAS chemicals. The company claimed that the levels of PFAS in the turf were below EPA accepted maximum levels of the chemical and could safely be labeled "PFAS-free". However, the EPA has recently concluded that no amount of PFAS chemicals are safe in drinking water, which is concerning as many components of artificial turf installations regularly make their way into surrounding waterways.

Microplastic Contamination

In addition to the chemical concerns surrounding artificial turf, there are also significant concerns relating to microplastic pollution. Artificial turf plastic grass blades can break off from the turf surface and migrate into the surrounding environment, creating microplastic pollution as they break down into smaller pieces over time. Artificial turf athletic fields that use crumb rubber infill can be even greater sources of microplastic pollution. One study in Norway found crumb rubber infill pieces in 85% of water samples taken in waterbodies downstream from artificial turf fields, and in 42% of samples taken from locations upstream. Microplastic pollution from artificial turf fields accounts for over one third of total microplastic pollution in Norway. Similarly, researchers have found that artificial turf fields are the second highest source of microplastic pollution in Sweden. Swedish authorities estimate that large artificial athletic fields lose 2-3 tons of infill to the surrounding environment per year.

Microplastic pollution is a concern for actively used artificial turf fields, and for discarded fields that await recycling or incineration or are illegally dumped. Discarded fields have the potential to release microplastic pollution into the surrounding environment indefinitely. Artificial turf lawns also can release microplastics via the grass blades' degradation over time, and depending on the choice of infill will also release infill particles into the environment. Researchers are only beginning to understand what the effects of this pollution might be.

Study of the effects of microplastics is relatively new. Studies have found the tiny particles worldwide, including in remote wilderness areas that have no human visitors, and in the umbilical cords of newborn babies. The effects of microplastic pollution on human health and the environment are still relatively unknown, but some early studies suggest that microplastic exposure and ingestion can cause harm to human health and the environment. One study in particular found that microplastics added to soil disturb natural biological processes and change soil structure. Knowledge of the long-term effects of microplastics will continue to develop over time.

Soil Quality

Artificial turf installation requires the removal of the existing top level of soil and heavy soil compaction to create a smooth surface for the turf. Compaction negatively effects the soil structure, disturbs the

soil's microbial activity, and can damage tree roots. After soil is compacted for athletic field installation, several layers are added between the soil and the artificial turf surface to level the playing field, improve storm water drainage, and provide cushioning. In artificial turf lawn installations, plastic and wire layers may be added beneath the turf for protection from burrowing animals, and weeds. In addition to the effects of soil compaction, artificial turf changes the quality of the soil beneath it by starving the soil of water, air, and light. Artificial turf has also been shown to degrade over time, leaching chemicals from the plastic turf material and the infill materials into stormwater runoff that can soak into surrounding soils, further disturbing soil health.

Pet Waste Buildup

Pet waste can build up over time on artificial turf, and additional maintenance is required to keep artificial lawns fresh. Artificial turf companies have designed special types of turf to improve pet waste drainage and claim that it can better eliminate waste than natural grass. Pet-friendly infill has also been created with a special coating to prevent odors and the growth of bacteria. Despite these measures, artificial turf needs to be rinsed off after use by pets. To fully sanitize artificial turf when pet waste builds up, infill must be vacuumed out and a special cleaner applied to break down urine and other waste. Natural grass and other plant installations do not need this type of maintenance and special products; the elements naturally break down remnant pet waste.

Cost

A New York Times investigation compared costs for artificial turf lawns. Bids to install a large artificial turf grass lawn averaged $10,000. The average lifetime of artificial grass is 10 years or less and there are maintenance costs associated with artificial turf, and costs associated with removal and replacement at end of life. Natural grass lawns are likely to have longer lifespans if managed sustainably. Natural lawn costs increase substantially if located in an area that requires supplemental irrigation. One way to lower such costs is to install drought-resistant or low-water species of grass in drought-prone regions, though irrigation systems will likely be needed even if used less frequently.

Regarding athletic fields specifically, many schools and universities choose to install artificial turf rather than natural grass fields because artificial turf is a durable play surface that allows for continuous use, while natural grass can require rest between athletic activities. Artificial turf can also save on maintenance costs associated with irrigation and mowing. However, artificial turf has been shown to require heat related closures, maintenance such as brushing and sanitization, regular replacement of infill material, and even irrigation to improve heat conditions and playability.

The Toxics Use Reduction Institute (TURI) has conducted several studies comparing costs between artificial fields and natural grass fields that show that organically managed natural grass fields can improve play conditions, reduce wear and tear related closures, and lower maintenance costs. Costs to install a variety of natural grass field installations range from $0.60-$5.00 per square foot, and estimates for artificial turf costs range from $4.50-$10.25 per square foot. TURI's research concludes that artificial turf athletic fields can cost 2 to 10 times more than organically managed natural grass fields over their life cycles when accounting for installation fees, maintenance fees, and disposal and replacement fees at the end of an artificial turf's lifecycle. Many sports facilities decide that the investment is worth it

because artificial turf can extend playing time, and be used in any season or weather condition, including in snow.

Conclusion

Artificial turf has gained popularity, particularly in the increasingly arid West, as it conserves water used on outdoor landscapes and sports fields, among other reasons, like extending playing time for athletic activities. While artificial turf eliminates the need for pesticides, herbicides, and fertilizers used on natural grass, it can have considerable drawbacks. Artificial turf can have unexpected negative impacts to water supplies including requiring watering for cooling on hot days and hindering groundwater recharge. The heat generated by artificial turf can increase urban heat island effect and cause heat-related injuries. To date, there are few sustainable options for artificial turf recycling, leading to stacks of discarded artificial turf building up the world over. In addition to the above issues, the chemicals and microplastic particles that make up artificial turf can leach into the environment, causing environmental and health impacts not yet entirely known. And, while many artificial turf companies tout the material as more cost-effective, cost comparisons with natural grass show that in some cases artificial turf is significantly more expensive. Better alternatives to artificial turf exist in the form of water wise landscaping, including drought-resistant and native species of grasses, trees, shrubs, and perennials. Water-wise landscaping can reduce irrigation water use significantly, with some native plants and grasses requiring no or very little supplemental irrigation. While water savings vary depending on what is installed, compared to cool season turf, water-wise plantings provide numerous other benefits such as pollinator habitat, reduced fertilizer and pesticide use, and groundwater recharge. As the West faces a hotter and drier future, we must continue to research and assess opportunities for reducing landscape water demand while maximizing benefits and minimizing negative consequences. For residential property owners seeking to be more water efficient or wanting lower maintenance landscaping, artificial turf is likely not the hoped-for solution due to costs and wide-ranging environmental and potential health impacts.