Drainage – A Crucial Component for Athletic Field Performance

Part Three: Sub-Surface Installed Drainage Systems

Water is applied to maintained turfgrass areas by irrigation or precipitation. Once water hits the soil surface, it may enter the soil, runoff the surface, or be evaporated into the atmosphere. Excessive rainfall, and/or winters with heavy snowfall, often produces excess soil water conditions. Thunderstorms will frequently result in runoff because the rainfall rate is greater than the rate at which water can infiltrate the soil. Irrigation can also cause puddles and runoff if the water application rate exceeds the infiltration rate.

Drainage is the removal of excess water from the soil surface and/or soil profile by either gravity or artificial means. Drainage is one of the most important issues when managing a sports field. Your field will not perform well if you do not have surface, internal, and/or installed drainage systems in place. Turfgrass areas need to be able to withstand foot and vehicular traffic in various weather conditions. Standing water and/or saturated fields can cause cancellation or postponement of events, increase likelihood for compaction and ruts, and lead to poor overall field health. Efficient soil drainage ensures that water does not collect on the athletic surface. A well drained athletic surface improves safety and playability, allows turfgrass plants to access necessary nutrients, allows better air exchange, and improves turfgrass recovery potential. It is important to understand drainage principles and what types of drainage will work best for your field to enhance user safety, reduce field closures, and keep your field healthy.

There are three key components to successful drainage – surface drainage, internal drainage, and sub-surface installed drainage systems. Surface drainage is when water runs off the surface of the field. Internal drainage refers to water entering and moving through the soil profile. Sub-surface installed drainage systems refer to pipe systems installed beneath the field to direct excess water from the rootzone to a drainage outlet. Depending on your facility, you may not have a sub-surface installed drainage system, or may not have the means to install a system. Therefore, it is important to maximize surface and internal drainage to ensure the health and safety of the field.

This bulletin is part of a three part series. The focus of this bulletin is sub-surface installed drainage systems. To access the other bulletins, please visit the STMA website.

Sub-Surface Installed Drainage Systems

Sub-surface installed drainage systems assist in moving water out of the soil profile by providing a pathway for "excess" or "drainable" water to leave the soil. Sub-surface drainage is effective at removing excess water from the rootzone during high rainfall events and at reducing the water table. Installed systems are most effective when good surface and internal drainage are in place.

Sub-surface drainage is the practice of placing drainage pathways, such as perforated pipe, at a specified grade and depth below the soil surface. Excess water enters the drain pipe through perforations and drains away to an outlet. Two factors determine the quality of an installed system: the effectiveness of water removal and the life of the system. Water removal is determined by the number of drains, if the system has the correct slope and layout, and if the system is properly installed. System life is determined by soil type and composition of the drain pipe used. Some soils can slowly infiltrate the pipe and clog. When considering installation, it must be determined how local soil conditions can affect the life of a system and what can be done to extend the life of the system. Discharge must also be considered as state and local codes may regulate type and location of discharge.

Installation of drainage pipe system - Photo courtesy of Brad Fresenburg, Ph.D.

Types of Sub-Surface Installed Drainage Systems

Pipe Drains

Pipe drains are the traditional drainage systems for sports fields. Pipe drains are 4 inch perforated pipes laid on beds of gravel or sand in trenches that are 12 inches wide and 2-3 feet deep. The pipes are then surrounded by 12-18 inches of sand or gravel. Trenches are generally 20 feet apart; however this is dependent on the size of the rain event for which the system is designed. Water enters the pipe perforations from the bottom. Pipe drains work by slowly and consistently removing water from the subsoil. Pipe drains can be used to assist with surface water drainage if the trench is filled with sand to the surface. Pipe drains are useful for removing water at a slow, consistent rate and/or to lower a shallow water table.

If athletic fields with installed drainage systems are poorly managed, functionality of the drainage system is inhibited. Understanding the soil texture of the rootzone and how the rootzone is constructed is of utmost importance when evaluating drainage issues.

A common mistake is contaminating the soil with various soil particle sizes. If sand is used to fill a drainage trench to the surface, it may become contaminated with finer soil particles through practices such as core aeration or topdressing. For a sub-surface drainage system to be successful, any amendment used on the field must match the particle size that is used in the drainage trench. Otherwise the system will clog and the result is an expensive drainage system that does not work as well as it could.

If the field has been built based on USGA recommendations for putting green construction, 6-12 inches of a finer textured sandy soil will overlay a coarser textured sand or gravel layer. The drainage pipes reside in the sand or gravel layer. This system works to deliberately create a perched water table so turfgrass plants have access to enough water and nutrients to sustain healthy growth. The finer textured layer must be completely saturated before water can move into the underlying coarse layer and access the drainage pipe. This system is successful; however, it can fail if not maintained properly. Application of a soil amendment that does not match the existing rootzone will create layers and inhibit water movement into and through the soil profile. Ways to remedy this problem include matching soil amendments to the existing rootzone, or deep tine aeration. Deep tine aeration creates channels that are backfilled with coarse sand and extend into the underlying sand or gravel layer.

Installation of drainage pipe system - Photo courtesy of Doug Linde, Ph.D.

Interceptor Drains

Interceptor drains, also known as French drains, are designed to intercept and channel away water that may flow onto an athletic field from surrounding areas. Each field should be designed and constructed as an individual drainage unit. Water should not be able to run on to any field from adjacent fields or terrain. Interceptor drains work well to isolate fields into single drainage units. The drains are often located in swales or low lying areas to collect water.

Interceptor drains - Photo courtesy of Brad Fresenburg, Ph.D..

Interceptor drains are essentially pipe drain systems that remove surface and sub-surface water from problem areas. However, interceptor drains differ from pipe drains because the trenches are filled to the top with coarse sand or pea gravel to speed water removal. The surface can be covered with washed sod, seed, or filled in by lateral growth from surrounding turfgrass plants. The trenches cannot be covered by topsoil or the system will clog and be ineffective.

Trackside Drains

Trackside drains run along the interior of a track with both the track and field sloping towards the drain. One of the advantages of this system is that it eliminates the need for swales and catch basins. Trackside drains can mimic the pipe drain system and be filled with sand, then overseeded, sodded with washed sod, or grown in by surrounding turfgrass. Another option would be to install a metal grate over the drainage system as seen below.

Strip Drains

Strip drains are cloth wrapped plastic or fiber structures about an inch wide and 4 to 6 inches high. Strip drains are installed in 12 inch trenches that are about 3-4 inches wide. The trench is then filled to the surface with coarse sand. Strip drains can be spaced 20 feet apart at 45-90 degree angles to surface runoff for best performance. Strip drains are attractive because they do not require water to flow across the entire field to drain. The systems are also beneficial because they cause less disruption to a field and require less labor during installation.

Strip drains to collector pipe - Photo courtesy of Brad Fresenburg, Ph.D.

Sand-Slit Drains

Sand-slit drains are narrow trenches with thin, perforated pipe at the bottom. Running perpendicular, or in a herringbone pattern, is another set of sand filled trenches, which help conduct water to the perforated drain pipe. The system should be oriented so the trenches run perpendicular to the way water flows in order to catch the water as it runs off the crown.

Sand-slit drain trenches backfilled with sand - Photo courtesy of Brad Fresenburg, Ph.D.

Coarse textured sand should be used to backfill the trenches all the way to the field surface to avoid clogging the system and a perched water table. A common mistake made with the slit trench system is maintaining the field the same as in the past. For example, core aerating brings native soil to the surface. If the cores are reincorporated into the surface or canopy, the trenches will eventually become clogged because of fine soil particles contaminating coarse soil particles. This will render the sand slit system useless. To prevent contaminating the sand with smaller soil particle sizes, collect aeration cores and topdress the field with sand that matches what is used in the trench.

Sand slit systems are usually installed by commercial companies and only inflict minimal disturbance to the soil surface.

Common Problems Associated with Sub-Surface Installed Drainage

Proper surface drainage in combination with a well constructed sub-surface installed drainage system is a key component to a well performing athletic surface. To maximize the lifespan and effectiveness of any drain system, it is important to take preventative measures against the following:

- When installing a drainage system, be sure the pipe maintains a consistent downhill slope to the drain outlets. If the pipe does not slope correctly, the result could be a soggy, unsafe playing surface.

- Drainage pipes can be crushed by heavy equipment during the field construction stages. This often happens when the sub-base is overcompacted. Once drainage systems are installed be sure to keep heavy equipment off of the surface.
- Trenches that are backfilled by sand on native soil fields can become contaminated over time through various methods such as wind, aeration, and topdressing.
- Finer soil particles can migrate into the drainage pipes. In an ideal system, the fines get washed out of the system, but over time, fines collect and clog the pipe. Some drainage systems, such as the strip drain, will use a filter cloth to prevent fines from entering the pipes. However, over time fines can build up around the filter cloth and prevent water from reaching the pipes. Using coarse particles and careful construction, build up of fines can be slowed.
- All drainage systems have a finite life span. However, proper design, construction, and materials can maximize the effectiveness and lifespan of a drainage system.

Conclusion

Successful drainage starts with proper planning. The best time to solve drainage problems is before they happen due to construction or reconstruction mistakes. On fields with existing drainage systems, identifying the most serious problem and correcting it is the most effective solution. Unless a plan is developed to correct the major problems, "band-aid" solutions will cause headaches over and over again.

References:
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Penn State University - Beneath the Surface
Penn State University - Understanding Field Drainage
2012 STMA Conference Presentation – Sports Field Drainage – What Are Your Options? – Ian Lacy
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