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See story on page 42.

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PUTTING GREEN MANAGEMENT

The Wisconsin Survey

By Robert J. Erdahl

Part One

There can be no doubt in the mind of any WGCSA member that a golf course putting green is one of the most intensively cultivated agricultural environments in existence today. We, as golf course superintendents, have at our disposal a dazzling arsenal of technological tools to control the performance of the turfgrasses growing in each of our 18 (27 in my case) micro-climates called putting greens. Before we suffer from a technological overdose, however, let us not forget that our profession is one part science and one part art/instinct, and the latter can not be taught. It is the efficient blending of technology and art/instinct into a workable putting green management program that is the mark of a successful golf course superintendent.

Given the overwhelming importance of putting greens, each of us carefully formulates a management program based on our acquired knowledge, our practical experience, and our countless efforts of trial and error. Our management programs, however, do not remain static from year to year for there is no such thing as maintaining the status quo in putting green management. Stand on last year's successes or repeat last year's management program and your neighboring golf course is liable to knock your socks off! We are employed in a dynamic profession that is constantly influenced by the latest innovations in equipment, irrigation, pesticides and fertilizers.

In order to keep pace with all of the changes, we participate in professional organizations such as WGCSA, GCSAA and WTA; we keep abreast of the latest university research; we read all the turfgrass publications we can lay our hands on and most important of all, we keep in touch with our peers. Without a doubt, a good one-on-one conversation with a fellow WGCSA member is the best way for me to gain valuable insight into one of my management problems.

It seemed logical, then, that an attempt to tap the cumulative knowledge of the WSGCA on the subject of putting green management would yield a wealth of information that could form the basis for an article in this publication. With this idea as a starting point, I developed a survey on putting green management and sent it out to 30 members of WGCSA. With 25 responses, I received enough information for two articles; but more about that a little later.

The survey contained questions about fertilization, cultural practices such as mowing, topdressing and aerifying, disease control, *Poa annua* control, irrigation practices and specialized problems such as the black layer problem and C-15 bacterial wilt. In addition, the survey asked for background information such as age of the putting greens, type of soil mix, pH, bentgrass to *Poa annua* ratio, bentgrass species, membership demands and management goals. It was not a scientific poll with a plus or minus five percent error factor. Rather, it was a simple attempt to examine where the science/art of putting green management is today in the State of Wisconsin and perhaps draw some conclusions about the future. The superintendents chosen to receive the survey represented a cross-section of golf courses in Wisconsin. Geographically, they ranged from Green Bay to La Crosse and from Wausau to Racine. Economically, they included both daily fee golf courses and private country clubs. The overall emphasis was to poll a diverse enough number of golf courses so that the results would have real significance to all WGCSA members.

As I previously mentioned, the enormous amount of in-

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formation I received in the survey responses has mandated a two-part article. The first part will review the background information and examine the nutritional aspects of putting green management. The second part, which will appear in the next issue of the *GRASS ROOTS*, will deal with the remaining survey topics. When reading both parts of this article, please bear in mind that the discussion and conclusions pertain only to the information supplied by the 25 respondents to this survey.

When comparing putting green management programs, it is necessary to first identify the background conditions under which those programs are administered. For example, a putting green built in 1910 with a poorly-drained native soil and a 50-50 mixture of bentgrass and *Poa annua* will probably be managed differently than a two-year-old putting green constructed with an 80 percent sand/20 percent peat mixture and seeded to Penncross bentgrass. On the surface, it would appear impossible to link these two management programs together and arrive at any valid conclusions. As the two articles unfold, however, you will notice that I attempt to not only average all survey results for a given topic, but I also make observations about management programs that are tailored to specific background conditions. All in all, I think you may be surprised to see some of the across the board similarities in management programs despite the various background conditions.

As we might expect, there is a relationship between the age of the putting greens and the soil mix they were constructed with. Table 1 indicates the age of the putting greens in the survey and Table 2 lists the soil mixes. Putting greens over 30 years old were constructed without the benefit of USGA specifications and are generally built out of the native soils. For many golf courses, this means poorly drained putting greens that create additional management problems. At some golf courses, however, the native soil was a well drained sandy loam that was quite adaptable to putting green use.

All of the putting greens in this survey that were built after 1960 were based on some variation of the USGA specifications and contain a sand content ranging from 60 to 90 percent. Unfortunately, some of these variations have proven to be candidates for rebuilding due to the poor quality of the raw materials and/or the mixing process. Several superintendents stressed the importance of laboratory analysis for the sand and peat plus the benefits of off-site mixing.

With the recent boom in golf course redesign, many golf courses (eight in the survey) now have several sand based putting greens to go along with their older soil based putting greens. This has created two different management programs for some of the topics included in the survey and I will point out those differences at the appropriate times.

Table 1.
Age of Putting Greens in the 1989 Wisconsin Survey

Age of Putting Greens	Number of Golf Courses[1]
Over 60 years	12
Between 30 and 60 years	4
Between 10 and 30 years	5
Under 10 years	12

[1]Golf courses with old and new putting greens are listed twice.

Table 2.
Soil Mixes for Putting Greens in the 1989 Wisconsin Survey

Soil Mix	Number of Golf Courses[1]
Poorly drained native	9
Well drained native	7
Sand mix with less than 80% sand	5
Sand mix with more than 80% sand	12

[1]Golf courses with native and sand mix putting greens are listed twice.

The pH of the putting greens fell in a range from 6.2 to 7.8 with an average of 7.1. While this range appears somewhat broad, I find no indication of any management techniques that were pH dependent. Micronutrient availability appears not to be a concern due to the universal use of fertilizers containing most of the essential micronutrients. In addition, there is no evidence that the efficacy of any pesticides is influenced by pH.

It comes as a surprise to me that the lower pH putting greens do not correspond to the higher bentgrass populations. In fact, one golf course with pH values of 7.8 has over 90 percent bentgrass while another golf course with pH values of 6.2 has 50 percent bentgrass. So much for low pH as a valuable tool to encourage bentgrass!

The determination of the bentgrass and *Poa annua* populations in putting greens is a difficult one. The issue has been further complicated by Dr. Don White's work at the University of Minnesota on the dynamics of the bentgrass and *Poa annua* populations in putting greens. Dr. White's research indicates that *Poa annua* populations peak in Spring and Fall and can decrease dramatically during the summer. For the purpose of this article, I assume that the bentgrass-*Poa annua* population estimates reported were from last summer when bentgrass levels would have peaked. Table 3 lists the bentgrass population estimates.

Table 3.
Estimated Bentgrass Population for Putting Greens in the 1989 Wisconsin Survey.

Bentgrass Percentage	Number of Golf Courses
Over 90	6[1]
75 to 90	8
50 to 75	5
Under 50	6

[1]Three of these golf courses are only two years old.

The most striking fact about the results in Table 3 is that the majority of the golf courses whose putting greens contain around a 50-50 mixture of bentgrass and *Poa annua* are among the finest in the state. So much for *Poa annua* ruining putting greens and superintendent's reputations! In fairness to bentgrass, however, the superintendents at the above golf courses, along with all the other survey respondents, indicate that their long range putting green management programs are designed to favor bentgrass.

While popular opinion generally links older, poorly drained soil mixes with higher *Poa annua* populations, the

bentgrass-*Poa annua* populations in this survey were not correlated to the age of the greens or the type of soil mix (with the exception of three new golf courses with sand based putting greens that were over 95 percent bentgrass). In fact, some of the oldest golf courses with putting greens that were constructed using poorly drained, native soil reported some of the highest bentgrass populations. The management programs at these golf courses must be very pro bentgrass in order to compensate for the inferior soil mix.

In general, the bentgrass-*Poa annua* battle is still being hard fought in Wisconsin. It is the conservative nature of Wisconsin superintendents that yields putting green management programs that encourage bentgrass without jeopardizing the health of *Poa annua*. The result appears to be a gradual shift to higher bentgrass populations, but not at the expense of playing conditions or our jobs! The specifics of these pro bentgrass programs will be discussed throughout this article.

The species of bentgrass found on the putting greens provides no real surprises. Putting greens built before 1954 are dominated by South German and Washington bentgrasses with smaller populations of Seaside and Toronto (C-15) bentgrasses mixed in. Following the release of Penncross bentgrass in 1954, the vast majority of new putting greens were seeded with this species. The exceptions are two golf courses that did reconstruction in the late 1960's and stolonized several new putting greens with Toronto bentgrass.

Of the three new golf courses in the survey (all are two years old), one seeded a mix of Penncross and Penneagle bentgrasses and the other two used straight Penncross bentgrass. There is also one new Pennlinks bentgrass putting green in the Milwaukee area.

I will cover overseeding in the second part of this article; however, I will mention here that Penncross bentgrass is the overwhelming choice for overseeding putting greens, while Penneagle and Pennlinks bentgrass are used on what appears to be an experimental basis.

One of the hardest jobs we have as superintendents is to formulate a putting green management program that will both satisfy the demands of our members and daily fee players and also maintain healthy turfgrass that will provide consistent playability all season long. Table 4 lists the most common demands of members and daily fee players along with the most common management goals.

Table 4.
Player Demands and Management Goals in the 1989 Wisconsin Survey.

Demands and Goals	Players	Management
Fast and Firm - Stimpmeter over 9′	14	8
Fast and Soft - Stimpmeter over 9′	6	0
Reasonable Speed - Stimpmeter around 8′	4	13
Consistency	7	12
Healthy Turfgrass	0	11

Values indicate number of golf courses in each category. Golf courses can be listed more than once in each column.

The results in Table 4 indicate that players still want fast and firm putting greens. There are also quite a few golf courses where the players demand fast putting greens that can hold a "screaming 3 iron." Unfortunately, only a handful of golf courses have players that are comfortable with reasonable speed. Consistency is also considered important and of course why would players care about the need for a healthy putting green!

From a superintendent's point of view, a healthy, consistent putting green that has a Stimpmeter reading of around eight feet appears to be quite popular. None of us like to mention soft putting greens and those of us, myself included, who manage fast and firm putting greens are hopefully doing so only to satisfy our players' demands rather than our own egos. I'll admit some guilt on that last count!

The conclusion to be drawn from Table 4 is that we must continue to educate our members and daily fee players about the benefits of playing on healthy, consistent and reasonably fast putting greens. The all out quest for fast putting greens will, in the long run, be detrimental to the turfgrass, our profession and the game of golf.

As you might expect, any comparison of 25 different fertilization programs for putting greens can get quite complex. To simplify the analysis, I have included several tables which summarize the data from all of the surveys. While the tables contain a great deal of information, I will limit my discussion to the major points of interest.

There is one major finding which must be discussed up front. It is the fact that the almost universal use of sand based topdressing (24 out of 25 golf courses) appears to mask the variability of putting green soil mixes that occurs from one golf course to another. In fact, with an average buildup of 1.5″ of sand based topdressing on the surveyed golf courses, it seems we are now managing the topdressing layer for fertility more than the original soil mix. Since these topdressing layers are all at least 80 percent sand, the differences in fertility programs from one golf course to the next are based more on management goals and player demands (see Table 4) rather than soil mix variability.

Any discussion of fertilization programs for putting greens always seems to start off with nitrogen, and this article will be no different. To begin, Table 5 lists the total nitrogen applied to the putting greens in this survey.

As would be expected, the highest total nitrogen applications (5.5, 6.0 and 7.0 pounds of N/M) occur on the three golf courses with new 80-90 percent sand based putting greens that are still "growing in". Those golf courses with one or two of the newer 80-90 percent sand based putting greens report that they require approximately 30 percent more total nitrogen than their older style putting greens. This additional nitrogen is usually applied in conjunction with the regularly scheduled fertilizations.

The estimated 22 golf courses have a total nitrogen application range of 1.5 to 4.5 pounds of N/M and an average of 2.5 pounds of N/M. My guess is that these figures are higher than we would have found on a similar table from five years ago.

It seems we are all increasing our total nitrogen application rates in order to improve overall turfgrass health, combat algae, improve ballmark healing, and to sleep better at night.

There is no pattern relating higher bentgrass populations to lower nitrogen rates or higher *Poa annua* populations to higher nitrogen rates. As I will discuss later, the timing of nitrogen applications rather than the total nitro-

Table 5.
Total Nitrogen Fertilization on Putting Greens in the 1989 Wisconsin Survey

Total Nitrogen for 1989 Pounds of N/M	Number of Golf Courses
1.0	0
1.5	5
2.0	4
2.5	5
3.0	5
3.5	2
4.0	0
4.5	1
5.0	0
5.5	1[1]
6.0	1[1]
6.5	0
7.0	1[1]

[1]Two year old putting greens

gen applied correlates closer to higher bentgrass populations.

Table 6 lists all of the nitrogen fertilizers used from April to October on the 25 golf courses in this survey. It is included only for your information and I am certainly not going to comment on which products are better than others; I'll let the numbers speak for themselves. Nitrogen fertilizers used for late fall and dormant applications are listed in Tables 8 and 9, and will be discussed later.

Table 6.
Sources of Nitrogen Fertilizer Used on Putting Greens from April-October in 1989 Wisconsin Survey.

Source of Nitrogen	Number of Users
Andersons 18-3-12	1
Custom Blended 8-0-12	1
IBDU 31-0-0	1
Lebanon 18-4-10	2
Lebanon 33-0-16	4
LESCO Iron Plus N	7
Milorganite 6-2-0	8
Nitroform 38-0-0	2
Nutriculture 28-8-18	9
Nutriculture 12-45-10	2
Scotts 22-0-16	3
Scotts 20-4-8	1
Scotts 17-23-6	1
Scotts 31-3-10	1
Scotts 15-0-30	9
Spring Valley 25-0-25	1
Spring Valley 12-4-8	1
Spring Valley 5-1-10	1
Spring Valley 6-1-12	1
46-0-0	5
12-62-0	3

Sources of nitrogen applied in October at a rate of 0.25 pounds of N/M or greater are listed in Table 8. All sources of nitrogen applied in November are listed in Table 9.

Table 7 lists the nitrogen applied monthly from April-November. Since the popularity of nitrogen rates and timing can easily be found in the table, I will only point out the continuing trend towards applying the majority of nitrogen in the fall. In fact in this survey, an average of over 60 percent of the total nitrogen is applied in September-November with 34 percent of that coming in November alone as a dormant treatment.

When analyzing the rates and timing for nitrogen applications in Table 7 together with bentgrass-*Poa annua* population values found in Table 3, the following general patterns emerge:

For putting greens with over 75 percent bentgrass:

1) No nitrogen before mid-May.
2) Spoon feed soluble nitrogen at 0.15 pound of N/M every three-four weeks from mid-May to mid-September.
3) Late fall nitrogen in mid-October at 0.25-1.0 pound of N/M.
4) Dormant nitrogen in November at 0.9-1.5 pound of N/M.

Table 7.
Monthly Nitrogen Fertilization on Putting Greens in the 1989 Wisconsin Survey.

Month	No. of Golf Courses Making an Application	Range of Applications Pounds of N/M	Avg. of Applications Pounds of N/M
April	5	0.05-0.50	0.12
May	22	0.05-1.00	0.30
June	21	0.05-0.90	0.25
July	16	0.05-0.50	0.16
August	13	0.05-0.50	0.12
September	25	0.05-0.50	0.30
October	16	0.05-1.00	0.32
November	20	0.25-1.50	0.82

Average yearly nitrogen application is 2.49 pound of N/M.

For putting greens with less than 75 percent bentgrass

1) May 15-June 10, one or two nitrogen applications totalling 0.5-1.0 pound of N/M.
2) June-August, granular and soluble nitrogen at 0.25 pound of N/M each month.
3) Early September, one nitrogen application at 0.5-1.0 pound of N/M.
4) Dormant nitrogen in November at 0.25-1.0 pound of N/M.

Table 8 lists the sources of nitrogen used for late fall fertilization. For the purpose of this article, late fall nitrogen fertilization is defined as applying at least 0.25 pound of N/M after October 1 and before any dormant nitrogen treatment.

As mentioned in the discussion of Table 7, the majority (75 percent) of the users of the late fall nitrogen fertilization technique are managing putting greens with over 75 percent bentgrass populations. Note that the nitrogen availability of most of the fertilizers in Table 8 is not temperature dependent.

Table 9 lists the sources of nitrogen used for dormant application. Slow release nitrogen fertilizers, whose WIN components are temperature dependent due to microbial activity, dominate the list. A strong preference for one product, Milorganite 6-2-0, indicates that superintendents are looking for very specific responses from their dormant applied nitrogen.

As I already touched on in my discussion of Table 7, putting greens with over 75 percent bentgrass populations are dormant fertilized at rates of 0.9 to 1.5 pound of N/M, usually with Milorganite, 6-2-0. Putting greens with less than 75 percent bentgrass populations receive dormant nitrogen at rates of 0.25-1.0 pound of N/M that is supplied by all of the products listed in Table 9.

Table 8.
Sources of Late Fall Nitrogen Fertilizer Used on Putting Greens in the 1989 Wisconsin Survey.

Source of Nitrogen	No. of Users	Range of Applications Pounds of N/M	Avg. of Applications Pounds of N/M
IBDU 20-0-16	1	1.00	1.00
IBDU 31-0-0	1	0.50	0.50
Nutriculture 12-45-10	2	0.25	0.25
Scotts Fertilizer & Fungicide	1	0.50	0.50
Scotts 22-0-16	1	0.90	0.90
Scotts 15-0-30	4	0.50-1.00	0.75
Spring Valley 12-4-8	1	0.75	0.75
46-0-0 Soluble	4	0.50-1.00	0.60

Late fall nitrogen fertilization is defined as applying at least 0.25 pounds of N/M after October 1 and before any dormant nitrogen treatment.

Table 9.
Sources of Dormant Nitrogen Fertilizer Used on Putting Greens in the 1989 Wisconsin Survey.

Source of Nitrogen	No. of Users	Range of Applications Pounds of N/M	Avg. of Applications Pounds of N/M
LESCO 14-0-28	1	0.75	0.75
Milorganite 6-2-0	12	0.36-1.50	0.90
Scotts 22-0-16	1	0.50	0.50
Scotts 15-0-30	4	0.25-1.00	0.75
Scotts FFII	1	0.50	0.50
Spring Valley 6-1-12	1	0.50	0.50

Dormant nitrogen fertilization is defined as applying nitrogen fertilizer in November.

Phosphorus fertilization (Note: In this article, phosphorus is elemental P and not P_2O_5) on putting greens reveals some striking differences in management programs. Seven golf courses in this survey are using no phosphorus in apparent attempts to reduce *Poa annua*. The three new golf courses apply phosphorus at average yearly rates of 5.0 pounds of P/M. The remaining 15 golf courses apply phosphorus at yearly rates of 0.2 to 1.3 pound of P/M with an average of 0.5 pound of P/M. On these same 15 golf courses, extra phosphorus is sometimes applied to the one or two new sand based greens at a yearly rate of 0.5 pound of P/M.

Although seven golf courses are using no phosphorus, several superintendents commented on both the fallacy of trying to control *Poa annua* with low phosphorus fertilization as well as the need to apply a fertilizer containing nitrogen, phosphorus and potassium, even when soil tests indicate adequate levels of phosphorus and potassium. They favor balanced nutrition with properly timed nitrogen applications along with cultural practices to control *Poa annua*. In fact, it turns out that many of the golf courses with the highest bentgrass populations on their putting greens have been applying yearly phosphorus rates of 0.4-0.6 pound of P/M for many years.

In general, phosphorus applications are made as part of a complete fertilizer containing nitrogen, phosphorus and potassium. There are two exceptions, however. The first involves four golf courses that apply a single Spring application of soluble 12-62-0 at an average rate of 0.30 pound of P/M. The second, takes into account the eight golf courses that use Milorganite, 6-2-0, during the season and the 12 golf courses that use Milorganite as a dormant nitrogen treatment. In 10 out of these 12 golf courses, the dormant phosphorus applied in Milorganite makes up 80 percent of the total phosphorus applied for the entire year.

Ideas about potassium fertilization (Note: In this article potassium is elemental K, not K_2O) are undergoing some dramatic changes. For years, the classic recommended N-K ratio was approximately 2-1 (Remember, K is expressed as elemental K, not K_2O).

In recent years, however, many superintendents have begun to use N-K ratios of 1-1, 1-2 and even 1-4 (The overall topic of N-P-K ratios will be covered in the discussion of Table 11.).

The increase in potassium use is due to the increases in disease resistance, drought tolerance and winter hardiness that have been attributed to potassium fertilization programs. Many of us seem to be applying the old saying that "If a little bit is good, more will probably be better." It must be pointed out, however, that most of the nation's turfgrass researchers are sticking to the traditional N-K ratio of 2-1. Some have even suggested that N-K ratios such as 1-2 and 1-4 may alter the soil chemistry enough to cause deficiencies of calcium and magnesium.

In response to the increased demand for potassium fertilizers, several companies have come out with products that apply nitrogen and potassium in ratios of 1-1 and 1-2. Those superintendents who want even more potassium are applying additional potassium sulfate, mainly in the Spring and Fall at rates of 0.5 to 1.5 pound of K/M per treatment.

Table 10 lists the seasonal variation of potassium fertilization on putting greens. Potassium application rates parallel nitrogen application rates (see Table 7). Both are applied at moderate rates in the Spring, sparingly in the Summer and the heaviest applications occur in the Fall. The average yearly application of potassium is 3.07 pounds of K/M. When compared to the average yearly nitrogen application of 2.49 pounds of N/M (see Table 7), the N-K ratio is 2.49-3.07 which factors out to 5-6. It appears then, that many of us are entering some uncharted fertility waters with our ever increasing use of potassium.

Table 10.
Seasonal Potassium Fertilization on the Putting Greens in the 1989 Wisconsin Survey.

Season	Range of Applications Pounds of K/M	Average of Applications Pounds of K/M
April & May	0.40-3.50	0.92
June-August	0.40-3.50	0.55
September-November	0.50-5.00	1.60
Total for the Year	1.30-12.00	3.07

Values are expressed as elemental potassium, not K_2O.

In my individual discussions of N, P and K fertilization programs, the ranges and averages for the application of these three nutrients is well documented. In my discussion of N-P-K ratios, I am going to deal with proportions of N, P and K rather than the actual values. For example: A N-P-K ratio for the actual pounds of N, P and K/M used on a putting green in one year might be 2.6-0.3-1.7. Comparing 25 different such values as this is difficult; so I convert the values by multiplying the N, P and K by a factor that changes the P value to a whole number and then round the N and K values to the nearest whole number. Thus an actual value of 2.6-0.3-1.7 becomes a modified value of 9-1-6. These modified values are much easier to compare. In a similar fashion, all 25 values for actual N-P-K ratios have been modified to the ratios found in Table 11.

The ratios in Table 11 are divided into three groups; N greater than K, N equal to K and N less than K.

The N greater than K group contains the six golf courses that come closest to matching the traditionally accepted ideal N-P-K ratio of 7-1-4 (based on elemental N, P and K).

The N equal to K group, with 11 golf courses, accounts for the most popular N-P-K ratio. In addition, I find it extremely interesting that all seven of the golf courses that do not use phosphorus fertilizer have a N equal to K ratio.

The N less than K group represents the eight superintendents who are breaking new ground in putting green management. As you can see from the ratios, some are using two to four times as much K as N.

The average ratio for all 25 golf courses is 13-1-16 as compared to the traditionally accepted ideal ratio of 7-1-4. It is obvious, then, that putting green fertilization in Wisconsin is evolving away from traditional standards and towards a new era of proportionately less N and P and more K.

Table 11.
N-P-K Fertilization Ratios on Putting Greens in the 1989 Wisconsin Survey.

N-P-K Ratio	Number of Golf Courses
N greater than K	
3-1-2	4
20-1-10	2
N equal to K	
1-0-1	7
15-1-15	3
40-1-40	1
N less than K	
2-1-6	2
5-1-10	3
20-1-30	2
12-1-48	1

The average N-P-K ratio for the 25 golf courses is 13-1-16. The derivation of the ratios is explained in the text.

Although N, P and K remain the three dominant elements in putting green fertilization, secondary nutrients (Ca, Mg and S) and micronutrients (Fe, Mn, Mo, Zn, Cu, B, Cl) are also generating some attention.

The use of sulfur is being limited by some superintendents in response to the "Black Layer" situation. This will be discussed further in the second part of this article.

Table 12.
Sources of Iron Fertilizer Used on Putting Greens in the 1989 Wisconsin Survey.

Source of Iron	Number of Users
Agriplex 0-4-4-5 Fe	3
Ciba-Geigy Fe330	4
Iron Sulfate	9
Microgreen	4

This table contains only those iron fertilizers not already listed in Tables 6, 8 and 9. Iron application range is 0.25 to 4.5 pounds of Fe/M. Iron application average is 0.80 pound of Fe/M.

Two golf courses add small amounts of magnesium sulfate (0.25 to 0.5 ounces of $MgSO_4$/M) to their regular soluble fertilizer applications. The reasoning is that supplying additional magnesium, the central atom of chlorophyll, will enhance the green color without increasing nitrogen application.

When it comes to micronutrients, many of the fertilizers listed in Table 6, 8 and 9 contain sufficient amounts to supply the needs of putting greens. Iron is the only micronutrient thought to be needed in amounts greater than that supplied by the above mentioned fertilizers.

Each of the 25 golf courses uses at least one of the iron containing fertilizers listed in Tables 6, 8 and 9. Additional iron fertilizers are given in Table 12. Single application rates can vary from 0.01 pound of Fe/M with soluble fertilizers up to 0.7 pound of Fe/M when using Milorganite, 6-2-0-4 Fe, as a dormant fertilizer at the rate of 1.0 pound of N/M. These rates place iron fertilization ahead of phosphorus fertilization at 18 of the 25 golf courses.

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The reason for iron's popularity is its ability to enhance the synthesis of chlorophyll which results in greener color without increased nitrogen use. Putting greens in Wisconsin also respond favorably to iron applications because of cooler soil temperatures throughout much of the growing season that limit the microbial release of iron from organic sources along with pH levels that are just high enough to start limiting iron availability in the soil.

Before concluding this discussion of putting green nutrition, I feel it is necessary to stress the importance of regularly scheduled soil testing. Pick a reputable soil testing laboratory that uses extraction procedures that are calibrated to Wisconsin soils. Be sure to submit representative samples that are the depth recommended by the soil testing laboratory. Testing every two years will assure you of staying on top of any changes in the nutrient levels in your putting greens.

The second part of this article will appear in the next issue of the *GRASS ROOTS*. It will cover the following aspects of putting green management in Wisconsin.

Aerification	Mowing
Spiking	Irrigation
Verticutting	Pesticide Applications
Rolling	Winter Protection
Turf Groomers	Snowmold Control
Top Dressing	*Poa annua* Control
Overseeding	Changing pH's
Wetting Agents	Additional Special Topics

CEDAR CREEK: Birthplace Of A Golf Course

(Part One)

By Pat Norton

Have you ever been involved in "bar talk"? Bar talk, by definition, is when avid golfers get together in post-round situations and begin discussing golf courses. I personally have had bar talk conversations with people ranging from golf professionals and club members to our pediatrician and fellow church members. They all assume that since I work in the golf course business I must really love talking about golf courses.

The conversations usually go something like this — "Have you ever played Hole in the Woods?" or "How about that third hole at Okeechobee Mounds?" Closer to home, every superintendent has probably been cornered and asked about remodeling those two or three bad greens, adding a dozen sand bunkers, and building those long needed ladies tees (now known as front tees). Usually the idea is that all of these projects will be absorbed into the existing maintenance budget, accomplished with in-house labor, and completed before the end of the year.

"Wouldn't that be great? Let's talk to the green committee about that, right guys? If they don't agree, then we should get together, buy some land, and build our own golf course! Membership here at Prairie of the Swamps is too darn expensive anyway!" That, my friends, is called bar talk.

The point is that golfers do love to talk and they do love to dream. Sometimes that's how new golf courses come into being. Cedar Creek is the result of one man's dream coming to fruition on 200 beautiful acres between Onalaska and Holmen in La Crosse County.

Initial site visits involved Terry Clemons, original project developer, and Bob Chalsma, project engineer. These preliminary visits determined site suitability for residential development. After Bob Lohmann was retained as golf course architect it was soon determined that the site was very suitable for golf course as well as residential development.

This site is close to La Crosse and will be within one mile of the new freeway connecting up with I-90. It also has 120 feet of elevation change, dense woods over some of the site, sandy soil in many places, and some really spectacular views — all great features for a new golf course project. But the key to starting this project was the availability of and accessibility to high quality residential lots on the property. These 1 to 1¼ acre lots range in price from $40,000-$65,000 depending on location, accessibility, and view.

After determining that the site was indeed suitable for this type of development, the golf course portion of the project began. Preliminary clearing and grading on holes four and five began in October 1987. These two holes were constructed on extremely hilly and wooded land. It seemed impossible, in my amateur view, to build golf holes through this maze of natural features. Where is the green supposed to be? Puzzlement was quite literally my attitude in the early stages of Cedar Creek. I couldn't imagine the land changing its appearance so abruptly and completely. But through the assurance of Phil Sage, project architect for Lohmann Golf Designs, I soon began to understand the grading plans and see what was happening. And there was a lot of finality in the three Cat D-6 dozers daily moving out trees and knocking down hills in enormous quantities. I got into the construction mode quickly.

Engineering, survey and layout, and construction itself continued in April 1988. As work proceeded, everybody quickly learned to trust the design plans, the layout stakes, and the earthmoving operators. Charlie Kisow and I were responsible for on-site project supervision, which meant anything from surveying, to lining up construction materials, to daily communication with the contractors. We were both relatively inexperienced at this earthmoving game, however, so it worked out best in the early stages to trust Terry Links' judgment. It was always stressed to us by Bob Lohmann that we were looking for a certain quality in the finished product. How it was achieved — the mechanics and methods — was Terry's decision as the primary earthmoving contractor. Daily cost figures were kept and periodic assessments were made — total hourly machine costs divided by total estimated yardage moved equals cost per yard. These costs were constantly compared to budget and shared between Terry Link and ourselves to insure that the earthmoving stayed on budget.

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