Natural Grass Playing Fields: Selected Case Studies from Southwest Pennsylvania

Introduction

Communities often have questions about whether natural grass can meet their athletic and recreational needs, and whether management of natural grass is cost-effective. This report describes the experience of selected school districts and communities in and near Pittsburgh. The Toxics Use Reduction Institute (TURI) has compiled this report to help communities and institutions learn from one another's experiences.

A growing number of schools and municipalities in and near Pittsburgh are managing their grass playing fields by implementing "cultural controls" such as aerating and fertilizing, which improve the health of the soil and grass. They have eliminated or minimized the use of pesticides, many of which are linked with environmental and health concerns, especially for children.

This compilation of case studies provides information about four communities that manage their grass fields using organic management techniques. TURI worked directly with the Borough of Heidelberg and Bethlehem-Center to help them with these small-scale rehabilitation projects. TURI learned about the practices of Pittsburgh Public Schools and Fort Cherry School District by interviewing their staff who manage these programs.

Heidelberg Park, Borough of Heidelberg, Pennsylvania

These examples demonstrate a range of experiences and budgets and provide a varied set of lessons learned. The Pittsburgh Public Schools provide an example of a large, ongoing, school district-wide sustainable program; the Fort Cherry School District provides information about sustainable grass management with little need for interventions due to native soil conditions; Heidelberg Park is an example of a town playing field that has been improved substantially using a simple set of maintenance practices; and Bethlehem-Center is an example of a school district that is in the early stages of working to improve field quality while also facing a range of other infrastructure challenges and financial limitations.

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What is Sustainable Grass Management?

Using sustainable practices for grass management, such as frequent aeration, frequent mowing, soil testing, and the use of appropriate amounts of fertilizer or soil amendments, can improve the health of soil and grass without the need for synthetic pesticides or fertilizers. Communities and schools can accommodate a wide range of recreational activities on their athletic fields by building healthy, balanced soil and a strong root system. Sustainably managed grass fields are an affordable, practical and safer alternative to artificial turf.

In some cases, an existing grass field may be renovated or rebuilt, but in most cases, the quality and resiliency of an existing grass playing field can be improved with sustainable management practices. The aim is to replenish soil nutrients and biodiversity, improving the long-term health of the soil.

Improvements to soil health can alleviate problems with athletic fields, for example water pooling. The U.S. Department of Agriculture notes that healthy soil holds more water by binding it to organic matter, which "holds 18-20 times its weight in water and recycles nutrients for plants to use."[1]

The core practices used in sustainable and organic maintenance are described below. For detailed information, view TURI's organic management fact sheet.

Assessing field conditions. A visual inspection of the field can help quickly identify problems with play conditions of the field. Symptoms such as bare spots, weed growth, or pools of water can indicate a variety of problems with the soil or grass growth.

Soil testing can identify imbalances within the soil's nutrient and mineral composition that may lead to the poor conditions on the field. Soil testing can measure texture, pH, presence of beneficial microorganisms, and levels of key nutrients such as phosphorus, potassium, nitrogen and calcium. Measuring these soil characteristics makes it possible to choose specific blends and amounts of fertilizers and soil amendments to be added to the field to create an ideal habitat for grass growth. Natural grass specialists recommend testing soil periodically as the needs of the field change with use over time. With a better understanding of the state of the soil, fertilizers and soil amendments can be selected based on the needs of the soil for that specific site.

Making a plan. A sustainable or organic maintenance plan can be built based on soil testing results and unique conditions of the field, including the starting conditions and the anticipated type and amount of use. A spectrum of maintenance practices can be adopted depending on the school or community's budget and goals. For some communities, simple changes such as regular mowing and aeration, along with adjustments to fertilizer use, may be sufficient.

Fertilizer and soil amendments. Organic fertilizer is generally made with natural ingredients such as soybean meal and potassium sulfate. Using sustainable management practices increases organic matter in the soil and helps to reduce fertilizer needs over time. Soil amendments, chosen based on soil testing results, can include soil conditioner, compost, or lime.

The communities described in these case studies did not use certified organic fertilizer in all cases. However, whenever possible they chose to use carbon-based fertilizers, which ensure that the grass can make use of nutrients without depleting the soil, and improve soil health over time. These communities determined application amounts

[1] U.S. Department of Agriculture. "Soil Health Key Points." https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1082147.pdf

based on soil test results, which eliminated over application and potential run-off pollution.

Seeding. Selecting the appropriate type of grass seed is critical to maintaining the long-term health of athletic playing fields. Individual grass species offer different protective capabilities, such as heat tolerance, cold tolerance, drought resistance, deep root systems, and weed resistance. It is also important to consider geography when choosing a type of grass. Multiple grass species can be used to create a resilient play surface to match the climate. The best time of year to seed depends on the type of grass seeds being used. Adding seed to thinning high use areas throughout the year, such as in front of soccer goals, can help fill in gaps in the grass and improve thickness.

Aerating. Aeration is arguably the most important step for maintaining healthy, natural grass. It relieves compaction of soil and thatching of grass by creating space in soil to allow air, water, and added nutrients to penetrate the soil. Relieving compaction can improve drainage, decrease the need for irrigation, and create a softer, more protective playing surface. Aeration is accomplished by pulling up plugs of soil and grass or by slicing into the soil using a riding or push machine. Consultants typically recommend aerating several times per year and more often in high use areas.

Mowing. A mowing program can be adjusted to accommodate changing growth rates and summer heat. Some experts recommend grass be mowed high (3 to 3.5 inches) to encourage deep roots and to shade the soil. Others focus on benefits from cutting grass more frequently to a shorter length. Fields often require mowing twice per week during the peak grass growing months and once per week at other times to avoid cutting more than one third inch of grass at a time. Sharpening mower blades is important to prevent tearing or damaging grass blades, as damaged grass blades lose moisture and are more susceptible to disease.

Pittsburgh Public Schools: Pesticide-Free Management of School Grounds

The Pittsburgh Public School ("PPS") district includes 54 schools. PPS has nine regulation sized natural grass fields.

PPS made the decision to stop using pesticides on grass fields and landscaped grounds three years ago in response to community concerns about herbicide hazards. When the district notified residents in advance of spraying, as required by the state,[2] neighbors expressed concerns. Given the numerous complaints, school district staff felt that pesticide use was not worthwhile. They now trim weeds and use other techniques to enhance attractiveness.

Field use. The athletic fields are used for junior varsity sports practices, such as football, soccer, and baseball, and school physical education. There is fairly minimal community use of the school district fields, although it depends on the neighborhood. Football and soccer practices take place on school fields, while games are held on artificial turf fields.

Baseball games also take place on grass PPS fields. Sometimes baseball games are cancelled if the skinned infield areas get too wet, in which case there are makeup dates.

Overall, the fields are in excellent shape, although this is partly due to a reduction in use in recent

[2] Pesticide applicators must provide advance notification of pesticide applications to those on a hypersensitivity list whose location is within 500 feet of an application site. See https://extension.psu.edu/pennsylvania-pesticide-applicator-certification.

years, as the number of children participating in sports has declined.

Maintenance practices. Staff aerate the nine regulation fields once, seed once, and fertilize once each year, as well as mowing, trimming, filling thinning spots and making other repairs as needed. They mow once per week during the growing season, weather permitting. They apply a starter fertilizer that is 18% nitrogen and 24% phosphate. The school district owns an aerator and a slicer.

In summary, PPS is following the main natural grass steps – aerating, seeding, and fertilizing. These are sufficient for the school district's needs. In addition, this approach is protecting the health of children playing on the fields and of neighbors in the surrounding community.

Borough of Heidelberg: Basic Organic Techniques for Improved Field Quality and Watershed Protection

The Borough of Heidelberg, Pennsylvania is a small community with a limited budget for management of public properties. TURI provided support to the Borough of Heidelberg to assist the community in improving the quality of the playing field at Heidelberg Park through the introduction of some basic, low-cost organic management practices.

Heidelberg Park is the largest green space in the Borough of Heidelberg. Located among a line of industrial sites, constructed on the footprint of an old scrap yard, the 1.52 acres of green space provide a community gathering place and public play space for recreation, sport, and community festivals.

Heidelberg Park in summer 2020, following rehabilitation

The field is used primarily by children for soccer, football, cricket, and softball practices. Approximately 15 to 25 children participate in each practice, and scheduled practices total about 21 hours per week in the spring, summer and fall. The park is open from dawn to dusk, and is used for unstructured recreation and pickup games. The annual Oktoberfest takes place there every September.

The field sits adjacent to Chartiers Creek, which is a tributary of the Ohio River. Chartiers Creek winds from Washington County through Allegheny County, where it meets the Ohio River at McKees Rocks. Because of use, abuse, and development, the creek is now part of one of the most polluted watersheds in Pennsylvania. Although improvements have been made, the watershed remains significantly impaired. The Chartiers Creek Watershed Association and the Lower Chartiers Watershed Association are two groups working to improve the environmental quality of the creek.

Baseline condition of field

The field area in Heidelberg Park was historically used as an old scrap yard, and was converted to an athletic field in 2008. During the athletic field construction, the field did not receive the quality soil needed for the field's base or the correct amount of soil. Soil ranges from two to five inches in depth before hitting the capping rock from the scrap yard. The town was still finding debris from the scrap yard left behind in the soil in 2019. The poor soil quality also led to severely compacted soil with poor drainage.

The grass on the field was primarily fescue, with ryegrass as well, and no underground irrigation. The field had bare spots, specifically in the areas in front of the soccer goals.

The field is maintained by the Borough's Public Works Department. Before 2019, Heidelberg's maintenance plan was minimal, and included only mowing and overseeding bare areas by hand.

Project design and startup

The Natural Grass Advisory Group (NGAG), with support from TURI, began working with Heidelberg in the spring of 2019, with the goal of upgrading and improving the grass field using organic techniques. The goals of the project were to provide a safe space for sports and other recreation, while protecting the surrounding environment. NGAG is a small natural grass field consulting group. It applies the principle that a natural grass field can accommodate any amount of play; maintenance practices simply need to be adjusted based on the amount and type of activity.

Approach to field improvements

The initial project focus was on building soil microbial life and balancing soil nutrients needed for grass to thrive. One goal was to build more organic matter. Increasing soil organic matter increases water retention and reduces the need for additional fertilizer over time.

Soil testing. As an initial step to assess the soil quality in the field, NGAG took a soil test. The soil test provided information to allow a rehabilitation plan to be developed.

Aeration. Aeration took place twice in September 2019. First, they aerated the field to a depth of 1 inch using a rented Pro Aerator from Home Depot. The purpose was to break up the soil to create a bed for grass seeds. A landscaping company aerated the field a second time using a Toro Pro Core to reach a 2-inch depth.

Fertilizer/ soil amendments. Fertilizers and soil amendments were added to the field to build soil health and foster the development of a robust root system. As shown in Table 1, they applied 10-2-5 fertilizer to the field in spring. This fertilizer contained organic chicken manure, and synthetic nitrogen sources. In the fall, they added a product to support growth of beneficial fungi, and an ammonium-sulfate fertilizer.

Table 1: Heidelberg Park field maintenance schedule, 2019, first season of field rehabilitation with organic techniques

Date	Activity	Product	Cost	Notes
May–June	Mow			• Mowed once per week
May 7	Fertilize	EarthWorks* Replenish 10-2-5	Donated	• 450 pounds
May 9	Soil Testing		$254	• Sent soil samples to lab
June 3–4	Verticut, Topsoil, Seeding	Perennial ryegrass blend	$70	• Verticut (removed thatch) in thin areas toward the front of the field • Smoothed out verticut areas, filled in low spots with one bag of topdressing soil, and seeded bare/ thin areas with perennial ryegrass blend (50 pounds)
July–Aug	Mow			• Mowed once per week to once every two weeks, as needed
Sept–Oct	Mow			• Mowed once per week at 3–3.5”
Sept 1	Aeration	Pro Aerator	$102	• Rented aerator from Home Depot
Sept 23	Aeration	Toro ProCore	$1,250	• Landscape company aerated the field
Sept 30	Seeding	Perennial ryegrass blend	$900	• Used a push spreader to apply 400 pounds of seed to the entire field
Oct 2	Fertilize	EarthWorks Myco-Replenish 3-3-3	$611	• 700 pounds total for the whole field
Oct 14	Fertilize	EarthWorks 21-0-0 ammonium sulfate	$125	• 250 pounds total for the entire field

* Note: Earthworks fertilizers are carbon-based.

Results

After one year of consistent mowing, two rounds of aeration, seeding, and fertilizing, the field had thicker grass cover and a smoother, softer surface. The areas that were bare in 2019 had healthy grass cover in spring of 2020. Heidelberg Public Works found that consistent mowing helped promote healthy grass growth and helped to cut down on the weed pressure. They also found that using a superior grass selection for seeding, also contributed to the decrease in weed pressure. Heidelberg plans to continue using this affordable management system. They would like to continue to mow consistently, test the soil periodically, fertilize, aerate, and seed. Following these basic practices will maintain a safe playing field for the community.

Bethlehem-Center School District: Low Budget Field Improvements

The Bethlehem-Center School District ("Beth-Center") is located in a rural area in Washington County, Fredericktown, Pennsylvania. The school district includes a high school, middle school, and elementary school.

TURI staff visited Beth-Center as part of a project to carry out natural grass case studies. The school was facing a limited facilities budget and was prioritizing immediate repair needs in the buildings, rather than focusing on the athletic fields. The athletic fields were in poor condition and the school was considering the possibility of taking on additional debt in order to install an artificial turf field to meet students' needs.

Based on the visit, TURI proposed to school district staff a collaboration on a small project to help improve the condition and quality of the existing grass athletic fields. TURI supplied $2,500 with support from the Heinz Endowments towards improving a practice soccer field using organic maintenance techniques. TURI also provided funding to hire a local athletic field consultant to guide the project and build a new maintenance plan.

Baseline condition of field

Beth-Center's outdoor areas include a soccer field, a combination football/ baseball stadium, and several athletic practice fields. The quality of these fields had declined over the years due to a decrease in available funds to properly maintain the grass on these play areas, along with other school infrastructure. The athletic fields were continually used. However, the play surface was in need of attention and repair.

Project design and startup

Starting in 2019, TURI provided initial technical and financial assistance to Beth-Center to help the district improve the condition and quality of its grass athletic fields. The athletic field consultant conducted a preliminary evaluation of one of their practice soccer field, including soil testing. Based on this evaluation, the consultant provided recommendations about short-term actions, using sustainable techniques, to improve field quality. TURI's financial support helped cover costs of recommended activities and products for to improve field maintenance in spring/summer 2019.

Prior to the start of these efforts, the school district mowed the grass athletic fields at the same frequency with which they mowed the rest of the school property. They did not take any additional field maintenance steps.

TURI and Beth-Center focused on diagnosing and rehabilitating a practice soccer field, measuring around two acres. This field had uneven soil with divots, patchy grass coverage, and no irrigation. The uneven surface and over-all poor condition of the field was a source of concern for injuries.

Approach to field improvements

Soil testing. The consultant mailed soil samples to PJC Organic, located in Massachusetts, for testing. The consultant collected two samples at three locations on the field, for a total cost of about $75. Results, summarized in Table 2, were similar across the three locations. Soil pH was in the range of 5.2 to 5.4, which is lower (more acidic) than the ideal range of 6.5 to 6.9. Organic matter was in the range between 6.0 and 6.8. The ideal range for organic matter is 5–15%.

Table 2: Soil testing results and recommendations from PJC Organic (example)		
Results	**Ideal range**	**Comments/ recommendation from PJC Organic**
pH: 5.4 Buffer pH: 6.7	6.5–6.8 6.9	• Two applications (spring and fall) of high efficiency calcitic lime
Percent organic matter: 6.8	5–15%	• Fertilize • Top dress & overseed thin areas in spring and fall • Return grass clippings when weed seeds are not present
Cation exchange capacity (CEC): 7.5	10–15	• CEC is a measure of the soil's ability to hold nutrients • Apply a humic acid soil amendment
% Base saturation K: 4.2% Mg: 14.9% Ca: 53.4%	 K: 2–5% Mg: 10–15% Ca: 65–75%	• Ca:Mg ratio is too low and will be addressed through liming with calcitic lime and/or Humic+ • It has been found that soils low in Ca and high in Mg tend to exhibit greater weed pressure and are more prone to compaction • Current ratio (Ca:Mg): 3.6:1. Ideal range: 7:1–15:1

Overall soil quality was assessed as "poor." PJC Organic stated: "Soils exhibiting *poor* chemical characteristics will exhibit signs of compaction (regardless of the amount of use) weed pressure, disease susceptibility, insect attraction and stress intolerance. The building of good quality soils from such poor beginnings will take several years before becoming sustainable."

Following soil testing, and working with Beth Center's small budget, the consultant made recommendations for creating a sustainable grass field system with the aim of improving the quality and playability of the fields. Because of the very low budget available to the school, it was necessary to focus on the interventions that would be lowest cost and could make the most difference. From this perspective, aeration and fertilizing were a high priority. In addition, because of the uneven surface on the field, rolling the field was necessary. Rolling is accomplished by pulling a heavy, typically water-filled drum over the field to smooth out the surface. Based on the soil testing, PJC also offered recommendations that could be accomplished with a larger budget.

The consultant created a work plan for Beth Center to rehabilitate the field on a limited budget. The goals were to create a smoother and softer playing surface, and to begin adjusting the soil to create conditions for a healthier root system. The elements of the plan were mowing, rolling, aeration, and plant feeding. Table 3 shows the schedule that Beth Center followed. Rolling of the field was completed in early June; this was followed by aeration in the second week of June. Fertilizer was applied later in the month. Mowing height was set at 2.5 inches in June, and increased to 3 inches in July and August.

Due to budget limitations, Beth-Center was not able to purchase organic fertilizer; however, their overall approach was consistent with organic management. Because of these limitations, the consultant recommended a single treatment with a synthetic fertilizer, as shown in Table 3.

Table 3: Bethlehem-Center field rehabilitation schedule	
Date	**Activity/Notes**
June (all month)	• Mow to a height of 2.5". Start to form a schedule to mow every 3-4 days. • Temperatures are still cool enough for grass to be actively growing. By mowing often, the grass will increase its density and overall grass coverage. The mowing promotes the grass to grow laterally.
June 1-5	• Roll field when ground is soft to smooth the surface. Try to roll after a light rain, so that the ground will smooth. Do not roll if the process leaves roller marks or tire marks on the field.
June 8-12	• Aerate. Aeration is key to alleviate compacted soil, dilute organic matter, and allows for water, air and nutrients to reach the grass's root system. It also allows the microbes in the soil to boost soil and plant health.
June 18-22	• Based on soil testing results, apply 8-14-4 fertilizer* at 6.5 lb/1000. • This product will help to higher the phosphorus in the soil, as well as bring up the pH in the soil. Phosphorus is important for root health and early plant development. The soil pH is very important because it enables the plant's ability for nutrient uptake.
July & August	• Mow once a week at 3". The goal is to preserve grass health during hotter temperatures.

* The three numbers provided for fertilizer refer to the ratios of nitrogen (N), phosphorous (P), and potassium (K).

Beth-Center facilities staff followed the schedule for rolling, mowing, aerating, and plant feeding. They mowed using a riding mower. They also used the riding mower to pull a water drum roller for smoothing the field. TURI provided a push spreader for spreading fertilizer and seeds; this cost under $100.

A landscaper from the local community volunteered to aerate the field free of charge. Over the longer term, the school district hopes to purchase a larger tractor that can pull equipment such as an aerator.

Results

Rolling and aeration gave immediate results by smoothing and softening the field; however, overall results are not yet available since Beth-Center is still in the process of transitioning the management plan. Based on the soil tests, PJC Organic mentioned that it may take several years for the soil to become healthy from this starting point.

TURI also helped Beth-Center identify possible funding sources to pursue in order to undertake longer-term improvements to the fields. The school district superintendent hopes to find grant money to afford a tractor, capable of pulling an aerator and other field maintenance tools.

Fort Cherry School District: Natural Grass Management without Fertilizer or other Products

The Fort Cherry School District, in McDonald, Pennsylvania, is a public institution located in a rural area about 20 miles southwest of Pittsburgh. The campus has two school buildings – an elementary center for grades K-6 and a junior-senior high school for grades 7-12. About 1,000 students are currently enrolled in the district's two schools.

Photo source: www.fortcherry.org

Jim Garry Stadium at Fort Cherry

The outdoor areas of the campus include a football stadium, a multi-purpose practice field, tennis court, baseball/softball fields, two vocational agriculture greenhouses, and a cross-country trail. Fields are used for sports, organized recreation, and informal recreation. All of the athletic fields within the school district are natural grass.

The Fort Cherry School District manages all of its property with few interventions thanks to the well-balanced native soil. They do not apply pesticides, fertilizers, or other products, but mows grass regularly, aerates once per year, and re-seeds as needed, especially in damaged areas.

The naturally managed fields produce healthy soil and grass that fully meet the school's needs for sports and other recreational activities. The fields have been recognized by Pioneer Athletics, a recreational supplier.[3]

Players are able to play through the rain, though the fields may be "squishy" while actively raining. Cancellations due to weather take place only if there is lightning.

There is little informal use of the fields by the city, but residents are allowed to sign out fields for use. There is some use of the athletic fields by students for gym class and other organized activities. For example, the marching band uses the practice football field for practice in the fall.

Field design

Successful water drainage planning can help avoid soil compaction, lack of oxygen in the soil, and pest and disease problems. The football stadium field was re-crowned around 2009. A field crown is the elevation of the center of a sports field, intended to promote runoff of surface water towards the edges of the field.

Maintenance

There is a four-person crew at peak work season. Maintenance includes aeration, seeding, and mowing. The school district does not use any fertilizer or other products because the native soil accommodates grass growth that outcompetes weeds.

The grass is mowed 2-3 times per week in spring and less often in hot summer weather. The school district owns and uses its own sharpening equipment to ensure the mower blades are sharp. Clover is sometimes a problem, but is managed by mowing more frequently.

[3] Pioneer Athletics. "Fields of Excellence Archive." Viewed at https://pioneerathletics.com/fields-of-excellence-archive, August 14, 2019.

Aeration is carried out once a year using a riding or push machine. Seeding is done periodically, especially in damaged places. Practice fields receive more maintenance than game fields, because they have more use.

Lessons Learned

The experience of Fort Cherry helps to show that use of fertilizers may be unnecessary in some cases, depending on geography. Before adding soil amendments, it is important to complete soil testing to determine what the soil needs to have balanced nutrients.

Fort Cherry does not need to use pesticides because weeds and pests can be avoided when soil and grass are healthy. For example, clover can be managed with increased mowing frequency.

Conclusions

Sustainable grass management is providing a practical and affordable playing surfaces that meet the needs of athletes and others who use the fields and other green spaces. The experience of the Pittsburgh Public Schools and of the Fort Cherry School District helps to show that it is possible to maintain athletic fields without the use of pesticides. Heidelberg's experience demonstrates the improvements that can be achieved through a relatively low-budget set of interventions. And the experience of the Bethlehem-Center School District illustrates initial changes that can be made at the beginning of a sustainable program to invest in improving natural grass fields.

To learn more about sustainable land care, see TURI's information sheet on organic management of natural grass athletic fields, and TURI's detailed case studies of the communities of Springfield, Marblehead, and Martha's Vineyard, in Massachusetts.

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