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Generally we'll use the steel mat. If the moisture level is higher, we'll use the cocoa mat instead. If conditions are too wet, we'll rake and forego the matting, letting the air dry it down. We keep the basepath firmer than the rest of the infield since that's the section that gets chewed up the most by players' spikes.

We wet down the infield if weather allows, but not if there's a chance of rain. The moisture soaks in overnight. The next morning, we wet it down a couple more times before we start to work it.

Once we hit the moisture level we want for maximum workability, we take a spike board or nail drag around the horn (from first base to third base and back again) and up and down (from the infield to the outfield and back again). By working the infield dirt in two different directions we will have walked the entire surface. If we find a hard spot, we put on a little more water and spike it to loosen it. If there's a spot that's too soft, we back off on the water.

Our nail drag is a standard three feet by three feet of 2-by-4 lumber with six rows of 20 penny nails spaced with 2-inch centers offset to create a 1-inch gap. For additional weight to sink the drag deeper, we'll use a 2-by-4, 2-by-6, or 2-by-12 cut to the same width as the spike board and placed on top of it, or we'll add a sand bag on top. The depth depends on how hard we want the under layer, with deeper equaling softer.

Edging eliminates or reduces lips and provides a sharp, defined edge.

Next we use the mat drag, starting in the opposite direction of the last direction used with the spike drag. We also mat drag in two directions. With the mat drag, we always stop exactly where we started to avoid changes in the surface level. Because we're manipulating the soft surface material, we pull away a little dirt from the area when we start the process and we'll deposit a little material when we stop.

During the morning session of working the infield, we stay two or three inches away from the turf edges. On the final pre-game mat drag we go right up to the turf edges to get a smooth finish. We have 20 minutes after batting practice to put the field back into condition. We may rake lightly to let the infield air out and drop the moisture level slightly. We want a firm base covered with a soft 1/4-inch topping. This is our last opportunity to hit that perfect consistency before the game begins.

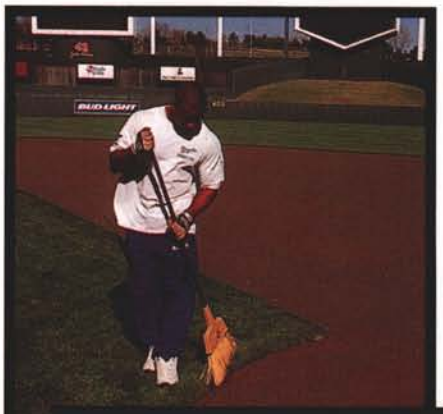
Tackling Transitions

The transition from the grass to the skinned area is critical for safety and playability. Clay will build up in the turf from the wind, a ballplayer's kick, or a slip in maintenance.

We sweep the edges after any on-field activity. We use a soft-bristled broom (also called a corn broom or witches broom) because, on our bluegrass turf, we can do more damage with aggressive sweeping. On the tougher bermudagrass, you can use a heavy bristled broom. We prefer sweeping over raking or blowing the edges to reduce the number of grass clippings on the skin and avoid disrupting the skin edge.

We power wash the edges when the team is out of town. We point the nozzle of a one-inch hose at the edge of the turf, with the water pressure on medium to low, and with the water shooting toward the skinned area. It's a quick process that, done carefully, doesn't damage the grass. It also deep waters the turf at the edges where the least water is applied during regular irrigation cycles.

We remove any lip buildup before every home stand. We measure the edges using a tightly stretched string, cut along the string with a power edge, and use our regular infield mix to fill in any spots where turf was removed. We also use the same power edger process around the pitching mound before every home stand. This gives us approximately 13 edge jobs a year.



Sweeping the grass along the skinned area gets clay out of the grass and back on the infield. A soft-bristled broom should be used on bluegrass, while a heavy-bristled broom is appropriate for bermudagrass.

Sod removed during the season may range from two to eight inches. When the amount removed reaches eight inches or more at the end of the season, we add a strip of sod. We cut out a section of old sod with a sod cutter, prepare the base for the new sod and fit it in place tightly. This process eliminates any lips.

Working the Tarps

Tarps are tricky to use in the Midwest with bluegrass turf. A short stretch under the tarp can stress the turf. If left on too long, it could burn or even kill the infield grass, so we minimize tarp time.

Our tarp is 170 feet by 170 feet and covers the infield and 10 feet around the outside of the infield. We'll track an in-coming storm and pull the tarp just prior to rainfall, even if it means coming to the ballpark at midnight or 3:00 a.m. to do it. We'll get the tarp off before the sun hits it.

If rain threatens, generally we'll opt to cover the field the night before the team comes in town and any time during a home stand. We may pull and replace the tarp four or five times a day, taking advantage of even a 20-minute window in the weather to get some air to the turf and help the skinned area dry. We welcome rain when the team is out of town and never tarp then.

If the infield skinned area becomes too wet, generally the combination of wind, radiant heat and working it with the nail drag will dry it down. If extended rainy periods, high humidity levels and no air movement make standard procedures ineffective, there are solutions to be used only in emergency situations. If time and budgets allow, a helicopter hovering overhead can serve as a giant fan. A labor-intensive alternative is removal of the upper portion of the skinned area and installation of a new surface.

Game Maintenance

We have a 20 minute window following batting practice for all remaining pregame maintenance. First, we chalk the field using a board template about 15 to 20 feet long and 4 inches wide with a screen on the bottom. Done properly, it provides a laser-like line. We rake and mat the baseline and home plate area. A team of two mats the infield. That leaves me approximately five minutes to wet down the infield surface before play begins.

We monitor the weather throughout the game to keep the umpires informed of any pending problems.

The fifth inning drag allows us to adjust conditions. If the infield is holding moisture, we may switch from the standard steel drag to a cocoa mat drag and just smooth the surface. Unless rain makes tarping an issue, once the fifth inning drag is completed we're on hold until post-game maintenance starts the cycle again.

As groundskeeper, you want the field to come into play only one time: when everyone walks into the stadium and sees how great it looks.

Trevor Vance is head groundskeeper for the Kansas City Royals Baseball Club. He has served on numerous Super Bowl and other high-profile field preparation teams and as a speaker at turf-related conferences.

Diamond Drainage

by Tom Burns

This article is the second of three articles on soil compaction and drainage issues. In the first part, Mike DePew discussed and defined terms to provide a better understanding of soil science principles relating to soil mechanics and soil strength principles. In this second part, Tom Burns discusses the multiple issues involved in drainage of baseball and softball fields.

An understanding of the soil science principles relating to issues of compaction and drainage is essential in athletic field construction and maintenance. On baseball and softball fields, the relationship between the physical properties of the various soil profiles during the wide range of climatic conditions and field-use situations affecting that field must be considered to properly manage field playability.

Drainage issues on athletic fields involve surface drainage—the movement of water across and away from the soil surface—and internal drainage, the movement of water into and through the soil. Infiltration describes water movement into the soil. Percolation describes water movement through the soil profile.

Field construction should provide for adequate surface drainage of the entire field and adequate internal drainage for the non-skinned portions of the field. The clay content of the skinned area combined with the degree of compaction required to provide firmness for play create a percolation rate too slow to move water into standard internal drainage systems.

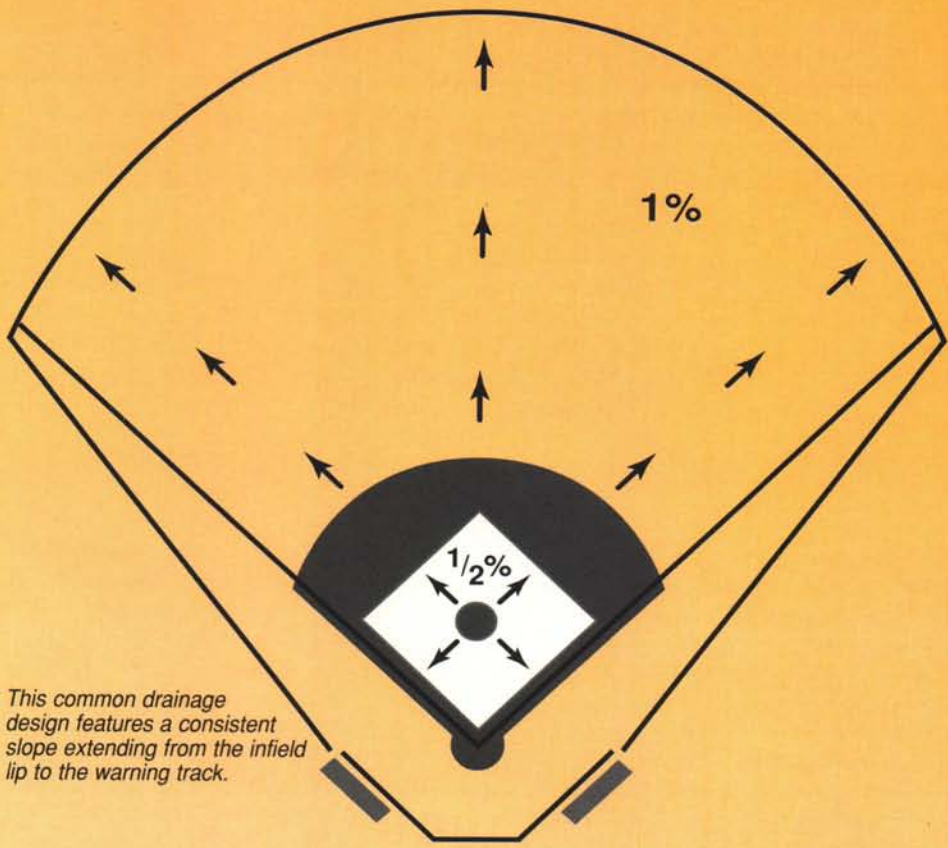
Surface Drainage

The main drainage issue on a baseball

or softball field is the movement of water away from the primary areas of play, the skinned and infield surfaces, and then away from the entire field surface. This is achieved through creating a degree of slope sufficient to move the water without producing a negative impact on field playability.

The general rule of thumb for this slope is one-half percent throughout the infield, one percent throughout the outfield, and one-quarter to one-half percent across the "dirt." This degree of slope could be increased or decreased slightly based on the average amount of rainfall the untarped field would receive. The higher the rainfall received, the greater the degree of slope.

The mound should be the high spot on the field with all water flowing away from it. Water hitting the center of the mound should flow in a cone away from the mound, moving equally in all directions. The infield slope should begin at the mound and continue equally and consistently in all directions past the basepath.

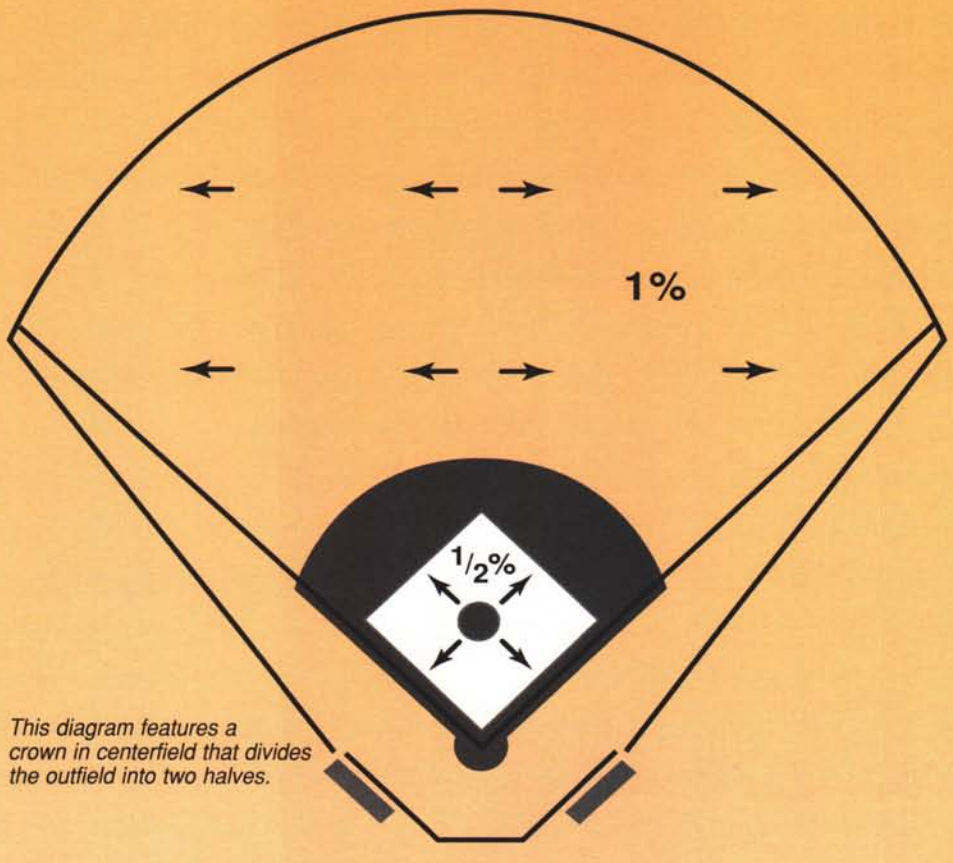


This common drainage design features a consistent slope extending from the infield lip to the warning track.

There are two common options for outfield drainage. The first continues the principle above, with an equal and consistent degree of slope extending outward in all directions to the warning track. The second option calls for a crown in center field, with the slope extending from the crown outward to the warning track. This option drains the outfield as two halves.

Field design and construction also must provide a method of removing the water accumulated at the perimeter of the field through surface drainage. This usually is handled through a channel drain at the edge of the field that connects to a central outside drain line that leads to a catch basin or sewer system.

If adequate surface drainage is not achieved, no internal drainage system can function well enough to compensate for the deficiencies and provide optimum field playability.



This diagram features a crown in centerfield that divides the outfield into two halves.

Design and Construction

Typically new construction will include an internal drainage system incorporating a network of drainage tiles leading to the external

drainage site. With higher-level sand-based fields, the drainage tiles are at the base, generally enclosed in filter fabric, and are covered with a layer of pea gravel. This layer is topped with the sand profile material. A layer of filter fabric will be placed between the pea gravel and the skinned area mix to prevent infiltration by the clay. The depth of each layer varies with construction design.

The drain lines often are placed on 15-foot centers throughout the field, though some field designs use 15-foot centers for the infield and sidelines and 30-foot centers in the outfield. If the budget allows, it's better to include the additional drains. It's far easier to add water to a field than to take water away. Typically the drains run under the skinned area, though little if any internal drainage will occur there, simply to tie drainage of the infield turf area into another pipeline. The drain lines do need to be sloped properly with some degree of downward fall leading to the collection point.

Warning Track

Surface and internal drainage of the warning track depend on the types of natural or synthetic materials used and the construction design. Natural material warning tracks typically have a slight slope though traffic and frequent maintenance make it difficult to maintain the integrity of the slope. Artificial warning tracks generally have an internal drainage line installed. Many field designs include drainage lines in the turf bordering the warning track or incorporate a slit or sand drain around the field.

A channel drain around the perimeter of the field also helps collect water run-off from the stands. If possible, drains and a drainage system within the stands can be used to reduce run-off onto the field. Rubber skirting at the bottom of the gates used for field access from the stands also help hold back the water and reduce washout areas. Some older fields featured a catch basin system with grates that could be covered with an artificial turf mat that could be removed to allow water to funnel through.

An effective surface drainage system helps remove water from the tarp when the field is covered. Some fields are designed with internal drainage on tighter centers in the

If adequate surface drainage is not achieved, no internal drainage system can function well enough to compensate for the deficiencies and provide optimum field playability.

area where the tarp water is dumped. This may include vertical drainpipes with caps that can be removed prior to dumping the tarp.

Problem Solving

Use imagination in solving drainage problems. Installation of a drainpipe, French drain or slit drain may eliminate a wet area, but will have limited holding capacity, so do tie it to an outside outlet.

Upright, capped drain tiles leading to the subsurface drainage tiles can improve water removal on a native soil field. The caps can be removed during heavy rains and additional excess water swept or squeezed into the openings. Swales placed off the playing surface can channel and direct run-off water. Swales should not be used on the playing surface. Even a slight dip and rise system has the potential to cause player injury.

Prevent lip buildup along the skinned area and turf transition points. The lip serves as a dam trapping water on the skin. Pay special attention to the back arc of the infield, sweeping or hosing it daily to remove excess material.

Be aware that a side effect of the field slope is the washing of skin material into the outfield. The contamination increases following aerification as the infield material washes into the holes created by the process. The clay particles from the skin are so fine they tend to seal off the natural drainage of the soil profile and damage the integrity of the root zone. Over time on high profile fields it will be necessary to solve this problem by removing and replacing a layer of sod approximately four or five feet into the outfield.

An effective surface drainage system helps remove water from the tarp when the field is covered.

On fields where the entire infield is a skinned area, monitor maintenance to eliminate the depressions that will be formed by player traffic. The areas around home plate and first base, the spots of choice for the second baseman and shortstop, and to a lesser degree, second and third base, will receive a higher level of wear and require close attention to maintain the integrity of the slope as originally constructed. Whatever the design of the field or the level of play, the groundskeeper must maintain and manipulate drainage to achieve top playability.

Tom Burns is director of grounds for the Texas Rangers and STMA board member representing Category I, those in charge of professional sports facilities. He is a frequent contributor to sports turf-related publications and a frequent speaker at turf-related conferences.