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October 10, 2009

Ms. Janet Bowser, Esq., Director
Wellesley Natural Resources Commission
Town of Wellesley
525 Washington Street
Wellesley, MA 02482

Dear Ms. Bowser,

This report documents my assessment of athletic fields in the Town of Wellesley, MA. The properties are either dedicated sports fields or school properties that contain a field within the overall footprint. The school properties may also be used for recess and physical education classes. Included is an explanation of the principles and protocols of natural turf management, detailed soil test data, site assessments, analysis of the current management program, and recommendations for beginning a natural approach to turf management.

As I walked the fields, I assessed the current conditions, specifically turf cover and density, weed and clover pressure, and compaction. The area was photographed to assist in documenting the strengths and weaknesses and soil samples were collected for Nutrient and Textural Analyses, as well as soil Bio-assays at three selected sites.

This report will document the existing physical condition of the turf area and will establish a baseline soil analysis for chemistry, texture, biology, and nutrient availability. This review is being prepared with the idea that these fields may be incorporated into a complete natural, organic management program at some point in time, and all recommendations will be made with that in mind.

When we discuss different management levels, we are referring to the cultural intensity required to maintain an individual turf area to the degree that meets expectations. Cultural intensity is the amount of labor and material inputs required to meet those expectations. Cultural intensity and the level of management will be a direct function of budget dollars committed to the project. One fact is a given in either a conventional or natural turf management program; minimal product and labor inputs meet low expectations, while higher levels of inputs meet higher expectations.

When a natural management program is put in place, there is a window of time referred to as the transition period. It is during this timeframe when new products are put in place and specific cultural practices are followed. During transition, the most important aspect is to focus on the soil; not just texture and chemistry, but the biomass as well. Addressing the living portion of the soil from the beginning makes the transition successful. The length of time for this process has a direct relationship to the intensity of conventional management practices that may be currently employed.

Conventional turf management programs are generally centered on a synthetic product approach. We have developed "A Systems Approach to Natural Turf Management™" that forms the basis for our recommendations. Our approach has been designed to be a systems approach that is based on three concepts. It involves natural, organic product as governed by soil testing, the acknowledgement that the soil biomass plays a critical role in fertility, and sound cultural practices.

The goal of a Natural Turf Management program is to create turf that is both aesthetically pleasing and that exhibits the functional qualities of good sports turf. At the same time, this turf will provide a surface that will be healthy and free from toxic chemicals. The products and program discussed will be designed to utilize materials and adopt cultural practices that will avoid any runoff or leaching of nutrients and control products into the water table.

Ours is a "feed-the-soil" approach that centers on natural, organic fertilization, microbial inoculants and food sources, and topdressing as needed with high quality finished compost. It is a program that supports the natural processes that nature has already in put in motion. These inputs, along with very specific cultural practices, that include mowing, aeration, irrigation, and over-seeding will be the basis of the program.

It is my experience that this approach will build a soil profile rich in microbiology and that will produce strong, healthy turf that will be able to withstand many of the stresses that affect turfgrass. The turf system will be better able to withstand pressures from heavy usage, insects, weeds, and disease, as well as drought and heat stress, as long as good cultural practices continue to be followed and products are chosen to enhance and continually address the soil biology. While problems can arise in any turf system, they will be easier to alleviate with a soil that is healthy, and that has the proper microbiology in place.

Sincerely yours,

Chip Osborne, Pres.
Osborne Organics

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Textural Analysis Summary

Soil is the foundation of our landscape. It is much more than just a functional medium to hold turfgrass and other plants upright. Soil is comprised of sand, silt, and clay mixed with varying amounts of organic matter, water, and air. The soil is very much alive. It is home to a microbial community that is made up of organisms both large and small. It is these microbes that give the soil its life. The makeup of soils in the Northeast generally falls within the following guidelines: forty-five percent mineral, twenty-five percent air, twenty-five percent water, and five percent organic matter.

All soil particles, from the microscopic sheets of clay to the largest grains of sand, should be surrounded on all sides by air. When soils have varying degrees of moisture, the water occupies the air space. The air and water portion is also referred to as pore space; therefore only one-half of healthy soil is solid particulate matter. The organic matter portion of the soil is where we concentrate our efforts in natural turf management, as it is the home to the soil microbiology.

Topsoil, as the name implies is the uppermost layer of soil. This surface layer of soil is usually darker than subsoil because of the accumulation of organic matter. In different parts of the United States we see very different depths of topsoil. It can range from six to eight inches in the Northeast to two feet in the Midwest. Loam, on the other hand, is a textural classification. Texture refers to the relative amounts of sand, silt, and clay. A loam is technically a soil with between 7% and 27% clay, 28% and 50% silt, and less than 52% sand. The term loam can then be modified to sandy loam, sandy clay loam, clay loam, silty clay loam, or silt loam as the individual soil fractions change. The soils at the different sites are sandy loams and loamy sands.

The USDA Textural Triangle is the tool we use to determine soil textural classifications. After testing determines the relative percentages of sand, silt, and clay, we refer to the Triangle and find the percentages on each side and follow the lines to the intersecting point.

Sands

Sands are loose and single-grained (that is, not aggregated together). They feel gritty to the touch and are not sticky. Each individual sand grain is of sufficient size that it can easily be seen and felt. Sands cannot be formed into a cast by squeezing when dry. When moist, sands will form a very weak cast, as if molded by the hand that crumbles when touched. Soil materials classified as sands must contain 85-100% sand-sized particles, 0-15% silt-sized particles, and 0-10% clay-sized particles. The reason that sands are referred to in the plural is that there are several USDA textures within this group. All of these textures fit the "sand" portion of the textural triangle, but they differ from each other in their relative proportions of the various sizes of sand grains.

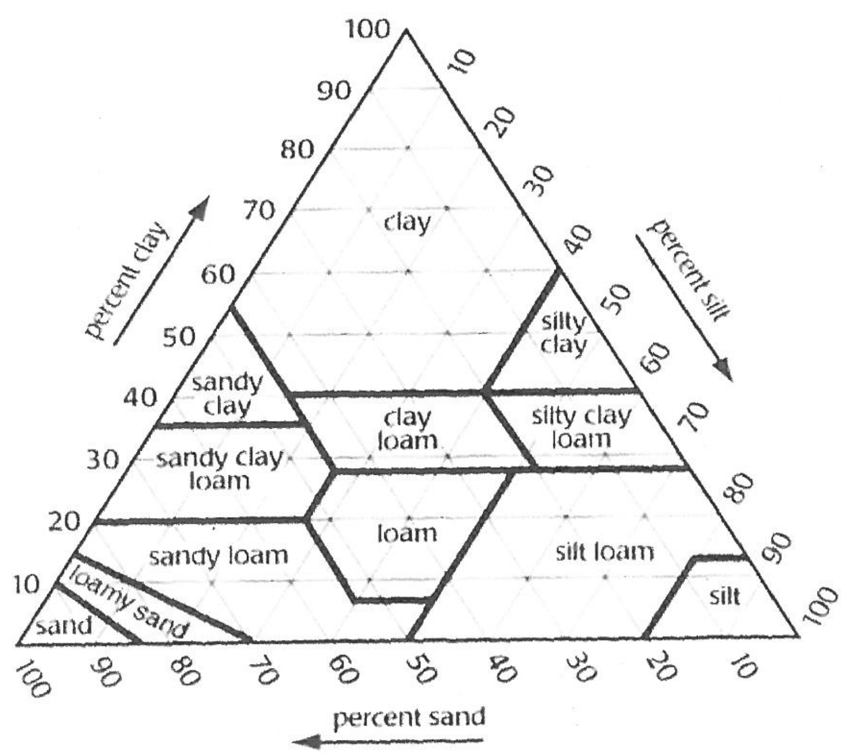
Silt

Silt is similar to silt loam but contains even less sand and clay. Sand-sized particles, if present, are generally so small (either fine or very fine sand) that they are non-detectable to the fingers. Clay particles are present in such low percentages that little or no stickiness is imparted to the soil when moistened, but it instead feels smooth and rather silky. Silt-sized particles are somewhat plastic, and casts can be formed that will bear careful handling.

Clay

Clay is the finest textured of all the soil classes. Clay usually forms extremely hard clods or lumps when dry and is extremely sticky and plastic when wet. When containing the proper amount of moisture, it can be "ribboned out" to a remarkable degree by squeezing between thumb and forefinger, and may be rolled into a long, very thin wire.

Textural Triangle



The following is the definition of the textural classifications found at the various fields in town.

Loamy Sand

Hunnewell FHockey
Hunnewell Soccer
Lee
Hunnewell FB
Hunnewell School

Loamy sands consist of soil materials containing 70-90% sand, 0-30% silt, and 0-15% clay. As such, they resemble sands in that they are loose and single-grained, and most individual grains can be seen and felt. Because they do contain slightly higher percentages of silt and clay than do the sands, however, the loamy sands are slightly cohesive when moist, and fragile casts can more readily be formed with them than with sands. As with sands, the loamy sands are dealt with in
the plural because there are several USDA textures within this group. The name assigned to a soil material in the loamy sands depends on the proportions of the different sand separates.

Sandy Loam

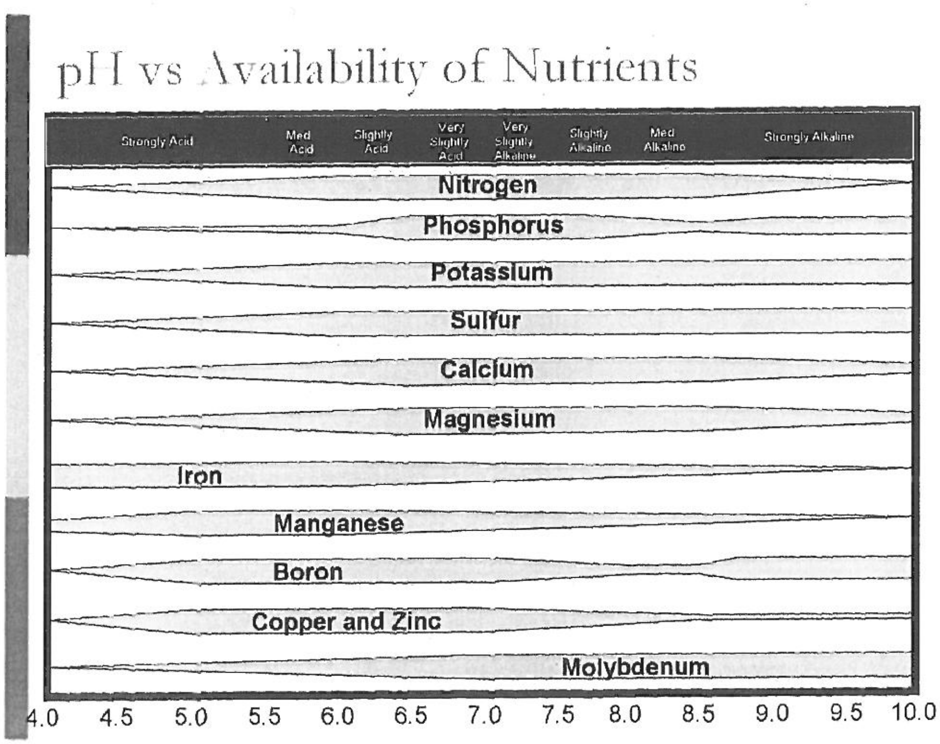
Hunnewell multi
Reidy
Sprague 5
Sprague 4ABC
Sprague 1
Hardy 2
Hardy 1
Perrin
Kelly
Upham
Phillips
Oulette
Schofield
Fiske
Brown

Sandy loams consist of soil materials containing somewhat less sand, and more silt plus clay, than loamy sands. As such, they possess characteristics that fall between the finer-textured sandy clay loam and the coarser-textured loamy sands. Many of the individual sand grains can still be seen and felt, but there is sufficient silt and/or clay to give coherence to the soil so that casts can be formed that will bear careful handling without breaking. Sandy loam is not dominated by any particular size of sand particle. It contains 30% or more very coarse, coarse, and medium sand (but less than 25% very coarse and coarse sand), and less than 30% either fine sand or very fine sand. Sandy loams tends to drain well.

Nutrient Analysis Summary

pH

The first and probably most important area of attention is the relative acidity (or alkalinity) of the soil. It is measured as pH. The ph scale runs from 1.0 to 14.0 with 7 being neutral. The cool-season (C3) turfgrasses prefer a pH in the 6.5 to 7.0 range. Establishment of the pH within this range is important to the success of a natural management program. The nutrients that the grass plant uses in the largest amounts are most readily available when the pH is within this range. The grass plant uses nitrogen in the largest amount, followed by potassium, and then phosphorus. When the pH is substantially below this range, there is less nutrient available to the grass plant (see Nutrient Availability vs. pH chart). The most important and critical step in a natural program is to adjust the pH to the desired range. Unless the pH is close to the 6.5 to 7.0 range, the grass plant does not get the nutrients it needs with any degree of efficiency. Fertilizer can be repeatedly applied, but will have less than the maximum benefit.



Lime is used as the preferred input for raising the pH. The calcium to magnesium ratio is considered when determining the type of lime to be used (calcitic or dolomitic). The guidelines we follow call for a 7:1 to 8:1 calcium to magnesium ratio. Calcitic lime is used for a specific purpose; it is higher in calcium and low in magnesium. It is somewhat more expensive than dolomitic lime, which has higher magnesium levels, but it will elevate the pH while raising calcium levels.

I recommend adhering to the generally accepted practice of not exceeding fifty pounds of lime per one-thousand square feet of turf in any one application. Recommendations for applications greater than fifty pounds will be split between spring and fall. Raising the pH is not a process that happens rapidly. It can take up to one-hundred days for lime to break down and begin to elevate the pH. Products that are marketed as soluble calcium to raise pH should be avoided. We are not after a quick change in the pH, but rather a sustained movement towards a slightly acid soil. The highly water-soluble products can be rendered less effective with heavy rains in the weeks following an application.

The pH adjustment is really a critical first step in a sound turf management program, conventional or natural. As described above, unless the pH is established within the desired range, the nutrients we apply simply cannot be used efficiently, resulting in wasted money. If establishing the proper pH by liming needs to be done, it is usually an expense occurred in the first years of a natural program. Natural fertilizers do not tend to acidify the soil in the way conventional products do after repeated applications. One of the benefits of natural fertilizers and composts that are used to "feed the soil" is a natural buffering of the soil and pH becomes stable in the desired range.

Nutrient Management

An approach using primarily synthetic, water-soluble fertilizers is directly "feeding" the grass plant. These products are broken down by soil moisture and are readily available to the plant. Natural, organic fertilizers work in a different way. It is the soil microbiology that breaks down the fertilizer and uses it as a food source. The microbes then make the nutrients available to the grass plant in a plant available form. It is this "feed the soil" approach that will be the basis for our recommendations on a nutrient program. In a natural program we do not focus on pounds of N in quite the same way as we do in conventional programs. A healthy soil, where the microbes are nourished with natural fertilizers, has the ability to cycle up to 2 lbs N to the grass plant on a monthly basis. This plateau is reached when sustainability is approached, generally three to four years into a complete natural turf management program.

All nutrient and cultural recommendations that I make will ultimately affect the microbes. They are a big part of creating and achieving good soil health and quality. This is really the starting point. Paying close attention to the soil, both soil chemistry and soil biology, is important in the transition process. There is a period of time involved in taking turf from a conventional program or an incomplete program (ph not established, etc.) to a natural one. That length of time varies with each different field or property. The process begins at this, the most basic level.

Abreviations

N	nitrogen
P	phosphorus
K	potassium
Ca	calcium
Mg	magnesium
ENR	estimated nitrogen release
CEC	cation exchange capacity
pH	measure of acidity
OM	organic matter

Organic Matter (OM) and Cation Exchange Capacity (CEC)

Organic Matter makes up a relatively small fraction of the soil. A typical agricultural soil has between 1% and 6% organic matter. A soil that supports turfgrass should have between 5% and 8% organic matter. Organic matter has a tremendous effect on most soil properties.

It is made up of living organisms, fresh residues, and well-decomposed residues. These three components of organic matter have been referred to as the living, the dead, and the very dead (Magdoff, University of Vermont). The living portion is comprised of a wide variety of microorganisms, including bacteria, fungi, protozoa, and nematodes among others. Also included are plant roots, earthworms, insects, and larger animals that spend time in the soil. This living portion represents about 15% of total organic matter. The fresh residues, or the dead portion, are comprised of recently deceased microorganisms, insects, earthworms, and compost if applied as a topdress. The dead portion also includes crop or plant residues, in the case of a turfgrass system, grass clippings left on the turf, that are decomposed by saprophytes. Nutrient cycling happens here in the dead portion of OM. The very dead part of OM is humus. Humus is the end product of decomposition or the living and dead portions that ultimately can decompose no further. Humus is fully stable and is considered to be a long-term soil resource lasting many hundreds of years.

Think of humus as one of the central components that tie together the interrelated functions of soil chemistry, texture, and biology. As we begin to address and enrich soil organic matter, we are improving the humus content of the soil and all of the interactions that take place. When we get all of these aspects working in harmony, we begin to achieve what is now referred to as soil health. Conventional soil science has looked at soil chemistry, texture, and biology separately. The emerging way of looking at soil is to try to achieve optimum levels in each of these areas and the result is referred to as soil quality or soil health. Many natural fertilizers are now including humates as part of the blend for the specific purpose of working to create a healthy soil. If not included in a fertilizer blend, humates can be applied separately in granular or liquid form.

The **Cation Exchange Capacity** is a measure of the nutrient holding capacity of the soil. The clay and humus (stabilized OM) portions of the soil contain negatively charged ions that attract and hold on to plus charged cations (nutrients). Older, well-aged OM (humus) contains the largest percentage of exchange sites. There are different clays that make up the soil profile, montmorillonite clays and koalinite clays, and they each have different characteristics with regard to possessing the ions to attract nutrients. We can look at different soil samples and see results that seem to contradict other results from the same general property, but most often the variable is that some soils are not native to the site, but rather brought in as a topsoil borrow to supplement existing soil on site.

Soil Biomass

Any discussion of nutrient management in a natural turf program would be incomplete if the soil biomass was not addressed. It is really the foundation upon which our nutrient program is based. As I have outlined in the cover letter as well as the description of fertilizer products, we take a "feed the soil" approach. The soil microbes are at the heart of this approach. It is the natural, organic fertilizer that is broken down by the microbial life and nutrients are made plant available. Synthetic fertilizers by nature, with their high salt content, compromise the activity of much of this life in the soil. The microbes do not reproduce and function at healthy levels in soils that exhibit high salinity.

During the transition period from a conventional fertility management program to a natural one, it is important to address the role of the microbial community and choose products that science has shown enhance their development and function. The soil environment, specifically the OM, is the home for soil microbial life. The processes that take place in the microbial community are extremely complex, but at the most basic level it is a predatory relationship. The organisms are really just competing for survival. Their existence depends on an aerobic soil of good texture, chemistry, and fertility. As a result of one organism consuming another, nutrients, particularly nitrogen, are released in a plant available form and are in a form that is ready to be taken up by the roots of the grass plant. This is really an over-simplification of the process, but in reality it is how it works.

It is the ability of the microbes to make the conversion from natural, organic sources of N to the inorganic N that allows natural fertility to work. When we design a fertility program that is based on natural, organic fertilizer product, we also include materials that support and maintain a healthy soil and microbial community. Compost and compost teas are two of there materials. There are also microbial inoculants, liquid fish hydrolysates, seaweed, and humates that directly affect the health of the soil and its community of organisms in a positive way.

Compost tea (see Compost Tea sheet in appendix) is the application that directly addresses the introduction of large numbers of microbes to the soil environment. The benefits are many, especially during transition. At the present time there are some contractors that can provide this service, but there are not many. We are working within the industry to change that.

Transition Period

When turf management programs change, there is a period of time we refer to as the transition period. When we move from a conventional program to a natural one, the length of time involved in transition is in direct relation to the intensity of current and past management practices and the overall turf quality.

During transition it is important to address the soil and its biomass as well as those cultural practices that support it and the turf itself. The biggest issue will be to move the management of fertility from the conventional program to a natural one. After many years of conventional fertility management that has used synthetic, water-soluble fertilizers with high salt levels, the soil microbiology has been bypassed and somewhat compromised. We will strive to support and restore the soil to good health during this transition period so that the natural processes of fertility will take over and produce healthy turf.

When a turf system is moved from a conventional to a natural program, we do not expect to see a collapse or failure. As long as the transition process involves the whole system; soil biomass, natural product, and cultural practices, we expect to see fields that exhibit all of the characteristics of quality athletic turf.

The costs discussed in this approach, other than for lime and those associated with the cultural practices of cultivation and over-seeding should remain constant for three years. At that point, sustainability will be achieved and a reassessment of the product requirements may be addressed.

It is important during this period that we establish a sound management plan that enables us to successfully move forward. The reality in the municipal sector is that there is not always budget money available in the amount desired or needed to implement any type of turf management program. In my approach, it is important to address the four P's; protocol, procedure, product, and prioritization. It is the concept of prioritization that allows us to create levels of management and then to allocate often scarce financial resources to those properties where the greatest impact will be made. This is critical, especially in the transition period, when we need to be the most aggressive with inputs and cultural practices.

Nutrient Budget

When we address fertility issues, it is important to look at the needs of the grass itself. Of the three major nutrients used by turfgrass, nitrogen is used in the largest amount. It is followed by potassium and phosphorus in that order. There are others, of course, but our primary focus is with these three. When we set nutrient budgets, we are basing them on nitrogen to be delivered in one form or another to the turf system.

When a turf area is used as a sports field, the turf is generally under some stress; grass plants get damaged and often can't reproduce at a rapid enough rate to maintain maximum turf density. The recuperative capacity of the grass plants is governed by the genetic capabilities of individual species as well as nutrient availability. We need more available nutrient, specifically nitrogen, to sustain this type of turf system as opposed to what we might need for a homeowner's lawn. It is available nitrogen that directly stimulates growth. A reasonable nutrient budget is in the 4 to 5 lb N range from all sources on an annual basis.

One of the basic differences between a natural program and a conventional one is that we do not get all of the N from fertilizer product alone. N from fertilizer is important, but it is only a part. We acknowledge the contributory N from compost topdressing, liquid fertilizers, compost tea and humic substances, microbial inoculants, and grass clippings returned to the system. As we use product to initially improve soil health, we are building a system that will make N readily available naturally to the grass in the future. It is this concept that allows us to have healthy turf at a lower cost three years down the road.

It is estimated that only 25% to 35% of the N from conventional water-soluble fertilizers actually benefits the grass. The balance is lost to volatilization and leaching below the root zone. As this material leaches it can become a ground-water contaminant, as well as runoff into fresh or saltwater bodies. With natural, organic product being a source of water-insoluble N, nearly 100% of the N reaches the intended target and provides a slow, steady release of nutrients over an extended time that "feeds the soil" and the soil microbial life in turn "feeds the plant". We generally need less lbs. of N annually with organic fertilizer to get the same response of the turf that we customarily see with synthetics.

Specific nutrient budgets will be discussed.

Fertilizer
A Product Analysis

We can use two kinds of fertilizer in our nutrient management program; granular and liquid. Both are considered to be natural, organic fertilizers. The granular product may be made up of three different sources of nutrient. The source of the nitrogen (the nutrient used in the largest amount by turfgrass) is either plant, mineral, or manure based. The liquid product is a fish hydrolysate.

The difference between natural, organic fertilizers and conventional or synthetic fertilizers is simple. Synthetic fertilizer is inorganic. It is manufactured by a chemical process that produces a highly water-soluble fertilizer. It breaks down on contact with soil moisture and is taken up by the grass plant very rapidly. This is why you see a "quick green-up" with these products. There is a way to coat or encapsulate the fertilizer to slow down the breakdown. The fertilizer is taken up rapidly, works quickly, and then leaves the root zone. This process is directly feeding the grass plant. Most synthetic fertilizer programs call for three, four, or five applications annually.

Natural fertilizer products work in a completely different way. Nature has put in place a system that makes nutrients available to plant material. A good example of this is a mature forest. No one fertilizes a forest, yet plant material grows and is healthy and adequately 'fed". Turfgrasses function in basically the same way, but because it is a closed system, we add fertilizer or compost topdress to supply nutrients in the way that fallen leaves decompose and supply nutrients in a forest.

Synthetic fertilizers, being water-soluble, move rapidly through the soil and can be major contributors to non point source pollution. With natural, organic fertilizers this does not happen. Because the fertilizer is broken down by soil microbes and used as a food source, it is naturally slow release. The major portion of the nitrogen source is water-insoluble nitrogen (WIN) and breaks down over time supplying a slow steady food-source. It does not move through the soil and create the same type of problems as synthetic products.

With so many different fertilizers and formulations on the market, it can be confusing trying to tell the difference between the products. As a rule, we can get an idea as to the type of fertilizer in the bag from the percentage of nitrogen in the analysis. The analysis is the three numbers on the bag that represent nitrogen, phosphorus, and potassium in that order. It is stated as a percentage of each nutrient in one hundred pounds of fertilizer. The reason that nitrogen is our benchmark is because it is the nutrient used in the largest amount by turfgrass. If the nitrogen number is less than twelve, the product is most likely a natural, organic product. If the number is between thirteen and eighteen we probably have a bridge product. Bridge products are those that contain both synthetic and natural, organic sources of nitrogen. When the nitrogen percentage is greater than nineteen, the product is synthetic.

It is the microbial life in the soil that really makes nutrients available to the grass plant. Remember that in high school biology we learned that a handful of soil contains billions of mostly beneficial living organisms that nature put in place for the sole purpose of growing plant material. It is these organisms that in fact make the nutrients (specifically nitrogen for turfgrass) available. We are using natural fertilizers to feed and nourish the microbes, so that they in turn through a complicated process can make the nitrogen available to the grass. We are now actually feeding the soil.

The nitrogen in natural fertilizers is in the organic form. It is important to note that plants can't use organic forms of nitrogen, but rather they can only use it in the inorganic form. That is why synthetics work so rapidly. Natural fertilizers supply organic nitrogen to the microbes as a food source, and the microbes break it down and in turn release it to the grass in the inorganic form. Nitrogen is nitrogen whether synthetic or organic. Neither form is a plant food, but rather a catalyst in the larger process of photosynthesis, which is how the real food or carbohydrates are produced. Synthetic and natural fertilizers work in completely different ways, but produce exactly the same results. It is simply a matter of understanding how they work and getting the proper timing of the applications. Natural, organic forms of nutrients, because they are not water-soluble, do not run-off and contribute to non-point source pollution.

We apply granular fertilizers twice a year. At times, we fertilize three times annually, but at lower rates. When we use the liquid fish hydrolysate as a fertilizer, we are using a relatively low dose of nitrogen. It is not the nitrogen that is of primary importance to us, but it is the proteins, enzymes, and amino acids preserved from the fish that directly nourish and stimulate the soil and in turn the grass. We are building a healthy soil environment that will support healthy grass. This type of product is relatively low cost and with the right equipment fairly easy to apply. In a tight budget situation this product can be very cost effective. For less than $100.00/acre we can deliver .2 to .4 lb N that has the equivalent benefit to the system of 1 lb N.

Fertilizer Specifics

There are several natural, organic fertilizers on the market with different analyses. They range from 4% to 12% N. There should be roughly ¾ of the N in the WIN form and the balance will be natural water-soluble N. This addresses both short and long term N needs. My recommendation would be to use a natural fertilizer with roughly a 1:1 N to K ratio. This will address N as well as K levels on the Baseball outfield and the Soccer field. The synthetic fertilizers currently used are generally high in N and lower in K.

The percentage of N only matters when we are calculating the amount to use on a particular size property (refer to the calculation chart). The higher the N%, the less product by weight we need to use. Simply put, we need twice as much fertilizer with 4% N as we do with a product that has 8% N.

% Nitrogen delivered in different formulations by weight of product used

4% N	= 1 lb N	@	25 lbs / 1000 sq ft
5% N	= 1 lb N	@	20 lbs / 1000 sq ft
6% N	= 1 lb N	@	16.5 lbs / 1000 sq ft
7% N	= 1 lb N	@	14.25 lbs / 1000 sq ft
8% N	= 1 lb N	@	12.5 lbs / 1000 sq ft
4% N	= ¾ lb N	@	18.75 lbs / 1000 sq ft
5% N	= ¾ lb N	@	15 lbs / 1000 sq ft
6% N	= ¾ lb N	@	12.5 lbs / 1000 sq ft
7% N	= ¾ lb N	@	10.75 lbs / 1000 sq ft
8% N	= ¾ lb N	@	9.5 lbs / 1000 sq ft
4% N	= ½ lb N	@	12.5 lbs / 1000 sq ft
5% N	= ½ lb N	@	10 lbs / 1000 sq ft
6% N	= ½ lb N	@	8.25 lbs / 1000 sq ft
7% N	= ½ lb N	@	7 lbs / 1000 sq ft
8% N	= ½ lb N	@	6.25 lbs / 1000 sq ft

Topdressing

Compost as a Soil Conditioner

Compost and composting is a complex subject. It is far more than just creating a pile of organic matter and watching it turn into a soil-like material. Composting is an exacting science when we want to produce a finished product of high quality. This discussion here is intended to give an overview of product and process, and in no way should be thought to impart all of the information necessary to fully understand the subject.

Compost is the product of an aerobic process, whereby microorganisms break down and decompose various forms of organic matter. The organic matter is referred to as feedstock or substrate and this can be made up from a wide range of materials. The feedstock can be random materials, or they can be chosen to meet a particular recipe. When we compost by recipe, the starting point in choosing materials is generally to follow a 20:1 to 30:1 carbon to nitrogen ratio. The microorganisms use the material as a food source throughout the decomposition process.

They produce heat, carbon dioxide, water vapor, and humus as a result of their activity. Humus is a highly stable by-product of the decomposition process. It can make up sixty percent of finished compost. The process also stabilizes nutrients and pH, giving us a finished material rich in nutrients and microbial life, a high percentage of humus and organic matter, and close to neutral pH, making this an ideal soil amendment and topdress material for established turfgrass.

Composting is done at the municipal level in many areas as well as in the private sector. Composters are generally required in most states to conform to guidelines that deal with health issues, but at the present there are no national standards that deal with compost quality. You need to have a good understanding of the criteria that define compost quality and rely on your own assessment that should include proper testing. Whenever possible you should obtain information from the supplier to support the quality of the compost.

Very briefly, compost quality is determined by several criteria. The finished material should have no offensive odor, there should be no recognizable remnants of the original feedstock, and it should be finished or mature. Maturity can best be determined by biological testing. There are four phases to the composting process; Mesophilic, Thermophilic, Cooling Phase (second mesophilic), and Maturation Phase. These are defined by temperature ranges and there are different populations if microorganisms at each phase. The Maturation Phase can best be determined by testing and determining the microorganisms present.

Immature compost would be considered to be a product of inferior quality. It can, in fact, be very detrimental to a turf system and can cause turf damage. Once the composting process has begun, it naturally wants to complete itself. Immature compost will pull N from the soil to try to complete the process, resulting in a yellowing of the turf. As the N levels drop, chlorophyll production in the grass plant decreases, resulting in a plant that no longer has the resources necessary to undergo photosynthesis at a satisfactory level. As photosynthesis decreases, carbohydrate production drops off and the turf weakens.

Application rates are generally in the range of ½ to ¾ cubic yard/1000 square feet. You may hear of recommended rates of 1 cubic yard/1000 square feet, but that is on the heavy side. The depth of material should be between 1/4" and 3/8". If the depth approaches ½" it is too heavy an application.

Compost as a topdress in a turf system does four things for us. It helps to increase soil organic matter. When we are dealing with low OM percentages topdressing is the preferred practice for addressing the deficiency. This practice in itself gives good results, but when we can combine topdressing with cultivation (core aeration) the benefit is magnified because the compost is able to fall into the core holes and reach the root zone. When a compost application is combined with over-seeding, it enhances germination and establishment. Think of it as creating a seed bed to receive the grass seed, not unlike a seed starting mix we might use to grow a tray of tomato seedlings for transplant. Compost, by virtue of its neutral pH and healthy microbial population, has the ability to help buffer the soil and counteract naturally acidic soils without the use of lime. As compost continues to decompose we experience nutrient release and get good greening of the turf, much the same way we do with a fertilizer application.

Compost is not a fertilizer, but in fact it is the microbial population that makes the nitrogen available to the grass plant. Lastly, it is the beneficial microbes in compost, particularly fungi that give the grass what has been referred to as acquired immune resistance. The beneficial fungi have the ability to fight and suppress many fungal pathogens, and disease issues in turf become easier to deal with.

Topdressing with sand or a blend of primarily sand with 20% to 30% compost added will not give the same benefits as a high quality compost. The conventional industry uses the sand based material, but natural programs are based on compost. Sand is used at times in our program for very specific purposes, but not as a general topdress.

Timing of topdress applications

Topdressing can be done at any time during the growing season. After application, the material breaks down and is assimilated into the turf within a matter of days. We do need a relatively short window when the field is not being used. This is only because the compost might be "muddy" after rain or irrigation. The three optimum times of the growing season for topdressing are mid to late-June, September, and late-October/early-November. The June and September windows are ideal to combine topdressing and over-seeding. The late fall application is to "set the turf up" for spring. Topdressing should always be combined with cultivation.

Cultural Practices

Irrigation

Irrigation schedules on those properties that have systems in place can be set to match the soil conditions. The park, with its high clay percentage, will hold more water and for a longer time than the sandier soils.

We need to be aware of field capacity for each property. In terms of soil moisture, field capacity refers to the optimum amount of water that is held in the root zone of a particular soil. As previously discussed, the soil profile is 45% mineral, 5% OM, 25% air, and 25% moisture. This means that a handful of soil contains 50% solid matter and the balance is pore space. When a field is irrigated to the point of saturation, either by rainfall or an irrigation system, the pore space becomes filled with water. After a period of time (variable depending on soil texture and compaction), the free water drains below the root zone and the remaining soil moisture is known as field capacity. As a general rule, irrigation systems should water to field capacity and not be run again until needed. They can be set to deliver different rates and lengths of time that correspond to the season of the year and general weather and growing conditions.

The best way to irrigate is to deliver enough water at each irrigation to provide a deep thorough watering. At times of over-seeding it is best to provide relatively frequent, shallow irrigation. We want the seed to stay as continually moist as possible without being overly wet.

Natural turf growing in sandy loam needs only one inch of water per week maximum and turf growing in a loam soil needs one-half inch weekly during the warmer periods of the growing season when going through the transition process. That timeframe is usually mid-May to mid-September. Once a natural turf system is well underway, irrigation requirements drop to one inch per week during dry spells. Of course, those properties that do not have irrigation depend on natural rainfall. A natural turf system is better able to deal with dry spells and periods of minimal rainfall than a conventional system.

Cultivation

Compacted soil is the biggest enemy of turfgrass. Compaction favors weeds and discourages the growth of healthy grass. Turfgrass roots, as well as soil microbiology, are entirely dependent upon an aerobic soil environment. Aerobic soils are those soils with a reasonable amount of oxygen available.

When we talk about soil aggregation, we refer among other parameters, to a loose friable soil. All soil particles from the microscopic sheets of clay to the largest grains of sand should be surrounded on all sides by air. This is referred to as pore space. When soil becomes compacted by heavy use, athletic play, mowing and other equipment, heavy rain, or regular irrigation; the turfgrass begins to struggle and certain weeds proliferate. As the soil is compressed by mechanical means, the 25% air portion of the soil is eliminated, oxygen is absent, and pore space is lost. We now have particle touching particle with nowhere for the grass roots to grow.

The roots of the grass plant should be long and fibrous, whereas some of the broadleaf weeds have shorter, thicker root systems. When soils become very compacted, the plant's roots can't penetrate and they become clubby. A short, clubby root system on a grass plant severely restricts the plant's ability to absorb nutrients, and it becomes weakened. The broadleaf weed begins to thrive, because it has a root system that is easily adapted to these conditions. Prostrate knotweed, broadleaf plantain, and pineapple weed are three indicator weeds that are routinely found on compacted sports fields. All of these reproduce from seed, so once fully established in sizable numbers, it takes some time to replace them with viable turf. The same is basically true in a conventional program.

The process to loosen the soil is cultivation. In a turfgrass system, the type of cultivation we employ is referred to as aerification. When we aerate a field, we are loosening the soil, introducing oxygen, and reestablishing pore space. There are different methods of aeration, the two most common being core and shatter tine aeration. This cultural practice can be done in-house or out-sourced as circumstances dictate.

As a part of the overall process in addressing the grass at the sites, aerification is central to future successes. Generally speaking, it is one of the least expensive things we can do, but it gives us the largest direct benefit.

Over-seeding

Turf density is a measure of the number of grass plants growing in one square foot of a field. When we come close to maximum density, weeds begin to be suppressed. Regular over-seeding on an annual basis is the most effective strategy for keeping weed populations down. Broadleaf weeds will be out-competed by thick, healthy turf. Minimum turf density is an invitation for crabgrass and other weed pests. A bare spot the size if a silver dollar can potentially become a crabgrass issue

When over-seeding is combined with a compost topdress application and either a core or shatter tine aerification, the germination and establishment phases both improve. These cultural practices should be combined whenever possible.

Maintaining genetic diversity of cool-season grasses in a sports field is important. As we broaden the genetic base with newer cultivars, we are taking a proactive approach to potentially minimizing negative impacts of insect and disease pressures. We can take advantage of cultivars that contain natural endophytes (fungi that give some grasses resistance to surface grazing insects) and those that are bred to have disease resistance.

Time to Germinate-based on 50°F and above soil temperature

	50°F	70°F
Perennial ryegrass	7-10 days	5-8 days
Fescue sp.	12-15 days	7-12 days
Kentucky bluegrass	21-23 days	12-18 days

Effective seeding windows

April	to fill bare spots and worn areas before spring weeds move in-want fast germination-50%+ perennial ryegrass
Mid to end of June	general over-seeding introducing higher % of Kentucky bluegrass if desired
September	general over-seeding introducing higher % of Kentucky bluegrass if desired

Over-seeding is a critical part of a successful natural program. Field use and seasonal considerations are always part of the decision making process when we over-seed.

There are different mixtures of cool-season grasses available for municipal turf. Different producers will have percentages roughly along these lines

50% Perennial ryegrass
50% Kentucky bluegrass

60% Perennial ryegrass
40% Kentucky bluegrass

33% Perennial ryegrass
33% Kentucky bluegrass
33% Creeping red fescue

30% Perennial ryegrass
70% Kentucky bluegrass

A general over-seeding rate is 3.5-6 lbs/1000 sq ft depending on the mixture

It is important to note that Kentucky bluegrass is a much smaller seed than Perennial ryegrass or Fine fescue, therefore 1 lb of blue is a lot more seed than 1 lb of the others

Species	Seeds/lb
Kentucky bluegrass	1,500,000
Perennial ryegrass	250,000
Fine fescue	400,000

Mowing

We should be looking at mowing heights in the 2 ½ to 3" range overall. Of course, this must vary from field to field and be adjusted to accommodate an individual sport.

The principle behind this mowing height is that there is more blade surface exposed to the sun, and photosynthesis takes place more efficiently and to a greater degree. The C3 grasses (cool-season) are not efficient photosynthesizers. As mowing height increases, it helps to counter this. As photosynthesis increases, more carbohydrates (the real plant food) are produced and the grass gets stronger and healthier with substantially more food resources and energy reserves. For every inch we increase mowing height we get a corresponding increase in carbohydrate production. The following studies support the concept of increased blade length in a natural system when appropriate.

Clippings should generally be left on the field. There are some cutting weeks in the spring when removal might be an option.

Any time a field is not in regular use during the middle of the summer, raising the height of cut helps strengthen the turf. As fall approaches mowing heights can be reduced, because the threat of weed pressures lessen. As mowing heights become shorter in the fall, the grass plant still needs the surface area to photosynthesize, and it aggressively sends out tillers, stolons, or rhizomes to create it. As vertical extension is reduced, lateral extension increases. The net overall benefit is a thickening of the turf.

Kentucky Bluegrass Rhizome Development

- Mowing Heights
- 1" 1.75" 2.5"

- Mg by weight of Rhizomes
- 1.0 64 656

E.E. Deal 1967

Height Effects on Leaf Area and Photosynthesis Capacity

- Mowing Height
- 1"　　　　2"　　　　3"

- Relative Change % in Photosynthesis
- 1.0　　　　240　　　　5760

Roberts 1992

Compost Tea

Compost tea is one of the inputs on the horizon that will change the way we deal with several of the management aspects of growing high quality turfgrass, either in your backyard, on your town's parks and athletic fields, or on commercial and institutional properties. It is already being used to some extent, but over the next few years it will become one of the foundations of a complete natural program. We now use the application of a compost topdress to address the organic matter content of the soil as well as to introduce beneficial soil biology and a plant available nutrient source. The application of a topdress can be expensive depending on the compost supplier and freight costs. When we have reached our target goal of organic matter percentage, the topdress applications can be reduced or eliminated, except when doing a major over-seeding.

In a turf system we generally do not see the rapid depletion of organic matter the way we might expect in other areas of agricultural production. Compost tea, although valuable from the beginning of a natural, management program, becomes especially important when topdress applications are reduced or eliminated. We rely on the compost tea to supply the microorganisms and all of the benefits that come with them. Compost tea does not directly add organic matter to the soil in the way compost does, but because our organic matter has reached our target level, we get along fine with increased biology.

Exactly what it is compost tea and how it is actually made? Compost tea is a liquid extract of high grade compost. More specifically, compost tea is a concentrated solution of microbial life produced by extracting beneficial microbes from vermicompost (worm castings) or compost. We call this process "brewing". We suspend compost in a type of "tea bag" in gently agitating water. The agitation is provided by different types of pumps that not only move water, but infuse the water with oxygen. This aspect is critical as the process of extracting needs to be done in an aerobic environment in order to sustain the life of some of the microbes. It is the gently agitating water that actually extracts the microbes. A nutrient source is added to the water to feed the microbes as they are being extracted and they then multiply to very large numbers over the twenty four hour extracting and brewing process.

Why is this solution an important asset for the turf manager? Aside from simply delivering large quantities of active biology to the soil profile, it does considerably more for us. It is a source of soil and foliar nutrients delivered in a biologically available form for both plant and microbial uptake. The beneficial microbiology will successfully compete with disease causing organisms and most times out-compete them, thereby suppressing a pathogen or disease problem before it gets to damaging levels. The microbes have the ability to degrade and break down toxic materials and pesticides, they produce essential plant growth hormones, and they can fix nitrogen and mineralize plant available nutrients.

As we introduce compost tea to the turf system, we begin to create a biologically active soil profile. As the soil continually becomes more alive, we see direct and lasting benefits to the turfgrass. When a healthy, balanced soil profile with the proper biology to sustain turfgrass is in place, we see benefits in the nutritional area, whereby the nutritional health and quality of the plant is improved as well as the soil's ability to retain nitrogen and other nutrients like calcium, potassium, and phosphorus. We also create a condition in the soil where the beneficial biology has the ability to suppress disease causing and pest organisms.

Lastly, we are improving and creating good soil structure that increases water infiltration, oxygen diffusion, and the water holding capacity of the soil. As you can see the benefits are many, and when the availability of compost tea becomes more prevalent, it will become one of the tools every turf manager will use. One of the attractive aspects of compost tea for the turf manager will be the relatively low cost. At a rate of roughly fifteen to twenty-five gallons to the acre, it will be a very economical way to take natural turf management to the next level. There was a time when spray equipment in the hands of the turf manager meant a pesticide application was imminent. Times are changing and that stigma will soon disappear.

Humates

Humates are metal (mineral) salts of humic or fulvic acids. Humus is a highly stable by product of organic matter decomposition. Humic acid is the most biologically active component of soil humus. The humus portion of the soil is relatively small. The organic matter percentage generally ranges from 3% to 8% with an optimum level in a turf system in the 6% to 8% range. Humus makes up 65% to 75% of the total organic matter. Humus plays an important role as a component of soil fertility. Its impact is far greater proportionally than the percentage of the soil mass that it makes up. The molecules of humus are not rapidly degraded by microorganisms as many non-humic substances are. Humus is in fact, slow to decompose, and when in combination with soil minerals can persist for several hundred years.

With the emergence of conventional, synthetic N P K fertilizers, we (agriculture in general) have lost sight of the natural order of soil management. When it was discovered that the synthetics had the ability to rapidly stimulate plant growth, the turf industry was born and jumped on the band wagon. The prolonged use of these products, in the absence of properly addressing soil health, can, and has led to many soil problems in the area of soil quality.

Humic substances that would be considered to be "fertilizer grade" are obtained from carbon containing mineral deposits in many parts of the world. Here in the United States there are several mines and deposits that contain good agricultural grade humic substances.

Naturally occurring humic substances from low grade lignites and leonardites (natures soil conditioners), are superior fertilizer ingredients. A major source of humic substances for fertilizer use is from leonardites. Leonardite is defined as a highly oxidized low grade lignite that contains a relatively high concentration of fulvic acids.

Nutrient, Textural, and Bio-Assay Analysis

Soil Texture

The soils are sandy loams and loamy sands. A full explanation is available in the Textural Analysis section. It is this information that guides the application rates of fertilizers. Our goal is to provide steady nutrient availability that avoids nutritional peaks and valleys. There is no point in applying more nutrient than the grass can use in a given timeframe.

Soil Chemistry

Overall soil chemistry at the various properties is very well balanced. This aspect in Wellesley is much better than many communities. There are no glaring deficiencies. An analysis follows:

- CEC is very good with the exception of Reidy and the Sprague fields. They are not bad, but are below optimum.
- The accompanying liming recommendations address the issue of pH.
- Organic matter is above 4.0 at all properties.
- The Ca:Mg ratio is within or very close to the desired range at all properties.
- Calcium levels are good.
- Magnesium levels are generally slightly low at the properties that exhibit lower pH and will be addressed by the lime application.
- Potassium levels are within the desired range.
- At all properties, phosphorus levels are high or very high. These results make the case for the inclusion of a phosphorus free fertilizer into the program. There is no further need to be using a 15% phosphorus fertilizer.

Soil Bio-Assay

The three samples submitted were from a composite of the Hunnewell fields, a composite of the Sprague fields, and Kelly.

This test gives us a real world picture of the living portion of the soil environment. From this information, we are able to begin to address the needs of the microbes. Keep in mind that in the Systems Approach to Natural Turf Management, the living biomass is critical for sustainable nutrient management. This is the aspect of the soil that is generally overlooked in conventional management.
Bacteria, fungi, protozoa, and nematodes are the primary organisms that we look at in this test. The protozoa and nematodes are the primary nutrient cyclers. They are predators that consume bacteria and other organisms and release nutrients in a plant available form.

Humates, suitable for both granular and liquid applications, are readily available and can be purchased from a variety of sources. They can be purchased as by themselves or as part of a proprietary blend of materials. The application of these products to a turf system is addressing the soil health and quality at its most basic level.

Some benefits include:

Builds healthy soil
Increased organic matter which helps to reduce N loss through leaching
Contains carbon as an energy source for microbes
Improves soil structure, aggregation, water infiltration, aeration, and water-holding capacity
Increases nutrient availability to the grass plant
Facilitates mineral breakdown
Increases microbial activity
Helps with root growth and penetration, and chlorophyll density

Nutrient Analysis
A&L Eastern Laboratories, Inc.

Field	pH	OM %	ENR lbs/ac	Ca:Mg Ratio	Ca ppm	Mg ppm	P ppm	K ppm	CEC Meq/100g
Hunnewell Multi purpose	6.3	5.4	110h	9:1	2139h	234m	134vh	123m	14.5
		6.5	120		1820	202	50	164	12-15
Hunnewell FHockey	6.0	5.3	110h	6.25:1	1650m	263h	179vh	130h	12.7
		6.5	120		1690	193	50	158	12-15
Hunnewell Soccer/JVBB	6.2	4.9	104m	9.75:1	1834h	186m	143vh	103m	12.5
		6.5	120		1690	193	50	158	12-15
Lee	6.3	5.6	116h	8.6:1	1688h	197m	110vh	106m	11.6
		6.5	120		1560	183	50	152	12-15
Hunnewell FB	6.4	4.9	104m	16:1	1971h	120l	293vh	115m	12.2
		6.5	120		1560	183	50	152	12-15
Reidy	6.0	4.3	98m	7:1	1203m	164m	150vh	131h	9.1
		6.5	120		1170	148	50	135	12-15
Hunnewell School	6.0	5.0	108h	11:1	1441h	132m	259vh	130h	10.2
		6.5	120		1300	160	50	141	12-15
Sprague 5	6.3	4.2	97m	8:1	1315h	163m	117vh	160h	9.3
		6.5	120		1170	148	50	135	12-15
Sprague 4ABC	6.2	4.8	106m	8:1	1330m	168m	149vh	177h	9.7
		6.5	120		1300	160	50	141	12-15
Sprague 1	6.2	4.6	104m	8.5:1	1226m	144m	130vh	152h	8.8
		6.5	120		1170	148	50	135	12-15
Hardy 2	6.4	5.4	113h	8:1	1759h	219h	156vh	106m	12.0
		6.5	120		1560	183	50	152	12-15
Hardy 1	6.5	4.9	104m	10:1	1901h	183m	170vh	125m	12.3
		6.5	120		1560	183	50	152	12-15
Perrin	6.4	5.9	117h	6.4:1	2050m	322h	191vh	214h	14.8
		6.5	120		1950	210	50	170	12-15
Kelly	6.1	5.4	113h	10:1	1687h	170m	95h	151h	11.9
		6.5	120		1560	183	50	152	12-15

Field	pH	OM %	ENR lbs/ac	Ca:Mg Ratio	Ca ppm	Mg ppm	P ppm	K ppm	CEC Meq/100g
Upham	6.7	4.4	98m	9:1	1635h	185m	188vh	112m	10.5
		6.5	120		1365	166	50	144	12-15
Phillips	6.3	5.1	108h	7:1	1708h	239h	186vh	108m	12.1
		6.5	120		1560	183	50	152	12-15
Oulette	6.5	5.6	116h	12:1	1896h	158m	172vh	159h	12.1
		6.5	120		1560	183	50	152	12-15
Schofield	6.6	5.1	109h	14:1	1850h	133l	172vh	120m	11.3
		6.5	120		1430	172	50	147	12-15
Fiske	6.3	4.4	99m	8.5:1	1442h	170m	217vh	117m	10.0
		6.5	120		1300	160	50	141	12-15
Brown	6.6	4.7	102m	13:1	1906h	144m	233vh	127h	11.8
		6.5	120		1540	180	50	147	12-15

Black = actual values
Blue = optimum levels (based on CEC, rounded to nearest whole value)
Green= desired
Red = rating (based on CEC)
vl-very low, l-low, m-medium, h-high, vh-very high

ENR is estimated nitrogen release. This is a measure of projected available nitrogen made available by active soil microbes and it is directly related to the organic matter percentage.

Percent Base Saturation

Field	pH	K	Mg	Ca	H
Hunnewell Multi purpose	6.3	2.2	13.5	73.8	10.6
Hunnewell FHockey	6.0	2.6	17.2	64.8	15.4
Hunnewell Soccer/JVBB	6.2	2.1	12.4	73.4	12.1
Lee	6.3	2.3	14.2	72.9	10.6
Hunnewell FB	6.4	2.4	8.2	80.5	8.9
Reidy	6.0	3.7	15.0	65.9	15.4
Hunnewell School	6.0	3.3	10.8	70.6	15.4
Sprague 5	6.3	4.4	14.6	70.5	10.6
Sprague 4ABC	6.2	4.7	14.5	68.7	12.1
Sprague 1	6.2	4.4	13.7	69.8	12.1
Hardy 2	6.4	2.3	15.3	73.5	8.9
Hardy 1	6.5	2.6	12.4	77.5	7.4
Perrin	6.4	3.7	18.1	69.2	8.9
Kelly	6.1	3.3	11.9	71.1	13.7
Upham	6.7	2.7	14.7	78.1	4.5
Phillips	6.3	2.3	16.5	70.7	10.6
Oulette	6.5	3.4	10.9	78.3	7.4
Schofield	6.6	2.7	9.8	81.6	5.9
Fiske	6.3	3.0	14.2	72.2	10.6
Brown	6.6	2.8	10.2	81.1	5.9

Desired Ranges

K	2-5%
Mg	10-15%
Ca	65-75%

Textural Analysis
A&L Eastern Laboratories, Inc.

Percentages

Field	Sand	Silt	Clay	OM	CEC Meq/100g	Textural Class
Hunnewell Multi purpose	62	31	7	5.4	14.5	Sandy Loam
Hunnewell FHockey	74	23	3	5.3	12.7	Loamy Sand
Hunnewell Soccer/JVBB	74	23	3	4.9	12.5	Loamy Sand
Lee	84	13	3	5.6	11.6	Loamy Sand
Hunnewell FB	76	21	3	4.9	12.2	Loamy Sand
Reidy	58	39	3	4.3	9.1	Sandy Loam
Hunnewell School	82	15	3	5.0	10.2	Loamy Sand
Sprague 5	66	25	9	4.2	9.3	Sandy Loam
Sprague 4ABC	66	29	5	4.8	9.7	Sandy Loam
Sprague 1	64	31	5	4.6	8.8	Sandy Loam
Hardy 2	74	21	5	5.4	12.0	Sandy Loam
Hardy 1	56	39	5	4.9	12.3	Sandy Loam
Perrin	70	23	7	5.9	14.8	Sandy Loam
Kelly	62	33	5	5.4	11.9	Sandy Loam
Upham	60	35	5	4.4	10.5	Sandy Loam
Phillips	70	27	3	5.1	12.1	Sandy Loam
Oulette	62	33	5	5.6	12.1	Sandy Loam
Schofield	68	27	5	5.1	11.3	Sandy Loam
Fiske	64	29	7	4.4	10.0	Sandy Loam
Brown	64	29	7	4.7	11.8	Sandy Loam

Bacteria are responsible for many functions in the soil including, but not limited to, dissolving phosphorus and fixing nitrogen. The fungal portion of the biomass is responsible for disease resistance and nutrient transfer from the soil solution to the roots of the grass plant.

As we begin to create healthy populations of a diverse community of microbes, the turf system responds positively. Turf prefers a ¾ : 1 fungal to bacterial ratio. This means that the soil wants to be slightly bacterial dominated.

These test results guide us in the necessary product applications and cultural practices we need to employ to create the healthiest possible soil.

The most important information we can take from these tests is the following:

- Hunnewell and Sprague are bacterial dominated.
- Kelly is fungal dominated.
- Protozoa are at good levels with above average nutrient cycling.
- Ciliate numbers are high in all tests indicating anaerobic conditions in the recent past. This is probably due to the somewhat compacted soils at Hunnewell and Sprague in combination with the above average rainfall this spring.
- Even though total fungi is good at the three locations, the active portion is low. It is this active portion that we need to increase. This information supports the use of the humic acid, compost teas, and fish hydrolysates.
- The continued use of synthetic fertilizers will further limit active fungal development.
- Because these organisms are totally dependent on oxygen, aeration of heavily used fields is critical.
- The natural organic fertilizers in our program will continually provide a food source for the organisms.

Site Analysis

Hunnewell Multi-purpose

- Turf density generally good
- Some clover throughout
- Good core penetration to 4"
- Area in right center field with substantial assorted broadleaf weed

Hunnewell Field Hockey, Soccer, Baseball

- Turf density is good
- There appear to be different grass species in the center area
- Very good core penetration to 6"
- Scattered clover throughout
- Occasional broadleaf plantain
- 74% sand

Lee

- Turf density is good
- Some clover and broadleaf plantain
- Core penetration to 3"
- No bare spots
- Some bentgrass infiltration
- Area was wet during site walk-question drainage issue
- 84% sand

Hunnewell Football

- Outside hash marks turf density is good
- Clover pressure increases density—if clover removed, turf density would be less
- Core penetration to 4"
- Inside hash marks core penetration to 3"
- Clover and broadleaf plantain-some prostrate knotweed
- The center of the field was relatively thin and has been seeded
- 76% sand

Reidy

- New sod-no weeds
- Would respond favorably to an additional N source (based on genetics of bluegrasses)

Hunnewell School

- A typical playground environment with pressure all year from recess and physical education-should be lower management level
- Very compacted, but increased aerification expense is probably not justified given site use
- There is multiple weed pressure including clover, broadleaf plantain, knotweed
- Not bad for what it is

Sprague 1

- Uneven grade
- Very wet
- Standing, very stagnant water between synthetic fields and Sprague 1 (see picture)—this is a possible health issue that should be addressed
- Core penetration to 2"—relatively compacted
- No weed pressure
- Turf density generally good
- New construction—some areas already in decline
- Would respond favorably to increased N source

Sprague 4 ABC

- New construction-sodded
- Compaction issues present-2" to 3" core penetration, then very hard and compacted
- Mowing height appeared to be very short-less than 1.5"
- At this time turf density is good with no weeds
- Can still see the seams of the sod—does not appear to be growing vigorously
- Small voids in the turf are beginning to appear
- Would respond favorably to increased N

Sprague 5

- New construction-not in use
- Thick turf-no weeds-generously watered
- Overall there is an average depth of loose soil in the 2" range-very hard underneath-no penetration
- Synthetic fertilizer and a lot of water are keeping this intact for the time being
- It appears that the area behind 2nd base is the low point—very soft, mushy outfield grass in shallow center field and standing water in the infield area (see pictures)-the grass behind 2nd base should actually be the high point of a baseball field by 2"

Hardy 1
Left side

- Appears to be lower level of management, but not supported by fertilizer schedule
- Mostly weeds-substantial knotweed and plantain pressure
- Compact-2" penetration
- Major ant problem
- Appears to be distinctively different soils

Hardy 2
Right side

- Better than Hardy 1
- Clover and plantain throughout
- Feels hard under foot, but there is good penetration
- I'm not sure that these fields have responded to the level of management indicated in 2008

Perrin

- Turf density is fair to good in places, thin in others
- Many voids and open areas in the turf
- Large areas of knotweed and plantain
- Fairly compact, but not the worst
- The aeration schedule of core and shatter at the same time does not give the same benefit as two separate procedures 6 weeks apart
- Some areas of pretty good turf

Kelly

- Looks very good-plays well
- Thick turf of very good density-deep rooted
- Substantial clover, but not necessarily a problem-contributes to density
- Some plantain and knotweed
- Loose soil

Upham

- Lower level of management
- Good condition for given management level
- Some clover and plantain
- Good turf density

Phillips Park

- Turf density fair to good
- Surprisingly low levels of clover and plantain
- Few rough spots
- Better than many parks in the same situation
- Relatively compacted-not bad for management level
- Infield redone-good turf, but question soil quality

Oulette

- Very nice-minimal weeds-large areas completely weed free
- Good turf density-some clover in localized large patches
- Core penetration to 3"

Schofield

- Two different turf areas
- Towards the back of the property, good density-thick turf
- Front of property recent renovation-lacks general vigor
- Turf is short and does not appear to be experiencing good spring growth
- Very compacted

Fiske

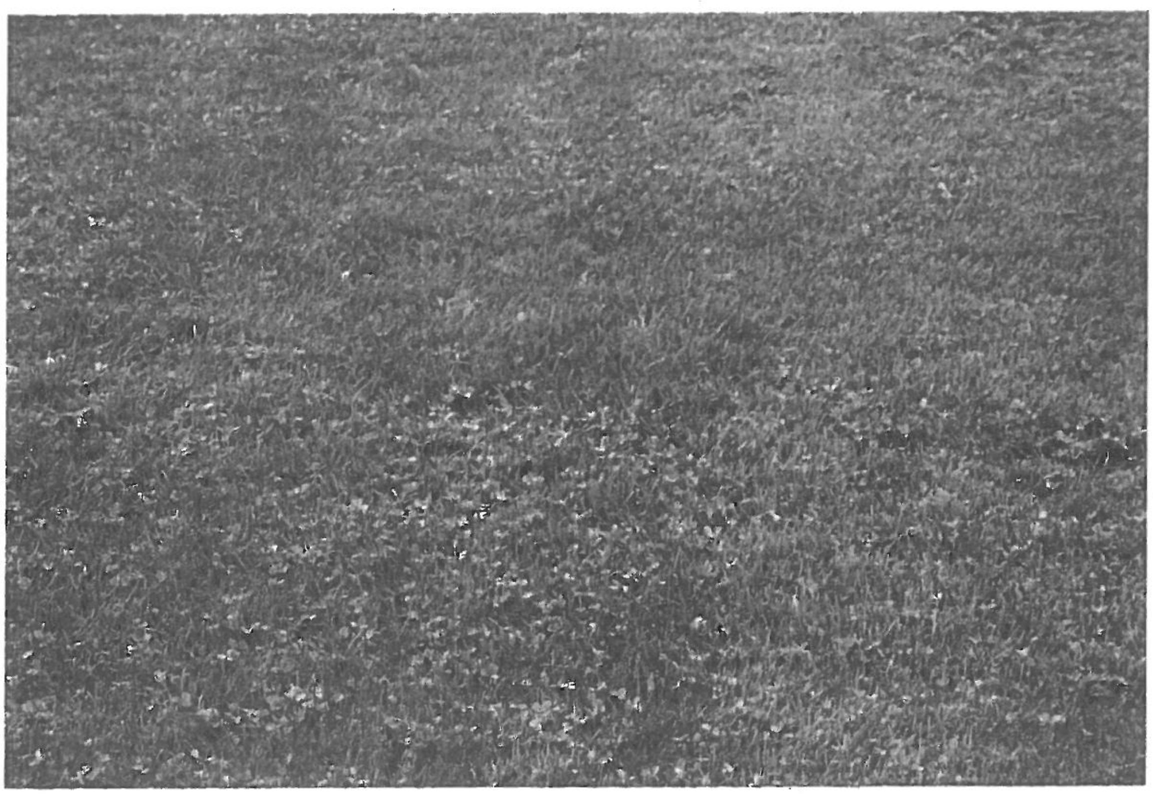
- This appears to be a sod renovation
- Serious issues as evidenced in the pictures
- Turf is thin and clumpy-appears to be in rapid decline
- Extreme compaction
- Little or no viable root development
- Soil or management issue

Brown Park

- Mid level management
- Similar to Oulette
- Not bad at all
- Some clover and broadleaf
- Good turf overall

Brown

Brown



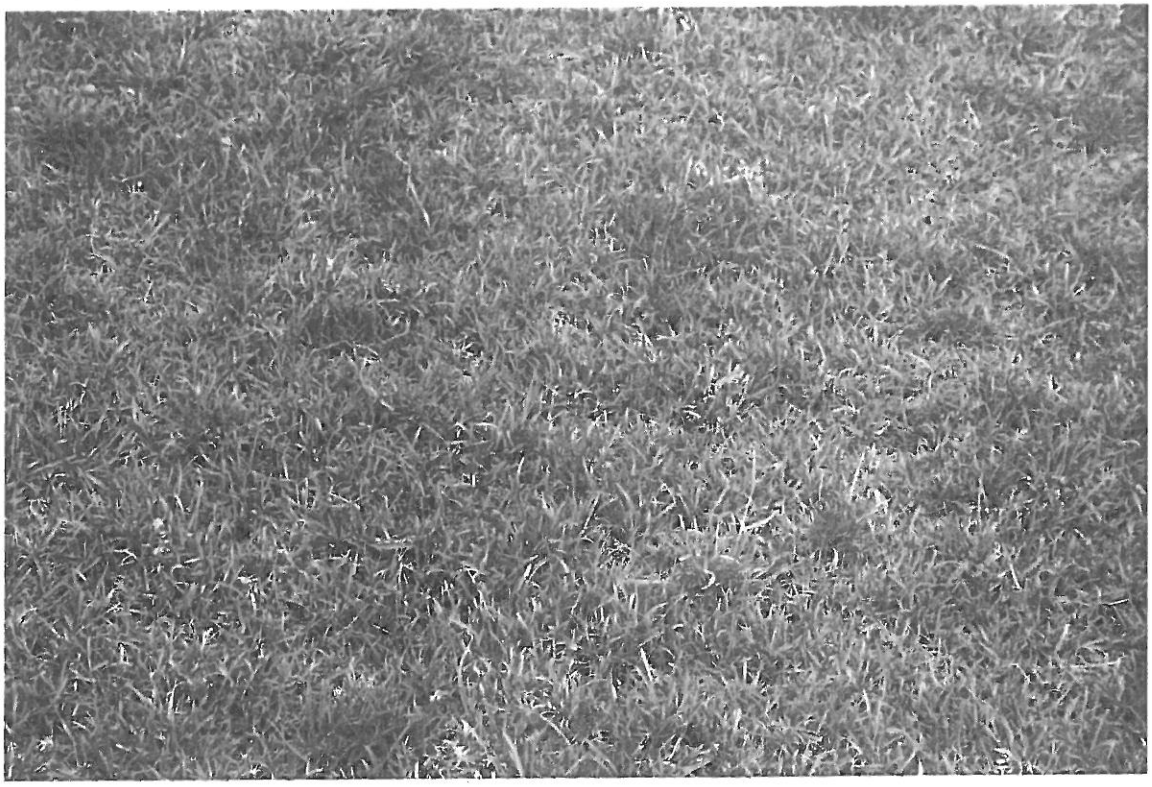
Fiske

Brown

Fiske

Fiske

Schofield



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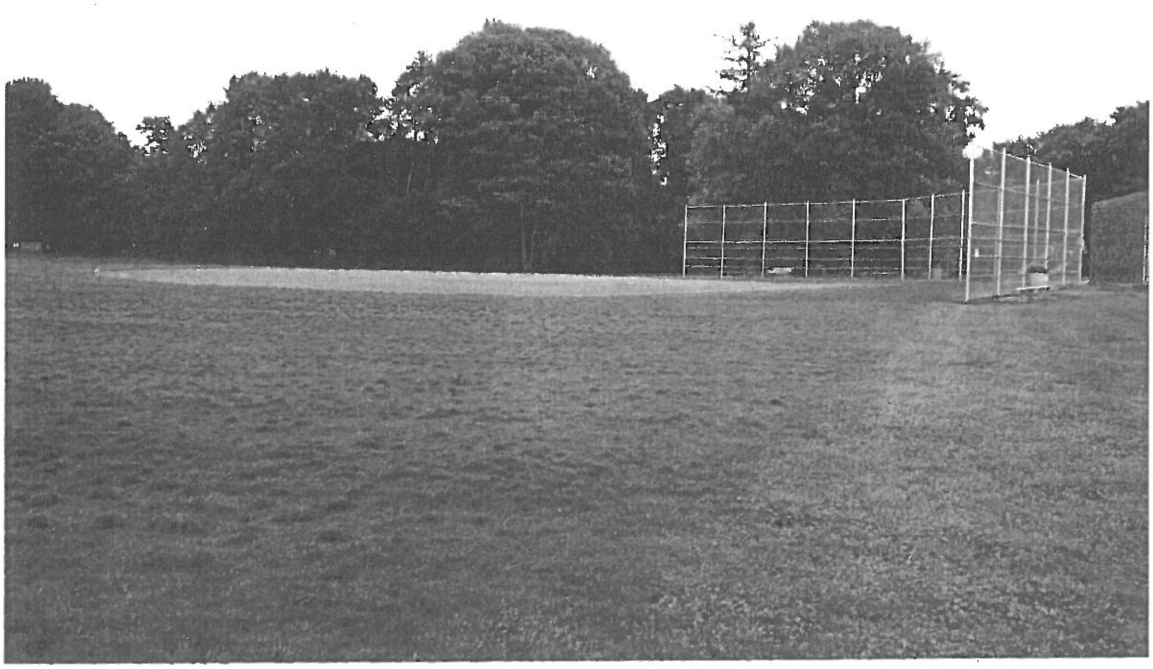


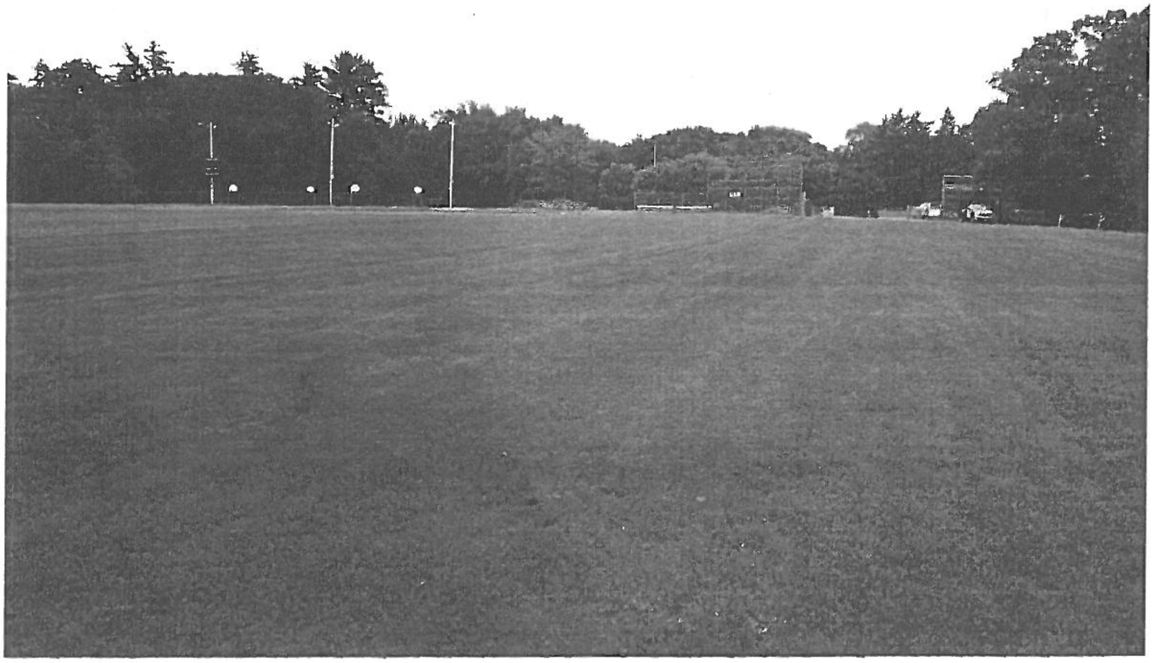
Hunnewell Multi-Purpose

Hunnewell Multi-Purpose

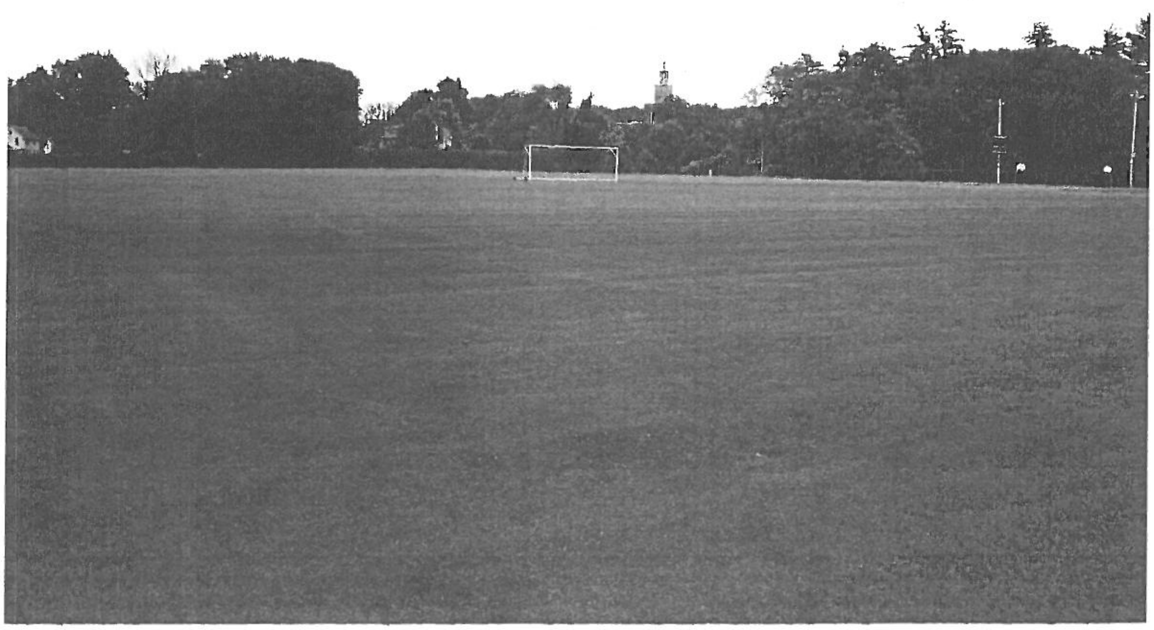
Hunnewell Multi-Purpose

Hunnewell Field Hockey

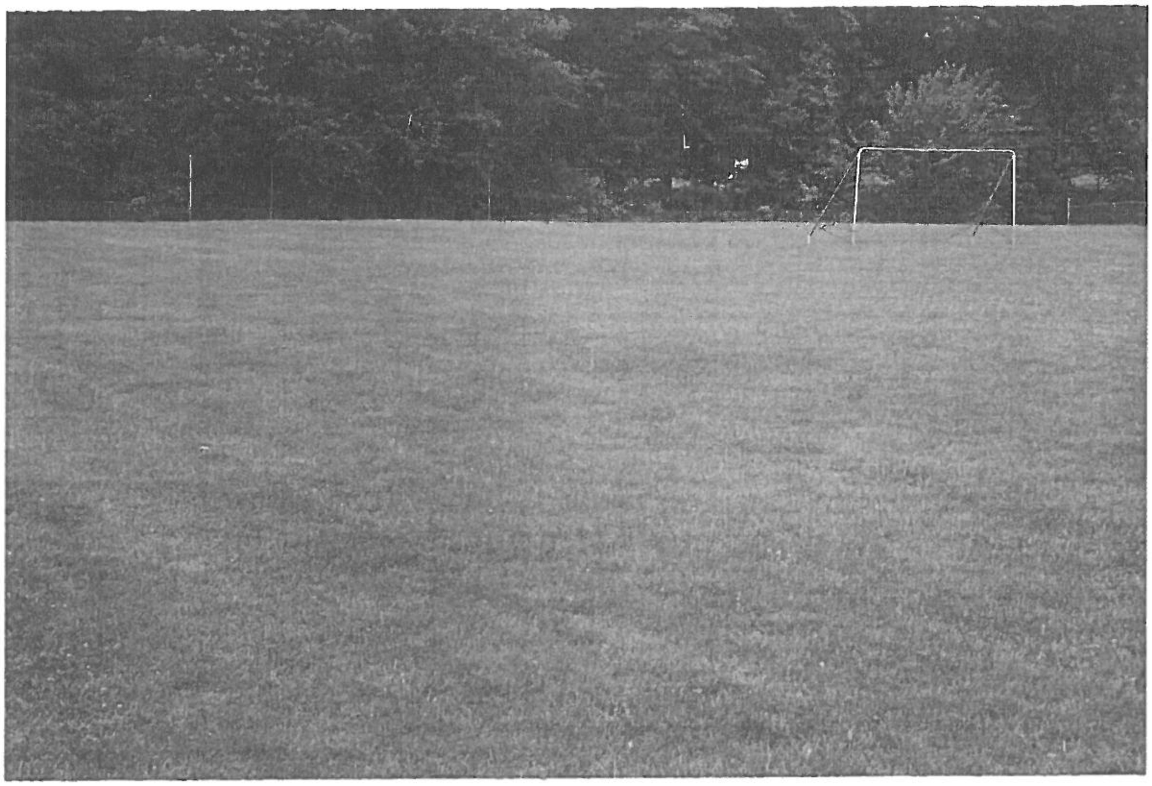
Hunnewell Field Hockey



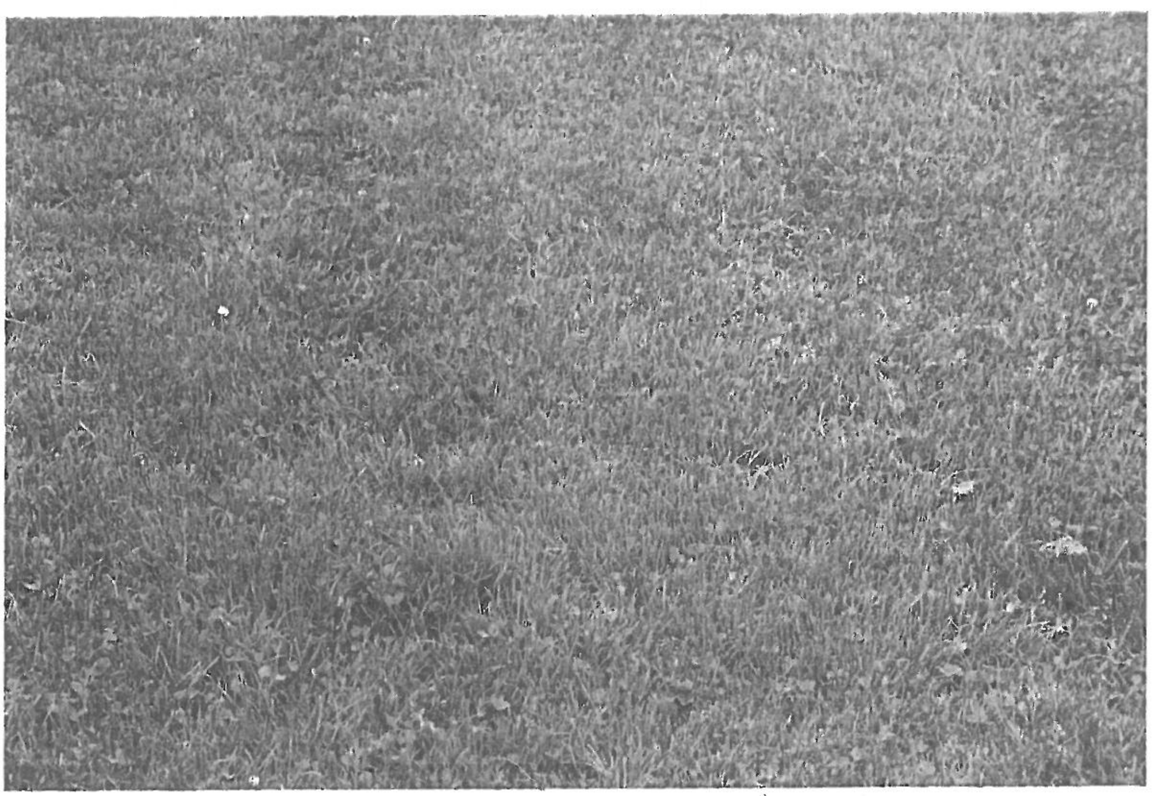
Hunnewell Varsity Soccer



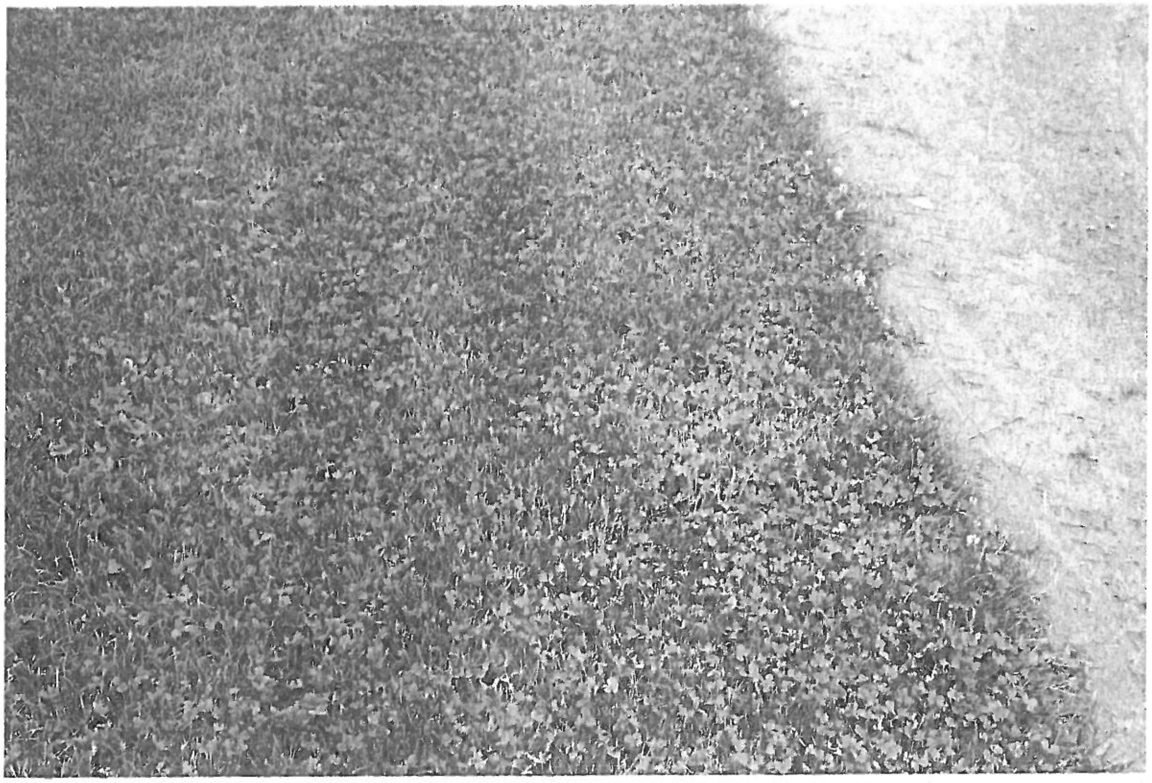
Hunnewell JV BB Outfield, Varsity Soccer



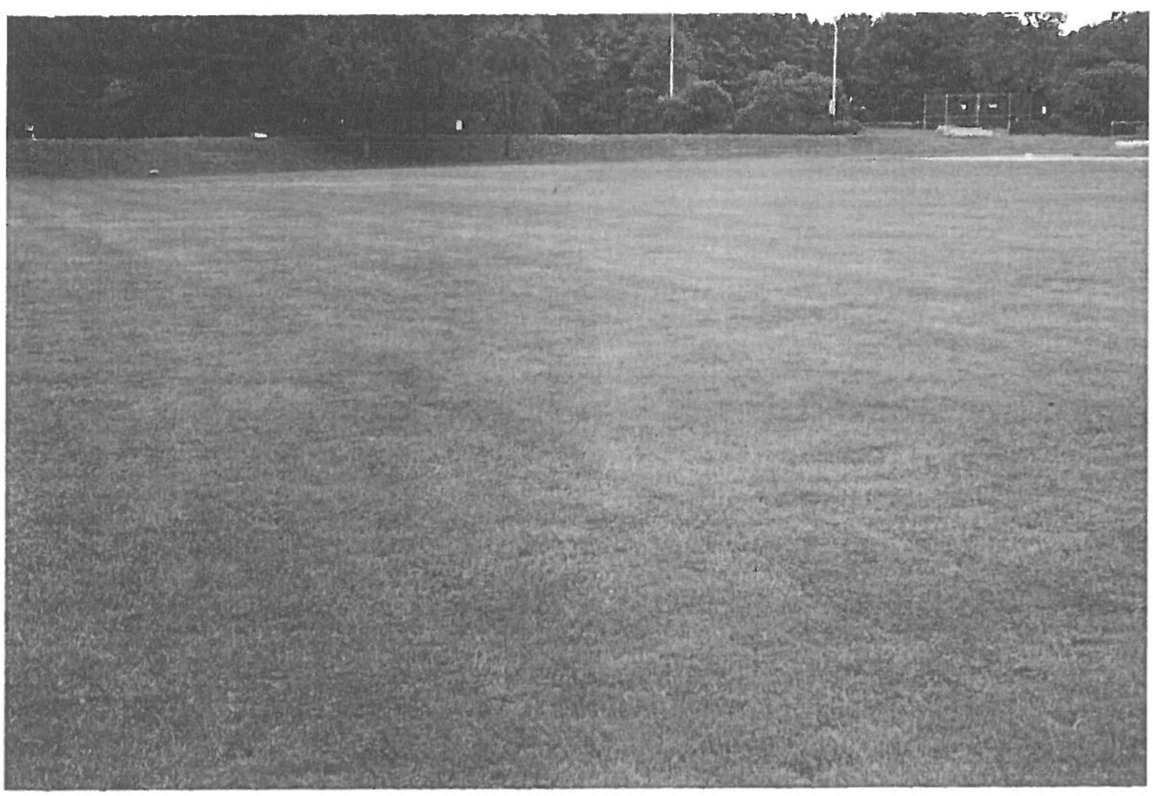
Hunnewell JV BB Outfield, Varsity Soccer



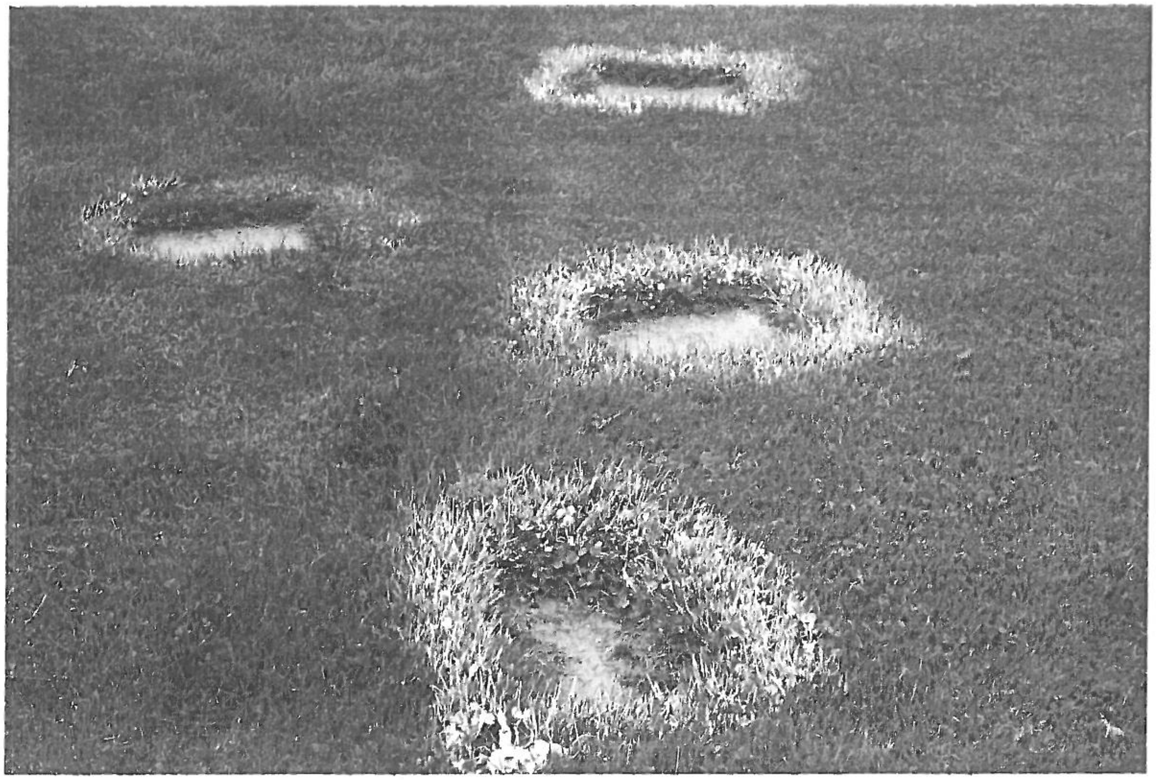
Hunnewell Varsity BB



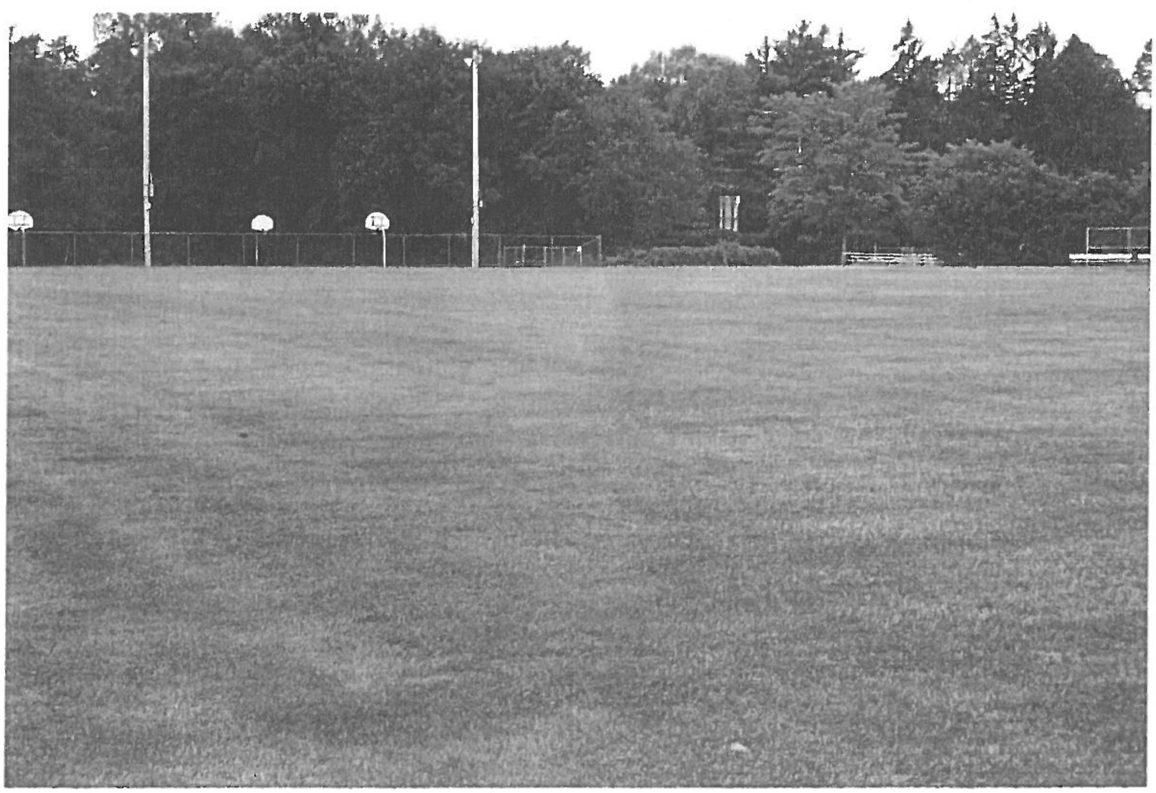
Hunnewell



Hunnewell JV BB Centerfield



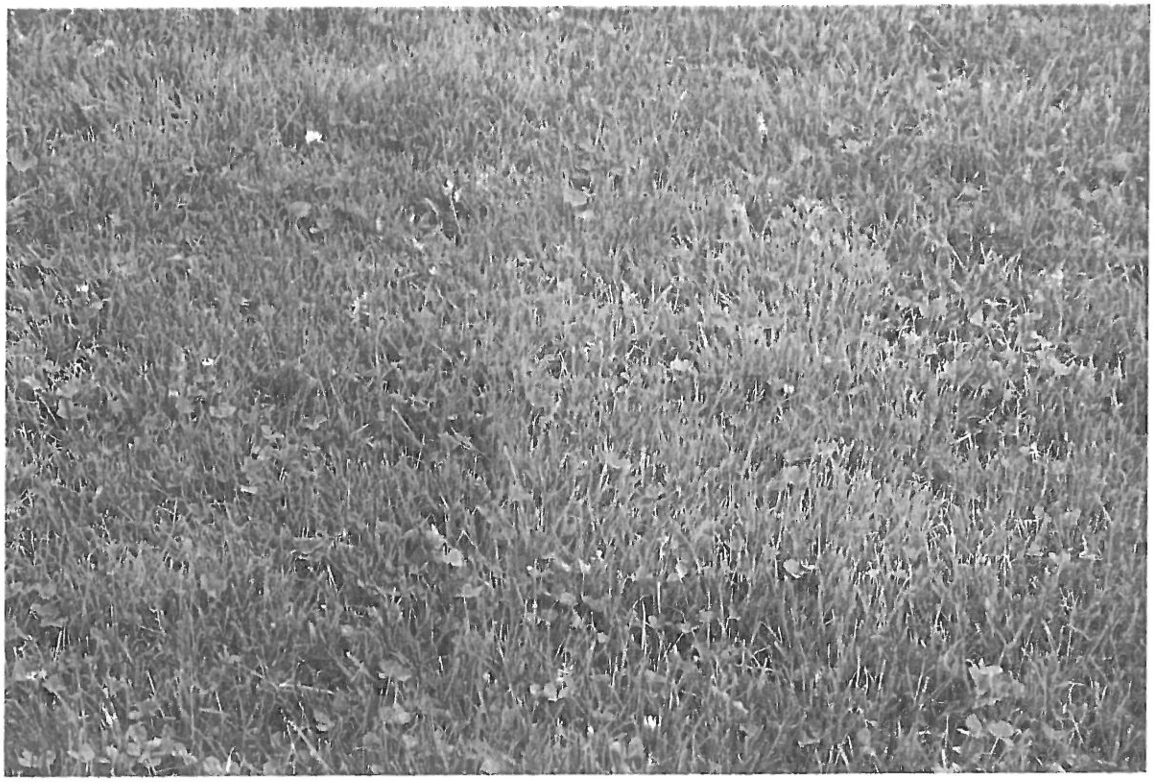
Hunnewell



Lee

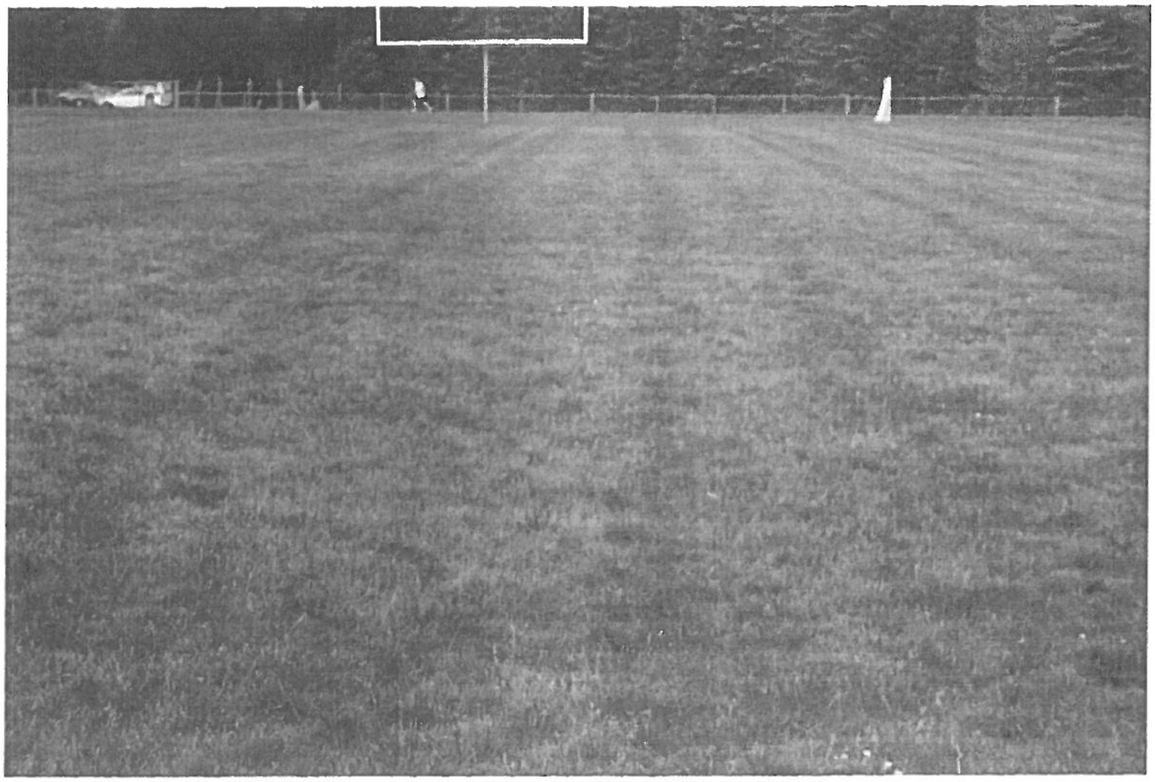
Lee

Lee

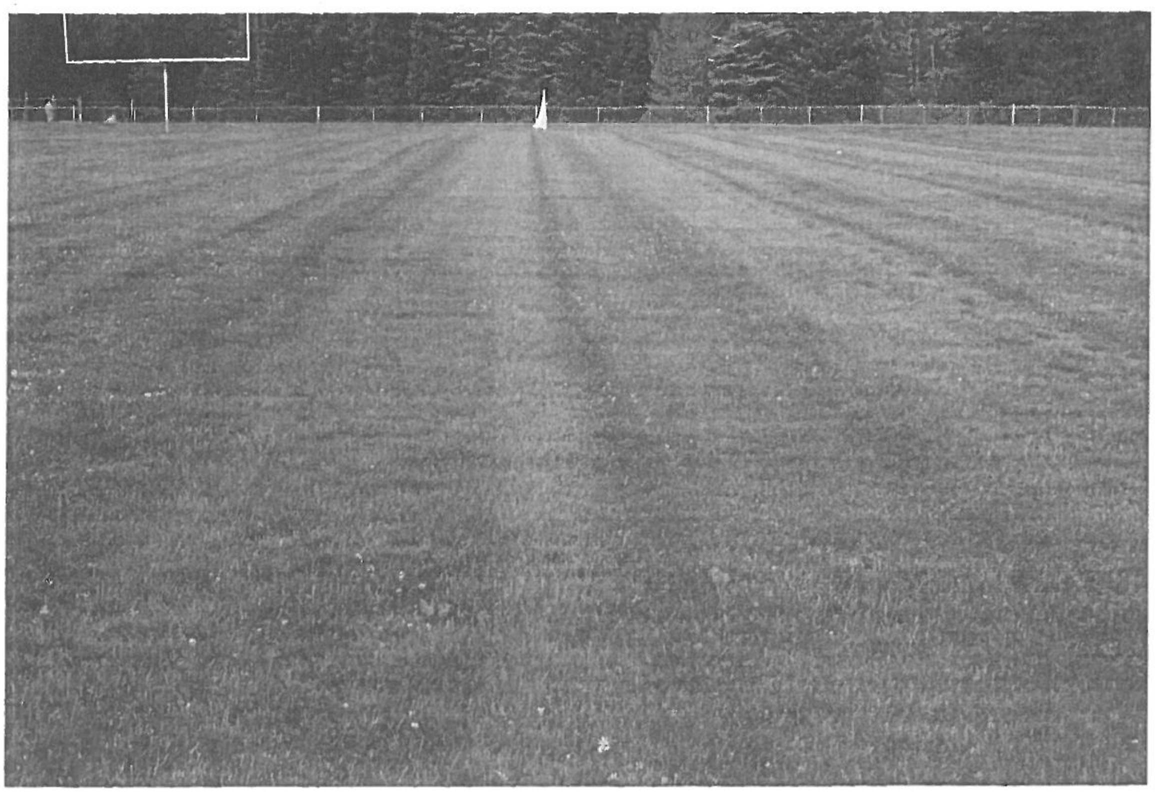


Hunnewell Football

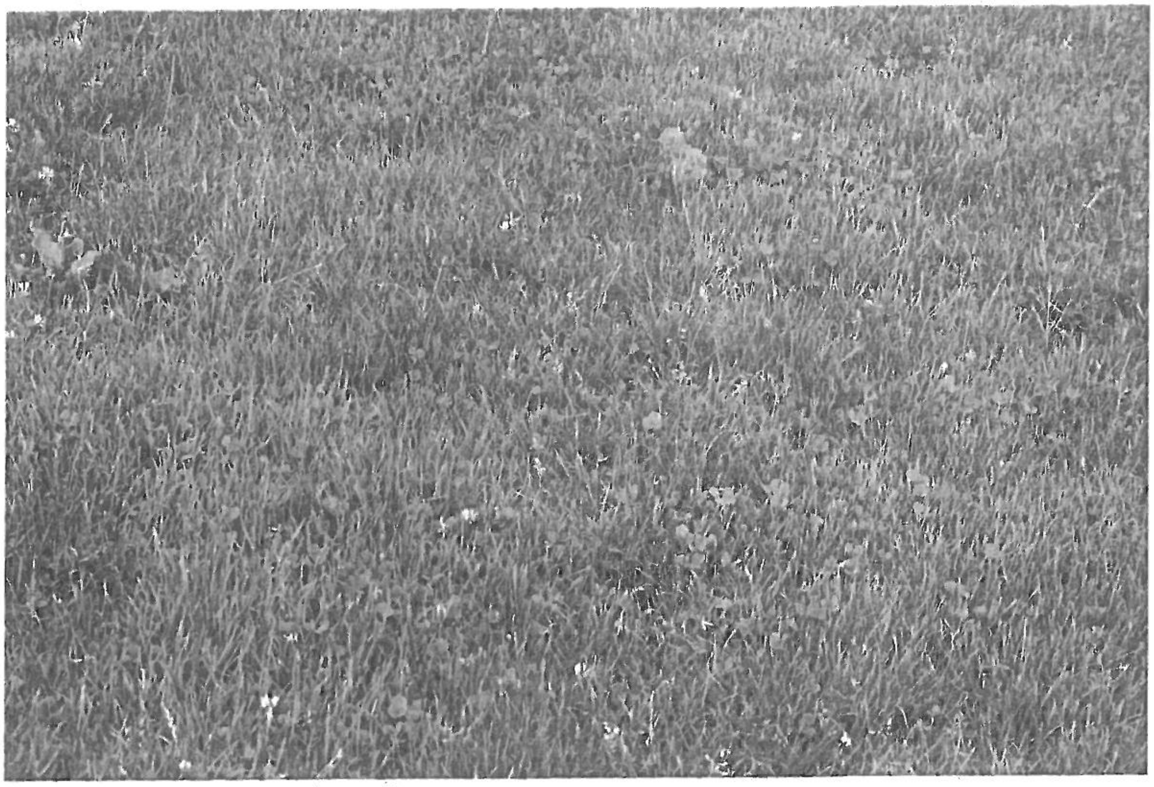
Hunnewell Football



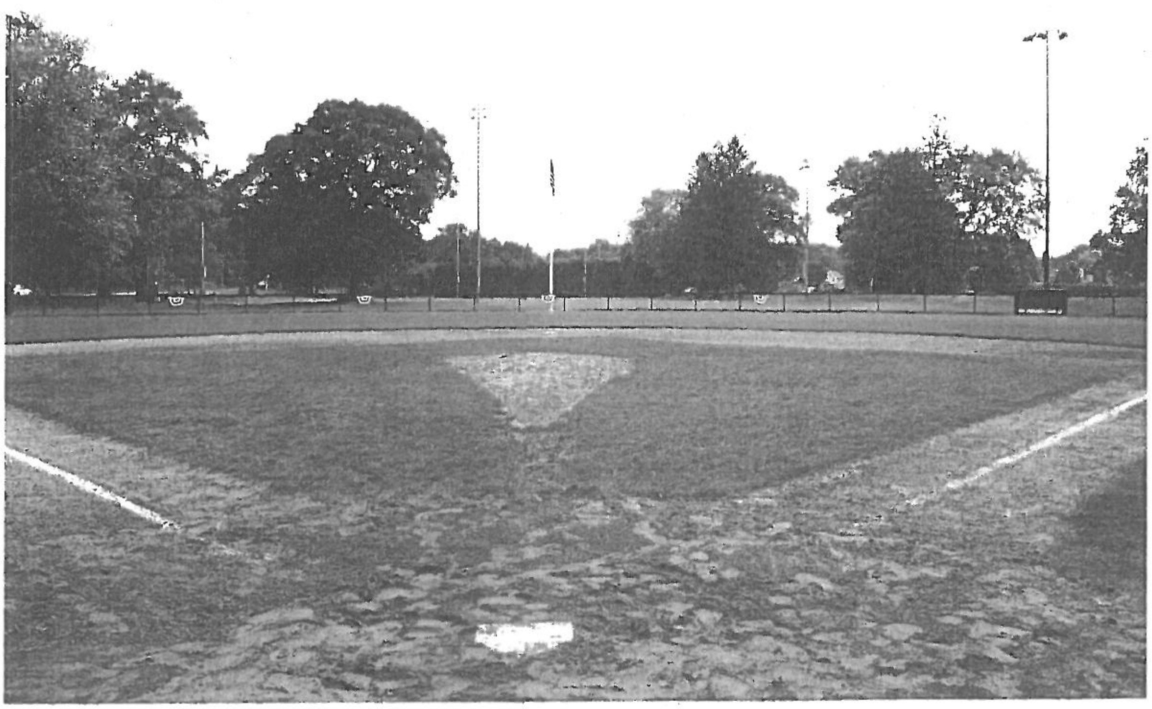
Hunnewell Football



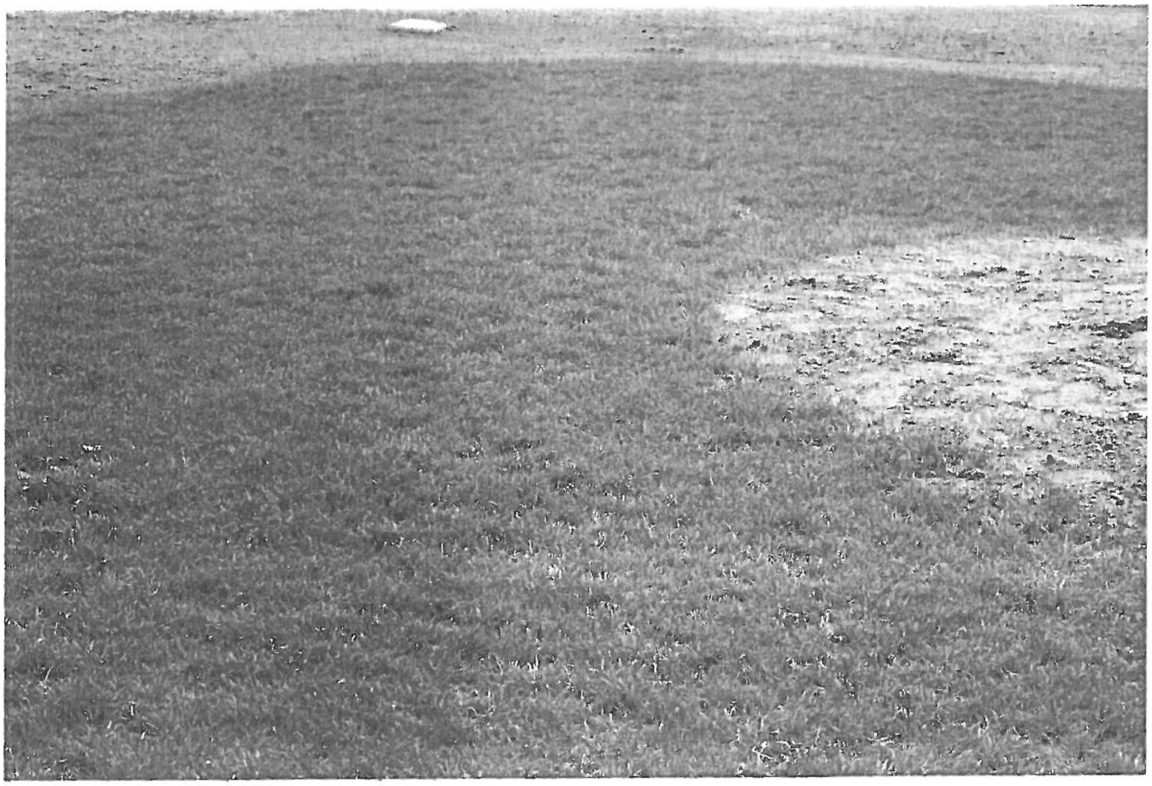
Hunnewell Football



Reidy



Reidy



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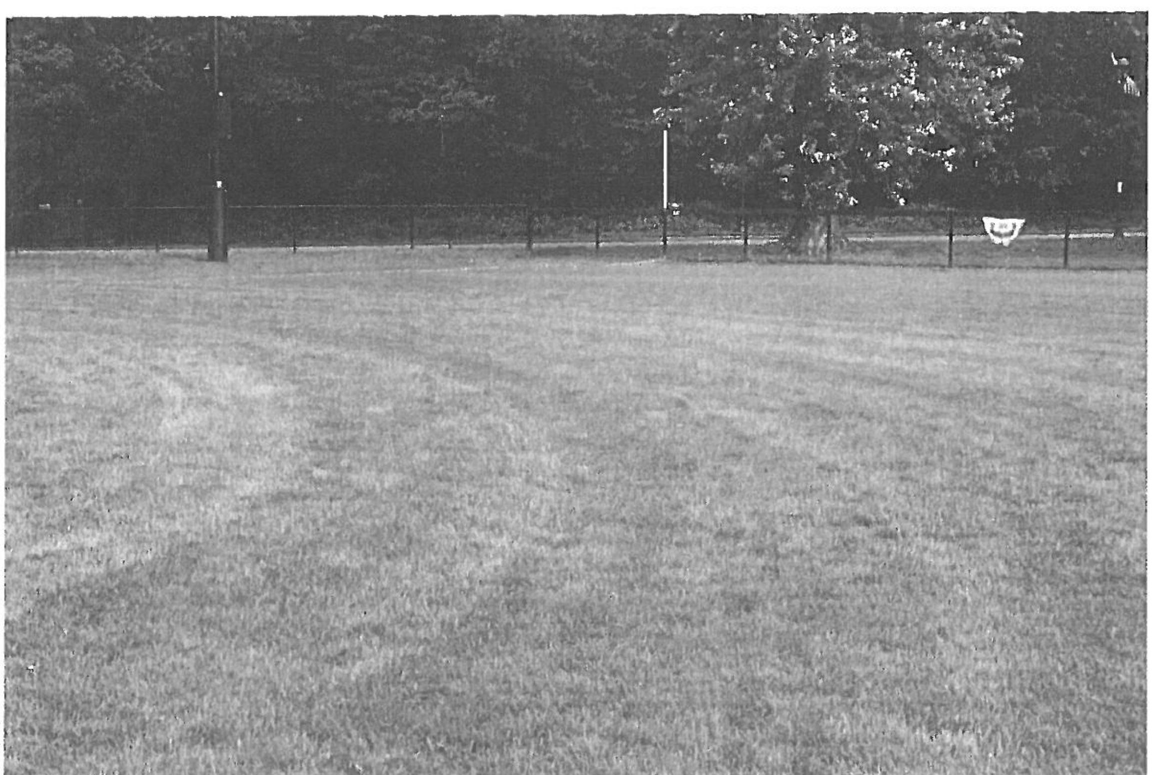
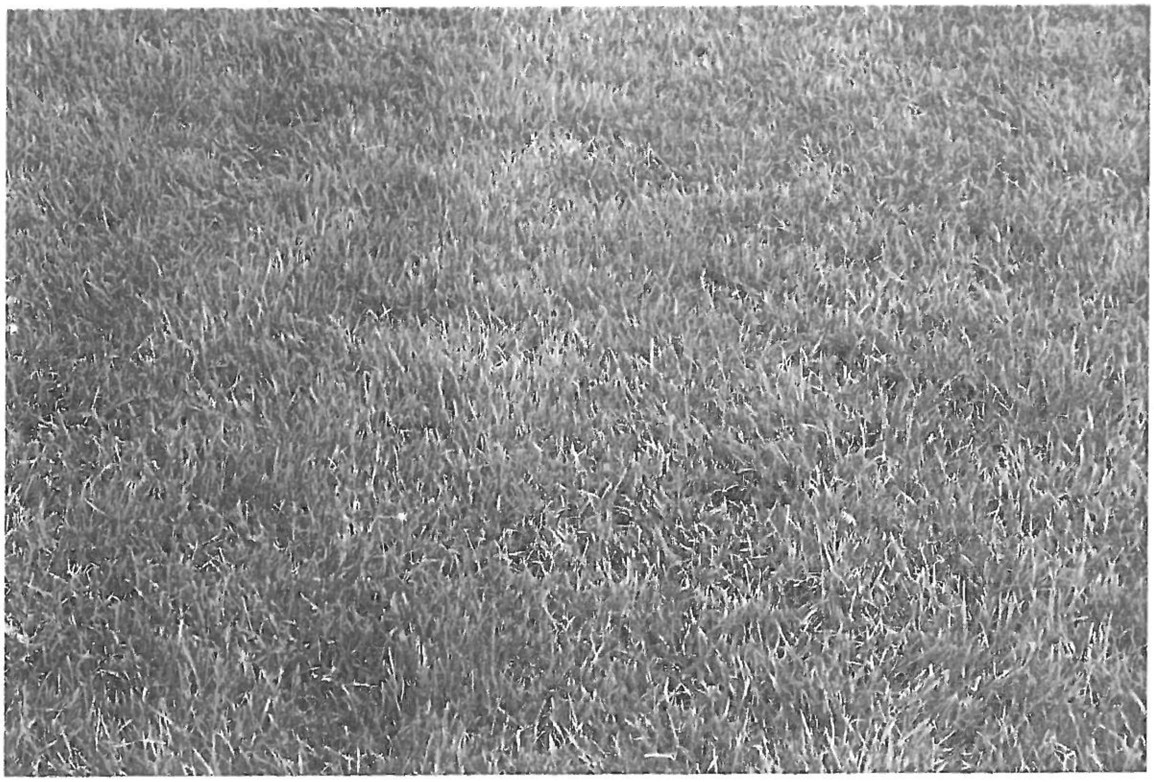
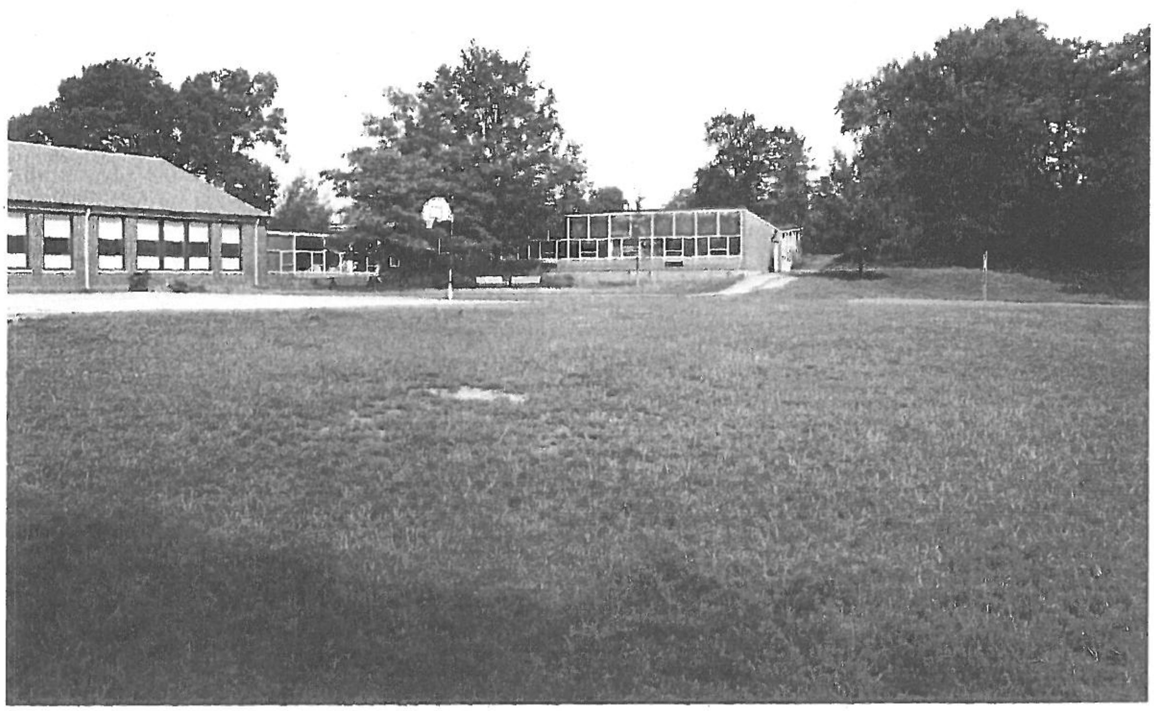


Reidy



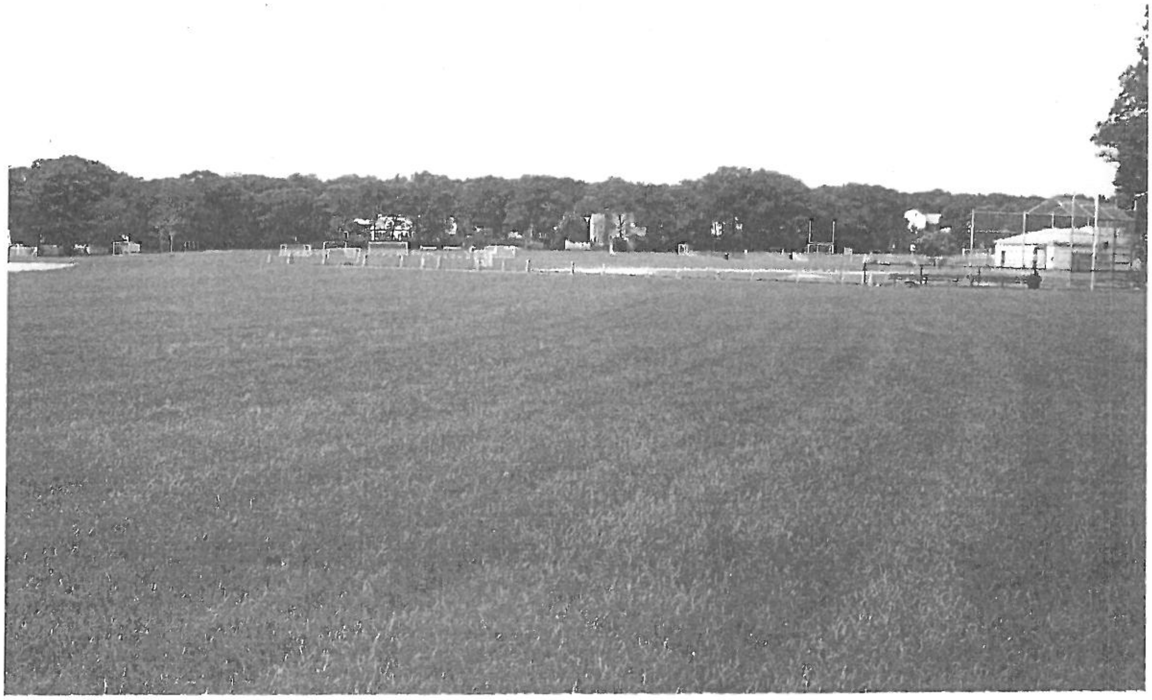
Hunnewell School



Hunnewell School

Hunnewell School

Sprague 5

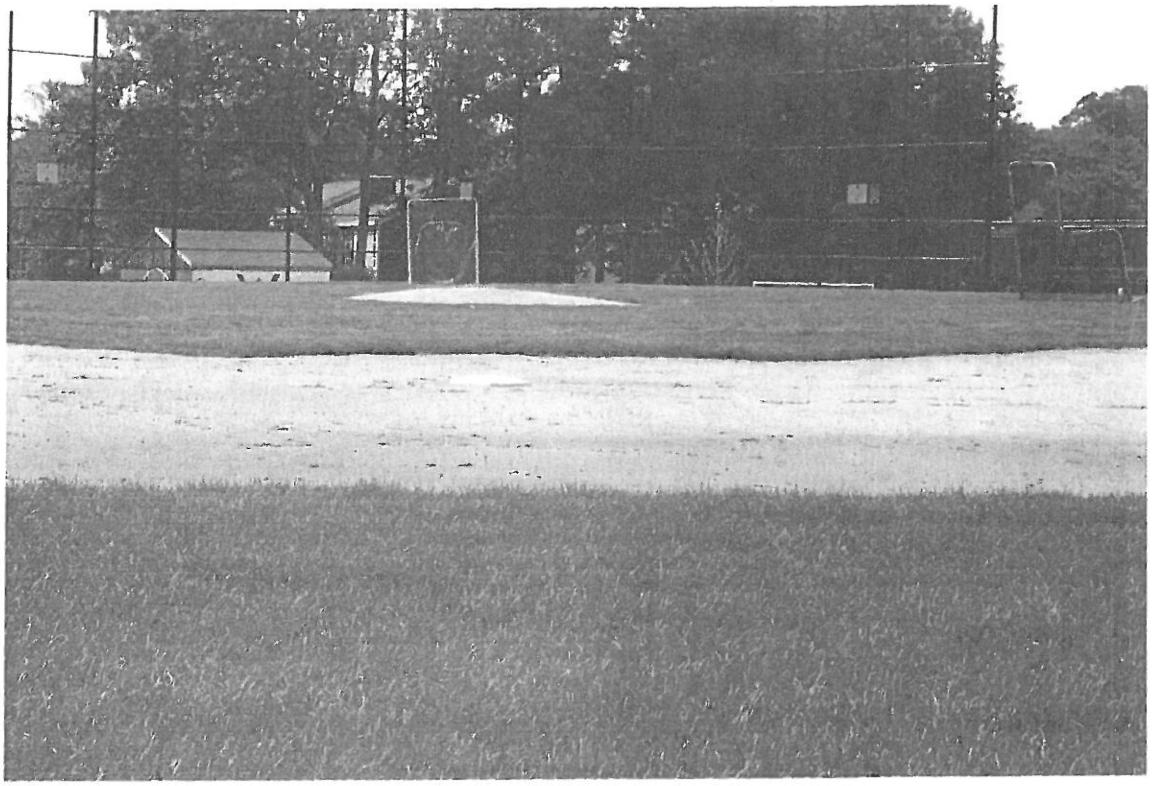


Sprague 5

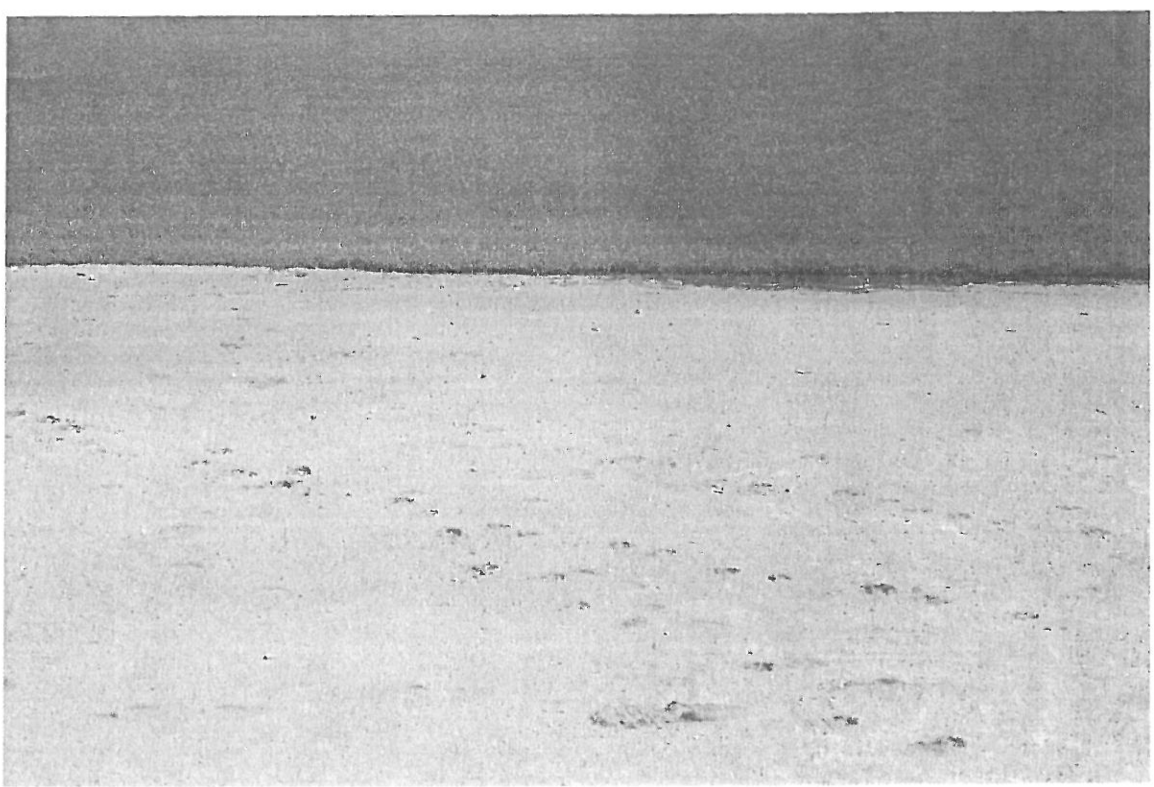
Sprague 5

Sprague 5

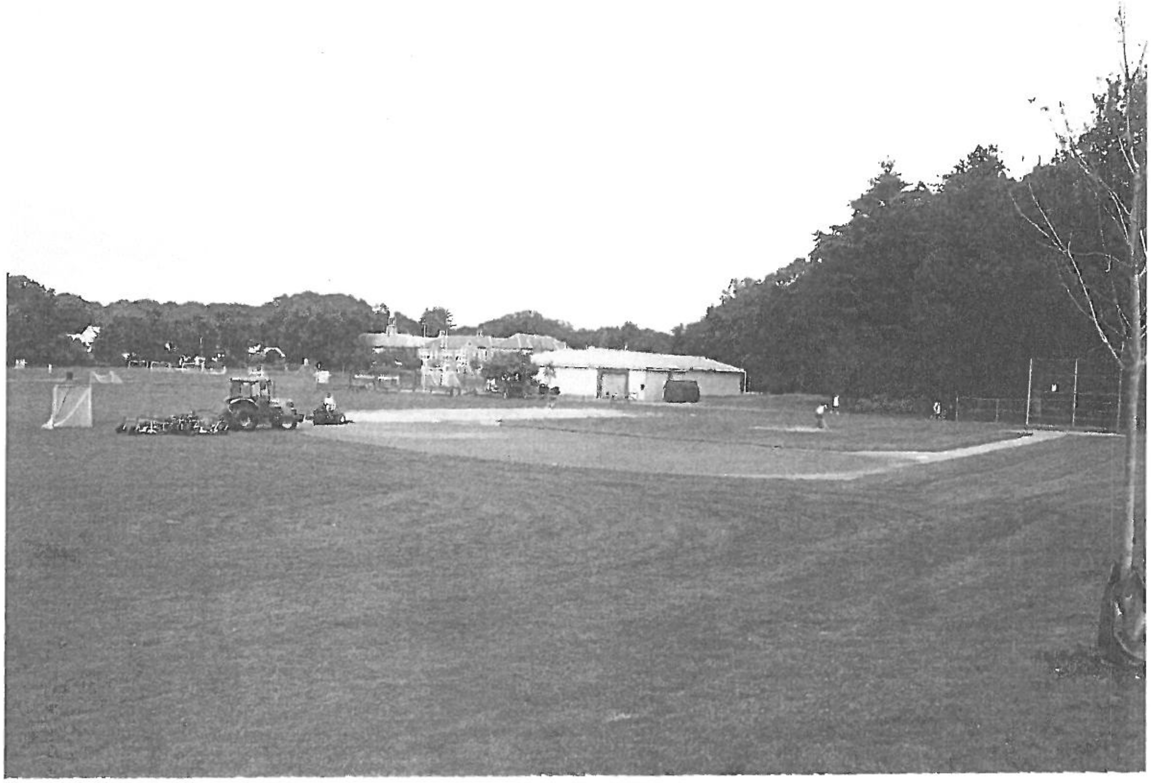
Sprague 5



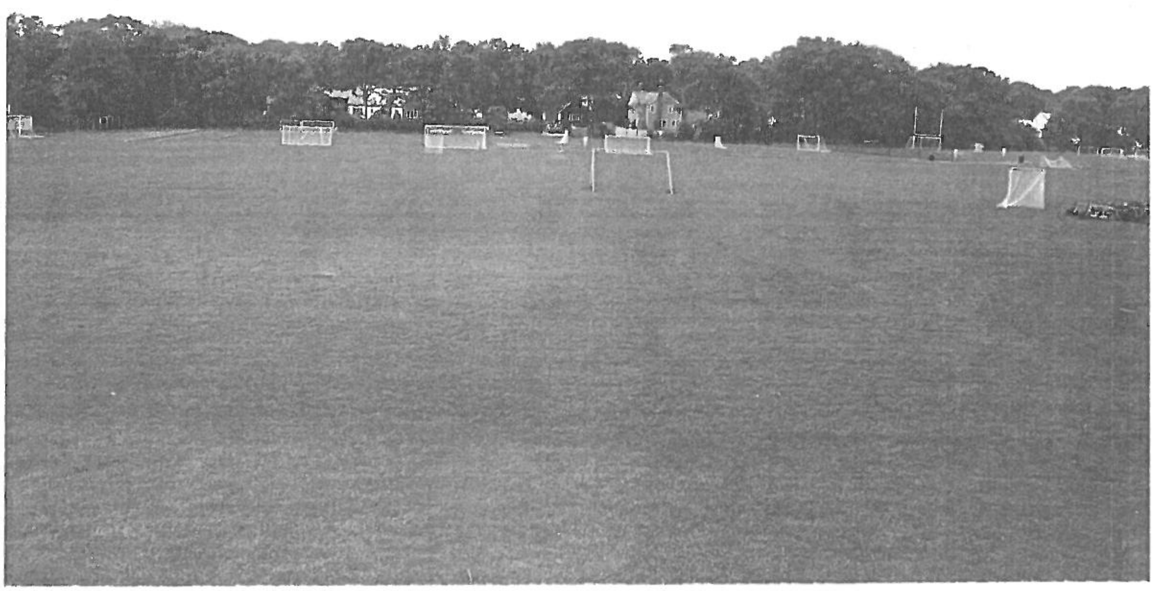
Sprague 5



Sprague 4 A, B, C

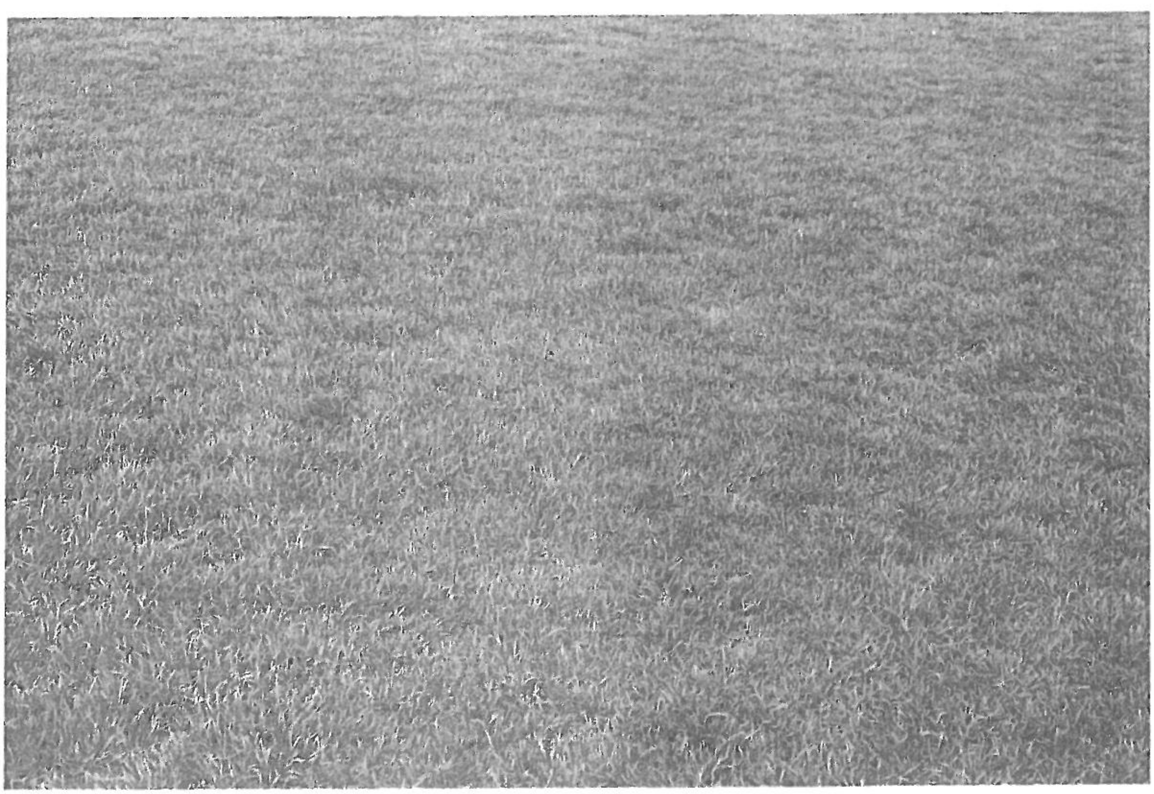


Sprague 4 A, B, C

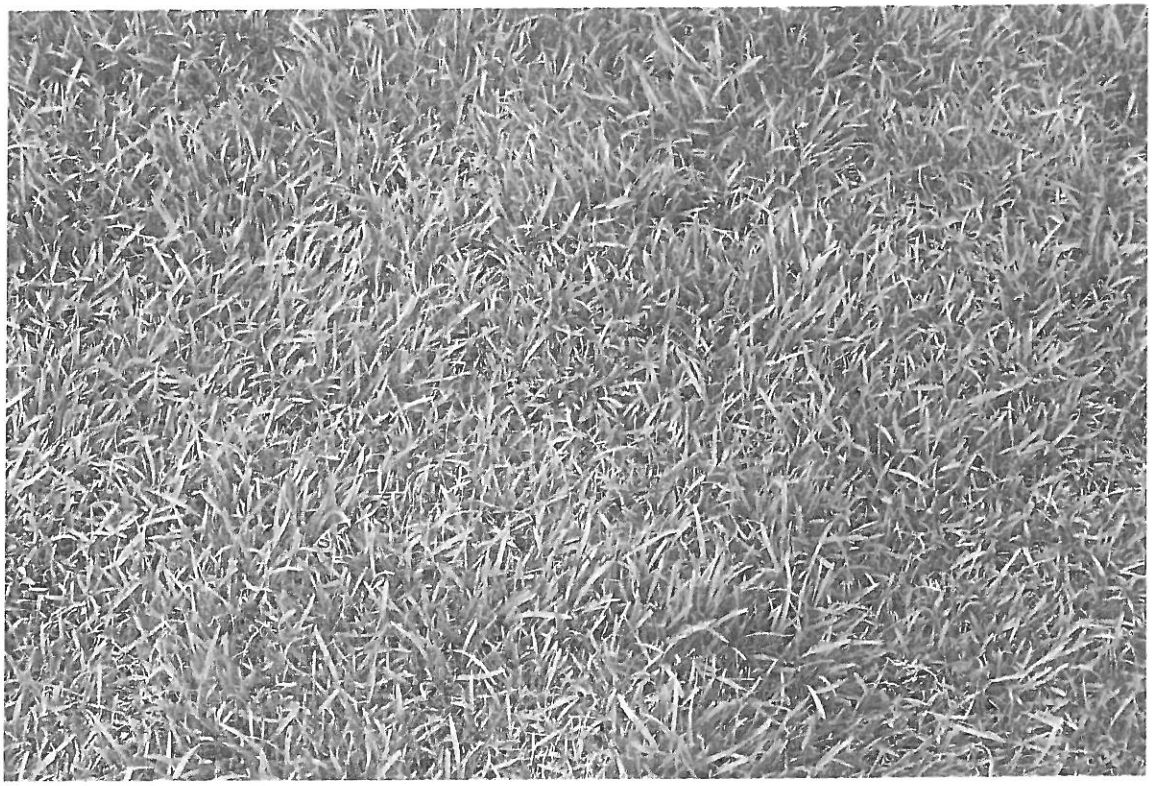


Sprague 4 A, B, C

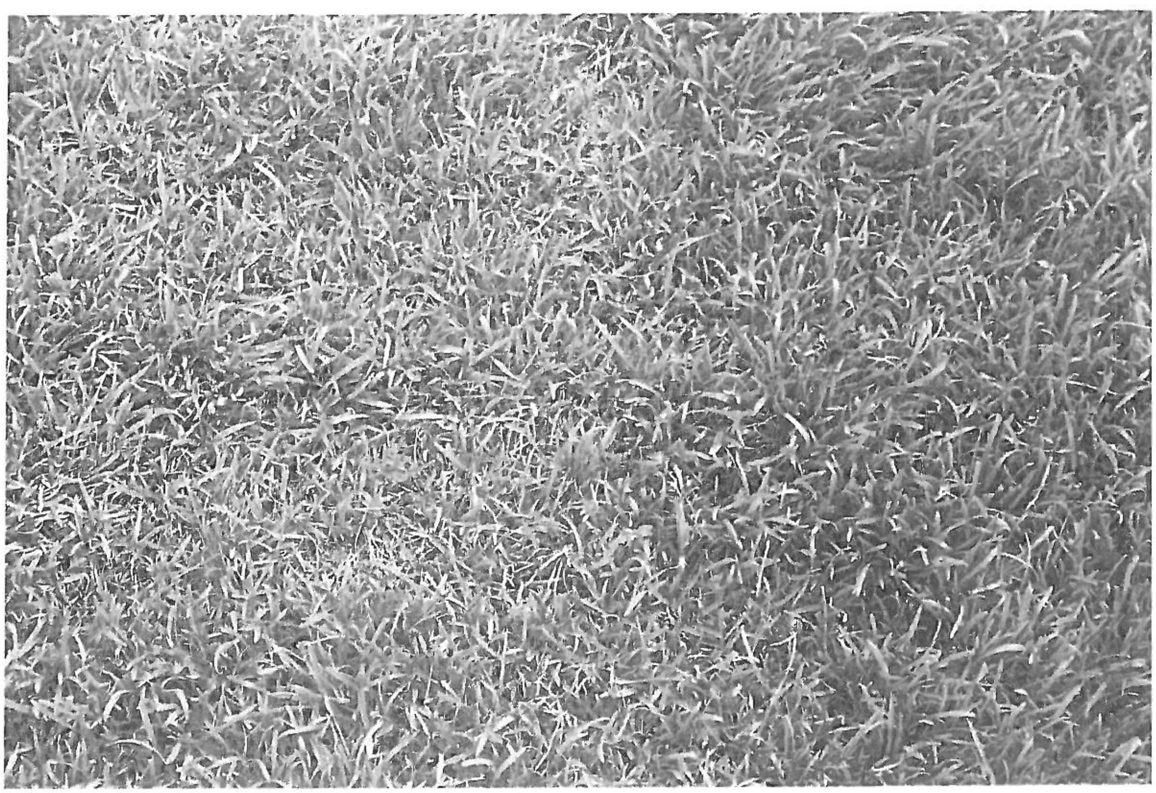
Sprague 4 A, B, C



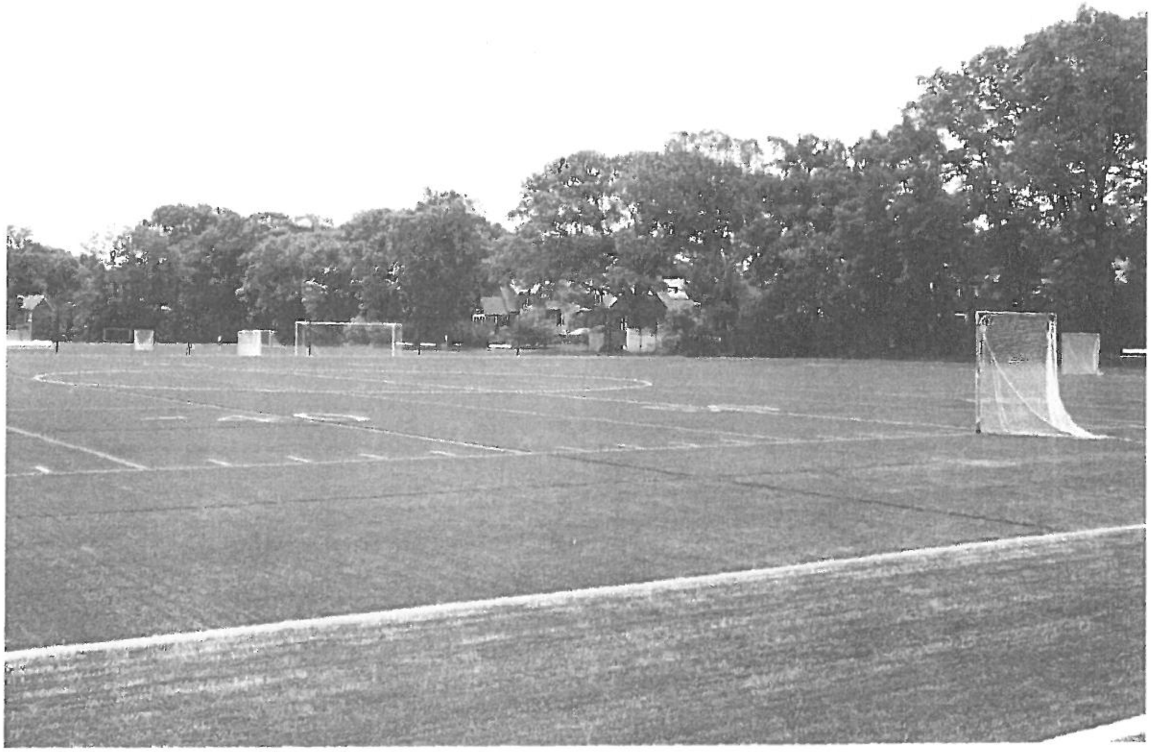
Sprague 4 A, B, C



Sprague 4 A, B, C



Sprague 2



Between Sprague 1 & 2

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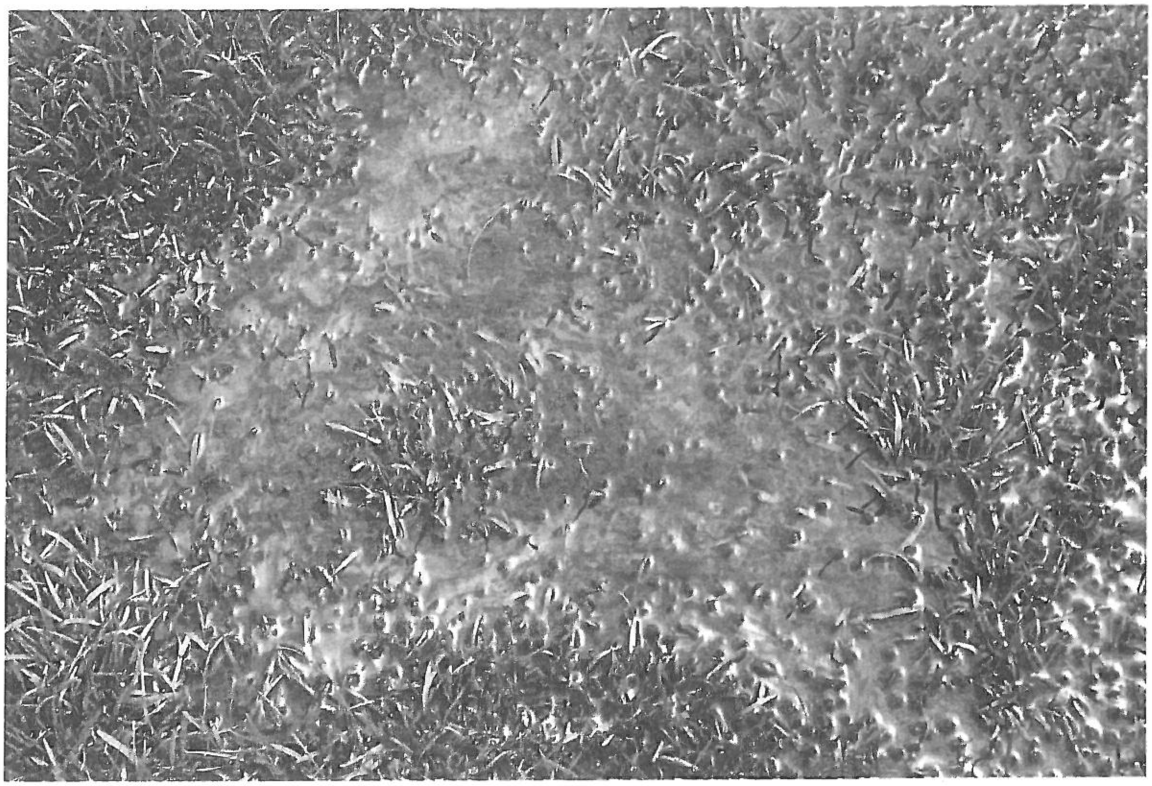
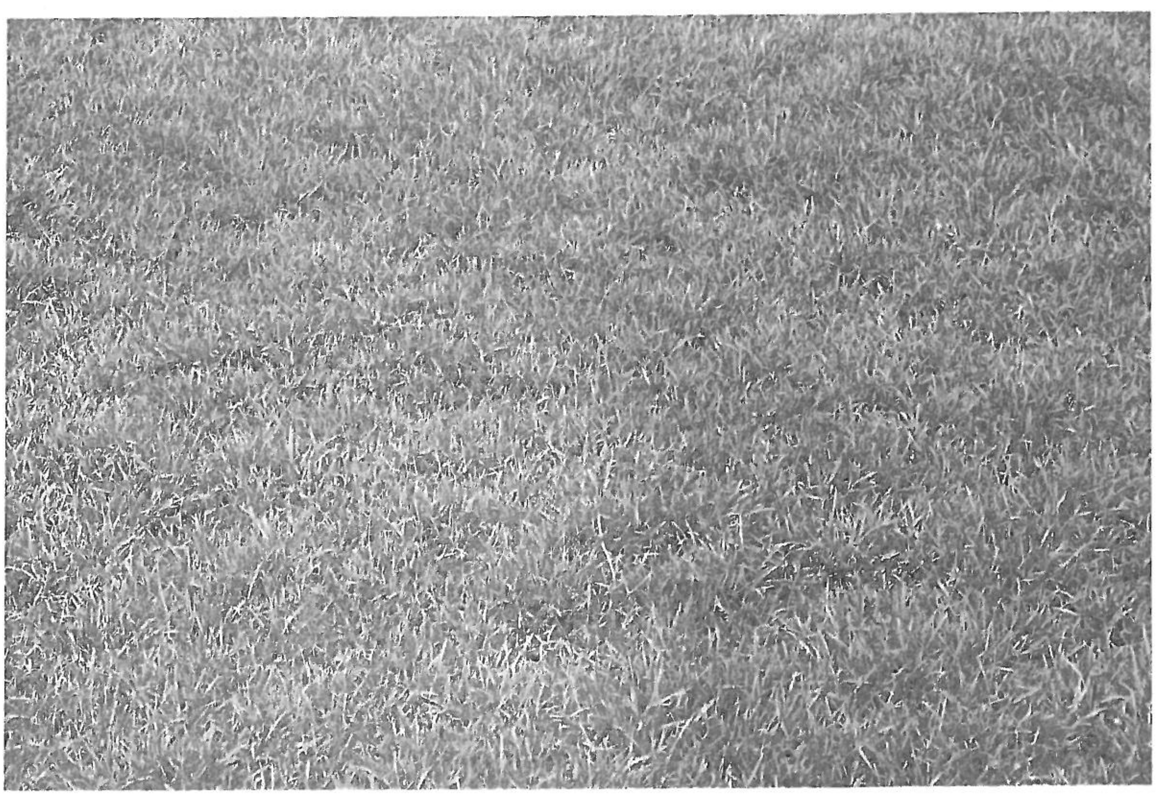


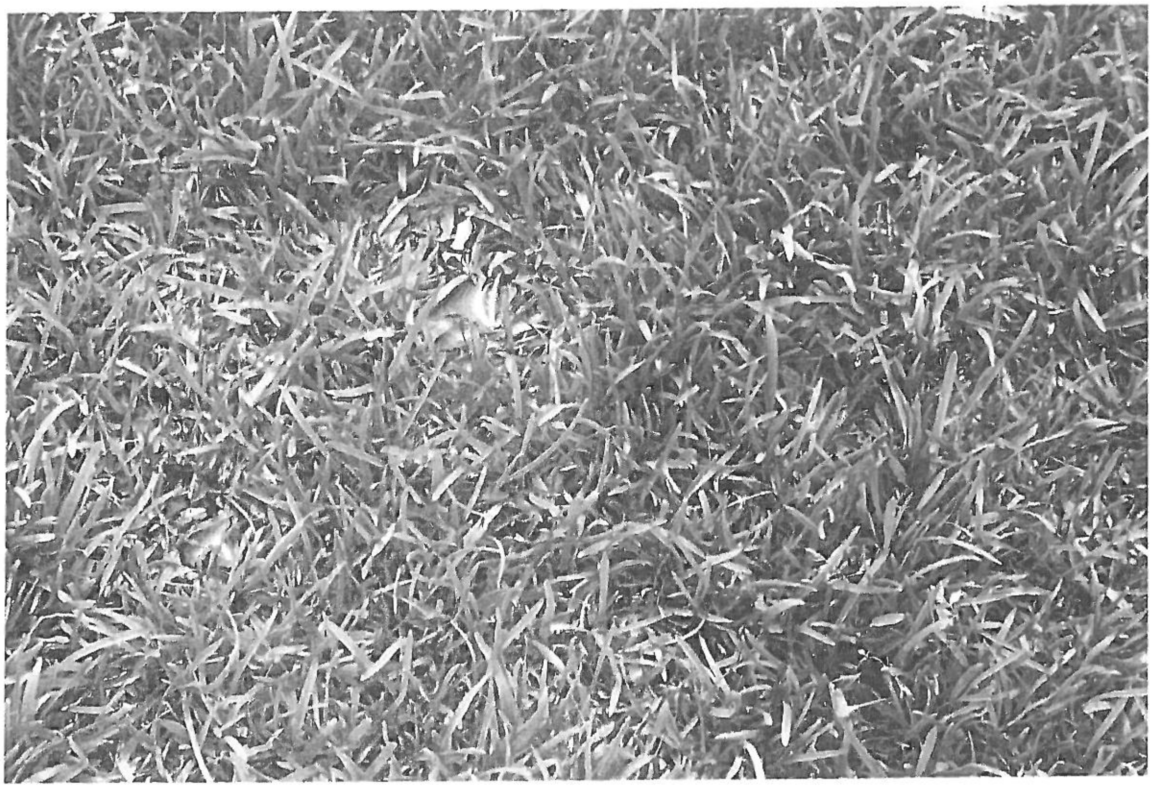
Sprague 1

Sprague 1

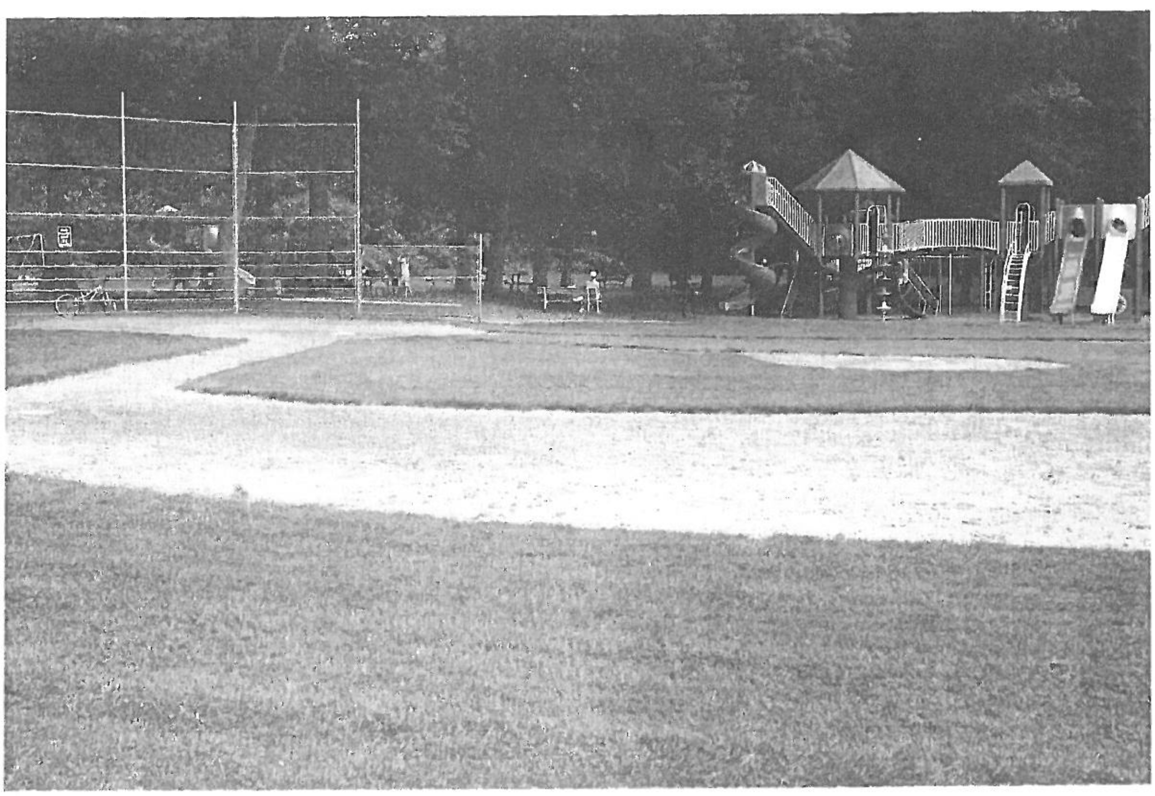
Sprague 1



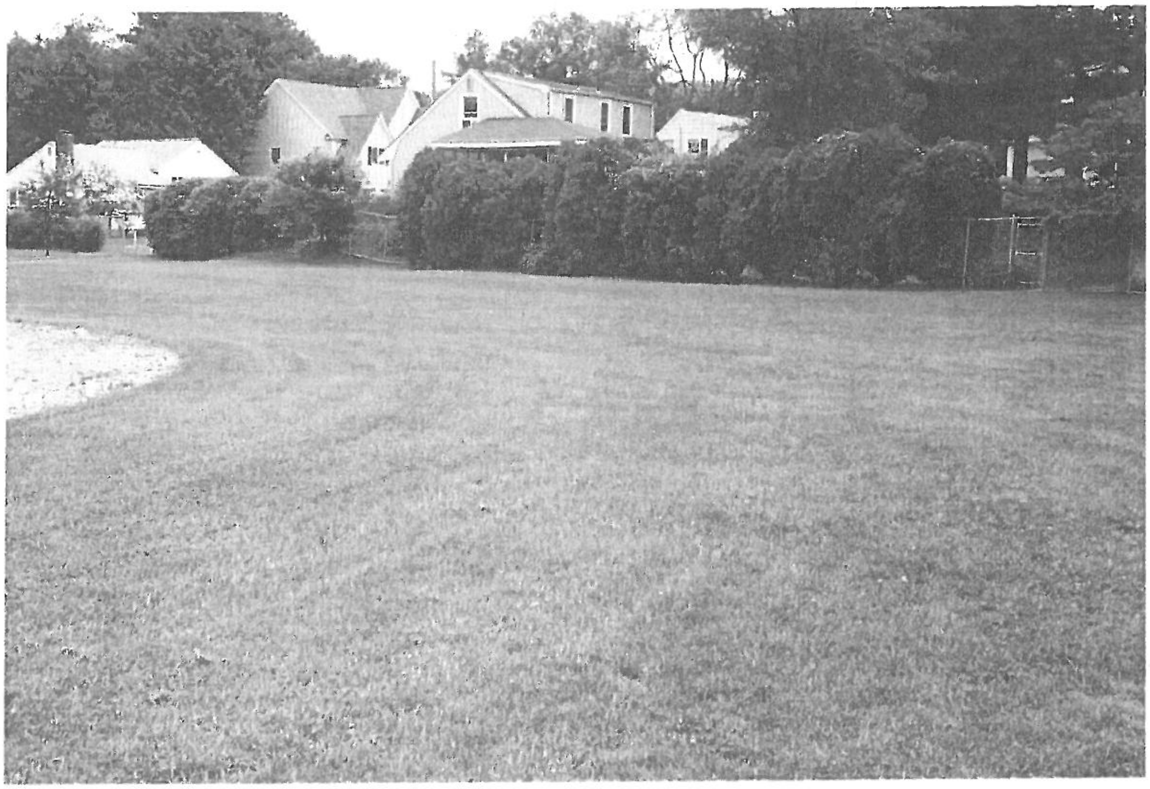
Sprague 1



Hardy 2

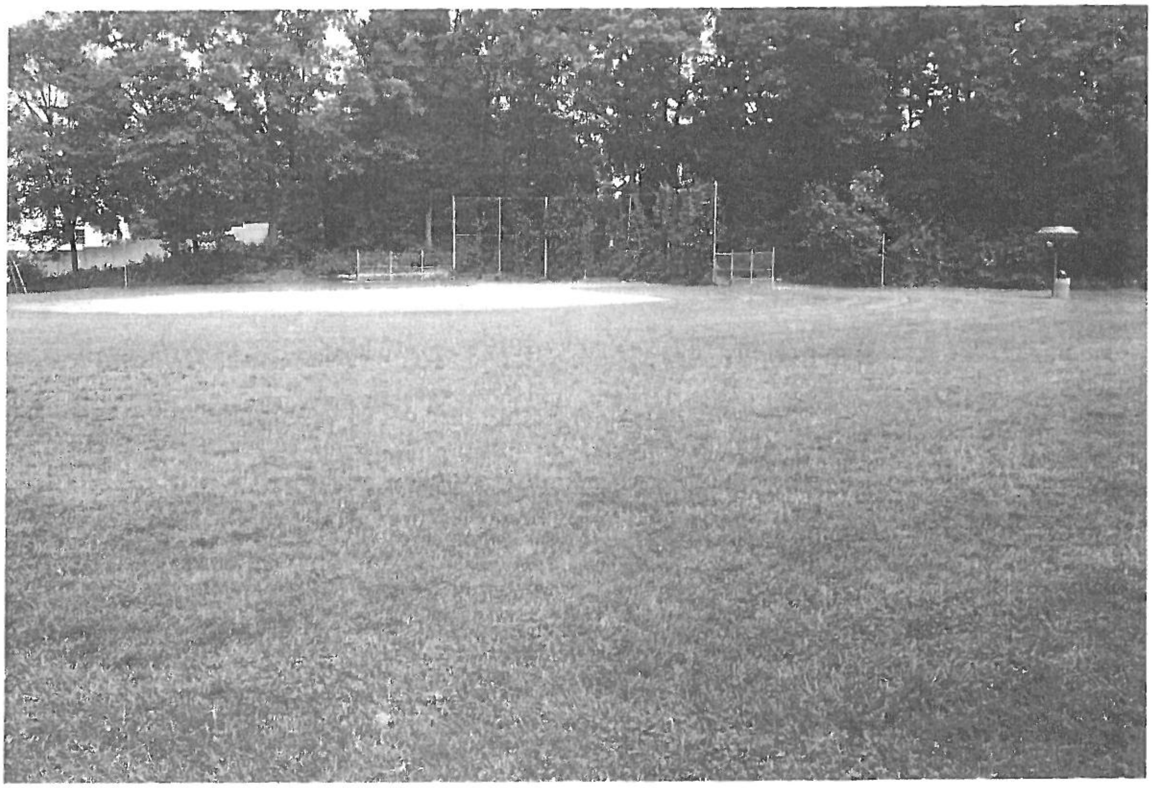


Hardy 2

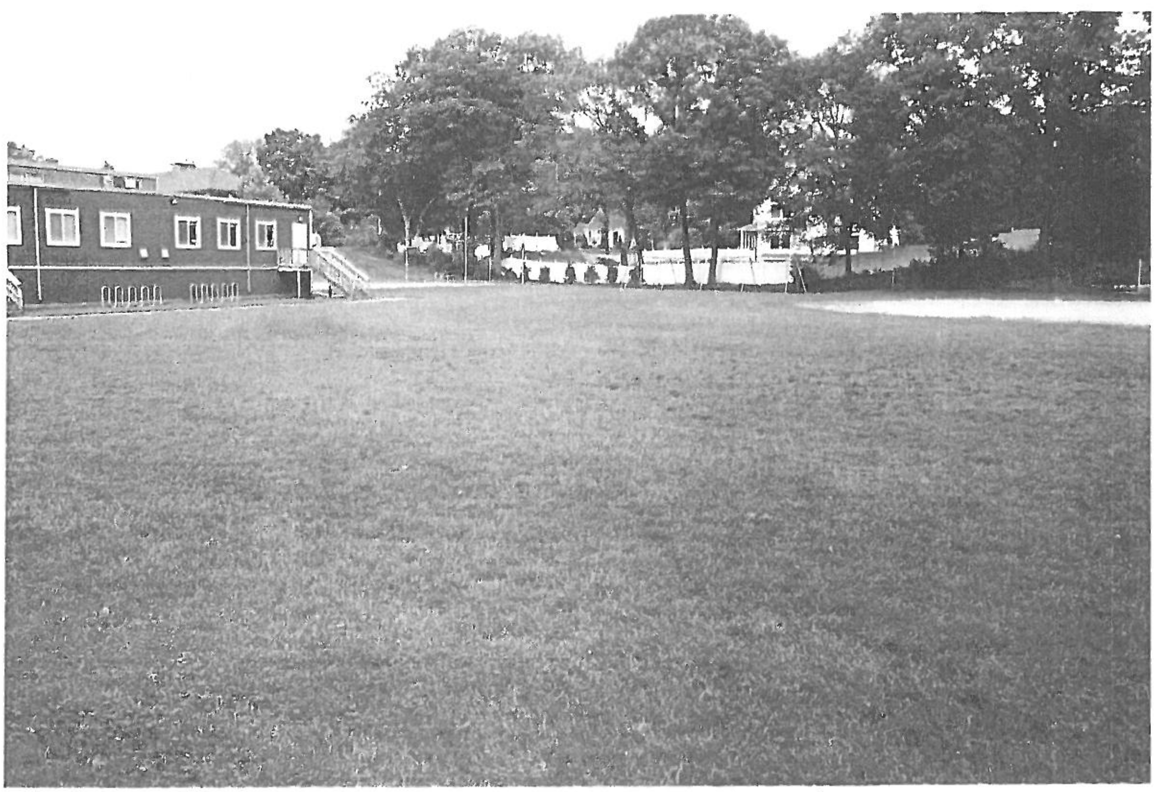


Hardy 2

Hardy 1



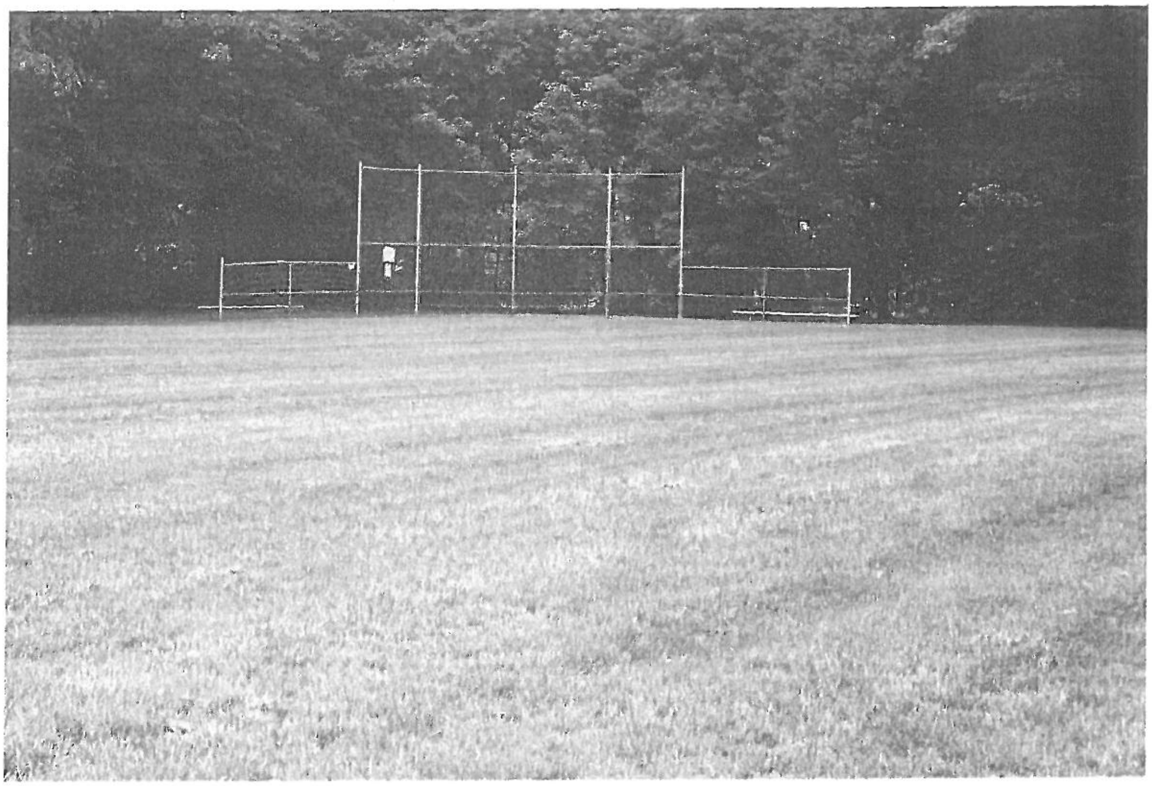
Hardy 1



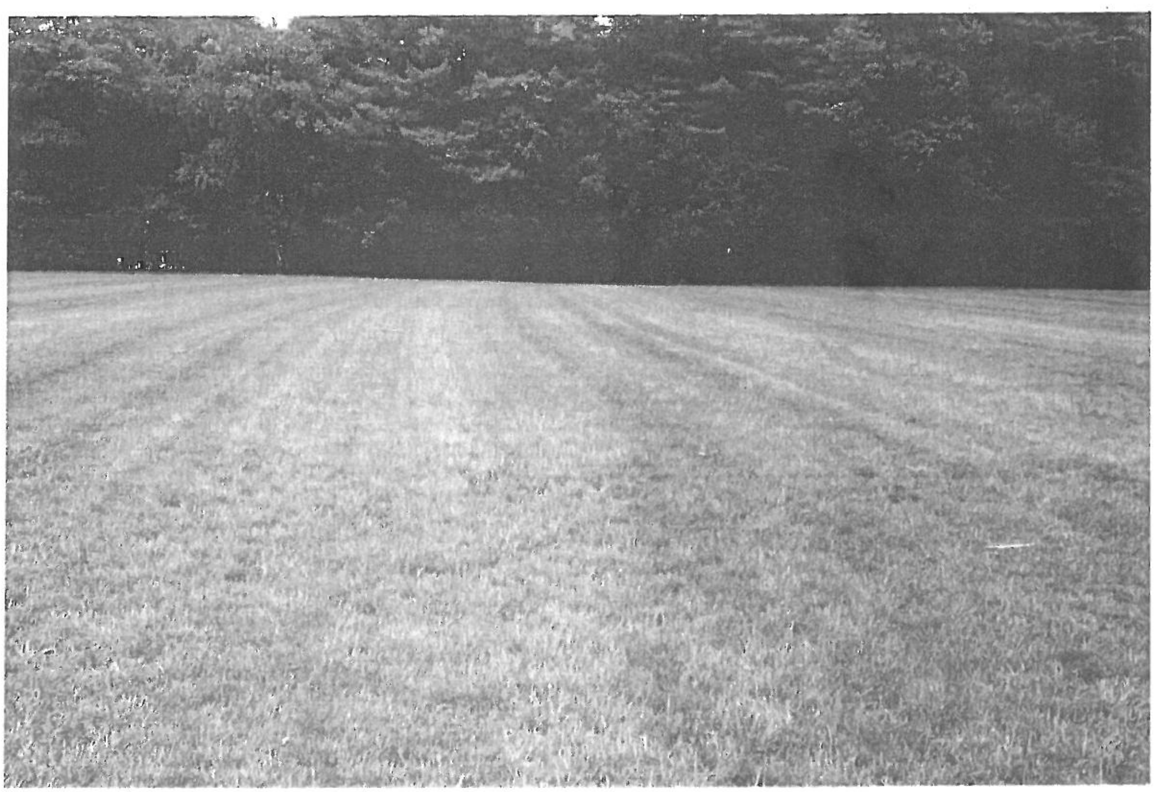
Hardy 1

Hardy 1

Perrin

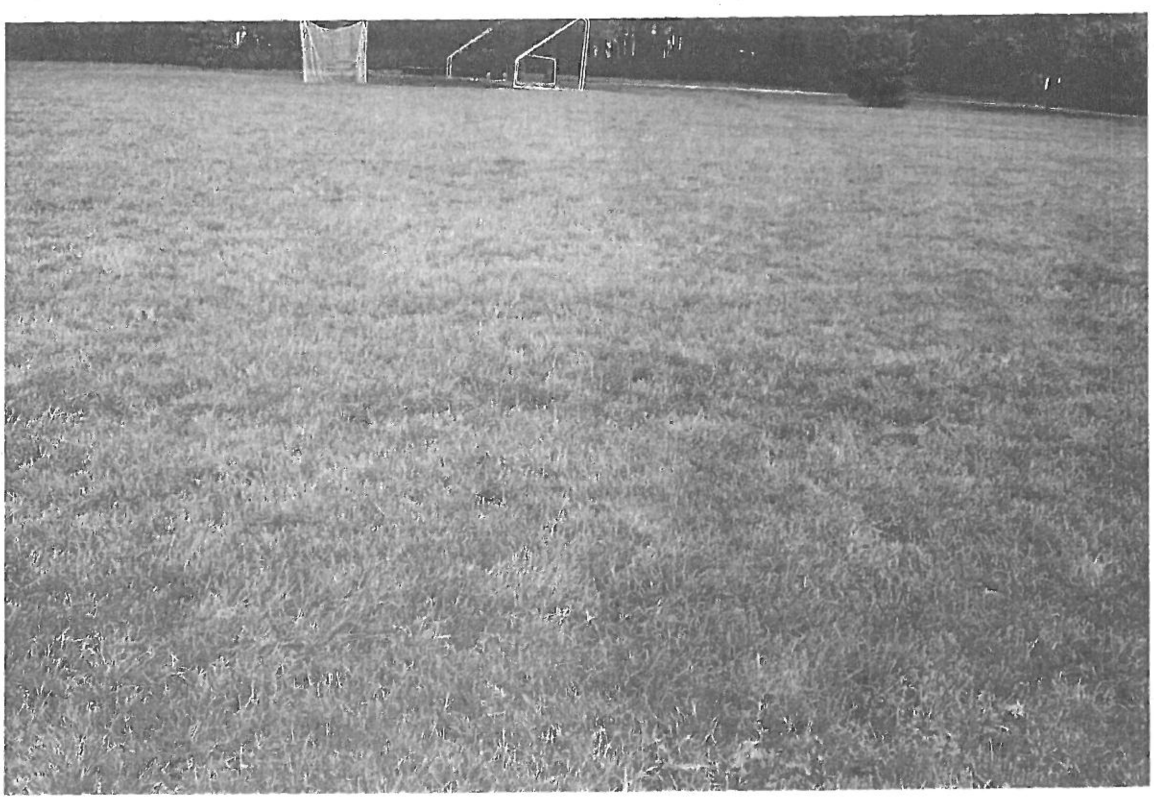


Perrin

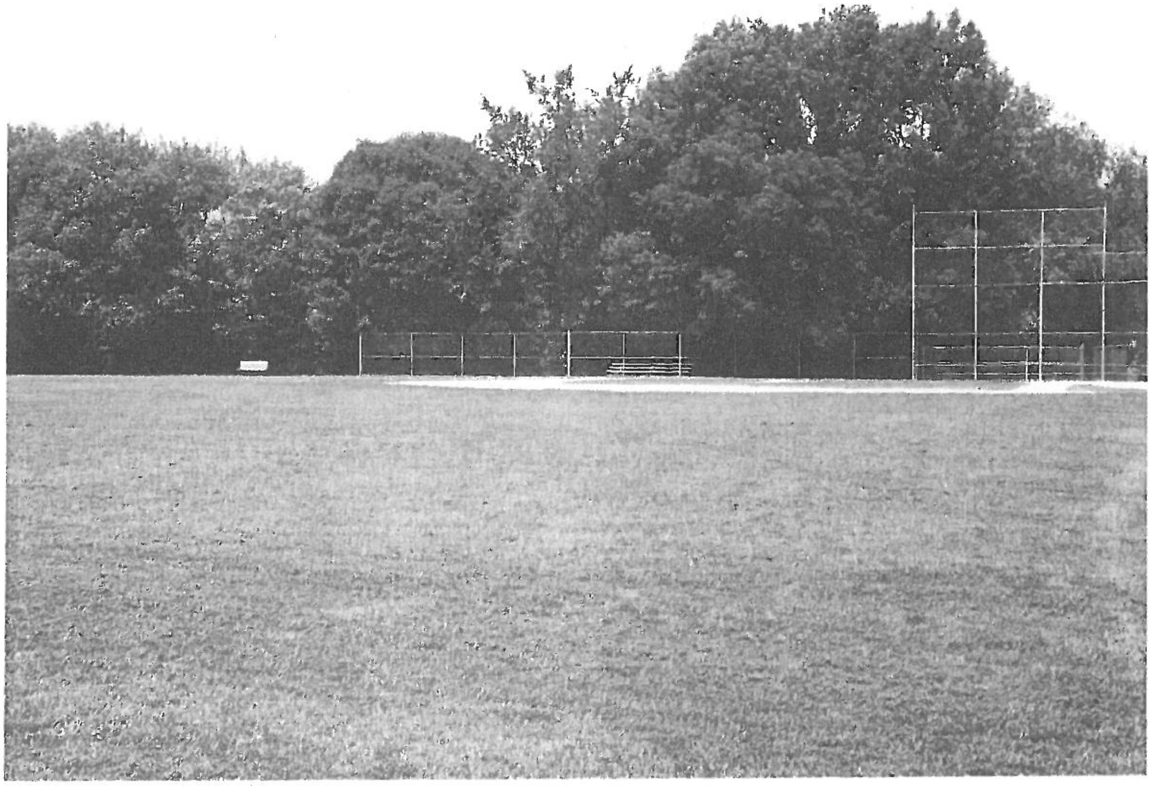


Perrin

Perrin



Kelly

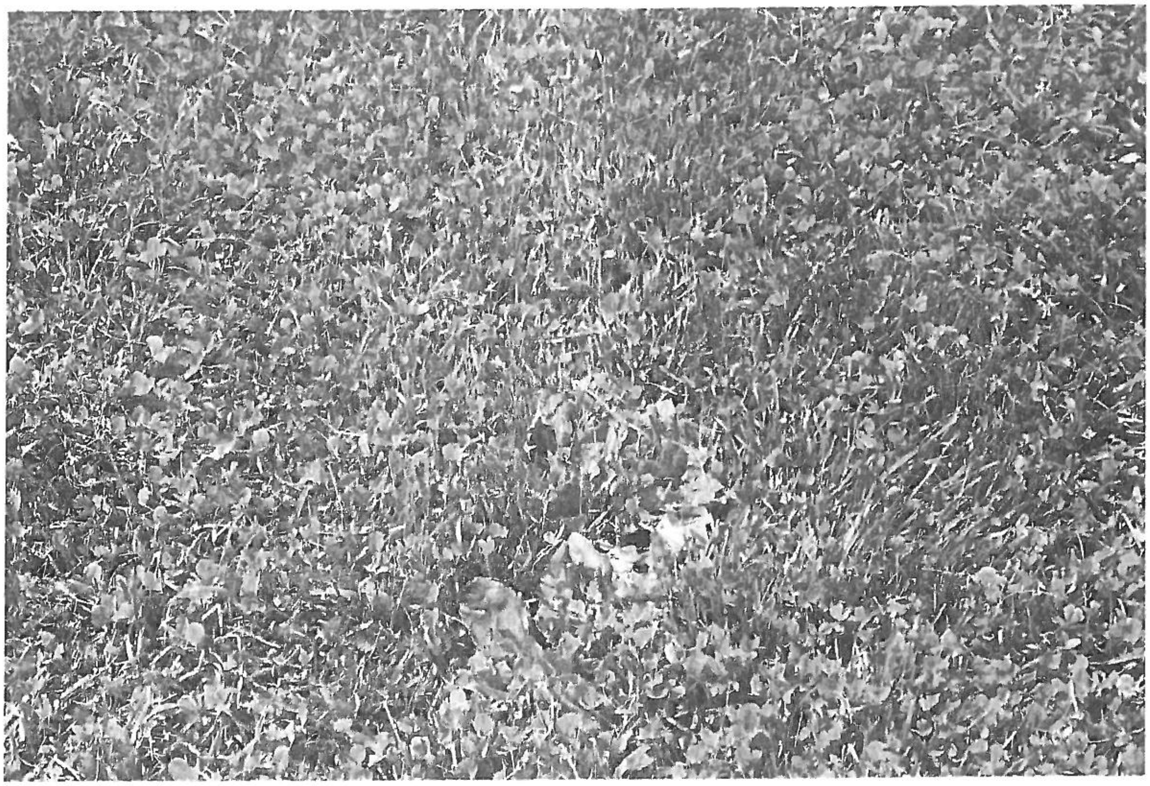


Kelly

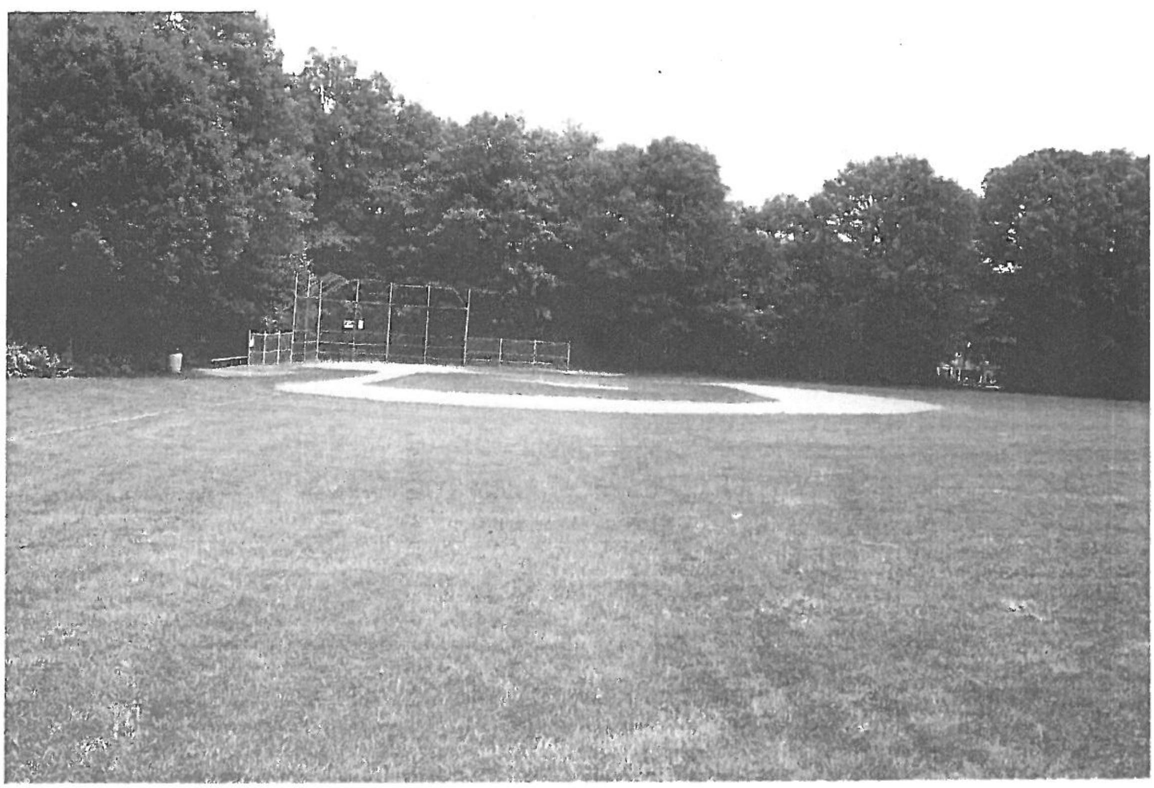
Kelly

Kelly

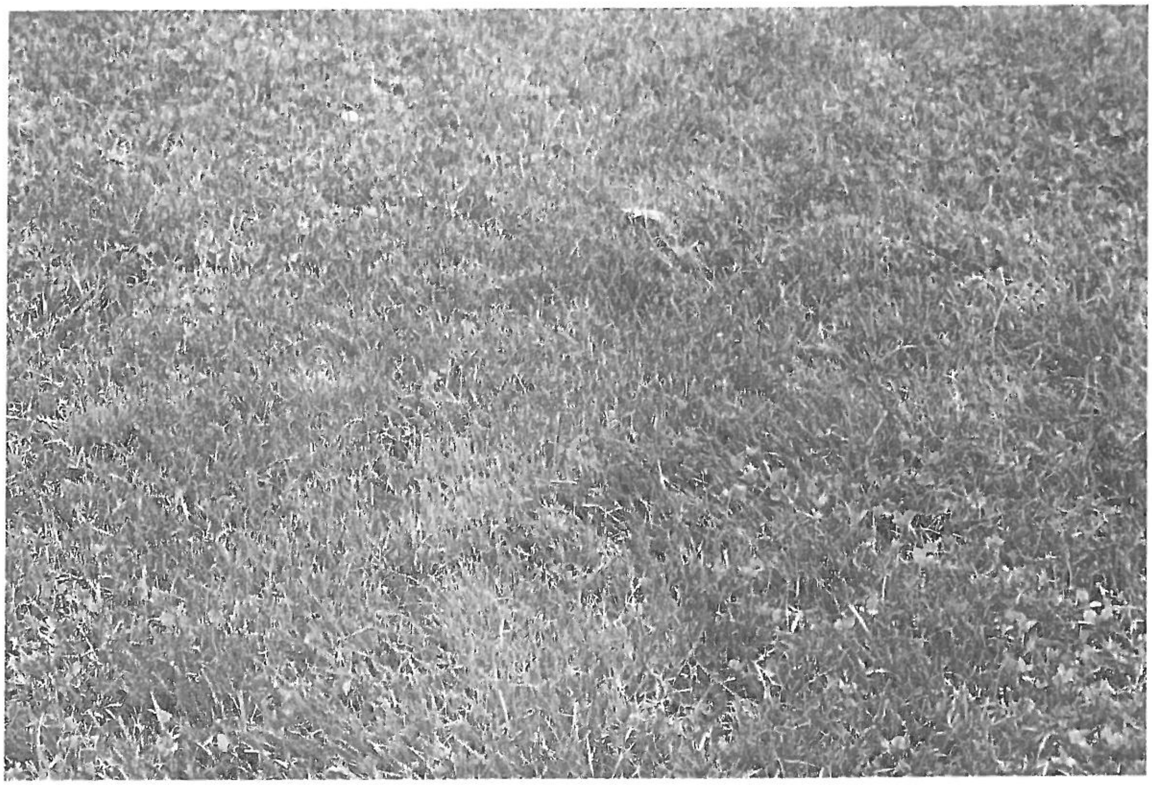
Kelly



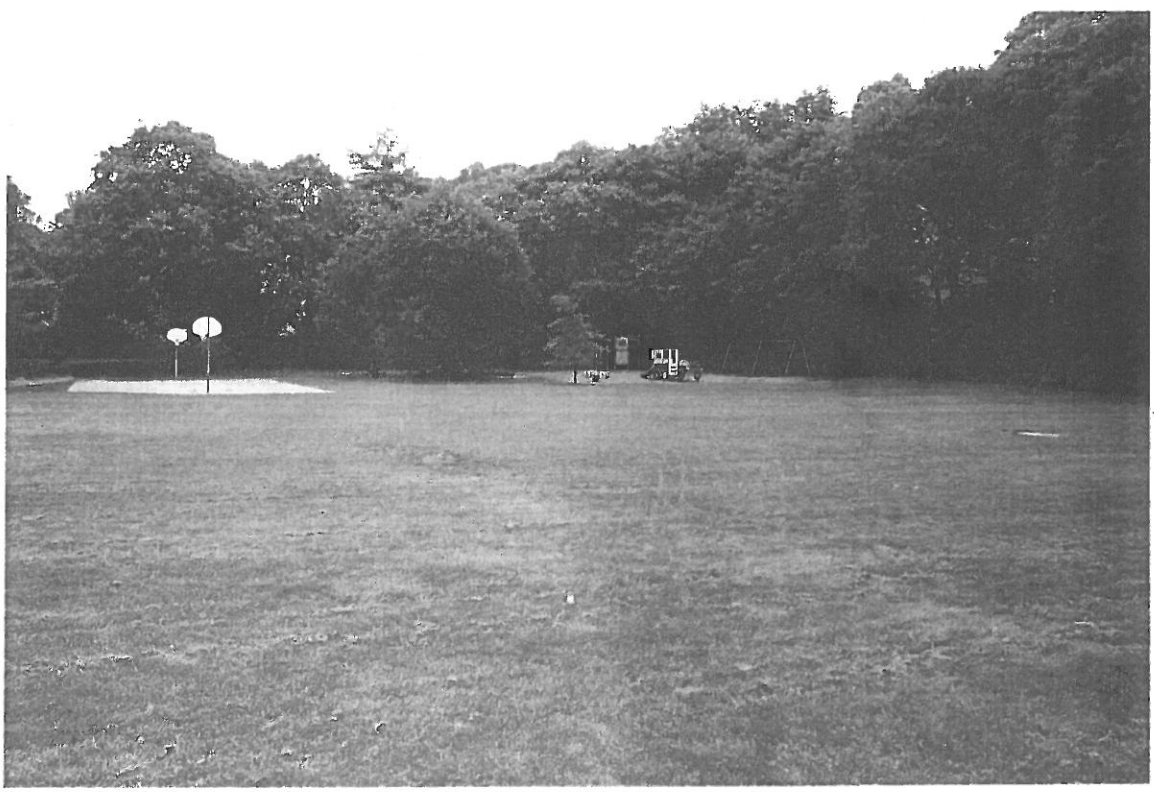
Upham



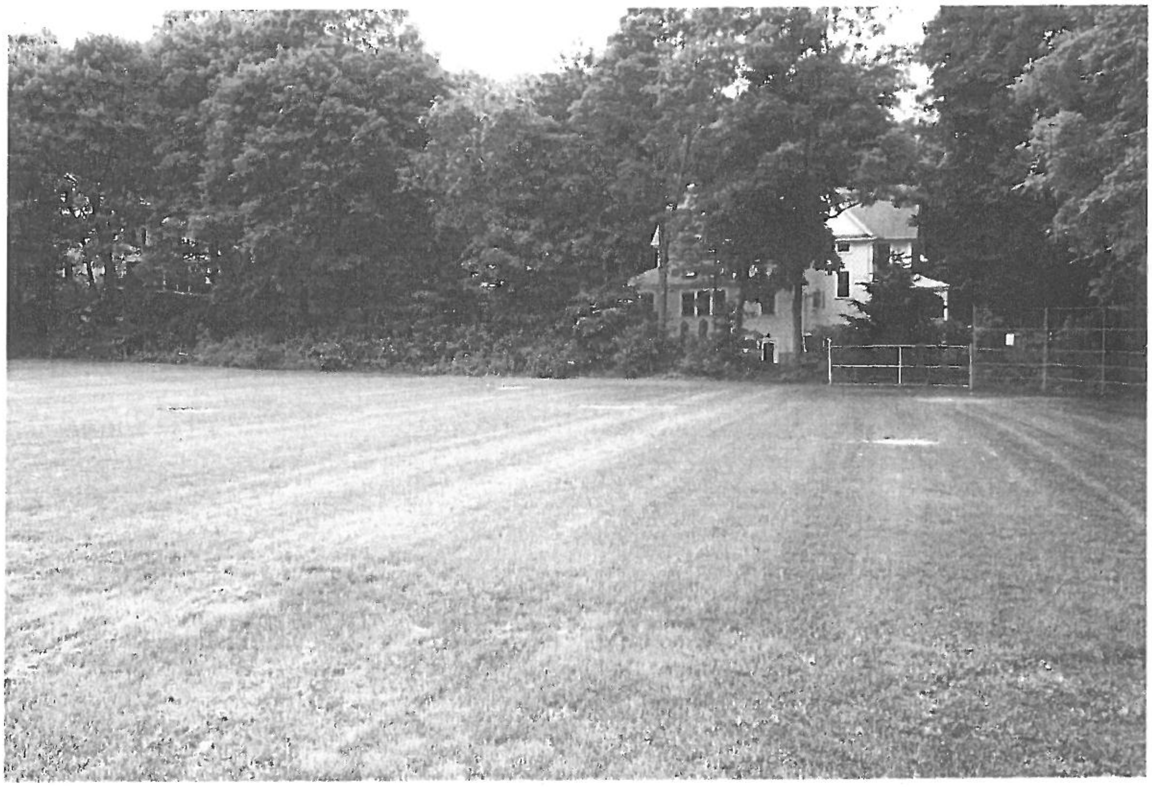
Upham



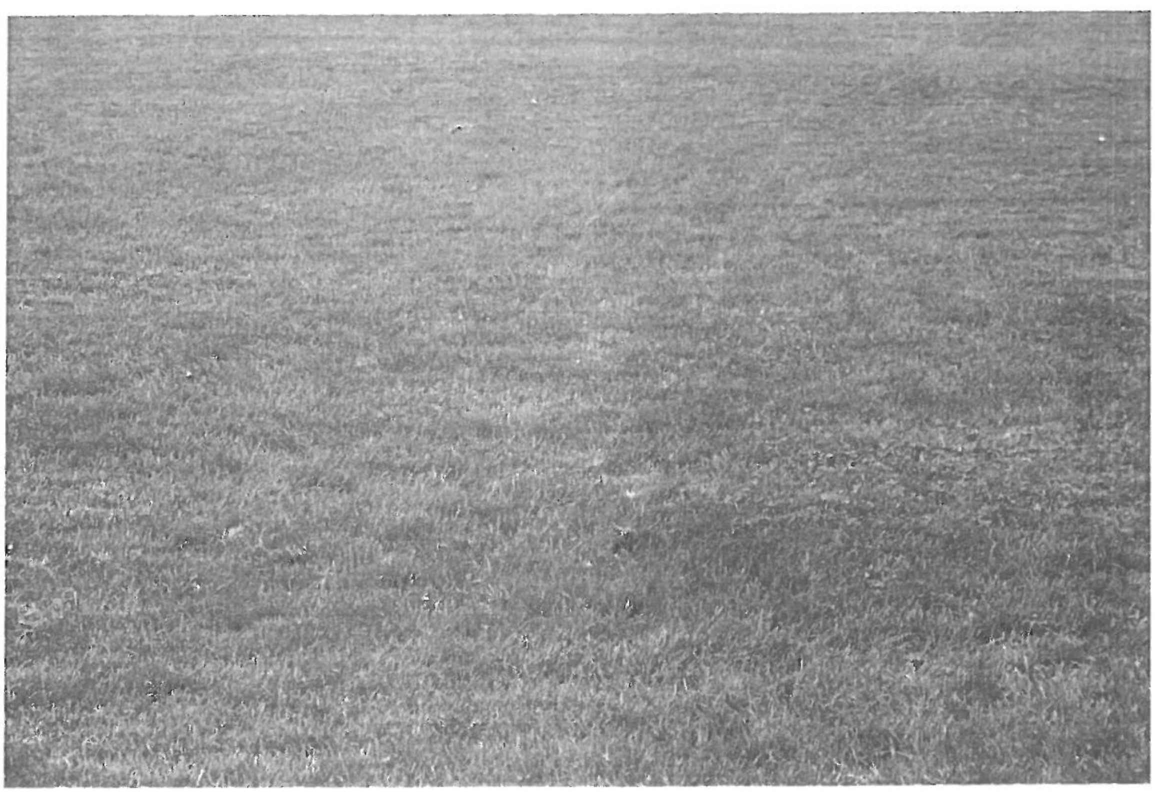
Phillips



Phillips

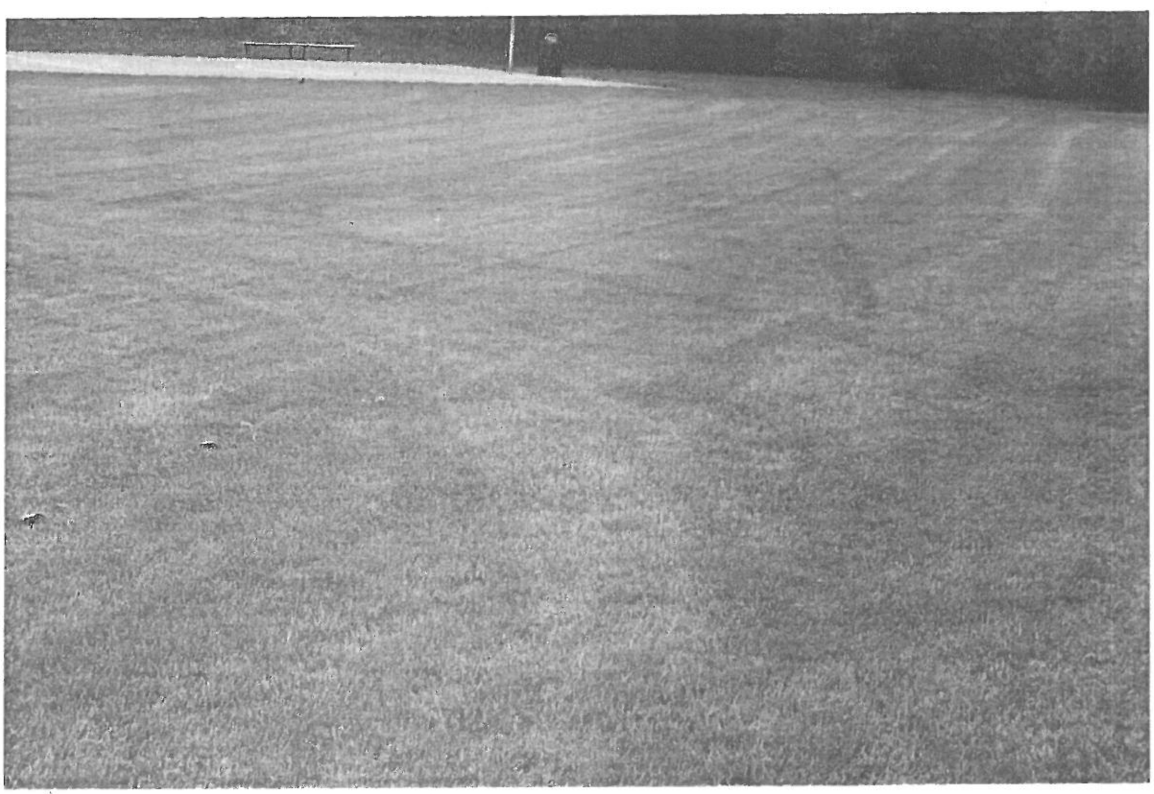


Phillips



Oulette

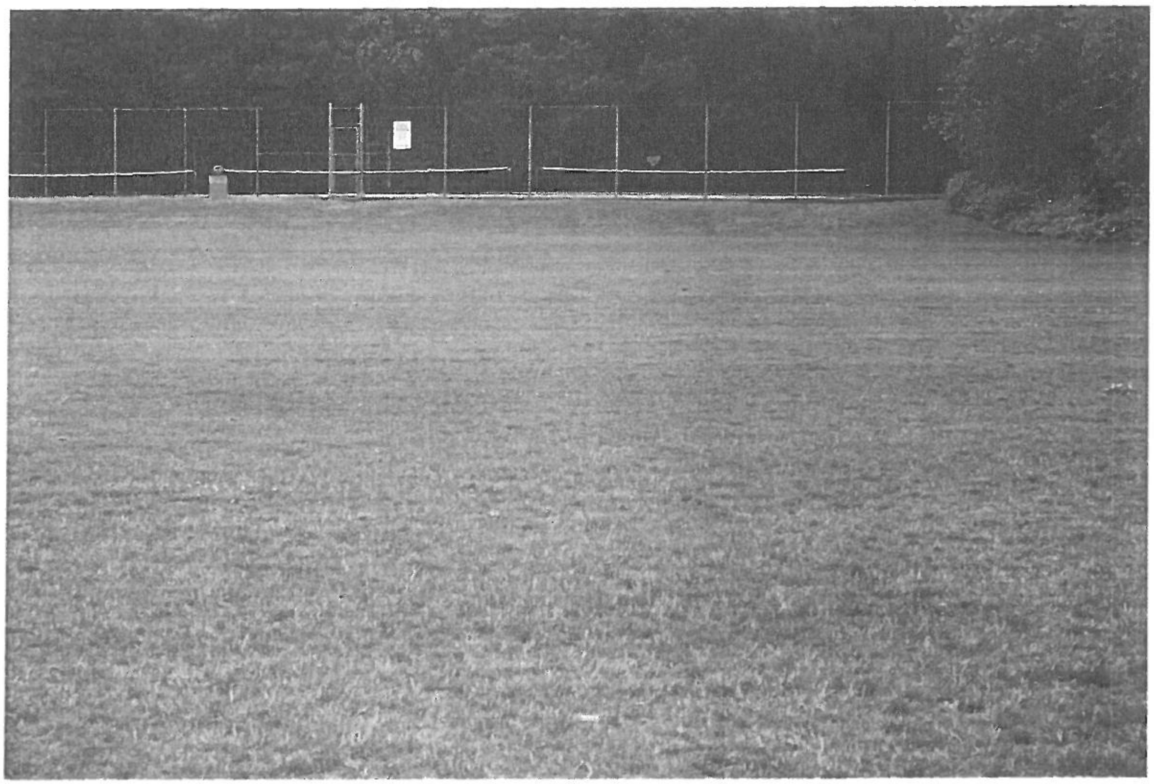
Oulette



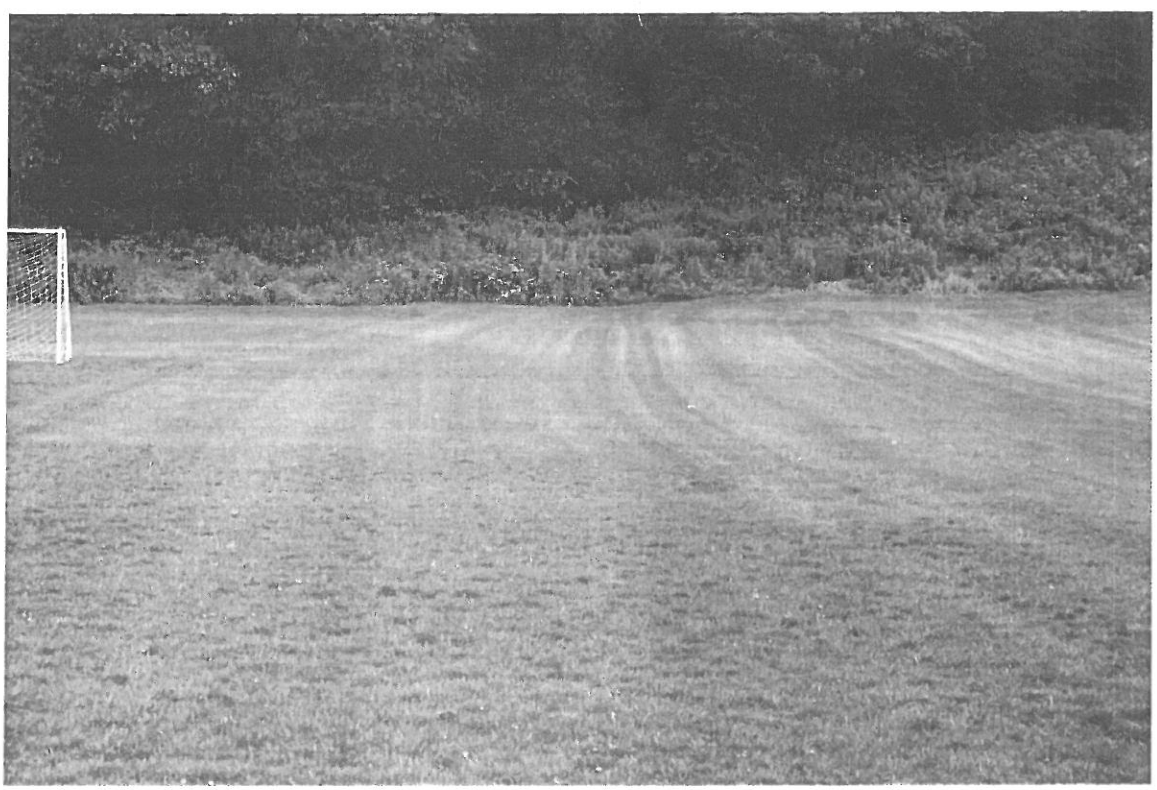
Oulette

Schofield

Schofield



Schofield



General Recommendations

Fertilizer Application Analysis and Recommendations

My analysis of the current program is based on information provided for 2008 actual applications. I will assume that applications were based on the same program in 2009 with dates of applications generally the same.

Current products	Lebanon Par Ex IBDU 26-3-13
	Lebanon Par Ex IBDU 15-15-15
	Sustane 8-2-4

The two Lebanon products are synthetic, slow release (N) fertilizers that that date back to the 1970's. The N is released through a dissolution process as opposed to microbial activity.

26-3-13	10% slow release N	16% immediately water soluble N
15-15-15	5% slow release N	10% immediately water soluble N

of the total N in each product 60% and 66% respectively are soluble

Of the water-soluble portion, it is generally acknowledged that roughly 35% actually affects the turfgrass in a positive way. The balance is lost to volatilization and runoff.

In each product there is 11% and 13% chlorine respectively.

8-2-4	7% slow release
	1% water-soluble

87% of the total N is water insoluble

The issue of moving fertility from a conventional program to a natural program is fully explained in this report. The modes of action of the different products is discussed as well.

Even if the cost of a natural fertilizer is a small percentage more than a conventional product, the fact that all the N ends up supporting the grass is a direct cost benefit.

I am not sure why the program consists generally of two applications of synthetic fertilizer applied at 1 lb N at each application and two applications of natural fertilizer applied at ½ lb N at each application. In further discussions the reasoning behind this approach can be discussed.

As depicted on the accompanying C3 growth habit graph, our grasses exhibit minimal root and shoot growth from the period of late July to late August. In all but the coolest summers in the Northeast, there is very little growth going on, but rather a period of natural slow down so that the plant can reserve carbohydrates for vigorous fall growth. We usually do not fertilize during this period, as it can be counter productive to the strength of the turf system. Applied fertilizer during this time very often can provide a stimulus to broadleaf weeds and annual grassy weeds. The fertilizer application that was made during early August should be scheduled in late August to receive maximum benefit.

The Sustane product that is used for the June and August applications is generally applied at a rate greater (label recommendations) than it is currently being used.

The schedule of Nutrient and Cultural Practices calls for fertilizer applications that are tailored to the genetic growth habit of our cool-season grasses as well as the soil textures that exist in the turf systems. Wellesley's primarily sandy loams and loamy sands can better assimilate N delivered at a rate less than 1 lb N. Our schedule is designed with these factors in mind.

Liming Recommendations

Based on current soil tests the liming requirements are as follows.

No Lime required

Hunnewell Football
Hardy
Perrin
Upham
Oulette
Schofield
Brown

Lime Required-Fall 2009

The Ca:Mg ratio determines the type of lime required. In all cases except Hunnewell Field Hockey it is well within the desired range. For matters of simplification, dolomite would be the lime of choice. The synthetic fertilizers, being salt-based products contribute to the acidifying of the soil. In some cases, after last year's lime applications that were based on the UMass tests, there was an elevation in the pH. In other cases there was little change.

The recommended rates below are based on the acidity of the soil (Hydrogen meq/100g). It is calculated as tons per acre (1 acre=43,560 sq ft rounded to 44,000). The rate is then further reduced for our purposes to lbs/1000 sq ft.

	lbs/1000 sq ft
Hunnewell Multi-Purpose	45
Hunnewell Field Hockey	60
Hunnewell Soccer/JVBB	45
Lee	35
Reidy	40
Hunnewell School	45
Sprague 5	30
Sprague 4 ABC	35
Sprague 1	30
Kelly	45
Phillips	40
Fiske	30

Compost Topdress

When a natural program is put in place, other than moving fertility to a new program, the use of compost is the single greatest difference. The use of compost does not fit into a conventional program. Conventional turf management uses primarily sand as a topdress, which does nothing to help build a natural system. As described in the narrative on topdressing with compost, there are several benefits that we experience from an application.

There may or may not be available money in the budget for this application. One of the primary reasons for the prioritization of management at particular properties is to free available funds for use to topdress higher profile properties on a rotating basis.

In order to topdress a football field, which is roughly 1.3 acres (field of play), we use 35 cubic yards. At an average cost of $30.00/yard, material cost is $1050.00.

Humic Acid-Fish Hydrolysate-Compost Tea

As with compost, these products are not used in conventional turf management. A service provider, if from the conventional side of the industry, may need assistance with the inclusion of these materials into a program. These products are the ones that contribute dramatically to building a sustainable turf system. They are not high cost materials. The most limiting factor to date regarding their use is the lack of knowledge about their function in a turf system.

Again, with concerns about budget issues, these products can contribute substantially at a very low unit cost. Prioritization of applications is the best way to phase in some of these new products.

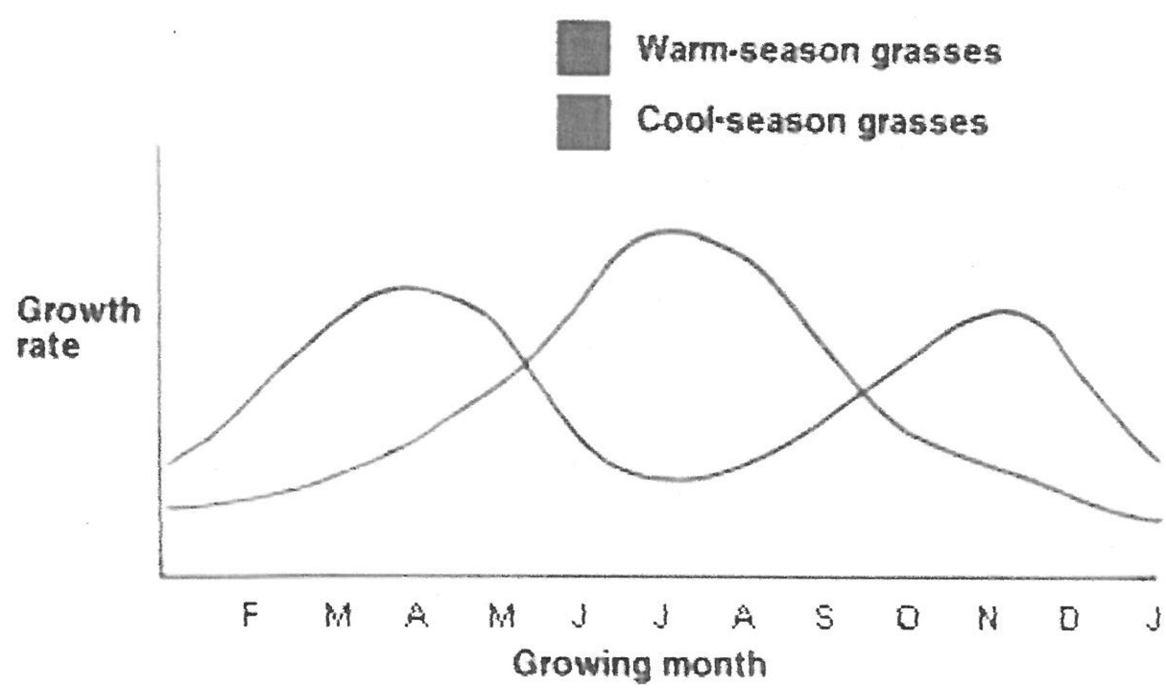
Cultivation

The current schedule of aeration appears to be sufficient. This schedule is producing the desired results. The three properties that have ongoing compaction issues are Hunnewell Football Field between the hash marks, Sprague 4, Schofield, and Fiske School and would all benefit from increased attention.

Irrigation and Seeding

Both of these cultural practices appear to be practiced in accordance with generally accepted guidelines. It is assumed that Wellesley Seed Mix is made up of grasses that exhibit the appropriate genetics for athletic field grsasses.

- Growth Pattern of C3 and C4 Grasses



Fertilizer Schedule and Rates
2008

Field	Date	Product	N lb/1000	Annual N lb
Brown Park	4/25	26-3-13	1	
	6/26	8-2-4	½	
	8/5	8-2-4	½	
	9/30	15-15-15	1 minus	3 minus
Fiske School	8/13	24-12-18	½ plus	
	9/30	15-15-15	1	renovate
Hardy School				
Softball Field	4/25	26-3-13	1	
	6/26	8-2-4	½	
	8/5	8-2-4	½	
	9/30	15-15-15	1/3	2 1/3
LL Field	4/25	26-3-13	1	
	6/26	8-2-4	½	
	8/5	8-2-4	1 minus	
	9/30	15-15-15	¾ minus	3 ¼ minus
Soccer	4/25	26-3-13	1	
	6/26	8-2-4	½	
	8/5	8-2-4	½	
	9/30	15-15-15	1	3
Back play	4/25	26-3-13	1	
	6/26	8-2-4	½ plus	
	8/5	8-2-4	½ minus	
	9/30	15-15-15	¾ plus	2 ¾
Hunnewell Football	4/25	26-3-13	1	
	6/16	8-2-4	1	
	8/5	8-2-4	1	
	9/30	15-15-15	1	4
Hunnewell FHockey	4/25	26-3-13	1	
	6/26	8-2-4	½	
	8/5	8-2-4	½	
	9/30	15-15-15	1	3

Hunnewell Prac FB	4/25	26-3-13	1	
	6/26	8-2-4	½ minus	
	8/6	8-2-4	¾ minus	
	9/30	mixed	?	3 ?
Hunnewell BB/Soc	4/25	26-3-13	1	
	6/26	8-2-4	½ minus	
	8/5	8-2-4	½ plus	
	9/30	mixed	?	3 ?
Hunnewell Reidy	4/11	18-24-12	½	
	6/26	8-2-4	½ minus	
	8/5	8-2-4	½ minus	
	9/30	15-15-15	¾ minus	2 ¼ minus
Hunnewell SB/Soc	4/25	26-3-13	1	
	6/26	8-2-4	½	
	8/5	8-2-4	½	
	9/30	15-15-15	1 minus	3 minus
Hunnewell Lee	4/25	26-3-13	1	
	6/26	8-2-4	½ minus	
	8/5	8-2-4	½ minus	
	9/30	15-15-15	¾ plus	2 ¾
Hunnewell School	4/25	26-3-13	1	
	6/26	8-2-4	½ plus	
	8/5	8-2-4	½ plus	
	9/30	15-15-15	1	3 plus
Kelley Field	4/25	26-3-13	1	
	6/26	8-2-4	½ minus	
	8/5	8-2-4	½ plus	
	9/30	15-15-15	1	3
Oulette Park	4/25	26-3-13	1	
	6/26	8-2-4	½	
	8/5	8-2-4	½	
	9/30	26-3-13	¾	2 ¾
Perrin Park	4/25	26-3-13	1	
	6/26	8-2-4	½	
	8/5	8-2-4	½	
	9/30	15-15-15	1 minus	3 minus

Phillips Park	4/25	26-3-13	1	
	6/26	8-2-4	½ minus	
	8/5	8-2-4	½ minus	
	9/30	15-15-15	1	3 minus
Schofield School	4/25	26-3-13	1	
	6/26	8-2-4	½	
	8/5	8-2-4	½	
	9/30	15-15-15	1 plus	3 plus

26-3-13

0 88685 56036 1

GUARANTEED ANALYSIS

Total Nitrogen (N)	**26%**
1.2% Ammoniacal Nitrogen	
10.1% Water Insoluble Nitrogen	
14.7% Urea Nitrogen	
Available Phosphate (P_2O_5)	**3%**
Soluble Potash (K_2O)	**13%**
Magnesium (Mg)	0.6%
0.02% Water Soluble Magnesium (Mg)	
Iron (Fe)	0.4%
0.04% Water Soluble Iron (Fe)	
Manganese (Mn)	0.8%
0.01% Water Soluble Manganese (Mn)	

Derived From: Ammonium Phosphate, Isobutylidene Diurea, Muriate of Potash, Magnesium Sucrate, Ferrous Oxide, Ferrous Sulfate, Manganese Sucrate.

Chlorine (Cl) not more than 11.0%

F699

NOTICE: This product contains the secondary nutrient iron. Iron may stain concrete surfaces and should not be applied on dry or water dampened concrete and should be removed from these areas promptly after application by sweeping or blowing. Do not wash off with water.

22-56036

ENVIRONMENTAL STEWARDSHIP

LebanonTurf encourages all of our customers to use our products responsibly. Help do your part in protecting our lakes, streams, and rivers by following label directions and cleaning all walkways and driveways after applications. Do not apply to frozen ground or allow fertilizers to fall into storm drains. By working together, we can help preserve the environment. To learn more, visit www.LebanonTurf.com/turf

LebanonTurf

For technical assistance or more information about our products visit www.LebanonTurf.com

Lebanon Seaboard Corporation

1600 E. Cumberland St. • Lebanon, PA 17042

www.LebanonTurf.com

15-15-15

0 88685 55052 2

GUARANTEED ANALYSIS

Total Nitrogen (N) 15%

9.0% Ammoniacal Nitrogen

5.4% Water Insoluble Nitrogen

0.6% Urea Nitrogen

Available Phosphate (P_2O_5) 15%

Soluble Potash (K_2O) 15%

Derived from: Ammonium Phosphate, Ammonium Sulfate, Isobutylidene Direau, Urea, Muriate of Potash.

Chlorine (Cl) not more than 13.0%

F699 **22-55052**

Lebanon Seaboard Corporation

1600 E. Cumberland St. • Lebanon, PA 17042

www.LebanonTurf.com

Suståne 8 • 2 • 4

All NATURAL ORGANIC
85% SLOW RELEASE NITROGEN FERTILIZER

Allowed for use on certified organic food and fiber crops.

GURANTEED ANALYSIS

Total Nitrogen (N) ....8 %
    0.5% Ammoniacal Nitrogen
    0.5 % Water Soluble Nitrogen
    7.0 % other Water Insoluble Nitrogen*
Available Phosphate (P_2O_5)......................2 %
Soluble Potash (K_2O)...............................4 %
Calcium (Ca)...2 %
Sulfur (S) (Combined)..........................0.5 %
Magnesium (Mg)...................................0.4%
Zinc (Zn)...0.4%

Primary plant food sources derived from aerobically composted turkey litter, hydrolyzed feathermeal, and sulfate of potash.
*This product contains 7.0 % slow release nitrogen.

2/03 F689

GENERAL APPLICATION RATES

Coverage

50 lb. covers 4000 sq. ft. @ 12.5 lb./1000 sq. ft.
25 kg. covers 400 sq. meters. @ 6.25 kg/100 sq. meters

Cool Season Turf

Greens, Tees, Fairways, Athletic Fields, Parks and Lawncare – Apply 3-4 times during growing season. Spring, Summer and Fall at at a of rate 12.5 lb. per 1000 sq. ft

Warm Season Turf

Greens, Tees, Fairways, Athletic Fields, Parks and Lawncare – Apply 4-7 times per season not exceeding 12.5 lb. per 1000 sq. ft. per application.

Fine grade: Mesh size -14+30 (2.8mm to 1.4mm)
SGN 100
Medium grade: Mesh size -7+14 (2.8mm to 1.4mm)
SGN 200

General Comments

- Suståne's highest nitrogen, all-natural fertilizer for turf and all crops organically grown
- Long lasting, 85% slow release nitrogen product rich in humates, humic, fulvic, ulmic and amino acids
- Will not burn turf, seeds or seedlings

Available in both FINE & MEDIUM GRADES

Manufactured by Suståne, A Division of Natural Fertilizer of America, Inc.
310 Holiday Avenue • P.O. Box 19 • Cannon Falls, MN 55009 USA (507) 263-3003
www.sustane.com

NET WEIGHT 50 LB (22.7 kg)

General Notes

Overall the fields and properties that I visited are in better shape than many municipalities. There are many strong points and some weaknesses. The overall approach to move the fields towards a natural management program should prove easy to do and the Town of Wellesley should expect very positive results.

The issue of cost of a natural program is always a cause for concern. The conventional industry has convinced us that an organic approach is four to five times more costly than their program. There was a time when there was a great disparity in the cost of fertilizer products. That gap has been closed to a great degree over the past two years.

Some of the procedures and applications like compost topdressing and humic acid applications are most important in the higher profile properties during the transition period. Once through transition, procedures can be reduced or even eliminated, freeing available money for other expenditures.

A key to success in a natural program is a sound prioritization plan that places the fields into different management levels. A greater allocation of dollars per 1000 square feet is made to the higher tier of management levels and less is spent on lower tiers. This is being done now to some degree, but I would encourage the creation of a sound procedural plan.. On some fields there is less frequent aeration and over-seeding, but the same applications of fertilizer. The lower levels of management will get by just as well with less fertilizer.

Other than clover, which is not necessarily a bad thing, the primary broadleaf weed pressure is from plantain and knotweed. In all but a few situations, it is not severe. Clover is only a problem if it is viewed as one. It is a natural supplier of nitrogen to a turf system, but some prefer not to have it in an athletic field. Some weeds are exacerbated by compacted soil conditions and others reproduce readily from seed.

I am not sure why on some fields spring aerations 1 and 2 or 2 and 3 happen on the same day or just two weeks apart with two different pieces of equipment and then not again until late summer or fall. This type of schedule does not address the ongoing nature of compaction and weed pressure can be the result.

If either broadleaf weeds or annual and perennial weeds that reproduce from seed are a concern, there are new control products with limited current availability. The product cannot be purchased yet, but there is a service provider in our area with proprietary products. They are natural and have been proven to be very effective and safe for children and the environment.

When working with service providers from the conventional industry, it is necessary to create the management plan and specifications and then present it to them. The industry is not yet at the point of having the level of education necessary in natural methods to implement a sound program. We would work together to create the best possible situation for the Town of Wellesley.

Schedule of Inputs and Cultural Practices
Level 1 Program

Town of Wellesley

April 25	Fertilize ¾ lb N/1000 Aeration #1 Seed to fill thin or bare areas
May 5-15	Mowing generally begins-height of cut determined by Ball Roll
June15	Aeration #2 Fertilize ¾ lb N/1000 Humic acid (5 lbs/1000 granular or 8 oz/1000 liquid) Compost topdress if applicable Over-seeding
July 15	Fish hydrolysate (16 oz/1000) or Compost tea (3/4 gal/1000) or both (most desirable)
August 25	Fertilize ¾ lb N/1000 Aeration #3 Aggressive dethatch--identified areas General over-seeding
September 25	Fertilize ¾ lb N
Late-October	Final mowing at 2" Aeration #4

* Frequency of aeration varies with prioritization of program levels. This is a general schedule.

Program Costs

The costs for a Natural Turf Management Program outlined here are based on the highest prices currently for organic fertilizers and grass seed. There is fertilizer product currently available at a cost of $6.50 per pound of N.

We present the numbers in a four-tier approach with Level 1, 2, 3, and 4 programs. This is our way of matching inputs (product and labor) with a program, as you create the prioritization of management practices.

The programs are based on an Annual Nutrient Budget, which varies with each program. The return of clippings is acknowledged to deliver N to the system and contributes to the overall budget. Compost as a topdress, liquid fertilizers, and compost teas have equivalent N/1000 values.

The costs of the Level 1 and 2 programs reflect the intensity of management during the transition period. This time varies, but two to three years is the generally accepted timeframe. After transition, costs decline as cultural intensity is reduced. It is at this point that the turf begins to become sustainable.

The prices in this section reflect the average cost of materials. The labor portion varies with each situation, depending on whether the work is performed in-house or outsourced. These numbers are intended to give you a guide from which to develop a cost analysis. For in-house implementation, costs can be very accurately projected. In an out-sourced situation, the cost numbers plus a reasonable mark up can be combined with average labor costs per application to give an idea on a service providers per acre charge. In any out-sourced situation, the only real cost information can only be obtained by drawing up an IFB and putting it out to the industry.

The Level 1 program is suitable for sports turf and not generally put in place for other municipal properties unless it is modified to address specific situations. It will produce extremely high quality turf in any situation. Level 4 management is reserved for those areas that are not considered to be of importance, but some fertility is desired. It is a program just above the turf system that receives little or no intervention except for mowing. Most municipal turf and parks fall into the Level 2 or 3 programs.

Level 1 Program 5lbs N

3 lbs N from granular product	$7.50/1lb N	$22.50/1000
1 Compost Topdress	$30.00/cu yd	$23.00/1000
2 over-seedings 5lbs/1000	$2.00/lb-$10.00/1000 x 2	$20.00/1000
*Other apps		$15.00/1000
		$80.50/1000

Level 2 Program 4 lbs N

3 lbs N from granular product	$7.50	$22.50
1 over-seeding 5 lbs/1000	$2.00lb-$10.00/1000	$10.00
Other apps	$15.00/1000	$15.00
		$52.50/1000

Level 3 Program 3 lbs N

2 lbs N from granular product	$15.00/1000	$15.00
Seeding to address thin /bare areas		$10.00
Other apps		$15.00
		$40.00/1000

Level 4 Program 1 lb N

1 lb N from granular product	$7.50/1000	$7.50
Minimal seed		$7.50
		$15.00/1000

The other applications line reflects product (liquid fish hydrolysates, humic acid, compost teas, mycorrhizal and microbial inoculants) that is important when addressing the transitional phase of a natural turf system. Because the health and quality of the soil environment is critical in the production of healthy turf, these products address this aspect from the beginning. They are intended to be presented in a menu approach, so that products from this group can be chosen based on regional availability.

Each of these products addresses the soil environment and nutrient availability in related ways. Our program ideally calls for humate products and compost teas to address the soil during transition. Compost tea may not be readily available at this time in all areas.

The liquid fish products are an extremely low cost way to make a big difference in municipal turf. As described in the fertilizer section, there are benefits to the system greater than just the N, P, K. If the ability is there to include this type of product in a program, the turf responds quite dramatically.

Individual average costs of the other apps

Liquid fish hydrolysate	$1.75/1000
Humic acid products	$2.00-$4.50/1000
Compost tea	$6.00/1000
Mycorrhizal inoculant	$.50/1000
Microbial, seaweed, humic combination	$7.50/1000

These are not all meant to be used repeatedly in our program. Compost tea and fish hydrolysates are ongoing, but humic products and microbial inoculants can be used in the transition process and then omitted, thereby realizing a reduction in costs in subsequent years.

Cultivation

This aeration schedule matches the cultural intensity of the various level of inputs.

Level 1 Program	3-5 times annually
Level 2 Program	2-3times annually
Level 3 Program	1-2 times annually
Level 4 Program	none

Osborne Organics
10 Ocean Avenue
Marblehead MA
781.631.2467

COOL SEASON TURF GRASSES

Grass Type	Growth Habit	Use	Wear Tolerance	Recoup Potential
Kentucky Bluegrass	rhizomes	Athletic, lawns high quality	Fair	Excellent
Rough Bluegrass	stolons	lawns	Poor	
Tall Fescue	tillers	Utility, lawns, athletic	Excellent	Poor
Fine Fescue Cr. Red, Chewings	Tillers (Rhizomes Cr. Red)	Lawns, low use areas	Poor	Poor
Perennial Ryegrass	Tillers	Athletic, lawns	Excellent	Poor
Bentgrass	stolons	Putting greens, fine playing surfaces	Poor	Excellent

Grass Type	Mix With Others	Mowing Height	Temperature Tolerance	Drought Tolerance
Kentucky Bluegrass	Yes	1.5 to 3 inches	Moderate heat Good cold	Good
Rough Bluegrass	No	.5 to 1.5 inches	Poor heat Good cold	Poor
Tall Fescue	No	1.5 to 3 inches	Good heat	Good
Fine Fescue Cr. Red, Chewings	Fair	1.5 to 3 inches		Good
Perennial Ryegrass	No	1.5 to 3 inches	Sensitive to ice and excess cold	Moderate
Bentgrass	No	.25 to 1 inches	Excellent heat Excellent cold	Poor

Grass Type	pH	Annual Fertility	Exposure	Other
Kentucky Bluegrass	6.5 to 7.0	2-6#N/ 1000ft2	Sun Poor shade	Thatch Insect/disease
Rough Bluegrass		2-5#N/ 1000ft2	Shade/moist Sun OK	
Tall Fescue	6.0 to 7.0	3-5#N/ 1000ft2	Fair-good shade	Not athletic Tends to clump
Fine Fescue Cr. Red, Chewings	5.0 to 6.0	0-4#N/ 1000ft2	Dry/shade Cr. Red	Won't tolerate wet soils
Perennial Ryegrass	6.0 to 7.0	2-5#N/ 1000ft2	Poor shade tolerance	Some insect resistance
Bentgrass				High maintenance required. Depends height cut

Functional Qualities of Sports Turf

Density is a measurement of the number of grass plants growing in a square foot. A dense turf indicates a high level of management, both culturally and inputs.

Uniformity describes what the whole turf area looks like. A high degree of uniformity is seen when we have all the same type of grasses. A turf that would be considered to exhibit a low degree of uniformity would be grasses that don't look alike or a turf area that has a substantial weed population.

Color can be a visual indicator of the quality of the turf and plant health. It can indicate when something is going wrong with the system. Off-color (light green or chlorotic coloring in a genetically dark green grass) can be a sign of a stress within the plant or the system.

Smoothness is different from uniformity. Uniformity refers to the population of plants and smoothness is the appearance of the tops of the blades of the grass plants. It indicates the quality of the cut when mowing. Poor smoothness appears as a ragged cut which indicates dull mower blades.

Rigidity describes how well turfgrass will stand up to some type of force.
It is a function of the blades of grass. The opposite of rigidity is softness.
In general, the coarser the blade, the more rigid it is. Rigidity is affected by water, fertilization, and mowing height.

Elasticity is a measure of how well the grass blades spring back after pressure of some type is applied. Elasticity is influenced by the type of grass, water, fertilizer, and cold.

Resiliency involves the whole system. It refers to the blades of grass, plus the thatch layer, the root zone condition, and the soil condition (well-aerated or compacted) It is a measure of how well the system absorbs the shockwhen an athlete hits the ground. Thick, dense, well-aerated turf provides a cushion for the athlete.

Good **Ball Roll** is an indicator of a high quality sports turf. It is influenced by smoothness, density, moisture, height of cut, quality of cut, and uniformity. Generally speaking, the smaller the ball, the shorter the grass needs to be maintained.

Recuperative Capacity involves the whole turf system. It is a measure of how well the turf recovers from any stress or athletic pressure. This is influenced by the type of grass, the time of year, and the cultural practices in use.

Wear Tolerance describes how the grass blades and crowns stand up to punishment before it is destroyed and cannot recover.

Report Number:
R09182-0017
Account Number:
65030

A&L Eastern Laboratories, Inc.

7621 Whitepine Road Richmond, Virginia 23237 (804) 743-9401
Fax No. (804) 271-6446 Email: office@al-labs-eastern.com

Send To: NORTH COUNTRY ORGANICS
POB 372
BRADFORD, VT 05033

Grower: WELLESLEY MA

Submitted By: CHIP OSBORNE

Farm I D: **Field I D:**

SOIL ANALYSIS REPORT

Page: 1 **Date Received:** 7/1/2009 **Date of Analysis:** 7/2/2009 **Date of Report:** 7/6/2009

Analytical Method(s):
Mehlich III

Sample Number	Lab Number	Organic Matter			Phosphorus				Potassium		Magnesium		Calcium		Sodium		pH		Acidity	C.E.C.
		%	ENR		Available		Reserve		K		MG		CA		NA		Soil	Buffer	H	
			lbs/A	Rate	ppm	Rate	ppm	Rate	ppm	Rate	ppm	Rate	ppm	Rate	ppm	Rate	pH	Index	meq/100g	meq/100g
HAR ONE 1	12982	4.9	104	M	170	VH			125	M	183	M	1901	H			6.5	6.8	0.9	12.3
HAR TWO 1	12983	5.4	113	H	156	VH			106	M	219	H	1759	H			6.4	6.8	1.1	12.0
PERRIN 1	12984	5.9	117	H	191	VH			214	H	322	H	2050	M			6.4	6.8	1.3	14.8
KELLY 1	12985	5.4	113	H	95	H			151	H	170	M	1687	H			6.1	6.8	1.6	11.9
UPHAM 1	12986	4.4	98	M	188	VH			112	M	185	M	1635	H			6.7	6.9	0.5	10.5

Sample Number	Percent Base Saturation					Nitrate		Sulfur		Zinc		Manganese		Iron		Copper		Boron		Soluble Salts		Chloride		Aluminum	
	K	Mg	Ca	Na	H	NO3-N		SO4-S		ZN		MN		FE		CU		B				CL		AL	
	%	%	%	%	%	ppm	Rate	ppm	Rate	ppm	Rate	ppm	Rate	ppm	Rate	ppm	Rate	ppm	Rate	ms/cm	Rate	ppm	Rate	ppm	Rate
HAR ONE 1	2.6	12.4	77.5		7.4																				
HAR TWO 1	2.3	15.3	73.5		8.9																				
PERRIN 1	3.7	18.1	69.2		8.9																				
KELLY 1	3.3	11.9	71.1		13.7																				
UPHAM 1	2.7	14.7	78.1		4.5																				

Values on this report represent the plant available nutrients in the soil.
Rating after each value: VL (Very Low), L (Low), M (Medium), H (High), VH (Very High).
ENR - Estimated Nitrogen Release. C.E.C. - Cation Exchange Capacity.

Explanation of symbols: % (percent), ppm (parts per million), lbs/A (pounds per acre), ms/cm (milli-mhos per centimeter), meq/100g (milli-equivalent per 100 grams).
Conversions: ppm x 2 = lbs/A, Soluble Salts ms/cm x 640 = ppm.

This report applies to the sample(s) tested. Samples are retained a maximum of thirty days after testing. Soil Analysis prepared by:
A & L EASTERN LABORATORIES, INC.

by:
Paul Chu, Ph.D.

Report Number:
R09182-0017
Account Number:
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A&L Eastern Laboratories, Inc.

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Grower: WELLESLEY MA

Submitted By: CHIP OSBORNE

Farm I D:

Field I D:

SOIL ANALYSIS REPORT

Date Received: 7/1/2009 **Date of Analysis:** 7/2/2009 **Date of Report:** 7/6/2009

Analytical Method(s):
Mehlich III

Sample Number	Lab Number	Organic Matter			Phosphorus				Potassium		Magnesium		Calcium		Sodium		pH		Acidity	C.E.C.
		%	ENR lbs/A	Rate	Available ppm	Rate	Reserve ppm	Rate	K ppm	Rate	MG ppm	Rate	CA ppm	Rate	NA ppm	Rate	Soil pH	Buffer Index	H meq/100g	meq/100g
PHILLIPS 1	12987	5.1	108	H	186	VH			108	M	239	H	1708	H			6.3	6.8	1.3	12.1
OULETTE 1	12988	5.6	116	H	172	VH			159	H	158	M	1896	H			6.5	6.8	0.9	12.1
FISKE 1	12989	4.4	99	M	217	VH			117	M	170	M	1442	H			6.3	6.8	1.1	10.0
SCHOFIELD	12990	5.1	109	H	172	VH			120	M	133	L	1850	H			6.6	6.9	0.7	11.3
BROWN 1	12991	4.7	102	M	233	VH			127	H	144	M	1906	H			6.6	6.9	0.7	11.8

Sample Number	Percent Base Saturation					Nitrate		Sulfur		Zinc		Manganese		Iron		Copper		Boron		Soluble Salts		Chloride		Aluminum	
	K %	Mg %	Ca %	Na %	H %	NO3-N ppm	Rate	SO4-S ppm	Rate	ZN ppm	Rate	MN ppm	Rate	FE ppm	Rate	CU ppm	Rate	B ppm	Rate	ms/cm	Rate	CL ppm	Rate	AL ppm	Rate
PHILLIPS 1	2.3	16.5	70.7		10.6																				
OULETTE 1	3.4	10.9	78.3		7.4																				
FISKE 1	3.0	14.2	72.2		10.6																				
SCHOFIELD	2.7	9.8	81.6		5.9																				
BROWN 1	2.8	10.2	81.1		5.9																				

ALE-Soil

Values on this report represent the plant available nutrients in the soil.
Rating after each value: VL (Very Low), L (Low), M (Medium), H (High), VH (Very High).
ENR - Estimated Nitrogen Release. C.E.C. - Cation Exchange Capacity.

Explanation of symbols: % (percent), ppm (parts per million), lbs/A (pounds per acre), ms/cm (milli-mhos per centimeter), meq/100g (milli-equivalent per 100 grams).
Conversions: ppm x 2 = lbs/A, Soluble Salts ms/cm x 640 = ppm.

This report applies to the sample(s) tested. Samples are retained a maximum of thirty days after testing. Soil Analysis prepared by:
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SOIL ANALYSIS REPORT

Page: 3 **Date Received:** 7/1/2009 **Date of Analysis:** 7/2/2009 **Date of Report:** 7/6/2009

Analytical Method(s):
Mehlich III

Sample Number	Lab Number	Organic Matter			Phosphorus				Potassium		Magnesium		Calcium		Sodium		pH		Acidity	C.E.C.
		%	ENR lbs/A	Rate	Available ppm	Rate	Reserve ppm	Rate	K ppm	Rate	MG ppm	Rate	CA ppm	Rate	NA ppm	Rate	Soil pH	Buffer Index	H meq/100g	meq/100g
REIDY 1	12994	4.3	98	M	150	VH			131	H	164	M	1203	M			6.0	6.8	1.4	9.1
LEE 1	12995	5.6	116	H	110	VH			106	M	197	M	1688	H			6.3	6.8	1.2	11.6
FB 1	12996	4.9	104	M	293	VH			115	M	120	L	1971	H			6.4	6.8	1.1	12.2
SOCCER 1	12997	4.9	104	M	143	VH			103	M	186	M	1834	H			6.2	6.8	1.5	12.5
FH 1	12998	5.3	110	H	179	VH			130	H	263	H	1650	M			6.0	6.7	2.0	12.7

Sample Number	Percent Base Saturation					Nitrate		Sulfur		Zinc		Manganese		Iron		Copper		Boron		Soluble Salts		Chloride		Aluminum	
	K %	Mg %	Ca %	Na %	H %	NO3-N ppm	Rate	SO4-S ppm	Rate	ZN ppm	Rate	MN ppm	Rate	FE ppm	Rate	CU ppm	Rate	B ppm	Rate	ms/cm	Rate	CL ppm	Rate	AL ppm	Rate
REIDY 1	3.7	15.0	65.9		15.4																				
LEE 1	2.3	14.2	72.9		10.6																				
FB 1	2.4	8.2	80.5		8.9																				
SOCCER 1	2.1	12.4	73.4		12.1																				
FH 1	2.6	17.2	64.8		15.4																				

Values on this report represent the plant available nutrients in the soil.
Rating after each value: VL (Very Low), L (Low), M (Medium), H (High), VH (Very High).
ENR - Estimated Nitrogen Release. C.E.C. - Cation Exchange Capacity.

Explanation of symbols: % (percent), ppm (parts per million), lbs/A (pounds per acre), ms/cm (milli-mhos per centimeter), meq/100g (milli-equivalent per 100 grams).
Conversions: ppm x 2 = lbs/A, Soluble Salts ms/cm x 640 = ppm.

This report applies to the sample(s) tested. Samples are retained a maximum of thirty days after testing. Soil Analysis prepared by:
A & L EASTERN LABORATORIES, INC.

by: Paul Chu, Ph.D.

Report Number:
R09182-0017
Account Number:
65030

A&L Eastern Laboratories, Inc.

7621 Whitepine Road Richmond, Virginia 23237 (804) 743-9401
Fax No. (804) 271-6446 Email: office@al-labs-eastern.com

Send To: NORTH COUNTRY ORGANICS
POB 372
BRADFORD, VT 05033

Grower: WELLESLEY MA

Submitted By: CHIP OSBORNE

Farm I D: **Field I D:**

SOIL ANALYSIS REPORT

Page: 4 **Date Received:** 7/1/2009 **Date of Analysis:** 7/2/2009 **Date of Report:** 7/6/2009 **Analytical Method(s):** Mehlich III

Sample Number	Lab Number	Organic Matter			Phosphorus				Potassium		Magnesium		Calcium		Sodium		pH		Acidity	C.E.C.
		%	ENR lbs/A	Rate	Available ppm	Rate	Reserve ppm	Rate	K ppm	Rate	MG ppm	Rate	CA ppm	Rate	NA ppm	Rate	Soil pH	Buffer Index	H meq/100g	meq/100g
MULTI 1	12999	5.4	110	H	134	VH			123	M	234	M	2139	H			6.3	6.8	1.5	14.5
HUNN SCH1	13000	5.0	108	H	259	VH			130	H	132	M	1441	H			6.0	6.8	1.6	10.2
SP FOUR 1	13001	4.8	106	M	149	VH			177	H	168	M	1330	M			6.2	6.8	1.2	9.7
SP FIVE 1	13002	4.2	97	M	117	VH			160	H	163	M	1315	H			6.3	6.8	1.0	9.3
SP ONE 1	13003	4.6	104	M	130	VH			152	H	144	M	1226	M			6.2	6.8	1.1	8.8

Sample Number	Percent Base Saturation					Nitrate		Sulfur		Zinc		Manganese		Iron		Copper		Boron		Soluble Salts		Chloride		Aluminum	
	K %	Mg %	Ca %	Na %	H %	NO3-N ppm	Rate	SO4-S ppm	Rate	ZN ppm	Rate	MN ppm	Rate	FE ppm	Rate	CU ppm	Rate	B ppm	Rate	ms/cm	Rate	CL ppm	Rate	AL ppm	Rate
MULTI 1	2.2	13.5	73.8		10.6																				
HUNN SCH1	3.3	10.8	70.6		15.4																				
SP FOUR 1	4.7	14.5	68.7		12.1																				
SP FIVE 1	4.4	14.6	70.5		10.6																				
SP ONE 1	4.4	13.7	69.8		12.1																				

ALE-Soil

Values on this report represent the plant available nutrients in the soil.
Rating after each value: VL (Very Low), L (Low), M (Medium), H (High), VH (Very High).
ENR - Estimated Nitrogen Release. C.E.C. - Cation Exchange Capacity.

Explanation of symbols: % (percent), ppm (parts per million), lbs/A (pounds per acre), ms/cm (milli-mhos per centimeter), meq/100g (milli-equivalent per 100 grams).
Conversions: ppm x 2 = lbs/A, Soluble Salts ms/cm x 640 = ppm.

This report applies to the sample(s) tested. Samples are retained a maximum of thirty days after testing. Soil Analysis prepared by:
A & L EASTERN LABORATORIES, INC.

by: Paul Chu, Ph.D.

Report #:
R09182-0060
Acount Number:
65030

A&L Eastern Laboratories, Inc.

7621 Whitepine Road Richmond, Virginia 23237 (804) 743-9401
Fax No. (804) 271-6446 Email: office@al-labs-eastern.com

TO: NORTH COUNTRY ORGANICS
POB 372
BRADFORD, VT 05033

Grower: WELLESLEY MA

Submitted By: CHIP OSBORNE

Date Received: 7/1/09 **Date Reported:** 07/06/2009

REPORT OF ANALYSIS

LAB NO.	SAMPLE ID	ANALYSIS	RESULT	UNIT	METHOD
13075	HAR ONE2	Sand	56	%	Bouyoucos 1962
		Silt	39	%	Bouyoucos 1962
		Clay	5	%	Bouyoucos 1962
		Soil Textural Class	Sandy Loam		Bouyoucus 1962
13076	HAR TWO2	Sand	74	%	Bouyoucos 1962
		Silt	21	%	Bouyoucos 1962
		Clay	5	%	Bouyoucos 1962
		Soil Textural Class	Sandy Loam		Bouyoucus 1962
13077	PERRIN2	Sand	70	%	Bouyoucos 1962
		Silt	23	%	Bouyoucos 1962
		Clay	7	%	Bouyoucos 1962
		Soil Textural Class	Sandy Loam		Bouyoucus 1962
13078	KELLY2	Sand	62	%	Bouyoucos 1962
		Silt	33	%	Bouyoucos 1962
		Clay	5	%	Bouyoucos 1962

ALE-MISC

Paul Chu, Ph.D.

Report N :
R09182-0060
Acount Number:
65030

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TO: NORTH COUNTRY ORGANICS
POB 372
BRADFORD, VT 05033

Grower:WELLESLEY MA

Submitted By:CHIP OSBORNE

Date Received: 7/1/09 **Date Reported:** 07/06/2009

REPORT OF ANALYSIS

LAB NO.	SAMPLE ID	ANALYSIS	RESULT	UNIT	METHOD
13078		Soil Textural Class	Sandy Loam		Bouyoucus 1962
13079	UPHAM2	Sand	60	%	Bouyoucos 1962
		Silt	35	%	Bouyoucos 1962
		Clay	5	%	Bouyoucos 1962
		Soil Textural Class	Sandy Loam		Bouyoucus 1962
13080	PHILLIPS2	Sand	70	%	Bouyoucos 1962
		Silt	27	%	Bouyoucos 1962
		Clay	3	%	Bouyoucos 1962
		Soil Textural Class	Sandy Loam		Bouyoucus 1962
13081	AULETTE2	Sand	62	%	Bouyoucos 1962
		Silt	33	%	Bouyoucos 1962
		Clay	5	%	Bouyoucos 1962
		Soil Textural Class	Sandy Loam		Bouyoucus 1962

ALE-MISC

Paul Chu, Ph.D.

Report N :
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Grower: WELLESLEY MA

Submitted By: CHIP OSBORNE

Date Received: 7/1/09 **Date Reported:** 07/06/2009

REPORT OF ANALYSIS

LAB NO.	SAMPLE ID	ANALYSIS	RESULT	UNIT	METHOD
13082	FISKE2	Sand	64	%	Bouyoucos 1962
		Silt	29	%	Bouyoucos 1962
		Clay	7	%	Bouyoucos 1962
		Soil Textural Class	Sandy Loam		Bouyoucus 1962
13083	SCHOFIELD2	Sand	68	%	Bouyoucos 1962
		Silt	27	%	Bouyoucos 1962
		Clay	5	%	Bouyoucos 1962
		Soil Textural Class	Sandy Loam		Bouyoucus 1962
13084	BROWN2	Sand	64	%	Bouyoucos 1962
		Silt	29	%	Bouyoucos 1962
		Clay	7	%	Bouyoucos 1962
		Soil Textural Class	Sandy Loam		Bouyoucus 1962
13085	REIDY2	Sand	58	%	Bouyoucos 1962
		Silt	39	%	Bouyoucos 1962
		Clay	3	%	Bouyoucos 1962

ALE-MISC

Paul Chu, Ph.D.

Report I :
R09182-0060
Acount Number:
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TO: NORTH COUNTRY ORGANICS
POB 372
BRADFORD, VT 05033

Grower: WELLESLEY MA

Submitted By: CHIP OSBORNE

Date Received: 7/1/09 **Date Reported:** 07/06/2009

REPORT OF ANALYSIS

LAB NO.	SAMPLE ID	ANALYSIS	RESULT	UNIT	METHOD
13085		Soil Textural Class	Sandy Loam		Bouyoucus 1962
13086	LEE2	Sand	84	%	Bouyoucos 1962
		Silt	13	%	Bouyoucos 1962
		Clay	3	%	Bouyoucos 1962
		Soil Textural Class	Loamy Sand		Bouyoucus 1962
13087	FB2	Sand	76	%	Bouyoucos 1962
		Silt	21	%	Bouyoucos 1962
		Clay	3	%	Bouyoucos 1962
		Soil Textural Class	Loamy Sand		Bouyoucus 1962
13088	SOCCER2	Sand	74	%	Bouyoucos 1962
		Silt	23	%	Bouyoucos 1962
		Clay	3	%	Bouyoucos 1962
		Soil Textural Class	Loamy Sand		Bouyoucus 1962

ALE-MISC

Paul Chu, Ph.D.

Report N...:
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TO: NORTH COUNTRY ORGANICS
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Grower:WELLESLEY MA

Submitted By:CHIP OSBORNE

Date Received: 7/1/09 **Date Reported:** 07/06/2009

REPORT OF ANALYSIS

LAB NO.	SAMPLE ID	ANALYSIS	RESULT	UNIT	METHOD
13089	FH 2	Sand	74	%	Bouyoucos 1962
		Silt	23	%	Bouyoucos 1962
		Clay	3	%	Bouyoucos 1962
		Soil Textural Class	Loamy Sand		Bouyoucus 1962
13090	MULTI2	Sand	62	%	Bouyoucos 1962
		Silt	31	%	Bouyoucos 1962
		Clay	7	%	Bouyoucos 1962
		Soil Textural Class	Sandy Loam		Bouyoucus 1962
13091	HUNN SCH2	Sand	82	%	Bouyoucos 1962
		Silt	15	%	Bouyoucos 1962
		Clay	3	%	Bouyoucos 1962
		Soil Textural Class	Loamy Sand		Bouyoucus 1962
13092	SP FOUR2	Sand	66	%	Bouyoucos 1962
		Silt	29	%	Bouyoucos 1962
		Clay	5	%	Bouyoucos 1962

ALE-MISC

Paul Chu, Ph.D.

Report No.:
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Grower: WELLESLEY MA

Submitted By: CHIP OSBORNE

Date Received: 7/1/09 **Date Reported:** 07/06/2009

REPORT OF ANALYSIS

LAB NO.	SAMPLE ID	ANALYSIS	RESULT	UNIT	METHOD
13092		Soil Textural Class	Sandy Loam		Bouyoucus 1962
13093	SP FIVE2	Sand	66	%	Bouyoucos 1962
		Silt	25	%	Bouyoucos 1962
		Clay	9	%	Bouyoucos 1962
		Soil Textural Class	Sandy Loam		Bouyoucus 1962
13094	SP ONE2	Sand	64	%	Bouyoucos 1962
		Silt	31	%	Bouyoucos 1962
		Clay	5	%	Bouyoucos 1962
		Soil Textural Class	Sandy Loam		Bouyoucus 1962

ALE-MISC

Paul Chu, Ph.D.

Combined Foodweb Results

Osborne Organics
Chip Osborne
11 Laurel St
Marblehead, MA 01945-1911
ozflor@aol.com

Submission Number: 01-019651
Sample Received: 6/29/2009
Report Sent:
Invoice Number: 0

Customer Reference	ID	Dry Weight	Active Bacteria	Total Bacteria	Active Fungi	Total Fungi	Hyphal Diameter	Protozoa Flagellates	Protozoa Amoeba	Protozoa Ciliates	Nematod	VAM	TF/TB	AF/TF	AB/TB	AF/AB	Nitrogen	Actino Bacteria
Soil																		
Kelly	01-107492	0.770	78.0	500	**9.49**	1031	3.5	36006	36006	1080	**3.66**	**0%**	2.06	**0.009**	0.16	**0.12**	100-150	3.57
Sprague	01-107493	0.790	49.0	1113	13.5	349	3	17455	17455	702	**3.07**	**1%**	**0.31**	**0.04**	**0.04**	**0.28**	100-150	2.08
Hunnewell	01-107494	0.750	68.6	1026	**5.76**	487	3	61739	61739	616	**5.74**	**1%**	**0.47**	**0.01**	**0.07**	**0.08**	200+	3.69

Foodweb Analysis
Soil

Report prepared for:
Osborne Organics
Chip Osborne
11 Laurel St
Marblehead, MA 01945-1911

ozflor@aol.com

Report Sent: 7/9/2009
Sample#: 01-107494 | Submission:01-019651
Unique ID: Hunnewell
Plant: turf
Invoice Number: 0
Sample Received: 6/29/2009

For interpretation of this report please contact:
Soil Foodweb Oregon
info@oregonfoodweb.com
(541) 752-5066

Consulting fees may apply

Organism Biomass Data	Dry Weight	Active Bacteria (µg/g)	Total Bacteria (µg/g)	Active Fungi (µg/g)	Total Fungi (µg/g)	Hyphal Diameter (µm)
Results	0.750	68.6	1026	5.76	487	3
Comments	In Good Range	Above range	Above range	Below range	Above range	
Expected Range Low	0.45	10	150	10	150	
Expected Range High	0.85	25	300	25	300	

	Protozoa (Numbers/g)			Total	Mycorrhizal Colonization (%)	
	Flagellates	Amoebae	Ciliates	Nematodes #/g	ENDO	ECTO
Results	61739	61739	616	**5.74**	**1%**	**0%**
Comments	High	High	High	Low	Low	Low
Expected Range Low	10000	10000	50	20	40%	40%
Expected Range High			100	30	80%	80%

Organism Biomass Ratios	Total Fungi to Tot.Bacteria	Active to Total Fungi	Active to Total Bacteria	Active Fungi to Act.Bacteria	Plant Available N Supply (lbs/ac)	Actino Bacteria (µg/g)
Results	**0.47**	**0.01**	**0.07**	**0.08**	200+	3.69
Comments	Low	Low	Low	Low		
Expected Range Low	0.8	0.1	0.1	0.75		
Expected Range High	1.5	0.15	0.15	1.5		

Nematode detail (# per gram or # per mL)
Classified by type and identified to genus.
(If section is blank, no nematodes identified.)

Bacterial Feeders	3.25	
Cephalobus		0.52
Diploscapter		1.03
Eumonhystera		0.07
Panagrolaimus		0.59
Prismatolaimus		0.22
Rhabditidae		0.81
Fungal Feeders	0.22	
Epidorylaimus		0.07
Mesodorylaimus		0.15
Fungal/Root Feeders	0.07	
Aphelenchoides	Foliar nematode	0.07
Root Feeders	0.74	
Heterodora	Cyst nematode	0.37
Longidorus	Needle nematode	0.07
Rotylenchus	Spiral nematode	0.07
Tylenchorhynchus	Stunt nematode	0.22

Osborne Organics
Chip Osborne
11 Laurel St
Marblehead, MA 01945-1911

ozflor@aol.com

Report Sent: 7/9/2009
Sample#: 01-107494 | Submission:01-019651
Unique ID: Hunnewell
Plant: turf
Invoice Number: 0
Sample Received: 6/29/2009

For interpretation of this report please contact:
Soil Foodweb Oregon
info@oregonfoodweb.com
(541) 752-5066

Consulting fees may apply

Dry Weight:	Check plant requirements, but moisture appears to be fine
Active Bacteria:	Bacterial activity above expected levels; Bacterial biomass will increase as long as nutrients are available
Total Bacteria:	Higher than normal bacterial biomass suggests high bacterial species diversity
Active Fungi:	Need to improve active biomass; Add 2 to 4 gal/ ac of liquid humic acids, or 5 to 10 tons/ ac fungal compost or woody mulch, or 20 gal/ ac fungal compost tea
Total Fungi:	Fungal biomass and diversity above typical range for this plant group, in this soil
Hyphal Diameter:	Good balance of disease suppressive and normal soil fungi
Protozoa:	Nutrients are being cycled and made available to plants in good rates.
Total Nematodes:	Need to combat root feeders and switchers. Need to add beneficial fungi, improve VAM colonization and inoculate beneficial nematodes. Fungal-dominated aerobic compost is needed.
Mycorrhizal Col.:	Mycorrhizal colonization of roots too low. Add an inoculum of mycorrhizal spores, then provide humic acids to feed mycorrhizal fungi and improve colonization.
TF/TB:	Too bacterial- dominated for turf. Will lack disease suppression, nutrient retention, ability to build soil structure. Need to improve beneficial fungi to balance bacterial biomass.
AF/TF:	Low activity; need to add fungal foods to encourage fungi
AB/TB:	Low activity relative to total biomass: add bacterial foods.
AF/AB:	Soil is bacterial dominated, and becoming more bacterial; addition of fungal foods might help maintain balance

Interpretation Comments:

Actinobacteria Biomass = 3.69 ug/g
Good fungal diversity, hyphal diameters 2 to 5 um.
VAM = hyphae & vesicles.

Foodweb Analysis
Soil

Report prepared for:

Osborne Organics
Chip Osborne
11 Laurel St
Marblehead, MA 01945-1911

ozflor@aol.com

Report Sent: 7/9/2009
Sample#: 01-107492 | Submission:01-019651
Unique ID: Kelly
Plant: turf
Invoice Number: 0
Sample Received: 6/29/2009

For interpretation of this report please contact:
Soil Foodweb Oregon
info@oregonfoodweb.com
(541) 752-5066

Consulting fees may apply

Organism Biomass Data		Dry Weight	Active Bacteria (µg/g)	Total Bacteria (µg/g)	Active Fungi (µg/g)	Total Fungi (µg/g)	Hyphal Diameter (µm)
Results		0.770	78.0	500	9.49	1031	3.5
Comments		In Good Range	Above range	Above range	Below range	Above range	
Expected Range	Low	0.45	10	150	10	150	
	High	0.85	25	300	25	300	

		Protozoa (Numbers/g)			Total	Mycorrhizal Colonization (%)	
		Flagellates	Amoebae	Ciliates	Nematodes #/g	ENDO	ECTO
Results		36006	36006	1080	**3.66**	**0%**	**0%**
Comments		High	High	High	Low	Low	Low
Expected Range	Low	10000	10000	50	20	40%	40%
	High			100	30	80%	80%

Organism Biomass Ratios		Total Fungi to Tot.Bacteria	Active to Total Fungi	Active to Total Bacteria	Active Fungi to Act.Bacteria	Plant Available N Supply (lbs/ac)	Actino Bacteria (µg/g)
Results		2.06	**0.009**	0.16	**0.12**	100-150	3.57
Comments		High	Low	High	Low		
Expected Range	Low	0.8	0.1	0.1	0.75		
	High	1.5	0.15	0.15	1.5		

Nematode detail (# per gram or # per mL)
Classified by type and identified to genus.
(If section is blank, no nematodes identified.)

Bacterial Feeders	1.71	
Cephalobus		0.16
Diploscapter		0.12
Eucephalobus		0.04
Panagrolaimus		0.48
Rhabditidae		0.91
Fungal Feeders	0.12	
Eudorylaimus		0.08
Microdorylaimus		0.04
Fungal/Root Feeders	0.52	
Aphelenchoides	Foliar nematode	0.32
Aphelenchus		0.12
Ditylenchus	Stem & Bulb nematode	0.08
Root Feeders	0.48	
Heterodora	Cyst nematode	0.08
Paratylenchus	Pin nematode	0.24
Pratylenchus	Lesion nematode	0.04
Rotylenchus	Spiral nematode	0.04
Tylenchorhynchus	Stunt nematode	0.08

Osborne Organics
Chip Osborne
11 Laurel St
Marblehead, MA 01945-1911

ozflor@aol.com

Report Sent: 7/9/2009
Sample#: 01-107492 | Submission:01-019651
Unique ID: Kelly
Plant: turf
Invoice Number: 0
Sample Received: 6/29/2009

For interpretation of this report please contact:
Soil Foodweb Oregon
info@oregonfoodweb.com
(541) 752-5066

Consulting fees may apply

Dry Weight:	Check plant requirements, but moisture appears to be fine
Active Bacteria:	Bacterial activity above expected levels; Bacterial biomass will increase as long as nutrients are available
Total Bacteria:	Higher than normal bacterial biomass suggests high bacterial species diversity
Active Fungi:	Need to improve active biomass; Add 2 to 4 gal/ ac of liquid humic acids, or 5 to 10 tons/ ac fungal compost or woody mulch, or 20 gal/ ac fungal compost tea
Total Fungi:	*Fungal biomass and diversity above typical range for this plant group*, in this soil
Hyphal Diameter:	Mostly the more disease suppressive fungi present
Protozoa:	Nutrients are being cycled and made available to plants in good rates, but high ciliates indicate recent anaerobic conditions.
Total Nematodes:	Need to combat root feeders and switchers. Need to add beneficial fungi, improve VAM colonization and inoculate beneficial nematodes. Fungal-dominated aerobic compost is needed.
Mycorrhizal Col.:	No mycorrhizal colonization. Add an inoculum of mycorrhizal spores, then provide humic acids to feed mycorrhizal fungi and improve colonization.
TF/TB:	Too fungal- dominated for turf. Need to improve beneficial bacteria to balance fungal biomass.
AF/TF:	Low activity; need to add fungal foods to encourage fungi
AB/TB:	Good bacterial activity
AF/AB:	Soil is fungal dominated, but becoming more bacterial; addition of fungal foods might re-align balance.

Interpretation Comments:

Actinobacteria Biomass = 3.57 *ug/g*
Very good fungal diversity, hyphal diameters 2 to 7 um.

Foodweb Analysis
Soil

Report prepared for:
Osborne Organics
Chip Osborne
11 Laurel St
Marblehead, MA 01945-1911

ozflor@aol.com

Report Sent: 7/9/2009
Sample#: 01-107493 | Submission:01-019651
Unique ID: Sprague
Plant: turf
Invoice Number: 0
Sample Received: 6/29/2009

For interpretation of this report please contact:
Soil Foodweb Oregon
info@oregonfoodweb.com
(541) 752-5066

Consulting fees may apply

Organism Biomass Data	Dry Weight	Active Bacteria (µg/g)	Total Bacteria (µg/g)	Active Fungi (µg/g)	Total Fungi (µg/g)	Hyphal Diameter (µm)
Results	0.790	49.0	1113	13.5	349	3
Comments	In Good Range	Above range	Above range	In range	Above range	
Expected Range Low	0.45	10	150	10	150	
Expected Range High	0.85	25	300	25	300	

	Protozoa (Numbers/g)			Total	Mycorrhizal Colonization (%)	
	Flagellates	Amoebae	Ciliates	Nematodes #/g	ENDO	ECTO
Results	17455	17455	702	**3.07**	**1%**	**0%**
Comments	High	High	High	Low	Low	Low
Expected Range Low	10000	10000	50	20	40%	40%
Expected Range High			100	30	80%	80%

Organism Biomass Ratios	Total Fungi to Tot.Bacteria	Active to Total Fungi	Active to Total Bacteria	Active Fungi to Act.Bacteria	Plant Available N Supply (lbs/ac)	Actino Bacteria (µg/g)
Results	**0.31**	**0.04**	**0.04**	**0.28**	100-150	2.08
Comments	Low	Low	Low	Low		
Expected Range Low	0.8	0.1	0.1	0.75		
Expected Range High	1.5	0.15	0.15	1.5		

Nematode detail (# per gram or # per mL)
Classified by type and identified to genus.
(If section is blank, no nematodes identified.)

Bacterial Feeders	1.81	
Cephalobus		0.28
Diploscapter		0.47
Panagrolaimus		0.28
Plectus		0.16
Prismatolaimus		0.04
Rhabditidae		0.51
Rhabdolaimus		0.08
Fungal Feeders	0.31	
Chrysonemoides		0.04
Eudorylaimus		0.24
Microdorylaimus		0.04
Fungal/Root Feeders	0.24	
Aphelenchoides	Foliar nematode	0.16
Aphelenchus		0.08
Root Feeders	0.08	
Heterodora	Cyst nematode	0.04
Pratylenchus	Lesion nematode	0.04

Osborne Organics
Chip Osborne
11 Laurel St
Marblehead, MA 01945-1911

ozflor@aol.com

Report Sent: 7/9/2009
Sample#: 01-107493 | Submission:01-019651
Unique ID: Sprague
Plant: turf
Invoice Number: 0
Sample Received: 6/29/2009

For interpretation of this report please contact:
Soil Foodweb Oregon
info@oregonfoodweb.com
(541) 752-5066

Consulting fees may apply

Dry Weight:	Check plant requirements, but moisture appears to be fine
Active Bacteria:	Bacterial activity above expected levels; Bacterial biomass will increase as long as nutrients are available
Total Bacteria:	Higher than normal bacterial biomass suggests high bacterial species diversity
Active Fungi:	Filamentous fungal activity and diversity in normal range
Total Fungi:	Fungal biomass and diversity above typical range for this plant group, in this soil
Hyphal Diameter:	Good balance of disease suppressive and normal soil fungi
Protozoa:	Nutrients are being cycled and made available to plants in good rates, but elevated ciliates indicate recent anaerobic conditions.
Total Nematodes:	Low numbers, low diversity. Need to add beneficial nematodes, improve conditions to allow their survival.
Mycorrhizal Col.:	Mycorrhizal colonization of roots too low. Add an inoculum of mycorrhizal spores, then provide humic acids to feed mycorrhizal fungi and improve colonization.
TF/TB:	Too bacterial- dominated for turf. Will lack disease suppression, nutrient retention, ability to build soil structure. Need to improve beneficial fungi to balance bacterial biomass.
AF/TF:	Low activity relative to total biomass; need to add fungal foods to encourage fungi
AB/TB:	Low activity relative to total biomass: add bacterial foods.
AF/AB:	Soil is bacterial dominated, and becoming more bacterial; addition of fungal foods might help maintain balance

Interpretation Comments:

Actinobacteria Biomass = 2.08 ug/g
Good fungal diversity, hyphal diameters 2 to 5 um.
VAM = hyphae.