



Integrated Pest Management (IPM.) Plan for Ledges Golf Club, South Hadley, MA

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I. Introduction:

The production and maintenance of high-quality turfgrasses on golf courses requires extremely close management of water, nutrients and a number of pests including insects, disease causing fungi/nematodes and weeds. The potentially adverse environmental impacts associated with these practices include 1) contamination of surface water and groundwater resources with nitrates and residual pesticides; 2) perceived health effects on humans, wildlife and other non-target organisms and 3) development of insect and disease populations resistant to currently used pesticides.

The concept of Integrated Pest Management has been developed over the past 10 year period as a "systems" approach to Turfgrass management with the prime objectives directed at reduction of potentially adverse environmental effects. University Turfgrass Programs throughout the nation as well as the USDA and private industry have focused intensely upon the goals of *reduced input*. Research programs (long and short term) have yielded important data concerning water and soil management, fertility and nutrition of turfgrasses, genetic improvement of turfgrasses toward lower requirements and pest resistance, efficacy and fate of commonly utilized pesticides and fertilizers, precise models to predict the timing and extent of pest problems and the development of biological controls for insect, disease and weed problems. Much effort has also gone into characterizing the turfgrass environment with regard to its very unique features compared to any other agricultural commodity. The concept of IPM is, very basically, to integrate all the above listed research knowledge into a "systems approach" to turfgrass management with the ultimate result of reducing all facets of input into the environment. IPM not only greatly reduces environmental impact; it also is an extremely cost effective approach to professional turf managers.

IPM programs have been developed over the years for most crop commodities and have expanded to include all production factors in order to sustain long-term productivity, optimize yields and profitability and maintain the integrity of the local ecosystem. IPM has expanded into the concept of ICM (Integrated Crop Management) which includes such factors as species and cultivar selection,

soil building practices, tillage systems, nutrient management, chemical, biological and cultural pest management as well as soil-water-energy and natural resource conservation. This integrated systems approach has been defined as "Turfgrass Management Systems" or TMS. TMS combines all cultural management factors for sustained productivity of an acceptable level of quality for turfgrass, course profitability and the integrity of ecosystems on and in the vicinity of the golf course. Critical components of TMS include selections of 1) turfgrass species and cultivars; 2) soil management practices; 3) clipping and cultivation practices; 4) nutrient management; 5) irrigation and drainage management and 6) chemical and cultural pest management. Conservation of soil, water, energy and other natural resources during the construction phases of the golf course as well as the maintenance phase are also primary goals of TMS.

IPM, ICM and TMS seek to minimize the disadvantages associated with intensive nutrient, pesticide and water inputs and to maximize the advantages of their use. The development of *site specific* TMS programs offers one of the few comprehensive solutions for systematic control of environmental problems related to management of ecosystems. Such integrated approaches offer options for selections of alternate control strategies and to maximize chemical efficiency. TMS (or IPM) does not preclude the use of pesticides and inorganic fertilizers when needed. The key phrase is *when needed*. The basic components of TMS are:

1. A system using multiple control methods.
2. A decision process based on intensive use of information.
3. A risk reduction system.
4. A cost effective and site specific management strategy.

II. Management Guidelines for Ledges Golf Club

A. Turf Management System (TMS) Based on IPM: (Pesticide Usage Plan)

1. Reduced Frequency of Pesticide Usage: The Ledges course will implement IPM procedures to radically reduce the frequency and rates of pesticide usage in general. *The selection of less toxic, less mobile and less persistent pesticides* coupled with the use of alternate strategies such as biological control and recommended cultural practices will reduce potentially adverse environmental effects. *Controlling the timing and amounts* of a particular pesticide application in relation to local environmental conditions, especially rainfall, will reduce offsite movement and enhance degradation characteristics of utilized compounds. This is especially effective when determining *Action Thresholds* of each target pest so that pesticides are used only when populations become economically critical and in need for control.

2. Selection Criteria and Usage of Pesticides: *Only pesticides specifically labeled for usage in Massachusetts* will be used at South Hadley and only by properly registered, certified and trained personnel. *Selection criteria* for the type of pesticide will include consideration of the target species or disease, pesticide characteristics and site characteristics. Important pesticide characteristics such as efficacy; solubility; formulation; degradation rate; volatility; adsorption; potential toxicity to natural pest enemies and toxicity to wildlife or non-target species will be carefully considered prior to usage or development of a timing program. *Selection of less toxic,*

less mobile and less persistent pesticides or use of alternate control strategies will reduce potentially adverse environmental effects. *Proper equipment maintenance and calibration* coupled with *the selection of formulations which reduce mobility* will enhance pesticide efficacy as well as degradation. Application methods such as incorporation or placement below the soil/thatch surface and "watering-in" will reduce exposure to runoff and enhance soil adsorption.

3. Handling, Storage and Disposal: The Ledges Golf course will store all pesticides in a State and Federally approved storage facility to ensure complete safety and security of all utilized materials. All applicators at the South Hadley course will be required to use protective clothing, gloves, shoes and respirators when recommended and all unused chemicals and containers will be properly stored or disposed of by State and Federal guidelines.

4. Alternate Pest Control Strategies: A significant component of the Ledges IPM/TMS plan will include the use of non-pesticide approaches toward pest control. The most fundamental approach will be the *maintenance of an actively growing and competitive turfgrass environment* which is well known to outcompete weed species, promote active soil microbial activity and reduce the inoculums of soil borne disease organisms. Whenever possible, turfgrass species selections will focus upon the use of *Endophyte enhanced* varieties which are extremely effective in biological resistance to almost all above ground insect pests. Endophyte enhanced species of turfgrasses are also much more disease resistant as well as having increased environmental resistance to drought and heat stresses. The use of *natural biological control species* such as parasitic nematodes, pathogenic bacteria as well as natural insect predation of pest species will be incorporated into the overall pest management plan. Commercially available insect attractants and traps will also be strategically placed throughout the course when active thresholds are determined.

B. TMS Plan for Fertilizer Nutrient Management:

1. Use of Minimally Acceptable Rates: The fertility program at Ledges Golf course will be devised and maintained according to the following criteria:

a. Determination and selection of realistic goals for turfgrass quality at all locations such as tees, fairways, greens and rough areas. The objective will be to use fertility rates recommended by research programs so that fertilizer input will be minimal. Tees and Greens will obviously receive higher maintenance levels and require higher rates of fertility while fairways will be significantly reduced and rough areas left to natural nutrient turnover.

b. *Utilize species and cultivars which are known to provide acceptable quality turfs under minimal fertility requirements.* At the onset of the fertility program, tissue and soil tests should be done on all areas/species to determine proper application rates. Tissue tests need only be done within the first year. Soil testing should be accomplished at least once per year at all sites.

c. *Utilize organic or slow-release forms of nitrogen on all locations to the greatest extent possible.* Fairways should be predominantly fertilized with natural or synthetic forms of nitrogen while tees and greens should be including at least 50% of their total nitrogen as a slow release form. Natural organics radically reduce or even eliminate the leaching of nitrate while at the same time dramatically stimulating soil microbial populations and activities which enhance pesticide immobility and degradation. Greens comprised of 70-80% sand need to be fertilized (particularly

with nitrogen) very frequently - usually at a rate of 1/4 to 1/2 LB of N/1000 sq. ft. per two week period. Considering the wetland areas adjacent to many of the greens at the South Hadley site, fertilization should be accomplished with materials composed of at least 50-60% short chain ureaforms (formolene/nutrilene/agrilene etc.) with the remainder being soluble urea. Absolutely no nitrate forms of fertilizer will be used and soluble ammonium sources should be avoided.

d. *Irrigation and drainage issues* are critical with regard to nutrient and, in particular, nitrogen mobility. In general, leaching of nitrates is extremely limited on turfs in comparison to all other crop commodities. This has been well established over the years and is due primarily to the extensive root systems and deposition of large quantities of organic matter to underlying soils within a turf profile. Irrigation on all areas of the course should be practiced on an "as needed" basis to keep water movement at a minimum and reduce cost of irrigation. Minimal irrigation also has the additional benefit of increasing a turfs natural ability for drought and heat resistance by increasing rooting and hardening of tissue. The concept of "as needed" is especially important for sand greens where irrigation will necessarily be most frequent.

C. Assessment and Monitoring of Off-Site Transport of Pesticides and Mineral Nutrients (Fertilizer)

Potential off-site transport of chemicals and fertilizers will be assessed by determination of existing soil textures, percent soil organic matter, depth to groundwater and distance from wetland areas and topographical considerations. The installation of test wells to periodically assess any possible movement and deposition of chemicals/fertilizers to ground water and wetland areas is in place. Strategic locations of these test sites include three areas where greens (3, 5 and 14) have been built in close proximity to the wetland areas. Two other test sites (7, 13) will be placed upstream, where the wetland enters the golf course and at the far most exit of the wetland to determine entrance of any possible contaminants from sources off the golf course as well exit of any chemicals or nitrates from the wetland area. Testing will take place yearly in November. Sample collection and analysis will be undertaken by a State approved laboratory to ensure accurate and unbiased procedure. Results of these periodic tests will be available upon request.

III. Conclusions:

The development and implementation of a Turf IPM/TMS plan has been shown to virtually eliminate any potential contamination by pesticide/nitrate movement into groundwater reserves or wetland areas when properly trained personnel follow procedure. Research has shown repeatedly that turfgrass ecosystems have the ability to restrict, degrade and utilize most pesticides with far more efficiency than any other agricultural endeavor. These results are a reflection of the relatively large and extensive root systems, yearly deposition of great quantities of organic matter to underlying soils and extremely active soil microbial populations. IPM/TMS ensures that all possible methods are being applied to reduce and eliminate non-point source contamination.

Specific Strategies Utilized in IPM for the Ledges Golf Club:

1. Cultural Practices Designed to Reduce Pesticide/Nutrient Input:

A) Compaction of the underlying soil on golf courses is a major problem, particularly on public courses receiving many rounds of golf per day/week/month/year. A compacted soil will promote disease, insect and weed problems and necessitate the over use of chemical controls as well as increasing fertilizer demands. Compaction also promotes surface run-off of irrigation/rainfall leading to movement of applied chemicals. A program of "aeration" and "topdressing" specific to the Ledges golf course will be developed according to the soil types and level of play (number

of golf rounds) calculated. Since the Ledges golf course will be a public access course, it is assumed that a relatively high level of play will occur and that at least 2-3 aeration events followed by topdressing, will be needed. Since golf greens received a more "focused" amount of compaction, aeration will follow a minimum spring, summer and fall schedule - even though greens will be constructed by USGA specifications. Fairways will be composed of bentgrass and will be aerated at least twice, each spring and fall season. The progressive program of aeration and topdressing will significantly reduce the usage of pesticides in general.

B. Mowing Practices: A general rule of thumb with regard to turfgrass culture is that the higher the mowing height, the more extensive the root system and the "healthier" the turf will be - particularly with regard to inherent disease/insect resistance. Mowing heights at the Ledges golf course will be maintained at the highest level possible while still maintaining modern golf turf quality demands. Not only will turf be more resistance to pests, but higher mowing heights will result in much less weed infestation due to "shading" of the soil surface and competition for mineral nutrients and water.

Mowing equipment will also be kept in "top notch" condition so that grasses are not scalped or cut poorly which would increase the possibility of disease occurrence. Different types of mowers are best for different conditions/grass types and the Ledges golf course will provide all appropriate and recommended mower types.

C. Irrigation practices are considered critical not only to maintaining a proper IPM program but also for economic considerations. The length of time (and hence, the amount of water) it takes to adequately water particular areas (i.e. fairways, greens, roughs) is determined by the time it takes to wet the turf to the depth of its root system. Most turfgrass roots extend to four to six inches into the soil. *Infrequent and deep* watering are preferred to shallow frequent events to avoid over usage of water as well as limit the amount of moisture on surface foliage to inhibit disease infestation.

Deep watering also promotes deep rooting. Ledges golf course will utilize tensiometer technology to characterize each area in terms of time necessary for irrigation to the proper depth. This initial plan will allow for precise irrigation with virtually no over usage. Greens areas will unavoidably be irrigated more since they are mown much lower than fairways and, therefore, will have shallower roots. Proper irrigation is, as mentioned earlier, critical to maintain high quality turfs as well as reduce pest infestations which will reduce pesticide and fertilizer usage. The Ledges golf club has installed a "state-of-the-art" irrigation system which will provide adequate irrigation to all areas of the golf course without overlapping. It is set on computerized timers and will be designed to provide optimum irrigation without excess water waste. In addition, irrigation equipment will be kept in proper repair, providing all areas of turf with adequate coverage. Low spots will be leveled or drained to avoid waterlogged soils which favor weed and disease organisms. Regulation of irrigation schedules will be adhered to, and the soil surface will be allowed to dry between irrigation events, inhibiting weed germination.

D. Thatch levels within all turf areas will be kept at a minimum. Thatch is a layer of dead turf material (primarily stem tissues) found at the surface of the soil and can build-up to unacceptable levels if not removed. A deep layer of thatch tends to intercept irrigation water keeping disease

susceptible crowns of grasses too wet and impeding flow of water to the root zone. A thick layer of thatch will also tie up insecticides and other pesticides at the surface not allowing for control of root-feeding insects or root diseases. Conversely, a minimal level of thatch is necessary for organic matter deposition as well as promoting the proper "cushioning" necessary for fine turfs. Ledges Golf Club has employed a thatch maintenance program involving periodic verticutting to remove thatch to proper levels and, as such, will decrease the usage of water and various pesticides.

E. Adequate nutrient levels will be provided through proper fertilization techniques to promote steady, healthy turf growth and development. A lack of soil nutrient levels promotes weed infestation as well as reduces overall vigor resulting in increased pesticide usage. The soil will be tested on a yearly basis for nutrient status as well as soil pH levels which will be modified to optimum levels according to soil tests. The Ledges golf course will utilize state of the art technology with regard to fertilizer application ensuring exact, recommended amounts are applied in a timely fashion. *Slow release and organic fertilizers materials will be used extensively throughout the ledges golf course.* The use of these materials will not only result in much more efficient use of applied nutrients but also greatly reduce the leaching and runoff losses of nitrogen. Slow release and organic sources of nitrogen also encourage a steady and controlled growth habit as well as *reduce the extent of disease infestation which results in much lower usage of pesticides.* Use of organic fertilizers also greatly encourages soil microbial activity which enhances production of beneficial organic matter/soil nutrients as well as promoting the breakdown of residual pesticides.

F. The use of surfactants (soil wetting agents) as well as commercially available organic biostimulants is an integral component in the Ledges course management plan. Wetting agents literally make water "wetter" by reducing surface tension allowing for more rapid water penetration through soils, particularly hydrophobic or localized dry spots. The use of wetting agents greatly reduces the effective usage of water as well as allowing for much more efficient use of pesticides resulting in an overall lower chemical usage. Organic biostimulants such as processed fish waste/seaweeds and other natural organic amendments have been shown to reduce the effects of environmental stresses such as heat, drought, salinity and wear by promoting deeper root systems and overall increased vigor. Reducing these environmental stresses also makes the turf much more resistant to biotic stresses such as diseases/insect and weed pests. A reduction in pesticide usage is again the ultimate result.

2. General Pesticide Usage Plan @ The Ledges Golf Club.

A. The current technology centered on IPM in turfgrass management of golf courses has been shown to vastly reduce the usage of all pesticides and fertilizers while continuing to maintain high quality turf necessary to the game of golf. Pesticide usage is, however, still a necessity for proper golf course maintenance. As noted in the overall IPM description, Ledges will be on a strict program which daily monitors all facets of weather, particularly temperature and moisture levels and will be directed by a highly trained golf course superintendent educated in the identification, diagnostics and life cycle of all possible pests. Daily weather and pest levels data will be used in a computer model to determine "threshold" levels of various pests so that once attained (if at all), the proper pesticide at recommended levels can be used. Using this IPM approach reduces any wasteful "preventative" usage and promotes a "curative" approach only when pest levels reach critical population levels (if at all). Reducing the number of applications and concentrations with this IPM approach has been shown

to be highly effective, economically sound and environmentally viable. This is truly a "holistic" approach toward turfgrass maintenance.

B. Ledges Golf Club Monitoring Program. To ensure groundwater quality, a groundwater monitoring program has been implemented and the results of this program made public. Five shallow groundwater monitoring wells on holes 3, 5, 7, 13 and 14 have been built and or added after the construction stage. And three surface areas have been located. Baseline testing of monitoring wells has been done, and yearly testing for pesticides of common usage as well as nitrate/nitrite will be done in November. If no pesticides and or nitrate/nitrites are found after the November 2011 testing, Ledges Golf Club will discontinue testing of the wells and surface water. *Testing will be done by a state approved laboratory and will represent an unbiased view of resulting data.*

Conclusions:

Ledges golf club has reviewed alternative programs regarding pesticide application and has concluded that the relatively complex IPM program strategies are the best and most scientifically accepted procedures for the reduction of pesticide usage. The essence of this program is the constant monitoring of the turf to allow strategies other than chemical application to have the best possible chance of succeeding and, thereby, preventing or greatly reducing the necessity for chemical application. IPM is a significant break from traditional golf course management which relied, for the most part, on standardized chemical application on fixed schedules without regard to actual need or site environmental conditions. IPM procedures recognize that chemical use is not the only solution to effective turf management, but rather, used only as a last alternative in a complex, site specific turfgrass environment. It should be noted that compared to high density residential developments, golf courses pose very significantly less a threat to the environment in all facets of lawn/turf management. Improper application rates coupled with too frequent application events by inexperienced homeowners is well known to be much more detrimental to surrounding wetlands, groundwater and well sites. Furthermore, golf course professionals must be licensed by the State of Massachusetts prior to handling any pesticides - homeowners do not! Extensive professional testing by the State on a yearly basis ensures that golf course superintendents remain "up to standard" with regard to safety and application procedures.

Model Pesticide Usage Plan for: The Ledges Golf Club

I. Weed Control:

A. Pre-emergence Weed Control: Provide effective control of crabgrass and other annual grass weeds for several weeks or months, depending upon dosage and products. The effectiveness of these materials is based upon their ability to provide control without turf injury. The best approach is application before annual seeds germinate and, as such, timing is important. These herbicides should be applied at least two weeks prior to expected weed seed germination - late April or early May in Massachusetts. These chemicals should be watered-in immediately after application. Ledges may update to newer improved chemistries as they become available.. The primary products that Ledges will utilize are as follows:

- *Bensulide (Betasan 4E)
- *Dithiopyr (Dimension IEC)
- *Pendimethalin (Pre-M 60DG)
- *Benefin + Trifluralin (Team 2G)

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Note: Only one or at the most, two of these compounds would be used once or twice yearly.

B. Postemergence Weed Control: Control of emerged grassy weeds and broadleaf weeds compliment a sound weed management program. These herbicides are applied after weed seeds germinate and are the most utilized materials for weed control. As such, there are many products available for uses that accomplish the same results. Selection of materials is primarily up to the experience and judgment of the superintendent who bases the decisions on efficacy, economics and environmental impact. Ledges may update to newer improved chemistries as they become available to prevent resistance. The following is a list of materials commonly in use - of which some will most likely be utilized at Ledges.

*Acclaim I

*Trimec

*Drive

*Proxy

*Banvel

II. Insect Pest Control:

The only insect pests known to be serious problems on golf courses are white grubs, sod webworms and cutworms, hyperodes weevils and bluegrass billbugs. The Ledges will utilize current state of the art technology with regard to "biological control" of insect pests to reduce usage of chemical control Biological control strategies are an important part of IPM and greatly compliment chemical control

A. Biological Control Materials:

1. Milky Spore: A natural bacteria which causes a disease of the digestive system of Japanese beetle grubs, It is non-toxic to humans and other non-target organisms,

2. Bacillus Thuringiensis (BT) : A bacteria which causes disease in several kinds of insects, Recently several new strains of BT have been identified which are quite specific in the kinds of insects they attack. The strains which are available are effective to varying degrees on cutworms and sod webworms

3. Entomopathogenic Nematodes: Small microscopic worms which attack certain insects such as cutworms and sod webworms and to some degree, white grubs,

4. Neem: A derivative of the neem tree which grows in India and other tropical settings, the compound is natural and repels several kinds of insects and often caused them to stop feeding, Neem also acts as an insect growth regulator preventing some insects from molting normally from one stage to another. Controls cutworms and sod webworms in turf.

5. Endophytic grasses: Some grasses contain "fungal endophytes" which are beneficial symbionts, These grasses have been shown to be highly resistant to all above ground chewing insect pests and to a limited degree, white grubs, The only endophytic turfgrasses are tall fescues (used primarily on roughs), fine fescues (used in roughs and fairways) and perennial ryegrasses

(used on roughs, fairways and tees). Usage of endophytic grasses radically reduces the usage of insecticides and the Ledges will incorporate these grasses as extensively as possible. Ledges may update to newer improved chemistries as they become available to prevent resistance.

B. Chemical Control: Insecticides:

Chemical control methods will be utilized only as specified in the IPM plan and only as a last alternative method, Merit, Mach II, MatchPoint, Triple crown

The Ledges Golf Club will only utilize materials known to be comparatively safe with regard to soil mobility, half-life properties and ground water contamination. .

III. Disease Control (Fungicides)

Most common turfgrass diseases are caused by fungi. Fungicides kill or inhibit the growth of fungi and there are two general types of fungicides: contact or protectant and systemic. Contact types cover the plant surface and prevent infections while systemic types are absorbed into plant tissues and may provide some curative action. Ledges may update to newer improved chemistries as they become available to prevent disease resistance. The following are a list of possible choices of fungicides on The Ledges course:

*Tersan 1991

*Insigna

*Segway

*Chipco 26019

*Subdue

*Koban, Terrazol

*Affirm

*Exteris

*Fame

*Interface

*Lexicon

*Mirage

*Signature

*Xzemplar

*Traction