

# FERTILIZATION AND MANAGEMENT OF EPIC TURF AREAS AND ATHLETIC FIELDS

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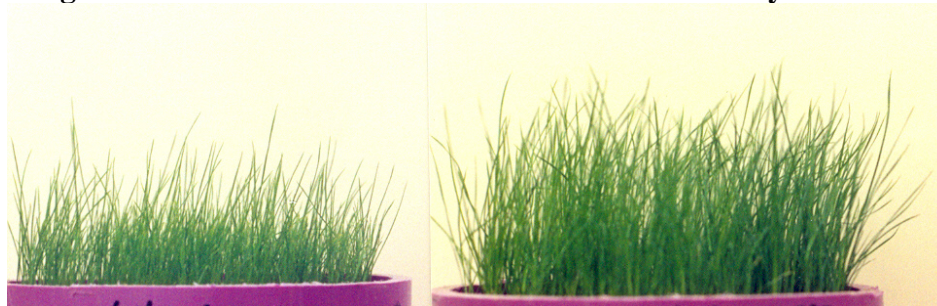
Among the many **water management** and **water saving** benefits found in EPIC installations, the primary reasons of using a washed sand profile in EPIC systems are a) its resistance to soil compaction, b) the ability to wick water upward, c) excellent drainage, and d) the ability to maintain an aerobic soil profile in the root zone. Most washed sands (or ordinary clay soils) however, are initially nutrient poor in some of the elements necessary for good plant growth and the nutrients have to be added to the sand profile. Water management alone is not a guarantee of successful plant growth.

Eight inorganic elements have been recognized as **essential nutrients** for plant growth, each with a specific function in plant physiology. The following table summarizes these eight and their function within plants.

Essential Element	Symbol	Plant usage
<b>Calcium</b>	Ca <sup>++</sup>	Calcium plays a prominent role in the absorption of other minerals from the soil. It neutralizes acids and has an antitoxic effect on other poisonous substances in the soil. Root hair cells contain calcium pectate, a colloid which enables it to imbibe water. This substance also forms the cementing material for holding all cells together, and is the first substance in the formation of new cell walls.
<b>Iron</b>	Fe <sup>+++</sup>	Iron is essential as part of the cytochrome oxidation system in respiration function. It is also essential for chlorophyll formation even though it is not part of the chlorophyll molecule. Many brown and reddish sands and soils may have an abundance of Iron, but it is not always in a form usable by the plant.
<b>Magnesium</b>	Mg <sup>++</sup>	Magnesium is a constituent of the chlorophyll molecule. Without chlorophyll there is no interaction with sunlight to produce plant tissue. However very high concentrations of magnesium are toxic to plants.
<b>Manganese</b>	Mn <sup>++</sup>	Manganese is thought to be necessary for the proper function of plant respiratory enzymes.
<b>Nitrogen</b>	NO <sub>3</sub> <sup>-</sup>	Nitrogen, only absorbed as a nitrate, is absolutely essential to growth, affecting particularly the growth of above ground parts. It is a constituent of chlorophyll, but is chiefly used for the production of proteins which are essential to every cell. A nitrogen deficiency quickly manifests itself as the yellowing of green foliage (chlorotic). Excess nitrogen may cause excessive vegetative growth which can result in weak and tender stems and foliage which are then susceptible to fungus and insect injury. Some nitrates are produced naturally through the interaction of lightning in thunderstorms; some is fixed by specialized soil bacteria living in nodules of

		specialized plants such as clover and alfalfa. Decomposition of dead organic material by soil organisms and their waste products (urea) may also provide nitrates through complex biological interactions. Urea → Ammonia → Nitrites → Nitrates. However, for lush thick turf, supplemental addition of nitrogen sources will almost always be necessary.
<b>Potassium</b>	K <sup>+</sup>	Potassium is necessary for the proper carbohydrate metabolism of the plant. When potassium is deficient, storage organs such as roots, tubers, and seeds are small and shriveled. Plants with ample supply of potassium have been reported to be more resistant to disease and insect injury.
<b>Phosphorus</b>	PO <sub>4</sub> <sup>- -</sup>	Phosphorus in the soil is most likely absorbed as a phosphate ion. It is essential for the formation of many compounds such as phosphoproteins and phospholipids. Lack of this element interferes with normal cell division and checks growth. It is important for proper functioning of photosynthesis and respiration. Phosphorus also increases root development and as such is important in the early stages of sod or seed growth.
<b>Sulfur</b>	SO <sub>4</sub> <sup>- -</sup>	Sulfur, absorbed as a sulfate ion, is a constituent of at least three amino acids that occur in proteins. Glutathione is an essential component in the respiration role of plants and the take up of oxygen.

Whether the source of the element and compound is derived naturally or artificially, in conclusion it is emphasized that if plants are to do their best, they must be supplied with a proper balance of all the essential inorganic substances. **If any one of the inorganic substances is deficient, its lack will soon be manifested in the growth of the plant regardless of how much of all the other substances may be available.**



**Kentucky Blue Grass 30 days after seeding in ordinary sand.**

**(Left) No nutrients added (Right) Addition of balanced nutrients**

The aspects of fertilization and agronomy however are not just a simple operation of opening a bag of fertilizer and dumping it over the growing area. Research has alluded to importance of other factors as soil and water pH, Cation Exchange Capacity (CAC), Base saturation levels, Zinc and other trace elements etc. The latest trends are experimentation with microrhizomes, humic acid levels, and microbial density indexes (MDI).

Good grass management has become, and is **both an art and a science** that not only involves nutrients but also mowing, aeration, thatching, awareness of disease, environmental factors, timing, and patience. **As an illustration** the following table depicts the **successful management formulas** of three award winning athletic fields in New York, Pennsylvania, and Colorado. The NY field was composed of a clay based sod, the PA field of loam, and the CO Field – sand based. While the formulas for the conventional fields is varied, some activities are also in common with EPIC field recommendations (green column), in many cases the program is simpler in EPIC.

Procedure	NY field	PA field	CO field	Minimum EPIC guide
<b>March</b>				
Field covers removed		When 60 F	Yes	
Aeration		Spike	¾” Core	Core
Fertilizer (with Gypsum)(*)		11-4-21* @ 1lb K/1000 sq.ft		15-15-15(*) @ 1 lb N /1000 sq.ft.
Soluble Fertilizer		20-20-20 @ 1oz.N,P,K /1000 sq.ft		
Biostimulant (as needed)		3 oz/1000 sf		Test for deficiencies
Overseed		50 lbs.blue	150 lbs.blue	3 lbs/1000sq.ft.
Top dress with sand			1/8 inch	
Mow 3 times/week		1 5/8”	1 ¼”	1 ½” 2 x /wk
<b>April</b>				
Aeration	Shatter tines	Spike	¾” Core	
Fertilizer	18-24-12 @ 1lb N/1000 sq.ft	11-4-21* @ 1 lb K/1000 sq.ft	11-4-21 @ 1lb N/1000 sq.ft	15-15-15 @ 1 lb N/1000 sq.ft.
Soluble Fertilizer		20-20-20 @ 1oz N,P,K /1000 sq.ft		
Biostimulant	1gal/acre	3 oz/1000 sf		By Test results
Overseed	Broadcast		150 lbs blue	
Iron	Chelated	4oz /1000 sf		4 oz/1000 sf
Mow 3 times/week	2”	1 5/8”	1 ¼”	1 ½” 2 x/wk
<b>May</b>				
Aeration		Core	¾”Core	Slice or Core
Fertilizer	24-5-11 @ 1/2 lb N/1000sq.ft.	10-2-5 @ 1lb N/1000sq.ft.		10-2-5 @ 1 lb N/1000sq.ft.
Soluble Fertilizer		20-20-20 @ 1ozN,P,K /1000 sq.ft		

Biostimulant		Need match 3 oz/1000 sf		
Overseed	Broadcast	150 lbs blue	150 lbs blue	3 lbs/1000sq.ft.
Amino Acid Package		2oz./1000 sf		
Soluble PKpackage		3oz/1000 sf		
Wetting agent		6oz./1000 sf		
Mowing 3 times/week	2"	1 5/8"	1 1/4"	1 1/2" 2 x/wk
<b>June</b>				
Aeration	Shatter	Spike	3/4" Core	
Fertilization	18-24-12 @ 1/2 lb N /1000 sq.ft.	20-20-20 @ 1ozN,P,K /1000 sq.ft	11-20-4 @ 1lb K /1000 sq.ft.	15-15-15 @ 1 lb N /1000sq.ft
Biostimulant	1 gal/acre	3 oz/1000sf		
Overseed	8lb/1000 sf		150 lbs blue	
Compost	40 cu yds			
Wetting agent		3oz./1000 sf		
Weed control		IPM proc.		Pull as needed
Grub Control		IPM proc.		IMP proc.
Top dress			1/8" layer	
Mowing 3 times/week	2" - 2 1/2"	1 5/8"	1 1/4"	1 1/2" 2x/wk
<b>July</b>				
Aeration		Spike	3/4" Core	
Fertilization	18-24-12 @ 1/2 lb N /1000 sq.ft	20-20-20 @ 1ozN,P,K /1000 sq.ft		15-15-15 @ 1lb N /1000 sq.ft
Biostimulant		3oz./1000 sf		
Overseed			150 lbs blue	
Compost		10-5-8 @ .75lbs N /1000 sq.ft.		
Wetting agent		3 oz./1000sf		
Weed control		IPM proc.		
Mowing 3 times/week	2 1/2"	1 5/8"	1 1/4"	1 1/2" 2 x/wk
<b>August</b>				
Aeration	Shatter	Core	3/4" Core	
Fertilization		Soluble P,K @ 3oz/1000sf		10-2-5 @ 1lb N /1000 sq.ft.
Biostimulant		4oz/1000sf x 2 3% Silicon @ 1.5oz/1000sf		
Overseed		200 lbs blue	150 lbs blue	
Compost		10-5-8 @ .75lbs N /1000 sq.ft.		

Amino Acid Package		2 oz./1000sf		
Wetting agent		1.5oz/1000sf		
Weed Control	IPM proc.			Pull as needed
Grub Control	IPM proc.			IMP proc.
Mowing 3 times/week	2 ½"-2 ¼"	1 5/8"	1 ¼"	1 ½" 2 x/wk
<b>September</b>				
Aeration	Shatter		Solid tines	
Fertilization	24-5-11 @ ½ lb N /1000 sq. ft.		Iron Only	
Overseed	Field center		150 lbs blue	
Biostimulant	1 gal/acre			
Mowing 3 times/week	2 ¼"		1 ¼"	1 ½" 2 x/wk
<b>October</b>				
Aeration			Solid tines	
Fertilization		20-20-20 @ 1oz N,P,K, /1000 sq.ft.		
Biostimulant		4oz/1000sf x 2 3% Silicon @ 1.5oz/1000sf		
Overseed		50 lbs/week	150 lbs blue	
Wetting agent		1.5oz./1000sf		
Top dressing			1/32"	
Mowing 3 times/week	2 ¼"	1 5/8"		1 ½" 2 x/wk
Field cover		When not used		
<b>November</b>				
Aerification	Core	Core	¾" Core	Core
Fertilization	18-24-12 @ ½ lb P /1000 sq.ft.	4-0-10 with Iron		0-20-20 @ ½ lb P /1000 sq. ft.
Overseeding		200 lbs. blue	150 lbs. blue	3 lbs/1000 sq.ft
Biostimulant	1 gal/acre	50 lbs/1000 sf		
Compost	20-25 cu yd	Peat		Optional
Topdressing	Compost	Sand	1/32"/game	
Mowing 3 times/week	2 ¼"	1 5/8"	1 ¼"	2" 1 x/wk
Cover		End of Nov.	Before snow	

As we can see from the table, there is not one successful formula for maintenance. Every turf manager has his/her own bag of tricks and experiences adjusted to climatic conditions and environments. Fertilizer manufacturers also provide their own special formulations and recommendations based on their research and experience. Input from regional agronomists and university research programs add more data and variations into the mix. The process of turf management quickly becomes an art form, and successful

athletic field complexes have relied on full time agronomists and turf managers to be the conductors.

Whether one is operating a high end professional sports field, a small municipal soccer park, or just their own back yard, certain scientific basics have always surfaced in successful turf management practices. A general summary of those practices are as follows:

1. Some type of nutrient (fertilization) program will be necessary and it will have a routine element attached to it. **Follow the routine even if the grass appears to be healthy.** We are balancing out the soil and making nutrients available for future growth. If we wait for the grass to look stressed before we react, the formulas may be too little, too late, or even chemically overwhelming to already injured and stressed grass.
2. **Rely on sound advice to establish the nutrient formula.** Large athletic fields should as a matter of routine **send in appropriate soil samples to agricultural labs at least once per year** to determine on what is missing and what supplement levels are needed. Nutrient levels and types cannot be seen and there are no simple field tests to get the information. Cost of these lab analyses is reasonable and provides a scientific base line data as to nutrient levels. Four testing laboratories that provide national services have been listed at the end of this section; other laboratories are available on the internet.

Discuss the results and recommendations with an agronomist or turf expert to formulate a routine. If reclaimed water is used for irrigation, a nutrient analysis is also needed of the water as it will become a contributing factor in the mix. Homeowners that may not use lab services should as a matter of routine stick to formulas recommended by reputable product suppliers, professional services, cooperative extension services, or literature. Do not mix product lines or application formulas from different sources.

3. **Mow frequently and keep mower blades sharp.** Grass grows from the bottom up constantly pushing the upper part of the leaf blade upward. The cut ends of leaf blades are “open wounds” where plant diseases can take hold. Sharp mower blades make a clean “wound” while dull blades cause shredding and pulling of tissue thus increasing the damaged area. Sharp Reel mowers are best but may not be as readily available or preferred as rotary mowers. However a sharp rotary mower is still better than a dull reel mower. Frequent mowing has four advantages:
  - a) Cutting off a smaller portion of the upper grass blade means that the formerly damaged tissue from the last mowing is again removed before diseases had time to establish themselves in the “open wound”;
  - b) By removing a smaller portion of the leaf blade, most of the photosynthesis surface area remains in tact thus the grass blade is less stressed;

- c) Smaller cut portions fall down between the grass blades easier, decompose quicker and the field looks greener; and...
- d) By not allowing the grass to stretch upward, grasses tend to respond by creating more shoots laterally providing denser, thicker turf.

4. **Keep records and be observant of change.** The keeping of dull data chronologically, on application events, formulas used, weather conditions, field usage, beginnings and progress of stress conditions, and recovery times provides invaluable assessment data to possibly reconstruct cause and effect relationships when problems do occur, and a success recipe when problems do not surface. For example certain diseases have a preference for specific nighttime temperatures and humidity levels. Start of a disease infestation a week after a visiting team's appearance may be related to disease introduction by transfer of contamination from athletic cleats. Ready data availability and subsequent sharing makes investigation and reconstruction of a problem puzzle a lot easier.

#### **Agricultural Laboratories**

<p style="text-align: center;">CLC Labs 325 Venture Drive Westerville, Ohio 43081 614-888-1663</p>	<p style="text-align: center;">Soil &amp; Plant Lab 352 Mathews Santa Clara, California 95050 408-727-0330</p>
<p style="text-align: center;">Soil Horizons, Inc. 865 Catalpa Place Marysville, Ohio 43040 888-933-5501</p>	<p style="text-align: center;">Wilber Turf and Soil Services 6419 Emerald drive Rocklin, California 95677 916-630-7600</p>

#### **DISEASES**

The first indication that something might be wrong with the grass is the appearance of a brown (dead) patch of grass blades, or a patch that is somewhat no longer green. A closer examination by the lay person may also show that the brown grass blades feel dry and brittle. It doesn't take a rocket scientist to recognize the obvious symptoms that something is wrong, but to zero in on the definitive cause will take some detective work, closer observation, book references, expert consultations, and perhaps even laboratory microscopic examinations, and a systematic elimination of the unlikely to the narrowing of the likely.





To illustrate the complexity - a “brown” patch may be caused by:

Lack of moisture	Too much moisture	Fertilizer spill	Chemical spill	Molds <b>Over 17</b> species
Deer urine Rabbit activity At night	Pet urine Yours or visitor	Rodent activity <b>Over 4</b> species	Insect activity <b>Over a 100</b> species	Missing or Imbalance of Nutrients
Mechanical damage	Insufficient sunlight	Heat stress	Cold stress	A combination of more than one factor

It is not within the scope of this paper neither to provide a definite identification guide nor to provide the solutions to all the problems. The subject is too complex with twist and variations that can even at times even confound the “best” experts.

## Bent disease stumps experts

By Scott Kauffman

**A** disease that has turf experts baffled is causing widespread damage to bentgrass greens in North Carolina and appears to be spreading throughout the Southeast, Southwest and Mid-Atlantic. Courses in North Carolina first reported isolated cases of the puzzling disease two summers ago. And this August an “explosion of new cases” was reported.

Some general “words of wisdom” to the managers and owners are offered as follows:

1. **Don’t take it as necessarily a failure of management practices.** While **no** management or **poor** management programs can initiate stressed grass conditions, problems will occur at times even in the best managed programs. A



lush, green vast area of sports turf maybe the human goal, but to nature it merely becomes an attractive smorgasbord of “food” for various opportunistic non human pests.

2. While we cannot control weather conditions, **be aware of weather conditions**. Applying fertilizers just before a rain event may be beneficial; applying it when the grass is still wet may not be a good idea. Some Fungicides and Pesticides on the other hand may be washed away and be useless if applied just before a rain event.
3. **Be flexible**. A tight schedule of maintenance activities shows determination and order, but it should have the ability to be overridden by common sense. Do not mow the grass if the grass is still wet. Do not use or even walk on the field if the frost is still on the grass blades.
4. **Don't jump to conclusions**. Be systematic and analytical in analyzing problems. Stressed grass conditions as mentioned can have many reasons. Some insects as fungi are invisible to the naked eye. A lot of damage may be occurring underground before it shows at the surface. No one person knows everything all of the time. Rely and obtain second and third opinions. Just when you know everything, Mother Nature can throw you a surprise.
5. **Be patient**. In a world of instant gratification grass response is a misfit. Even on the best of conditions it will still take 5 to 10 days for grass seed to germinate, several more weeks to “look” green and several months to be ready to stand up to abuse. It may take several days and up to a week for pesticides and herbicides to be effective, and then only if we have chosen the right formula.

## WATER MANAGEMENT

Water needs for turf or any plant can be divided into two categories a) the water needed to provide the **physical content** of water in the roots, stems, leaf structure tissue itself; and b) the water that is lost by **transpiration** activities of the plant. A succulent plant like a cactus stores a lot of water in its structure, but transpires very little. Grass and most leafy plants on the other hand provide minimal storage in structure, but transpire a lot of water by transpiration. Transpiration is the invisible physical activity of growing plants where water absorbed at the root level is transferred through the supporting stems and out to the surrounding atmosphere from leaf openings called “stomata”.

Turf grasses may transpire as little as **0.10** gallons per square foot per day during cool night time periods, or over **0.40** gallons per square foot per day during hot, dry windy conditions. Water loss by **transpiration** is a **variable rate** that will be dependent on a combination of all of the following factors:

- Plant species
- Leaf area (of growing tissue)

- Humidity
- Temperature
- Wind speed
- Sun exposure (cloudiness)
- Health of the plant

In conventional sprinkler irrigation an **estimate** of water need is distributed at the surface with the anticipation the water will find itself to the roots and satisfy the transpiration needs of the turf. A temporary reservoir is created in the root/soil structure such that enough water will be available until the next application. If we apply too much water and/or the soils are compacted, excess water is lost by runoff. If it is windy, water is lost from the target area, and there may also be insufficient water available until the next cycle. Inefficiency arises from:

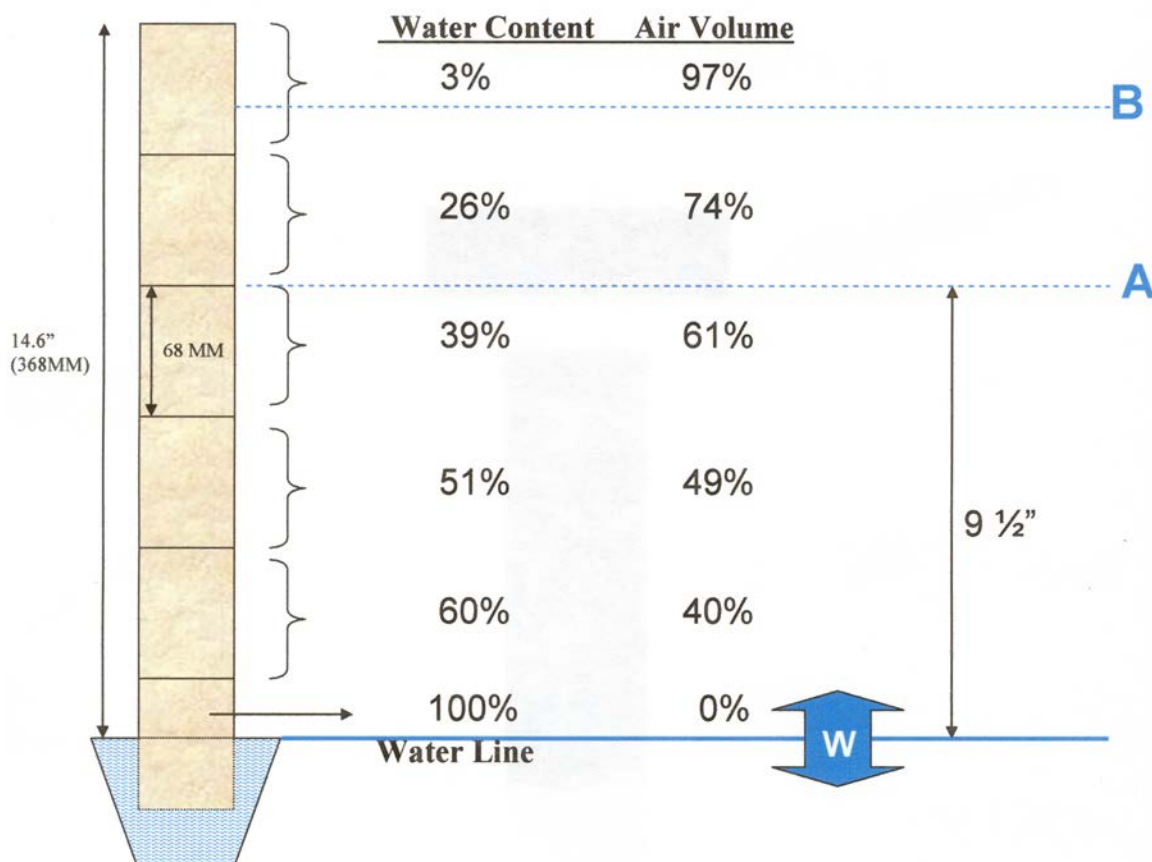
- Difficulty of predicting the exact transpiration needs due to the just mentioned changing variables.
- Variability of distribution coverage due to the mechanical state and nature of the sprinkler head.
- Slope and compaction levels of soils that influence drainage and water loss.

### **Grass does not waste water – people do.**

In EPIC, irrigation can be 100% efficient not that plants or grass themselves are forced to use less water, but because EPIC eliminates the above inherent problems of sprinkler irrigation. Properly constructed, EPIC systems will match the transpiration needs of the plant by simply providing a stable underground reservoir, and the plants themselves determine the water uptake they need. It is important to understand the function of an EPIC moisture profile to enable the operator to adjust moisture levels at any time to a desired level.

In a given volume of medium sized sand grains, about half of the space (47%) is occupied by the sand particles themselves, leaving the approximate other half (53%) as a void space. In pure dry sand the void space is occupied by air. In a growing environment of an EPIC profile this void space is available to be occupied by a combination of water, air or other gases, and growing plant tissue (roots). As capillary physics draws water upward from the **saturated zone** (area totally submerged with water) a **graduated water concentration** occurs in the profile. The closer we are to the water line the more saturated the sand, the further we are from the water line the drier the sand. The physical differences are shown in the following diagram:

## SATURATION PROFILE IN ECS SYSTEMS

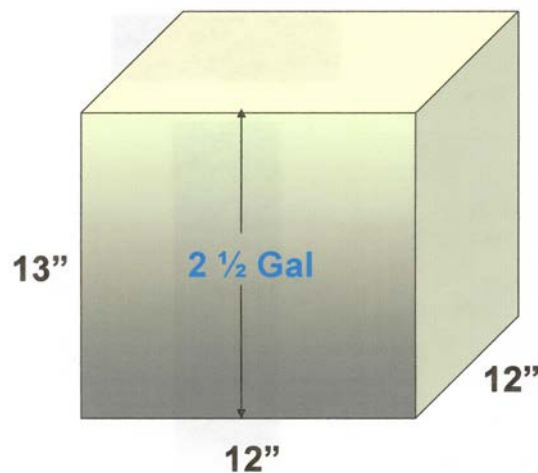


The normal water operating level (**W**) in a flat athletic field is the midpoint of the 6" distribution pipe on either end of the field. As such the surface of the field is 9 1/2 " above this water line as depicted in (**A**), where the water content in the sand is approximately 35% and the remaining void space is then 65%. The surface will feel damp and there is sufficient moisture to germinate seed.

The water level (**W**) can be easily raised or lowered from its normal operating level in flat EPIC fields. By extending the outlet overflow point and adding more water, the water level will rise uniformly in the field and the water content in the sand will increase proportionately to the distance from the water line as shown in the diagram. Raising the water 9" we can achieve a flooded condition (100% water content of void space) right below the surface. By shutting off the water supply, the water level will start to recede (drop) as transpiration and evaporation move the water from the sand into the atmosphere. If the water level is allowed to drop 3 1/2" (the bottom of the liner) the moisture level at the surface will only be 5% water and 95% air as depicted in (**B**).

As previously mentioned, a given volume of sand has about 53% of its volume available as free space which can be occupied by water or gases (air). In a 15" deep EPIC profile at

saturation (normal operating level) about 2 ½ gallons of water is stored underground for every square foot of surface area. See the following diagram.



If the water supply is shut off, the volume of water will still be held by capillary adhesion and will slowly start to **dry out from the top down**. A shut off of the water supply in EPIC systems does not mean a quick drying affect and water will continue to be available to turf that has a fully developed root structure. If the transpiration rate is 0.40 gallons per square foot per day (hot windy conditions) sufficient water is still available for approximately 6 days.

$$2.5\text{gal.} \div 0.40 \text{ gal/sq.ft./day} = 6.25 \text{ days}$$

If the installation is in a moist cool climate the transpiration rate will be lower and water shut off conditions can be maintained for a longer period of time.

$$2.5 \text{ gal.} \div 0.10 \text{ gal./sq.ft./day} = 25 \text{ days}$$

In Climate areas that have frequent rain events, it is possible that supplementary water may never need to be turned on, as the **rain water is harvested and stored**, and only excess water is drained.

In summary by adjusting operating water levels and controlling the supply sources, water management can be achieved to any desirable level.

## **AEROBIC CONDITIONS**

Oxygen (aerobic condition) must be available for respiration in roots, which in turn is necessary in order that growth may occur. Experiments on numerous plants have shown that growth ceases when oxygen is removed in the root zone by replacing it with another gas or water. The amount of oxygen necessary for growth varies with the species. Roots at great depths or in water logged soils or in very compact soils are likely to suffer from lack of oxygen.

The washed sands used in EPIC profiles assure that pore space is always available for a certain amount of oxygen content. Air (21% Oxygen) is generally introduced into the profile from air pressure (14 p.s.i.) above the field, which then disperses in the upper layers of the sand profile, combining with moisture films around the sand grain, thus making it available to the root hairs.

On the other hand the respiration of roots in healthy growing plants, and the biological activity of soil organisms produce carbon dioxide gas which has to equalize itself with the carbon dioxide levels of air. While the carbon dioxide level in air is a mere 0.03 %, the soil content can be 5 % or more. Oxygen therefore is not only used up physically to form carbon dioxide, but is also displaced by the carbon dioxide concentrations. As such it is necessary to maintain an exchange pathway between the soil and the air above it so equalization can take place. This exchange pathway can be blocked or hindered by:

- Compacted clay soil
- Tight plant thatch
- Sod that has not been cored **within a few months** of being laid
- Rapidly decomposing organic material or dead grass
- Lack of soil worm activity
- **Infrequent or lack** of core aeration

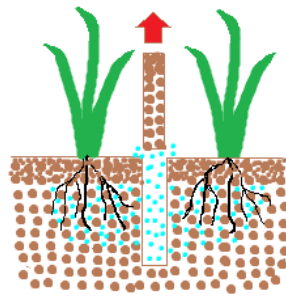
While the use of a sand growing media may in some applications reduce the aeration frequency as compared to clay soils, its importance as illustrated in the maintenance tables is not eliminated in successful maintenance programs.

## **AERATION OF TURF**

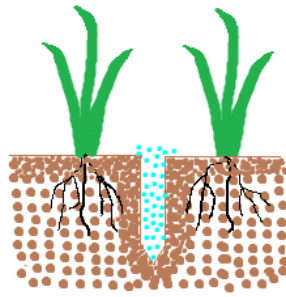
One of the most important aspects of healthy athletic fields is aeration. Aeration is necessary not only to improve drainage characteristics of thatch buildup, but also for the importance of gas exchange where the accumulated carbon dioxide buildup in the root zone can equalize by the introduction of oxygen. **The need for oxygen in the root zone is as important as balanced nutrient levels.**

Most turf managers agree that aeration in the form of **plug aeration** followed by a systematic removal of the thatch plugs is the best accepted method in all sports fields and other turf areas.

**Tine aeration** makes holes, but in the process compresses adjoining soil and thatch without improving drainage characteristics

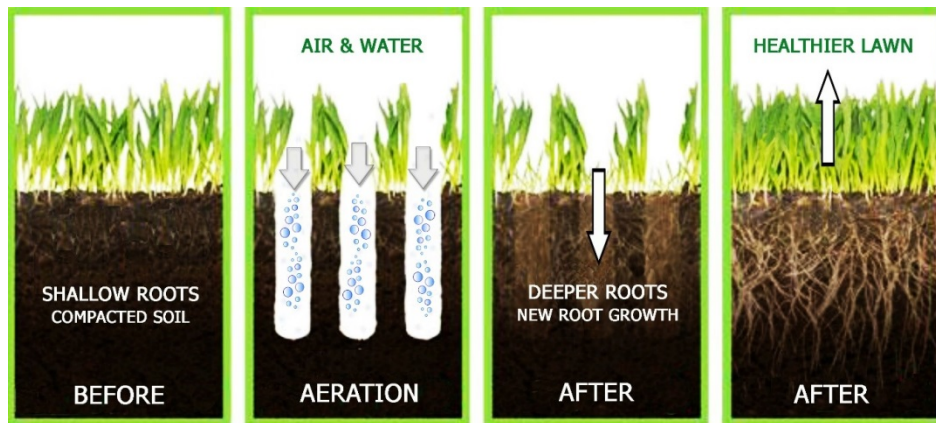


Holes created by core aerator. Soil compaction is reduced by removing cores out of ground. This allows water, air, and fertilizer to reach grass roots easily.



Holes created by spike aerator. Soil around the holes is compacted further, which creates a barrier for water, air, and fertilizer.

**Plug aerators** physically remove a core of the thatch material and in the process allow air, water and nutrients to penetrate into the root zone more easily.



**What does a good aeration look like?** Typical plugs are ½" in diameter and physical holes 4"-6" apart.







The field will look “battle born” with a high density of holes and plugs which unfortunately will have to be raked up and taken off the field or the dead thatch will again quickly fill the holes.

Fortunately in EPIC fields top-dressing is not required as the sand falls off the thatch during the raking process.

Did your aeration look like these pictures ?

