Installing a successful drainage system

BY DR. JAMES MCAFEE

One of the most important aspects for sports field construction is designing the field for maximum drainage before and/or during an event. Unfortunately, too many sports fields are constructed like the high school football field in the photo on the opposite page. These fields are constructed without an installed internal drainage system and don't have adequate crowns to remove excess moisture rapidly.

Once the topsoil on a sports field becomes saturated, the water will do one of two things, pond or run-off. In this case, the water starts ponding because there is no crown in the field. Playing games when the soil is saturated with water will cause severe damage to the playing surface and increase the amount of soil compaction, thus making the drainage problem with the field worse.

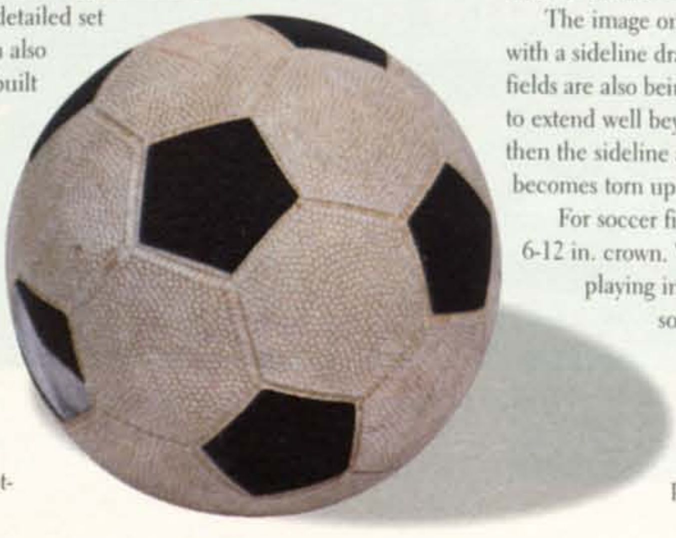
Over years of working with sports field construction, I have always been amazed at how little attention is given to this critical element, or how many times at the last minute the internal drainage system was removed from the original design specs to try and save money. Key factors to consider when designing drainage systems for a sports field include: moving water onto the field from surrounding areas; type of soil and soil depth; ability to remove excess water away from the field (storm sewer, creek, etc.); and weather factors such as rainfall. In areas of east Texas where average rainfall is 55-60 in. per year, proper drainage is going to be more critical than in areas of west Texas where average rainfall is 10-11 in. per year, for example.

A laser attachment can insure that you end up with a uniform, continuous grade in the base of your trenches.

First steps

One of the first steps in assuring proper drainage is to hire an architectural firm and/or contractor with extensive, specific experience. Just because someone knows how to run a grader doesn't mean they can build a sports field. It is important to have developed a very detailed set of specifications for the new field. I am also amazed at how many sports fields are built without any specs for soil type and depth, drainage system, irrigation, etc. Without these, when a problem arises, the school or city has no recourse to get the problem corrected.

Excess moisture is generally removed through surface run-off and/or through an installed internal drainage system. For fields built out of a native soil or an amended native soil, surface drainage is going to be the main removal means. For football fields, the general guideline is to build a 12-18 in. crown in the center of the field with a continuous grade from the center to and past the sideline areas.



For sandy loam to loam soils, a 12-in. crown is normally sufficient grade (slope) to remove excess moisture. For fields built with clay type soils, it is recommended to construct an 18-in. crown in the center with a continuous grade from the center of the field to and past the sideline areas. It is important to install a drainage system on the sideline areas to remove the excess moisture there as well.

The image on page 26 shows installation of a 12-18 in. crown on a football field with a sideline drainage system. Note that many high school football and city park fields are also being used for soccer. If this is the case, then the slope for the field needs to extend well beyond the normal sideline area of the football field. If this is not done, then the sideline areas of the football field where the players stand during games becomes torn up and this will make a very poor playing surface for the soccer games.

For soccer fields built out of native soils, the recommendation is to provide for a 6-12 in. crown. While most soccer players prefer a 6-in. crown, they also don't like playing in a quagmire. If an internal drainage system cannot be included in a soccer field design, then it is best to use a 12-in. crown to insure good surface drainage.

While a crown in the center of football and/or soccer field is the most effective method to provide for surface drainage, it should be recognized that for some fields, surface drainage can be provided by sloping the entire field from sideline to sideline or from

Unfortunately, too many athletic fields are constructed without an installed internal drainage system and don't have adequate crowns to rapidly remove excess water.

endzone to endzone. The further the surface water has to flow to get off the field however, the less effective the drainage becomes.

For fields built with a proper sand mix, a 6-in. crown is generally the recommended guideline. Providing a continuous, uniform grade on the field is just as important as providing the correct height for the crown. Any low areas in the grade will disrupt the flow of surface water from the field. Improper grading and settling of the topsoil are the two main reasons for low areas occurring in the final grade.

Baseball fields

For baseball fields, the high point of the field should be the pitcher's mound, which is normally 10 inches higher than home plate. Then the field should be sloped in all four directions away from the mound at a 1.0 to 1.5 % slope. As with football and soccer fields, this slope needs to continue to the sideline areas of the field and then some type of drainage system installed to remove excess moisture from this area.

Also, for baseball fields it is very important that this 1 to 1.5% slope continue across the skinned portions of the field and into the outfield. If constructed correctly, there will be very little movement of water down through the soil profile in the skinned area of the field. Surface drainage is the main method to remove excess water from this portion of the baseball field.

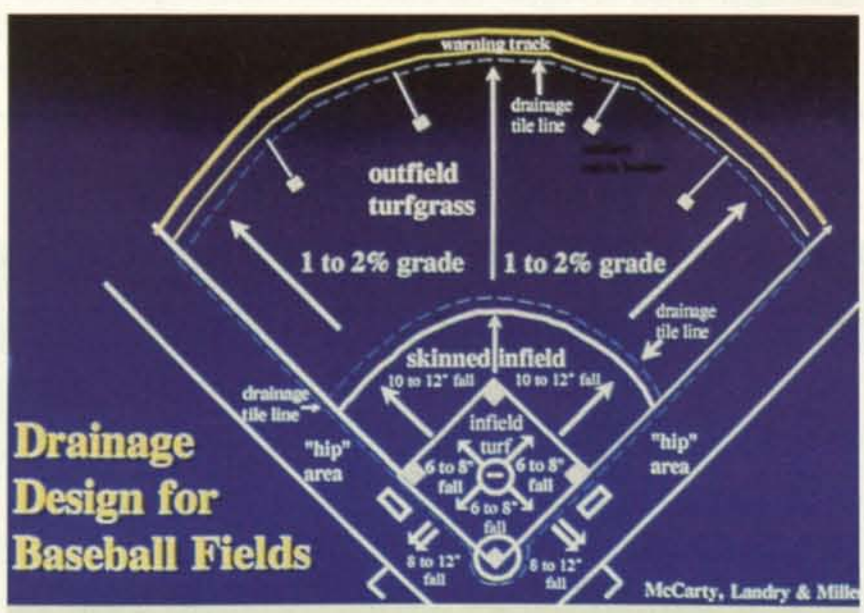
Another problem that often occurs on baseball fields is the build up of lips on the grass areas next to the skinned area; these lips will prevent water from flowing off the skinned area and into the grass. Regular maintenance will prevent this. From the skinned area, the field is then sloped at a 1 to 1.5% slope to the outfield fence.

The image at right provides a basic guideline for grading a baseball field. For softball fields they are a couple of common ways to grade the field. The most common grade is to slope the entire field, starting at the backstop and going toward the outfield fences at a 0.6 to 1.0% slope.

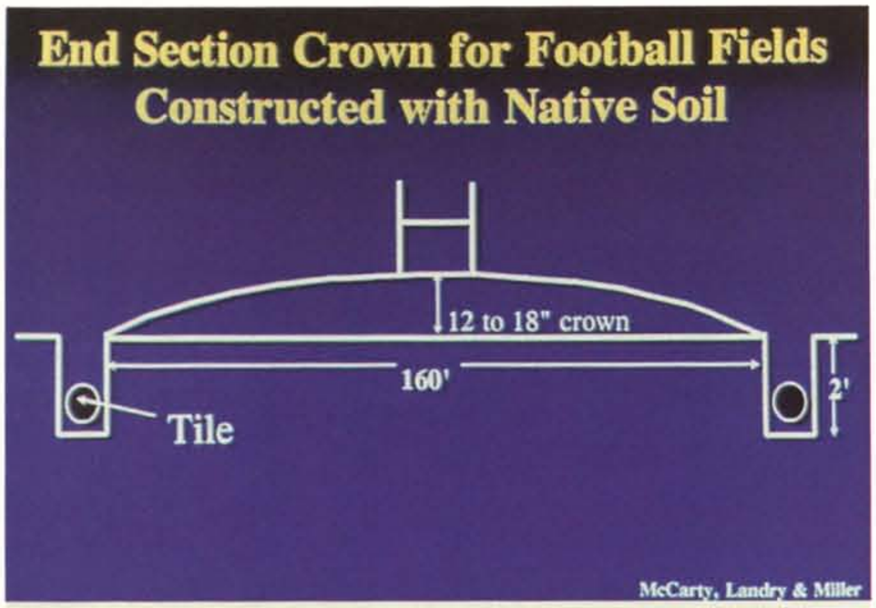
A second method is to provide a level crown through the center of the softball field going from home plate to the pitchers mound through second base and then to center field. Then the field is sloped at a 1 to 1.5% grade from the center of the field toward the right sideline and from the center of the field to the left sideline. The advantage of this design is that home plate and the pitcher's mound are at the same height, which for fast pitch softball is important.

With the exception of sand-based fields, assuming that the correct sand is selected, the movement of water into the soil profile (infiltration) and then down through the profile (percolation) is very slow. The amount of pore space and type of pore space in the soil generally determine movement of water into and through a soil profile.

Macropores (large pores) provide for good drainage and good aeration, but provide for very little moisture retention. Micropores (small pores) provide for good moisture retention, but provide very little drainage and aeration. Sands used for sports field con-



Here's a basic guideline for grading a baseball field.



Schematic of installation of 12 to 18-in. crown on a football field with sideline drainage.

struction generally have more macropores and fewer micropores. While these soils provide for excellent internal drainage of excess moisture, they generally require more input of supplemental irrigation and fertilization to maintain a healthy stand of turfgrass.

On the other hand, native soils high in clay and/or silt content have a larger number of micropores and fewer macropores. Internal drainage of excess water on these type fields is very slow. Providing a crown for good surface drainage is a must for these fields. Before selecting a particular soil, send a sample to a certified soil testing lab to be tested for texture analysis, porosity, saturated hydraulic conductivity, and compressibility. This step is not an option but a must. While testing for physical characteristics of a soil is considerably more expensive than chemical analysis, the fee for these tests is a drop in the bucket compared to the overall costs of constructing a sports field.

Another step that is often overlooked by inexperienced contractors is removal of the excess moisture from the subgrade. Movement of water into the subgrade of the field can only occur once the topsoil profile becomes saturated. Then, drainage of the field occurs at percolation rate of water down through the subgrade, which as a rule is much slower than the percolation rate for the topsoil. If means are not provided to assist in removing excess water once it hits the subgrade, then the field will tend to hold water at the interface between the subgrade and the topsoil.

During heavy rainfall, the field then acts like a bathtub and fills up with water, thus dramatically increasing the amount of time required for the field to drain. On native soil fields, it is very important that the subgrade not be heavily compacted before placing the topsoil mix over the subgrade. This is often another mistake inexperienced contractors make. Compaction of the subgrade will further reduce the flow of water from the topsoil profile down into the subgrade, thus increasing the time required for removing excess moisture from the topsoil. While you do need a firm subgrade to prevent excess settling of the subgrade, do not heavily compact the subgrade before placing topsoil over the subgrade.

For sand-based fields, it is necessary to stabilize the subgrade with compaction. However, it is also important to install an internal drainage system in the field to remove excess water from the subgrade area of the field. Note, installation of an internal drainage system on fields built using native soils will also help in the removal of excess moisture from the subgrade, just not as well as a sand-based field.

Drain lines

Correctly installing drain lines is critical to the successful removal of excess moisture during heavy rainfall periods. Spacing for the trenches should be at a 15-20 ft. spacing for sand-based fields. However, on native soil fields I would recommend a maximum of 10-15 ft. spacing. The grade on the trench should have a minimum positive slope of 0.5% with 1.0% grade preferred. Note, use of trenchers with a laser attachment can insure that a uniform, continuous grade occurs in the base of the trench.

If any low areas occur in these trenches, this will impede the flow of water through the drain lines and thus allow the fine soil particles, silt and clay, to settle out in the bottom of the drain lines and eventually plug up the drain lines. In most cases, it is recommended to line the drainage trench with a plastic material to keep the silt and clay soil particles found in the subgrade from moving into the trenches, and thus slowing down the movement of water into the drainage pipe.

Next, place a 1-2 in. layer of fine gravel, 1/4 to 3/8 in. gravel, in the base of the trench. Place the plastic pipe used for drainage on top of the gravel layer and then top off the pipe with a minimum 1-2 in. layer of the same fine gravel. For most sports fields, a sand layer is then placed over the gravel to the top of the drainage trench in the subgrade. Again, remember that it is just as important to send samples of the gravel and sand used in the drainage trenches as the soil for topsoil to a certified lab for physical analysis.

Most sports fields today use the corrugated plastic pipe with fine slits in the plastic for the drainage system. However, if PVC pipe with a single row of holes in the pipe is used, it is very important to place the holes on the bottom of the trench to encourage faster movement of water. Note, the common size for drainage trenches in the subgrade of sports fields is a 6-in. width with a minimum 8-in. depth. The key is to make sure that the pipe is placed deep enough in the field so that aerification with a deep tine aerifier will not pierce the pipe. You might be surprised how often this actually happens. For most new football and soccer fields, the drain lines are installed lengthwise in the field which requires much less trenching and also allows for maximum interception of water flowing from the center of the field toward the sidelines.

Recently, I have been involved with the construction of a couple of sand-based baseball fields that used the flat corrugated pipe for drainage instead of the 4-in. round corrugated drainage pipe. Instead of digging trenches in the subgrade, they laid this pipe flat on the surface of the subgrade, covered the pipe with a 4-in. layer of fine gravel, and then placed the sand topsoil mix over the gravel. So far this has worked excellently. The key to this system is installing a uniform, continuous subgrade surface with no low areas. The slope should be a minimum of 1% with a 1.5% grade preferred. It is also critical that a layer of fine gravel be used to cover the pipe. Also, spacing for the drainage pipe should be placed at a 10-15 ft. spacing for best results. Note, I would not recommend using this type of drainage system for sport fields constructed using native soils and/or amended native soils. **ST**

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Achieving successful drainage

1. Select an architect and/or contractor with experience in building sports fields.
2. Send the soil, sand, and gravel to be used in construction to a certified lab for physical analysis.
3. Construct a uniform grade on field surface to provide maximum surface drainage. This is especially critical for native soil fields.
4. Prevent any low areas from occurring in the field surface.
5. Install an internal drainage system.
6. Before construction, survey the site to determine any movement of water onto the field from neighboring sites. If this is a potential problem, then install interceptor drainage lines around the field to prevent such water movement.
7. Make sure excess water can be easily moved away from the field through storm sewers or natural areas such as a creek.