VII. Appendix D

INTEGRATED TURF AND PEST MANAGEMENT PLAN

***THE* PRESERVE COUNTRY CLUB**
Old Saybrook, Connecticut

Adapted from:

Environmental Management Plan The Preserve Country Club
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INTRODUCTION

A proposal has been made for the development of an 18-hole golf course as an element of The Preserve Country Club in Old Saybrook, Connecticut. The Preserve golf course, like other well-run golf course operations, will rely on a combination of management programs, including an integrated turf and pest management program. Turfgrass cultural practices include mowing, fertilization, irrigation, cultivation, and the use of Integrated Pest Management. Many people assume, erroneously, that when fertilizers or pesticides are used on a golf course they move off-site in response to irrigation or rainfall and create environmental problems, particularly to surface waters or shallow groundwater. While there is a potential for such movement, this potential can be reduced to negligible levels and negative environmental impact can be virtually eliminated by proper course design and management practices.

The following integrated turf and pest management plan has been prepared to serve as both a design and construction guide and an operations and maintenance manual for the proposed golf course. As a design and construction guide, the plan defines appropriate minimum siting criteria for golf surfaces relative to sensitive resource areas (e.g., setbacks from wetland and watercourse areas), turf species selection criteria to ensure that the turf established on the site is suited to both environmental and future use pressures, and the initial grow-in fertilization needs of the turf. As an operations and maintenance manual, the plan defines the elements of integrated pest management, the specific fertilizer and pesticide materials which may be utilized on the golf course, site-specific pesticide use restrictions and the basis for establishing those restrictions, and training requirements for the superintendent and other maintenance personnel.

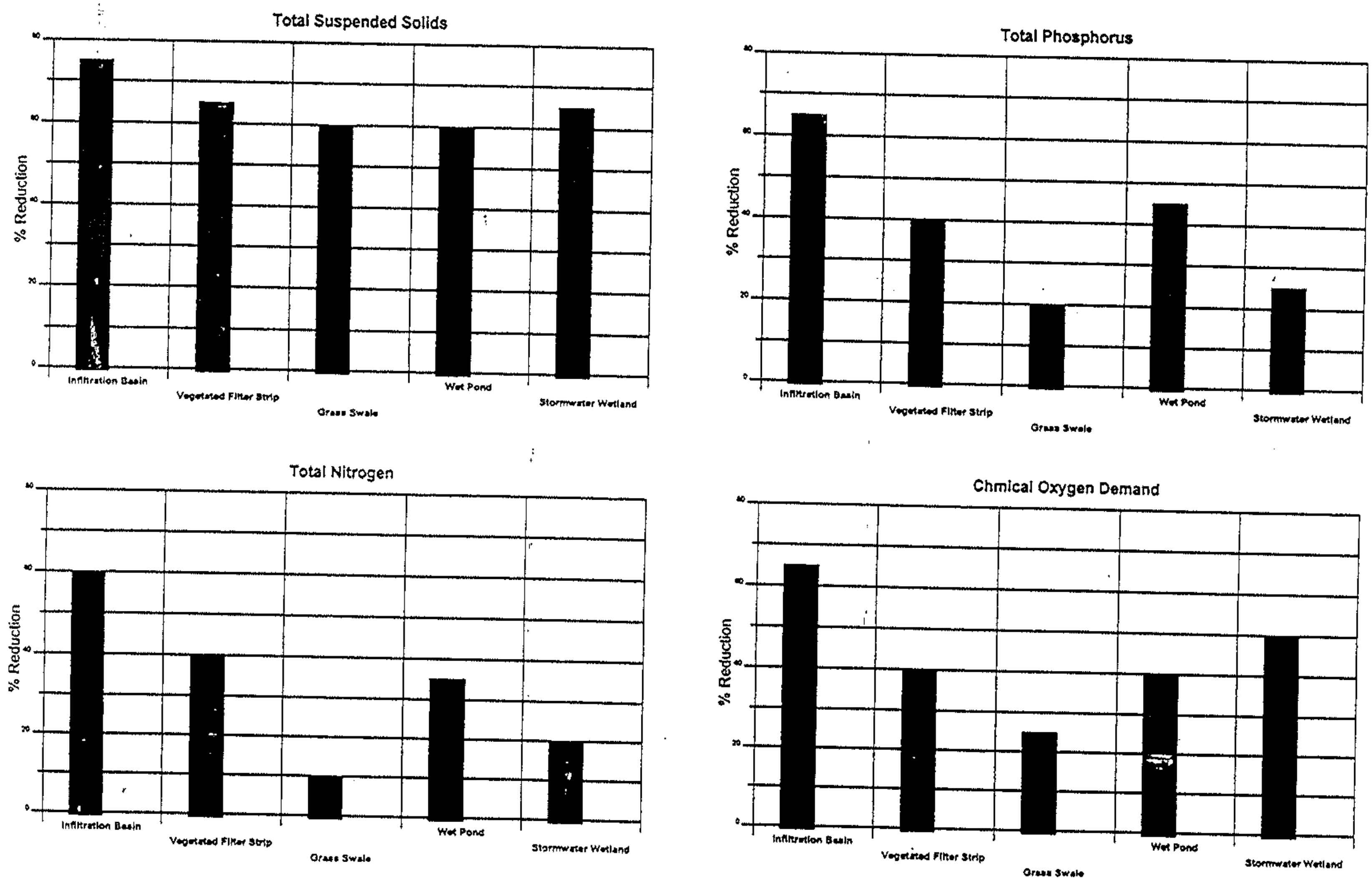

Figure 2. Relative effectiveness of Best Management Practices to protect surface waters. (USEPA, 1993)

height are physical factors which restrain soil erosion and sediment loss by dissipating impact energy from rain and irrigation water droplets providing a resistance to surface movement of water over turf. Turfgrasses have an extensive fibrous root system with 80% of the root mass found in the upper 2 inches of the soil profile (Welterlen et al., 1989). Therefore it is a combination of the turf canopy and root mass which have a strong soil stabilizing effect.

Table 5. Storm water pollutant removal efficiencies of urban BMP designs per Schueler (1987) and NYSDEC (1993)

BMP/Design *	Total Suspended Sediment (TSS)	Total Phosphorus (TP)	Total Nitrogen (TN)	Zinc (Zn)	Lead (Pb)	Biological Oxygen Demand (BOD)
Extended Detention Pond						
Design 2	75%	50%	35%	55%	55%	40%
Design 3	80%	70%	55%	75%	75%	50%
Wet Pond						
Design 4	55%	35%	25%	25%	45%	25%
Design 5	75%	55%	40%	40%	70%	40%
Water Quality Basin						
Design 7	70%	50%	50%	50%	50%	70%
Filter Strip						
Design 11	40%	20%	20%	40%	40%	20%
Design 12	90%	50%	50%	90%	90%	70%
Design 12A	80%	40%	40%	80%	80%	60%
Grassed Swale						
Design 13	20%	20%	20%	10%	10%	20%
Design 14	30%	30%	30%	20%	20%	30%

Table 5. Storm water pollutant removal efficiencies of urban BMP designs per Schueler (1987) and NYSDEC (1993) (cont.)

* Design Criteria:

Extended Detention Basins

Design 2: "First flush" runoff volume produced by 1.0 inch, detained for 24 hours.
Design 3: Runoff volume produced by 1.0 inch storm detained for 24 hours or more with shallow marsh added in bottom stages.

Wet Pond

Design 4: Permanent pool equal to 0.5 inches of runoff per watershed ac.
Design 5: Permanent pool equal to 2.5 times the volume of runoff from the mean storm (0.5 in.).

Water Quality Basin

Design 7: Infiltration basin which filtrates "first flush" of 0.5 inch runoff/impervious acre.

Filter Strips

Design 11: 25 to 50 foot turf strip.
Design 12: 100 foot wooded strip.
Design 12A: 25 to 50 foot wooded strip.

Grassed Swale

Design 13: High slopes with check dams.
Design 14: Low gradient (less than 5%) with check dam.

Grassed swales - Grassed swales are designed to carry storm water runoff. When combined with other structural storm water BMPs, swales can substantially improve the quality of storm water. The grassed swales will be constructed initially as part of the erosion control plan. After site stabilization, the grassed swales will be regraded and seeded to maximize infiltration capacity. An example of their use is the routing of water from the under-drains of greens. Filtration can be greatly increased by carefully choosing the route of water from the under-drain. If space is limited, drainage water could be directed to flow along a path that maximizes the distance of contact with vegetation, rather than be directly routed to the lowest point. Swales will be planted with a dense growth of water tolerant grass (such as tall fescue) maintained at the highest end of the optimum range for more effective filtration, and reduced maintenance requirements. They will have 3:1 side slopes and have a minimum length of 50 feet. Grassed swales provide the following water quality benefits:

- Erosion Control
- Removal of pollutants by filtering action of the vegetation.
- Increased time of concentration, thereby decreasing peak rates of runoff.

Vegetated filter strips - Filter strips are manmade or naturally occurring flat areas which are established at the perimeter of the disturbed or impervious areas to intercept runoff as sheet flow and remove particulate contaminants. Either grassed or wooded (forested) areas can function as filter strips. The most sensitive portions of watercourses are the areas immediately adjacent to the water. Disturbance within and adjacent to watercourses can degrade water quality by increasing the availability and transport of pollutants. The retention of vegetated buffers along watercourses is, therefore, one of the most effective practices used to protect water quality. Turf buffers are very effective filters that allow drainage of water from the course and, at the same time, effective filtering to improve water quality. Turf density, leaf texture and canopy height are physical factors which restrain soil erosion and sediment loss by dissipating impact energy from rain and irrigation water droplets providing a resistance to surface movement of water over turf.

Structural BMPs - The following structural BMPs proposed for the project include infiltration, if practical, and a catch basin to collect runoff from the clubhouse area. Each of these types of BMP are described below.

Infiltration devices. Infiltration devices such as infiltrators®, infiltration trenches, and infiltration basins rely on absorption treat runoff. Water is percolated through soils, where filtration and biological action remove pollutants. Infiltration will be used where practical.

Catch Basins. A catch basin will be used to capture the runoff from the clubhouse area. Water will be collected in the basin, and it will be conveyed to a particle separator prior to discharge.

Maintenance of Storm Water Management and Quality Facilities

General periodic long-term inspection and maintenance of the proposed storm water management and quality facilities for The Preserve Country Club will be essential to ensure that they will function as designed. Responsibility for their inspection and maintenance shall rest with the golf course superintendent and maintenance crews. The maintenance plans for the Preserve Country Club provide the foundation for an effective stormwater facilities plan. Descriptions of proposed stormwater maintenance for The Preserve Country Club are provided in the following paragraphs.

<u>Grassed Swales</u> - Swale maintenance is largely aimed at keeping the grass cover dense and vigorous. This primarily involves periodic mowing, occasional spot reseeding, and weed control. Watering may also be necessary in the first few months after establishment. Excessive sediment buildup behind check dams shall be removed as necessary.

<u>Vegetated Filter Strips</u> - Man-made filter strips should be mowed two to three times a year to suppress weeds. The height of the turf should be allowed to grow to the highest end of the optimum range for more effective filtration. Periodic spot repairs, watering and fertilization may be required to maintain a dense, vigorous growth of vegetation. Fertilization should not occur more than twice per year. Accumulated sediments deposited near the top of the strip will need to be manually removed over time to keep the original grade. All filter strips should be inspected on an annual basis. Strips should be examined for damage by foot or vehicular traffic, encroachment, gully erosion, density of vegetation, and evidence of concentrated flows through or around the strip. Extra strip maintenance must be devoted in the first few months to make sure the strip becomes adequately established. This may involve extra watering, fertilization and reseeding (MWCOG, 1987).

Detention Basins - The basin should be inspected on an annual basis to ensure that the structure operates in the manner originally intended. When possible, inspections should be conducted during wet weather to determine if the pond is meeting the targeted detention times. Other problems which should be checked for include: subsidence, erosion, cracking or tree growth on the embankment; the accumulation of sediment around the riser. Repairs should be made when the need for them is observed. The side-slopes and embankment should be mowed at least twice a year to discourage woody growth and control weeds. The use of native or introduced grasses which are water-tolerant, hardy, and slow-growing are recommended. Debris and litter should be removed during regular mowing operations. Accumulated sediment should be removed periodically in order to preserve the available stormwater management capacity of the basin, and to prevent the outlet from becoming clogged.

AGRONOMIC CONSIDERATIONS AND REQUIREMENTS

Agronomic and cultural practices are important components in maintaining environmental integrity and enhancing conditions at The Preserve Country Club. The following are the critical agronomic and cultural practices to be implemented in the construction and management of The Preserve Country Club.

Soil Mixes and Modifications

While soil modification on large acreage is impractical, some soil modification is necessary. Grading will result in a mixing of topsoil and subsoil and will require extensive soil testing for determination of nutrient levels prior to seeding/sodding.

Putting Greens - It is important that greens be constructed to withstand traffic and wear, and at the same time, protect environmental resources. Playing surfaces will be constructed with materials which provide good drainage and resist wear and compaction. This will maximize the playability even immediately after rainfall or irrigation. It is also important that surface and subsurface drainage be filtered so that water resources are protected. For these reasons, the greens will be constructed based on a United States Golf Association method as detailed in "USGA Recommendations for a Method of Putting Green Construction" (USGA Green Section Record, 1993).

This method of construction is based on soil physics and principles of drainage and moisture retention within the soil profile. This unique system takes advantage of discontinuity within the soil profile which disrupts internal drainage until saturated conditions occur. By using a four inch layer of primarily one-quarter inch diameter gravel, overlaid with approximately 14 to 18 inches of a specified high sand content intermediate and/or root zone mixture, water will be retained in the soil profile for turfgrass use without immediate drainage until saturated conditions occur. Materials which may have a propensity to move in the soil solution are held for maximum attenuation times and if trace amounts are transported under saturated flow conditions, maximum dilution within the soil profile will occur. The entire putting green is underdrained by a series of perforated pipes installed at the sub-grade. These are spaced on no less than 15-foot centers and will have outflow directed to infiltration trenches or surface outlets located at least 100 feet from a wetland. This type of system affords the best approach to irrigation management and controlled discharge of excessive rainfall from these more intensively managed areas of the golf course.

Successful construction of a USGA green requires these specifications to be rigidly followed for five basic values, which are used as criteria for recommending the root zone mixture. These values are percentages of total porosity; capillary (micro-) pore space which contributes to the water holding capacity; non-capillary (macro-) pore space which adds aeration porosity; saturated conductivity (water permeability); and organic matter content. In addition, particle size and mechanical analyses are usually run as the percentage of sand, silt and clay as well as the different percentages of the sand fractions. These will determine how fast the soil will drain and its potential to resist compaction from traffic and wear. To meet the requirements, samples of materials to be used in construction will be sent to a qualified soil physical testing laboratory to determine the proper ratio for mixing of these materials to meet the standards listed in Table 6. Subsequent recommendations for pH adjustment of the root zone mixture and addition of fertilizers will depend on the final ratio of materials used and will be made based on chemical analyses of the mixture.

Table 6. Standards for physical parameters to meet the specifications for a green constructed to the USGA Green Section method.

Parameter	Minimum Allowed	Maximum Allowed
Total Porosity	35%	55%
Capillary Porosity	15%	30%
Noncapillary Porosity	15%	25%
Saturated Conductivity	6 to 12 inches/hr	12 to 24 inches/hr
Organic Matter Content	1% by weight	5% by weight
Particle size		
Medium and coarse sands	60%	---
Fine sand	---	20%
Very fine sand	--	5%
Silt	---	5%
Clay	---	3%

Tees - Tees are the most trafficked areas on the golf course. Tees will be constructed in the same manner as the putting greens. The higher height of cut on the tee surface provides a much deeper root system in the soil profile and imparts considerably better wear tolerance than is usually observed on putting greens. Typically tee areas are not as intensively managed as greens and the nutrient and pesticide requirements are lower. Surface runoff and subsurface drainage from tees will discharge at least 100 feet away from wetlands and watercourses with the exception of the back two tees of hole #5. The surface drainage from the back tees of hole #5 will drain away from the adjacent wetlands and will discharge from the tees at a distance of at least 50 feet from the wetland area. Subsurface drainage from these tees will be discharged at least 100 feet away from the wetland area.

Fairways and Roughs - Soil modification of fairways and roughs is not practical since this encompasses a significant portion of the acreage involved with the golf course development. Soil samples will be analyzed from as many locations as necessary, once final grading begins, so that pre-planting fertilization recommendations can be made.

Turfgrass Selection

Over the years, extensive turfgrass breeding programs and research have resulted in grass varieties that are exceptionally well-suited for golf course turf. Cultivars selected for use at The Preserve Country Club will be those that are efficient in water use and low in susceptibility to insects, disease and weed infestation.

The natural characteristics of turfgrasses limit movement of pesticides and fertilizers into underlying soils, surface water, and ground water. Thatch produced by the turf acts as an organic filter to chemically bind pesticides that might otherwise enter the local surface and ground waters. Producing a healthy turf, which is needed for a golf course, has the added benefit of immobilization and microbial degradation of pesticides retained in the thatch layer. In addition, turfgrass root systems are quite extensive and fibrous, and are able to adsorb and absorb applied pesticides that might penetrate the canopy and thatch and reach the roots. Thus, a healthy turf results in effective nutrient and pesticide retention and control.

Greens, Tees, and Fairways - These will be seeded with creeping bentgrass. Selection of exact cultivars will be based on recommendations from the USGA Green Section Turf Advisory Service agronomists. Over the past ten years, a number of new creeping bentgrass cultivars have been developed which show markedly increased resistance to disease and insect problems, a finer-textured more upright growth habit with less grain, rapid establishment, excellent wear tolerance and good recuperative rates, and improved water use efficiency. At the same time, the amount of water, nutrients, and pesticides necessary to produce a high quality turf has been reduced. Cultivars such as L-93, Providence, Southshore, Pennlinks, Putter, and others have provided quality golf course turf at a number of locations, all of these are improved compared to Penncross.

Roughs and Turf Buffers - These will be seeded with a blend of Kentucky bluegrasses and fine fescues. As with the creeping bentgrasses, recent improvements in cultivar characteristics including texture, color, insect and disease resistance, and level of management means newer varieties are better performing and require less inputs of water, nutrients, and pesticides to maintain a quality turf.

Construction and Grow-In Requirements

Soil erosion is most likely to occur during the construction and grow-in phases of golf course development. The major pathway for phosphorus loss is soil erosion, as sediment is the carrier. Therefore, any technique effective in reducing soil erosion will also reduce phosphorus losses. Use of buffer strips, grass waterways and berms, the sodding of steep slopes, and the use of silt screens are examples of structural techniques for erosion control that will be used during construction and grow-in.

Final plant bed preparation will ensure surfaces are reasonably free of large dirt clods, roots and other debris that would interfere with sodding and seeding and subsequent maintenance operations. Initial pH correction, if necessary, and fertilization will be based on soil test recommendations and will be applied prior to planting. Care will be taken in fertilization because of the potential for runoff at this time. A minimum four-foot wide sod strip will be installed along the base of slopes in areas of golf turf located within 50 feet of a wetland or watercourse prior to seeding such that stormwater runoff from the seeded areas will be filtered through the sod strip before entering any wetland or watercourse. A 15-foot wide "sod strip" will be installed along the base of golf turf slopes in excess of 15 percent grade located within 100 feet of a wetland or watercourse. The 15-foot wide "sod strip" will consist of a four-foot wide section of sod along the bottom, a seven-foot wide seeded area, and a four-foot wide section of sod along the top. All seed beds will be floated with a drag to ensure smoothness and firmness for planting.

Once the course has been seeded, the future of the course will depend on how well it is grown-in and maintained. The objective of the grow-in program is the rapid establishment of a high quality turf cover to minimize water erosion and weed infestation.

The judicious use of water and fertilizer is essential for a quality turf cover. While areas must be kept continuously moist, they must not be kept excessively wet, otherwise the potential for erosion is increased. Mulching or hydro-mulching may be necessary on some slopes for soil erosion control. On and around buffers, where irrigation may not be available, a mulch may be used to preserve topsoil and provide favorable moisture conditions for seedling establishment.

Watering - Planted areas should be kept continuously moist throughout the germination period of approximately three weeks. This means frequent, light watering rather than soaking the soil when it becomes dry. Water should not be allowed to puddle or run off the surfaces. After germination, watering frequency should be decreased with application volumes increased. This will ensure adequate soil moisture at depths to optimize root growth of the new seedlings.

Fertilization - On tees, fairways, and roughs at three to four weeks after germination or sodding, or at the first mowing, apply a 2-1-1 or 4-1-3 ratio fertilizer at the rate of one pound of nitrogen per 1000 square feet (45 pounds per acre), with at least 50 percent of the nitrogen from a slowly available form such as IBDU, SCU, or a natural organic product such as Ringer, Sustane, or similar material. Additional fertilizations at this or a lower rate will be necessary every six to eight weeks until the turf has reached full cover. Once the turfgrass on the course has matured, the management objective becomes slower growth with good color, density, and playability.

Mowing - To help control weeds and promote lateral growth, mowing should begin when the creeping bentgrass is approximately one inch in height for tees and fairways and ½ inch for greens. Mowing at these heights should be done for the first two or three mowings and then the height reduced to the height that is optimum for the turf. This will encourage lateral spread, increase density, and maintain a fine texture. The mowing should be frequent enough so that no more than one-third of the top growth is removed at any one clipping. For roughs, once the Kentucky bluegrass reaches a height of 2.5 inches, mow down to two inches and maintain at this height for the first two or three mowings and then reduce to the desired height.

Rolling - To provide a smooth, firm surface for future operation of mowing equipment and golf carts, all areas may need to be rolled a few times. The first rolling should not occur until the grass covers approximately 25 to 50 percent of the area.

Developing Tee and Putting Surfaces - During the growing-in period, tees and greens will need topdressing and rolling and perhaps aerifying and/or vertical mowing a number of times to produce smooth, true, and firm surfaces. Topdressing material should be identical to the material used in the root zone mix.

Pest Control - The course should be inspected daily for pests. Control efforts should follow the IPM protocol. When chemical control is necessary, follow label directions and precautions utilizing materials approved in this plan, and follow restrictions as defined in this plan.

GOLF COURSE CULTURAL PRACTICES (POST GROW-IN)

The primary cultural practices that produce and sustain a healthy turf are mowing, irrigation and fertilization. These three operations, alone or in combination, often cause changes in the root and canopy micro-environment. These changes can have either a positive or negative effect; thus, it is essential that these practices be executed in a proper and timely manner to ensure turfgrass quality and playability. The best deterrent to weed, insect, and disease infestation is a healthy turf. Maintaining hearty grasses will minimize the need to apply fertilizers and pesticides.

Mowing

Mowing is the most basic maintenance operation on a golf course. Without regular mowing at the appropriate heights of cut, the course will become unplayable. With good mowing practices, density, texture, color, root development, wear tolerance, and other aspects of turf quality are enhanced. Proper mowing practices also can reduce the amount of irrigation needed. Taller grass can have a significantly higher evapotranspiration rate and, thus, a greater need for water. Mowing grass too short stresses the turf which not only produces a need for more water, but can cause the weakened turf to be more susceptible to weed, insect, and disease infestation. Recommended mowing practices are presented in Table 7.

Table 7. Recommended mowing practices for the turf areas at The Preserve Country Club.

Mowing	Greens	Tees	Fairways	Roughs
Height (inches)	5/32 - 3/16 (0.156 - 0.250)	3/8 - 5/8 (0.375 - 0.625)	½ - 1.0 (0.5 - 1.0)	1½ - 2 (1.5 - 2)
Frequency	Daily	2 to 4 times per week	2 to 3 times per week	7 to 14 days
Clippings Disposal	Remove	Remove	Return	Return

Grass variety and turf use have the greatest influence on mowing height. Each turfgrass has a mowing tolerance range within which it can be expected to provide outstanding turf. The best approach is to use the highest mowing height acceptable for the various playing surfaces. However, if fast greens are required for tournament play, mowing can be lowered below recommended minimums for a short period of time. On the other hand, another possibility is to continue mowing at the higher height and double cut twice; this operation will produce the same green speed as the lower cut. During the summer months when stress is likely to occur, do not lower the height of cut. If faster green speeds are required, try double cutting once or twice per week before lowering the height of cut. Additionally, rolling several times per week can improve speed without lowering the height of cut.

Mowing height and growth rate have the most influence on mowing frequency. As a rule-of-thumb, mowing should be done often enough so that no more that one-third of the leaf is removed at any cutting. Frequent mowing is best because it minimizes the negative effect on photosynthesis, and helps maintain a high percentage of leaf surface which is necessary for healthy root development.

If mowing is scheduled at appropriate intervals and the grass clippings are dispersed uniformly, leaving the clippings on the fairways and roughs should not cause problems. Research has indicated that returning clippings to the surface does not greatly increase thatch buildup on turf that is otherwise properly managed. Clippings decompose rapidly, thus returning some fertilizer and organic matter to the soil, and they also help conserve moisture and insulate the soil.

Clippings are always removed from greens and tees to prevent interference with the play. Collected clippings should be combined with a high carbon source (such as leaves) and composted. Compost can be used as a soil amendment for renovation or other landscape projects.

Spiking

Spiking is most useful in breaking up soil surface compaction and improving moisture infiltration and gas exchange. In addition, it is useful in lifting the blades of grass before mowing to aid in preventing the turf from thatching.

Vertical Mowing

When done on a timely basis, vertical mowing can be used to remove mower induced grain on greens and reduce thatch. In addition, vertical mowing can be used to thin turf so that a better job of reel mowing can be done. Also, vertical mowing is used to separate the soil from aerifier cores and mix the soil with the sand used to fill the aerifier holes and topdress the playing surface.

Aerifying

The main purpose of aerification is to relieve surface compaction which in turn improves surface water infiltration, allows for good root penetration, provides for easier air exchange in the soil, improves nutrient uptake, removes excess thatch and increases turfgrass vigor. Two types of aerification are used. Coring involves removing plugs from the soil profile, thus allowing for lateral expansion of the remaining soil thereby relieving soil compaction. This is accomplished using an aerifier equipped with hollow coring tines. Using solid coring tines, or water injection can provide benefits to the soil by improving infiltration and soil aeration, but they do not relieve soil compaction. Both approaches are normally incorporated into management strategies. Core aerification on putting greens is commonly followed with topdressing.

Topdressing

Topdressing aids in thatch decomposition, lessens grain development in the turf, stimulates new shoot growth, encourages stolon rooting and makes the ball roll true and faster. Although a small amount of thatch (¼ - ½ inch thick) is desirable to provide a certain amount of resiliency, thatch is the greatest single limiting factor in the development of fast, uniform greens. Although topdressing does not prevent the development of stems and roots which contribute to thatch buildup, it does keep the thatch separated to prevent dense, compacted mats from forming. By mixing suitable topdressing materials with the organic material, thatch layers, as such, will not develop and will decompose faster.

Rolling

New light weight self propelled rolling equipment has made rolling a viable practice for smoothing the turf surface and improving green speed. It is frequently used in the summer months to allow a higher height of cut for improved stress tolerance while increasing green speeds. However, recent research has shown it can be overdone. Rolling more often than once or twice a week can lead to excess wear and compaction.

Fertilization

The most important aspect of the fertilization program at The Preserve Country Club is to ensure that the nutrients applied to the golf course turf and landscape areas do not migrate to surface or ground water. Migration of the nutrients (primarily nitrogen and phosphorus) can result in pollution of resources, most notably eutrophication. Nitrogen and phosphorus are the elements most often associated with the eutrophication of lakes and streams (Jones and Bachmann 1976; Wetzel 1982). Eutrophication of water bodies may result in algal blooms, aquatic plant infestations, reduction in depth, and a marked decrease in overall water quality.

Attention must be given to protect ground water resources at The Preserve Country Club from contamination by nitrate-nitrogen. Much of the nitrogen fertilizer applied to the golf course will be in the ammonium and nitrate forms, and most of the ammonium should be converted by soil microorganisms to nitrate, provided there is adequate aeration and optimum soil pH. Nitrate is highly mobile and readily available for plant uptake; however, the mobile nature of nitrate also allows it to be leached into ground water. The Federal drinking water standard for nitrate is 10.0 mg/l. However, nitrate concentrations should be less than 1.0 mg/l to be protective of the freshwater ecosystems at the site.

A review of the published research on nitrogen fertilizers applied to turfgrasses (Petrovic, 1990) has determined that nitrate-nitrogen concentrations in soil water leaching through surface soils exceeds drinking water standards of 10.0 ppm only on sandy soils when one of the following conditions exist: 1) high levels of soluble nitrogen are applied, greater than 3.0 lbs. N/1000 sq.ft. at one time; or 2) excessive irrigation is practiced coupled with application of water soluble nitrogen sources. Minimizing nitrate movement is directly related to best management practices that control nitrogen sources and irrigation. This is accomplished by applying the correct nitrogen source at the correct time, rate, and location and by applying the correct amount of irrigation at the correct time, rate and location. Reports by Walker and Branham (1992) concluded that several management options are available to minimize or eliminate threats to ground or surface water quality, including:

- limiting irrigation to replacement of soil moisture,

- using slow release nitrogen sources,
- timing fertilizer applications in relation to active uptake, and
- using realistic nitrogen application rates.

All of these factors are part of the management program for The Preserve Country Club.

When a fertilizer is applied in excess of what the plant can use or when the turf is not actively growing due to temperature, water, light, lack of an individual nutrient, etc., much of the application could be lost from the golf course. For these reasons, before a fertilizer is applied, the limiting growth factors for the turfgrass should be considered. In addition, only a fertilizer containing the nutrients in the right form needed by the plant should be used and applied at the right rate and frequency. Plants will respond to fertilizer only if it contains a nutrient that is deficient. As a first step, soils must be analyzed to determine pH, calcium, magnesium, phosphorus and potassium availability and balance. From this information a valid lime and fertilizer program can be developed with the assurance that excess nutrients will not be applied.

Nitrogen is the nutrient used by grasses in the largest quantities. Its function is to stimulate vegetative growth and provide the grass with green color. Nitrogen fertilization will be determined by color, density and rate of growth (clipping yields) of grass, tissue analyses, as well as soil nitrogen reserves. Interpretation of soil nitrogen analyses to exact amounts which are available to the plant is difficult. For this reason, nitrogen rates will be adjusted, but not solely based on soil testing. Leaching of nitrate nitrogen can be safely regulated by making controlled applications (spoon feeding), using controlled materials (slow-release), or using a combination of these approaches.

Controlled applications can be made by using soluble fertilizers and applying the materials with sprayers that have been calibrated to put out an accurate amount of material per acre. The superintendent can personally control the rate and frequency of fertilizer application, and thereby reduce the tendency to apply excessive amounts of nitrate and ammonium forms of nitrogen on an infrequent basis.

Materials such as natural organic sources (Milorganite, Ringer, Sustane, etc.), isobutylidene diurea (IBDU), methylene ureas (MU) and coated ureas (SCU, Polyon, Poly-S, Sulfurkote-II and others) are all slow-release (SR) nitrogen sources. They have the advantage of supplying a longer more uniform source of nitrogen, have a lower salt index, and result in reduced nitrogen leaching. By combining soluble nitrogen sources with the slow-release nitrogen products, availability can be extended to the grass without fear of nitrogen leaching into the groundwater.

Creeping bentgrass and Kentucky bluegrass can be grown within a wide soil pH range. However, for optimum soil microbial activity and improved nutrient availability it is preferred to keep the pH in the 6.0 to 6.5 range.

General Fertilization Application Rates

The following discussion provides a general overview of nitrogen, phosphorus and potassium applications on various playing surfaces. Adjustments to the rates provided here will be made based on analyses which will include color, density and rate of growth (clipping yields) of grass, tissue analyses, as well as soil nitrogen reserves. It is also important to maintain a calcium to magnesium ratio of 10:1.

Greens. - If soil tests indicate that either dolomite for soil pH correction and/or phosphorus are needed, they should be applied during the aerifying operation so that they can be worked more deeply into the root zone. The addition of potassium should be made in three to four applications per year and applied at the rate of 0.5 to 1.0 pound per 1000 square feet. Slow release sources of nitrogen should be applied at the rate of 0.5 to 1.0 pound per 1000 square feet (see Tables 8 and 9).

Tees - If phosphorus and dolomite are needed, the tee surfaces should be treated in the same manner as the greens, described in the preceding paragraph. Nitrogen and potassium should be applied at about the same rate as for the putting greens (see Tables 8 and 9).

Fairways - Dolomite and phosphorus applications will be based on soil test results. No individual application of nitrogen or potassium should exceed 45 pounds per acre, with half the nitrogen from a slow release source (see Tables 10 and 11).

Roughs - Roughs should be fertilized two times per year. Dolomite and phosphorus applications should be based on soil test results. Individual applications of nitrogen and potassium should not exceed 40 pounds per acre, with half the nitrogen from a slow release source (see Tables 10 and 11).

Table 8. General Fertilizer Applications on Greens and Tees at The Preserve Country Club.

Area	Nitrogen (lb/1000 ft/yr)	Phosphorus (lb/1000 f'/yr)	Potassium (lb/1000 f'/yr)
Greens	3 to 6	1 to 5	2 to 5
Tees	3 to 6	1 to 3	2 to 5
Adjustments should be made based upon soil and tissue testing results and turf response.			

Table 9. Suggested Fertilizer Schedule for Greens and Tees for The Preserve Country Club.

Greens & Tees	Apr	May	June	July	Aug	Sep	Total
Nitrogen (lb/1000 f'/yr)	WS 0.5 SR 0.5	WS 0.5 SR 0.5	NO 1.0	WS 0.5	NO 1.0	WS 0.5 SR 0.5	5.5
Phosphorus (lb/1000 f'/yr)	0.25		0.4	0.4	0.4		1.45
Potassium (lb/1000 f'/yr)	0.5	0.5	0.8	0.8	0.8	0.5	3.9

- *Adjustments should be made based upon soil and tissue testing results and turf response.*
- *An application may be reduced or eliminated after first several years.*
- *WS = Water Soluble, SR = Slow Release, NO = Natural Organic*

Table 10. General Fertilizer Applications on Fairways and Roughs at The Preserve Country Club.

Area	Nitrogen (lb/acre/yr)	Phosphorus (lb/acre/yr)	Potassium (lb/acre/yr)
Fairways	90 to 180	45 to 135	90 to 225
Roughs	45 to 90	0 to 45	45 to 90
Adjustments should be made based upon soil and tissue testing results and turf response.			

Table 11. Suggested Fertilizer Schedule for Fairways and Roughs for The Preserve Country Club.

	May	Jun	Jul	Aug	Sep	Total
Fairways						
Nitrogen (lb/acre/yr)	WS 22.5 SR 22.5	NO 45		NO 45	WS 22.5 SR 22.5	180
Phosphorus (lb/acre/yr)	22.5	18		18		58.5
Potassium (lb/acre/yr)	45	36		36	45	162
Roughs						
Nitrogen (lb/acre/yr)	WS 22.5 SR 22.5				WS 22.5 SR 22.5	90
Phosphorus (lb/acre/yr)	22.5					22.5
Potassium (lb/acre/yr)	45				45	90

Adjustments should be made based upon soil and tissue testing results and turf response.
WS = Water Soluble, SR = Slow Release, NO = Natural Organic

Fertigation System

Fertigation is the process of fertilizing at frequent, low rates through the irrigation system. A fertigation system will be incorporated into the irrigation system. Snyder et al. (1989) concludes that turfgrass nitrogen uptake and subsequent plant growth is more uniform and the potential for leaching greatly reduced by fertigation compared to conventional fertilizer application methods.

The type of fertilizer that will be used in the fertigation system will be similar to CoRoN 28-0-0. It is a controlled-release liquid nitrogen fertilizer with 70% of nitrogen coming from controlled release and 30% from water soluble urea. Other brands of fertilizer with similar slow-release nitrogen characteristics as CoRoN 28-0-0 may be used in the fertigation system, depending on the turf needs and site conditions. A state-of-the-art irrigation system will be installed at The Preserve Country Club that will have a computerized system that has individual head control for each of the sprinklers. Fertigation is not to occur when prevailing wind speeds exceed 15 miles per hour. Pesticides will not be applied via the fertigation system.

Studies in Florida, a very environmentally sensitive area because of depth to ground water and soil type, have focused on comparing nitrogen loss under sensitive soil conditions using various nitrogen sources and fertilizer application techniques. Snyder et al. (1981) found that the greatest amount of nitrogen leaching occurred from using a completely water soluble nitrogen source, 9.3% of the total applied, compared to slow release sources which ranged from 0.1 to 5.5% of the total applied on bermuda grass maintained under fairway conditions. Nitrate-N concentrations in the leachate water averaged only 1.4 ppm at the highest for the slowly available materials compared to 2.4 ppm for the water soluble sources. Previous studies by Snyder et al. (1980) found that during periods of excessive irrigation and/or high rainfall, nitrogen leaching can be reduced by daily "fertigation", fertilizing at low nitrogen rates (1/8 pound of N/1000 sq.ft.) through the irrigation system as compared to applying soluble nitrogen tri-weekly at a rate equivalent to that applied by fertigation during a 3-week period. Subsequent work by Snyder et al. (1989) documented that working on a sand soil with a high percolation rate, nitrogen leaching was reduced by over 80% with the use of fertigation compared to conventional applications of granular soluble carriers.

BASIC ANNUAL MAINTENANCE GUIDE FOR THE PRESERVE COUNTRY CLUB

A basic annual maintenance schedule for The Preserve Country Club is presented as Table 12. This schedule is based on a recognition of the general maintenance requirements of golf courses located in Connecticut and surrounding states. It is intended to serve as an initial guidance document. Adjustments to this schedule are to be made by the superintendent as knowledge of specific site conditions develops following course construction.

Table 12. **Basic Annual Maintenance Guide for The Preserve Country Club.**

Operation **	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Soil Analysis			X						X			
Calibrate Equipment	X	X	X	X	X	X	X	X	X	X	X	X
Greens												
Mowing			X	X	X	X	X	X	X	X	X	X
Fertilizing			X	X	X	X	X	X	X			
Irrigating			X	X	X	X	X	X	X	X		
Spiking				X	X	X	X	X	X			
Vertical Mowing				X	X	X			X	X		
Aerifying			X		X		X		X	X		
Topdressing			X	X	X	X		X	X	X		X
Liming					X							
Disease Control			X	X	X	X	X	X	X	X	X	
Weed Control				X	X	X	X	X	X	X		
Insect Control					X	X	X	X	X			
Wetting Agents					X	X	X	X	X			
Tees												
Mowing			X	X	X	X	X	X	X	X	X	
Fertilizing					X	X	X	X	X	X		
Irrigating				X	X	X	X	X	X			
Spiking				X	X	X	X	X	X			
Vertical Mowing					X	X			X			
Aerifying			X		X				X			
Topdressing					X	X			X			
Disease Control			X	X	X	X	X	X	X	X		
Weed Control				X	X	X	X	X	X			
Insect Control					X	X	X	X	X			
Liming												

Table 12. Basic Annual Maintenance Guide for The Preserve Country Club (cont.)

Operation **	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Fairways												
Mowing			X	X	X	X	X	X	X	X	X	
Fertilizing					X	X		X	X			
Irrigating					X	X	X	X	X			
Aerifying						X						
Disease Control						X	X	X	X			
Weed Control				X	X	X	X	X	X			
Insect Control					X	X	X	X	X			
Liming					X							
Roughs												
Mowing				X	X	X	X	X	X	X	X	
Fertilizing					X				X			
Irrigating					X	X	X	X	X			
Liming						X						
Bunkers												
Raking & Edging			X	X	X	X	X	X	X	X	X	

** Definition of Operations:

- *Soil Analysis:* *Sample representative greens, tees, fairways and roughs for analysis and recommendations. The primary purpose of soil testing is to insure nutrient availability and balance for good growth of the grass.*
- *Calibration of Equipment:* *All spreaders and sprayers must be repaired, if needed, and calibrated for proper distribution of fertilizers and pesticides.*
- *Mowing:* *Mowing is the most important and most time consuming maintenance operation on a golf course. Without regular mowing at the appropriate heights of cut, the course would become unplayable. With good mowing practices, density, texture, color, root development, wear tolerance and other aspects of turf quality are enhanced.*
- *Fertilizing:* *The fertilizer program will be based on soil test results for pH, calcium, magnesium, phosphorus and potassium. Nitrogen fertilization will be determined by color, density and the rate of growth (clipping yields) of the grass and tissue N content.*

Table 12. Basic Annual Maintenance Guide for The Preserve Country Club (cont.)

▪ *Irrigation Program:*	*The irrigation regime is determined by a ET rates (See Section 4.0, Water Conservation). However, each time water is applied the system should operate to wet the soil to the depth of rooting. When greens are stressed, hand water or syringe during the heat of the day in addition to regular night irrigation.*
▪ *Spiking:*	*This procedure is needed to relieve surface compaction and insure good gas exchange (ox·gen and carbon dioxide).*
▪ *Vertical Mowing:*	*During the growing season, this operation is needed to reduce mower induced grain and thatch buildup, and to provide a smoother, faster putting surface.*
▪ *Aerifying:*	*Aerifying surfaces relieves compaction, increases soil and surface air exchange and improves fertilizer and water movement into the soil. This includes both coring and injection aerification practices.*
▪ *Topdressing:*	*In addition to following coring, topdressing should be applied once or twice per month during the growing season at the rate of one-quarter cubic yard per 1000 square feet. This practice not only helps control thatch, but also helps provide a smooth, true surface for mowing and accurate ball roll.*
▪ *Liming:*	*Apply dolomitic limestone to any area where soil test results indicate a need.*
▪ *Wetting Agent Applications:*	*If localized dry spots appear on the greens, apply a good quality wetting agent and water immediately to prevent yellowing of the grass.*
▪ *Raking/Edging Bunkers:*	*Bunkers need to be raked daily and edged a minimum of once per month.*
▪ *Weed Control:*	*Monitor for the presence of weeds. If the population becomes so large that it effects the playing surface, use the appropriate herbicide. Also see Section on weed control in 'Specific Local Problems'.*
▪ *Insect Control:*	*Monitor daily for beetles, grubs, caterpillars and other insect pests. However, do not treat unless the pest is found, identified and present in damaging numbers or a chronic problem has been documented. Also see Section on insect control in 'Specific Local Problems'.*
▪ *Disease Control:*	*During periods when disease or conditions favoring a disease outbreak are prevalent, inspect the surfaces daily and treat only as necessary. Also see Section on disease control in 'Specific Local Problems'.*
▪ *Nematode Control:*	*May be needed infrequently. A soil nematode analysis will determine population levels and suggest treatment.*

PEST CONTROL

Integrated Pest Management

Integrated Pest Management (IPM) is a management program that uses information about turfgrass pest problems and environmental conditions which may precipitate these problems, and integrates these with turfgrass cultural practices and pest control measures to prevent or control unacceptable levels of pest damage (Ferrentino, 1990). It is a preventative approach incorporating a number of objectives including the following: 1) development of a healthy turf that can withstand pest pressure; 2) judicious and efficient use of chemicals; 3) enhancement of populations of natural, beneficial organisms; and 4) effective timing of handling pest problems at the most vulnerable stage, often resulting in reduced pesticide usage. It is an ecologically based system that uses biological and chemical approaches to control.

Like BMPs, IPM strategies have been incorporated into every aspect of this plan for The Preserve Country Club, and have taken into consideration the entire scheme of golf course operations as they relate to environmental impact. Integrated Pest Management (IPM) programs rely on six basic approaches for plant and environmental protection. These include: 1) *Regulatory* - using certified seed and sod to prevent unwanted weed contamination and selecting the best adapted turfgrass species; 2) *Genetic* - selecting improved grasses which perform well in specific areas and show a resistance to pest problems; 3) *Cultural* - following recommendations made for proper primary and secondary cultural practices which will maintain the turf in the most healthy condition and influence its susceptibility and recovery from pest problems. Practices such as aerification, vertical mowing, topdressing, maintenance of proper soil nutrient levels, sound irrigation management and proper mowing techniques should produce a high quality turf; 4) *Physical* - cleaning equipment to prevent spreading of diseases and weeds from infected areas; 5) *Biological* - enhancing populations of natural antagonists and, for a limited number of pest problems, biological control can be used whereby natural enemies are introduced to effectively compete with the pest; 6) *Chemical* - pesticides are a necessary and beneficial approach to turf pest problems, but use can be restricted in many cases to curative rather then preventive applications, thus reducing environmental exposure. Pesticide selection is based on a risk assessment approach that strives to use pesticides that are effective, are not toxic to non-target species, act quickly and degrade quickly, and are not soluble or persistent. Few pesticide applications will be made on a regularly scheduled basis. Exceptions may include pre-emergence herbicides, insecticides used to control chronic problems for timing when pests are the most vulnerable, and fungicides used to control *Pythium* and patch diseases which cause damage before visual symptoms are noted. Additionally, materials must be applied strictly in accordance with label instructions, at labeled rates, under appropriate environmental conditions (i.e., no spraying on windy days or when rain is forecast), with a low-volume sprayer to reduce the possibility of drift, and using shrouded sprayers around sensitive areas. Materials will be rotated as to use to deter the development of resistant strains of pests which may require more frequent and/or higher rates of pesticide applications.

An IPM approach includes six basic components:

1. monitoring of potential pest populations and their environment;
2. determining pest injury levels and establishing treatment thresholds;
3. decision making, developing and integrating all biological, cultural, and chemical control strategies;
4. educating personnel on all biological and chemical control strategies;
5. timing and spot treatment utilizing either the chemical, biological or cultural methods;
6. evaluating the results of treatment.

Figure 3 is a flow chart for decision making based on IPM strategies.

One of the most critical components to IPM programs is course monitoring. A well-trained and experienced golf course superintendent will scout the course themselves and/or designate someone as an IPM scout to detect symptoms of pest problems on a daily basis. This approach, coupled with

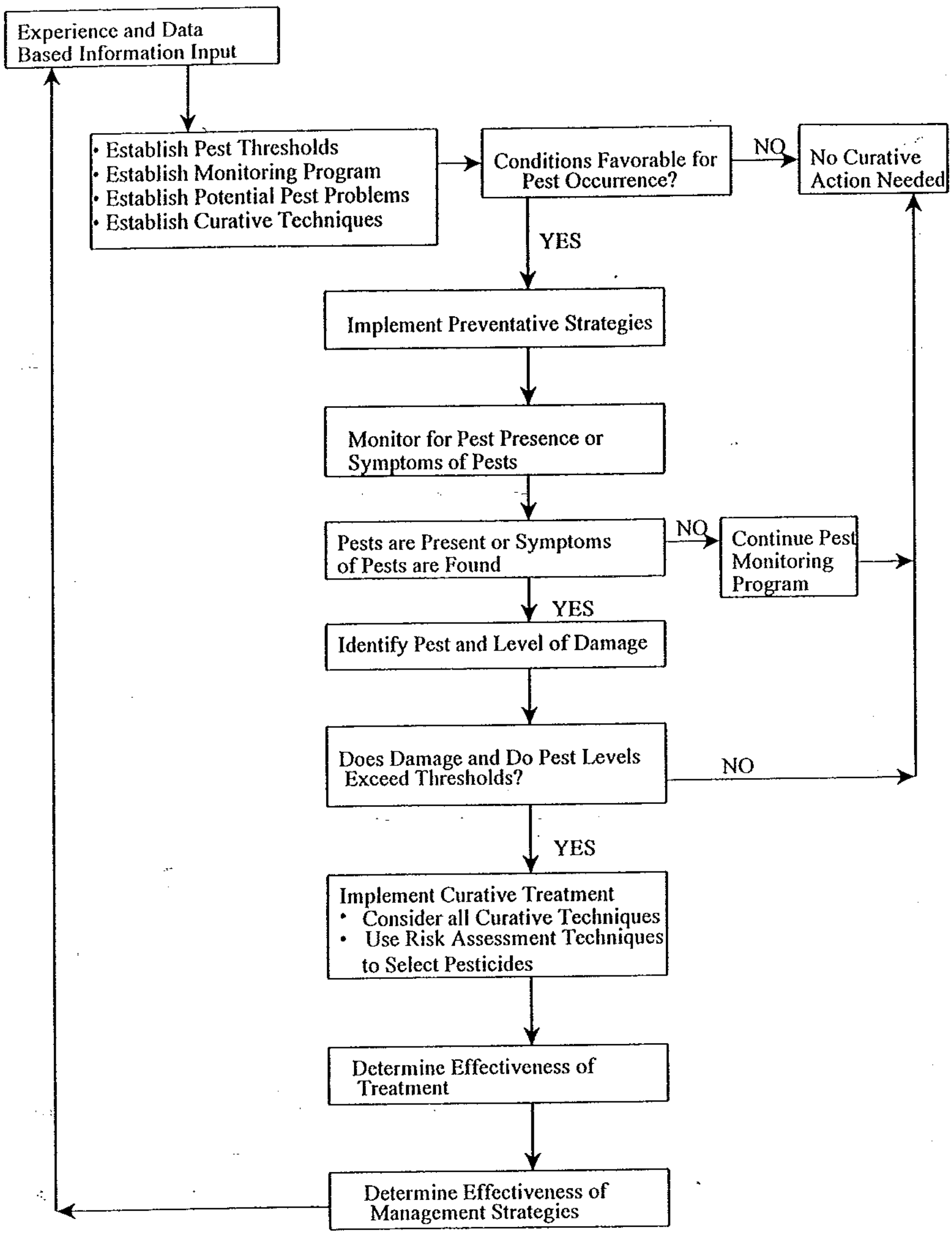

Figure 3. Integrated pest management decision flow chart.

compiling a site specific history and consulting with other superintendents in the area and specialists in turfgrass management, make it a workable program.

Pesticide Selection

Pesticides have been selected for use at The Preserve Country Club based on risk assessment approaches developed by the Environmental Protection Agency (U.S. EPA, 1992). The potential human and environmental health risks of pesticides that are appropriate for use at this golf course have been evaluated. Only those pesticides that have the least impact to the environment and human health, while meeting the needs of the golf course superintendent, have been selected for use. Selection criteria are conservative, and coupled with BMPs, management zones and the practice of IPM at the golf course, probabilities for negative impacts are minimized.

The greatest potential for contamination of both surface and subsurface waters from pesticide application is the movement of materials with water. A review of research studies to evaluate the movement of materials from golf courses to environmentally sensitive areas is summarized in Attachment 1.

In order to prevent nonpoint pollution problems, close attention must be paid to management of pesticide applications. Numerous studies and summaries have focused on selection criteria for minimizing nonpoint movement of chemicals from turf sites. In order to determine if certain materials should be precluded from use at The Preserve Country Club, even though they are registered by the US Environmental Protection Agency and the State of Connecticut and legal for use, a system of qualitative and quantitative models were used to evaluate all pesticides proposed for use on the landscape and golf course areas. From this evaluation, a recommended pesticide list was developed for each pest category for use in the Integrated Pest Management program.

Concerns over protecting water quality from both a surface and ground water perspective involve addressing the following four factors:

- Conditions of the site;

- Properties of the soil;
- Properties of the pesticide; and
- Management practices.

Integrating all of these factors results in reduced probabilities for unwanted chemical movement.

<u>Site Conditions</u> - Depth to groundwater and surface runoff potential are important considerations in protecting natural resources. Groundwater is generally 5 to 6 feet below the soil surface where the golf course will be constructed. Attenuation of chemical concentration occurs through distance traveled and the medium over which water must move (e.g., turf and thatch layers). Surface water is protected by the many mechanisms that have been discussed throughout this plan (e.g., vegetative swales, buffers, locations of golf holes away from natural resources).

<u>Soils</u> - Soil texture, permeability, water holding capacity, pH and organic matter content are important considerations for pesticide selection. Texture and permeability will greatly affect how fast water percolates through the soil profile. However, this will change with the maturity of the turf area. Current research at North Carolina State University has found that permeability of a putting green soil can decrease by as much as 66% during a period of very active turf growth due to the influence of the root system on soil drainage (Peacock, unpublished data). This is advantageous from a pesticide application viewpoint in that it slows percolating water movement allowing longer times for material degradation to occur. Organic matter content influences soil water holding and ionic exchange capacity. As the organic matter content increases, the soil can hold more water, reducing percolation, and adsorption capacity increases holding pesticides in the root zone favoring microbial degradation (Weber, 1990). Turfgrasses are strong soil builders, adding organic matter to the soil over time due to root and/or shoot growth. Soil pH also affects the sorption of basic and acidic pesticides and it affects microbial activity favoring breakdown of materials.

<u>Pesticide Properties</u> - Much of the propensity for pesticide movement in the soil solution is based on the chemical properties of the materials. Properties that are known to

influence potential for pesticide movement include solubility, the soil binding capacity, volatility, and degradation rate. Weber (1990) noted that in order for a pesticide to contaminate ground water, the chemical must move through the soil partitioning itself between the organic matter fraction and the soil solution at a faster rate than it degrades.

Management Practices - Application methods, pesticide rates and application timing and irrigation management must be critically evaluated to protect water quality. Pesticides which are applied at low rates are more favorable since the quantity of parent compound to be degraded is smaller. A qualified golf course superintendent, trained and licensed to properly apply materials, in consultation with agronomic specialists who are aware of and sensitive to local environmental conditions should be able to provide the margin of safety required for wetlands and water quality protection.

Pesticide Selection-Risk Assessment

Overview

Pesticides were evaluated for use at The Preserve Country Club using standard risk assessment techniques that were developed by the US Environmental Protection Agency (1992). Through this risk assessment process, pesticides with the least potential for toxic effects were selected for use at The Preserve Country Club.

The steps followed in evaluating the pesticides were as follows:

1. A list of potential pest problems was developed for the golf course. Pesticides appropriate for use on the pests were then identified.

2. The list of pesticides was evaluated using a three step process developed by the US Environmental Protection Agency (Tier 1, Tier 2 and Tier 3).

Tier 1. Tier 1 is a conservative, screening level risk assessment, that incorporates conservative estimates of pesticide application rates, along with conservative exposure and risk characterization methods, to provide estimates of the potential for chemical risk. That is, the screening level risk assessment generates the highest risk levels possible for a specific pesticide. The EPA models used in the Tier 1 assessment are SCI-GROW (ground water) and GENEEC (surface water). These models were developed by EPA's Office of Pesticides and are considered the current best models for screening pesticides impacts to the environment (Parker and Rieder 1997, Barrett, 1997). These models have been adopted by the joint EPA task group on pesticide exposure modeling (for more detail on the models or the joint task group see http://www.femvtf.com on the world wide web). This task group is made up of EPA and industry personnel.

The amount of pesticide that was assumed to be used in these models was very conservative; that is, the greatest active ingredient concentrations were used, the amount of turf treated was the whole golf course at the same time, and the number of times that treatment occurred was 10 times for fungicides, 4 times for herbicides, and 5 times for insecticides. Thus, the amount assumed to be used was far greater than any actual use. A comparison was made between the amount of pesticides actually used at a golf course in Westchester Co., NY and the amount modeled for use at The Preserve Country Club. The amount used in the model was approximately 1,200 times, on average, greater than the actual use at that golf course in 1996; the range was 5 to 9,900 times greater in the models than actually used in 1996. Data for chemicals are provided in Attachment 2.

Tier 2. Tier 2 uses the results from Tier 1. For those pesticides shown to have a potential for effect in the Tier 1 assessment, a Tier 2 risk assessment may be implemented, or pesticides may be removed from the approved list for The Preserve Country Club. Tier 2 uses exposure models including PRZM2 (ground water, EPA

1993) and the Simulator for Water Resources in Rural Basins-Water Quality (SWRRBWQ, surface water).

Tier 3. Tier 3 risk assessments are detailed, site specific studies that are time consuming, costly and were not conducted at The Preserve Country Club. Rather than conduct Tier 3 risk assessments, pesticides which failed the Tier 1 assessment either have been eliminated from consideration for use at The Preserve or their use will be restricted.

3. Based on the results of this process, pesticides were selected for use, and restrictions were specified.

4. After being selected for use, the pesticides were rated based on Cornell University's Environmental Impact Quotient method, so that the golf course superintendent knows which of the chemicals is the most safe to use.

Selection Procedure

Using the risk assessment approaches developed by the Environmental Protection Agency (U.S. EPA, 1992), an evaluation was made of the potential human health and environmental health risks of pesticides that are generally appropriate for use at this golf course. Based on rigorous evaluations of potential toxic effects, selection of materials for use at the golf course include only those pesticides that have the least impact to the environment and human health, while meeting the needs of the golf course superintendent to provide healthy turf. This approach evaluates the potential impacts of pesticides to human and environmental health in three tiers (Figure 4).

Tier 1, the screening level risk assessment, incorporates conservative estimates of pesticide application rates, along with conservative exposure and risk characterization methods, to provide estimates of the potential of chemical risk. The Screening Concentration in Ground Water (SCI-GROW) and the Generic Expected Environmental Concentration Program (GENEEC) was used to estimate exposure concentrations of the pesticides. These models were developed by EPA's Office of

Pesticides and are considered the current best models for screening pesticides impacts to the environment (Parker and Rieder 1997, Barrett, 1997). Exposure concentration estimates were compared with ecological (LC_{50}) and human health indicators of risk. For those pesticides shown to have a potential for effect in the Tier 1 assessment, a Tier 2 risk assessment was implemented. Tier 2 uses high quality data and more accurate methods to generate estimates of pesticide risk.

The major components (see Figure 4) of a pesticide risk assessment are problem formulation, exposure assessment, effects assessment, and risk characterization. Each of these components is implemented within each tier of the risk assessment process. However, the methods, data requirements, and interpretation of the risk process is tier-specific.

Problem Formulation - The objective of a pesticide risk assessment is to provide rigorous scientific information about the potential toxic effects of pesticides. Using the outputs from the assessment, pesticides were selected that will minimize any potential environmental or human health impacts of pesticides that may runoff into drinking water sources or water bodies containing aquatic life. In addition, the assessment provides the future golf course superintendents with information useful for selecting effective pesticide application rates and practices, while minimizing any adverse impacts to human or environmental health.

The problem formulation stage is the general planning stage for the assessment. The major information gathered in this stage includes the following:

1. A list of candidate pesticides for use at the golf course. These pesticides are evaluated in the tiered risk assessment process.

2. A detailed description of the golf course site and surrounding areas, including topography, drinking water supplies, and water bodies potentially receiving runoff from the site.

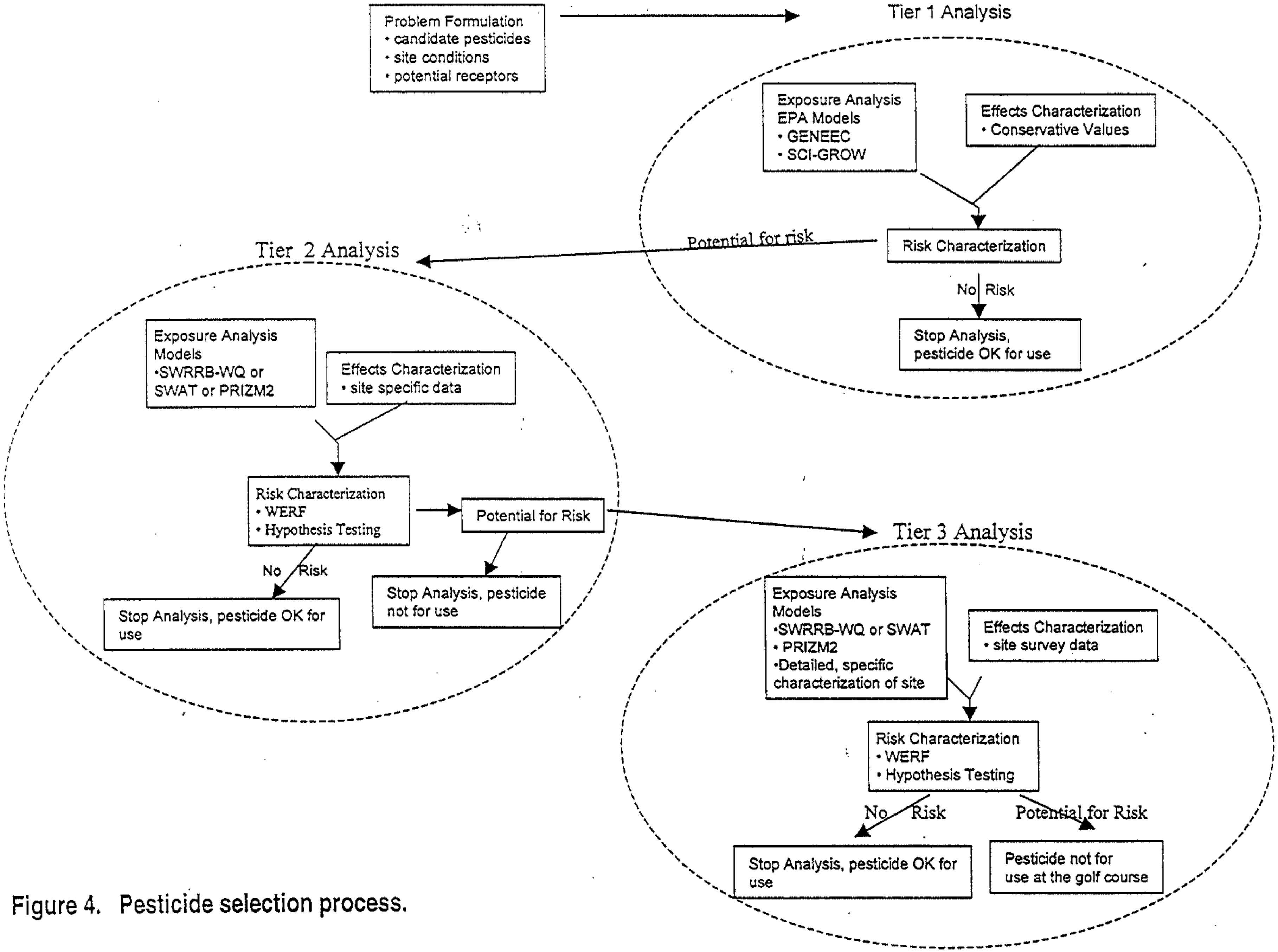

Figure 4. Pesticide selection process.

3. A list of potential receptors (e.g., those animals or human communities potentially impacted from pesticide runoff or ground water flow). Information should include routes of exposure for specific chemicals and information on the signs and symptoms of pesticide toxicity. A literature review of the concentrations of specific pesticides shown to cause toxicity to humans and biota is also required.

4. A chemical description of the candidate pesticides including chemical structure, partition coefficients (Koc), half life, degradation rate, and volatility.

5. A description of the soil system under and surrounding the golf course, including soil type, number of horizons, and transfer coefficients between horizons.

6. Supporting information useful for evaluating the exposure concentrations of the pesticide and risk of the pesticide to human and environmental health. Typical information includes representative meteorological data, health affects levels (HAL), and environmental screening criteria (e.g., LC_{50} of a sensitive local species).

During this stage, a list of pesticides that are candidates for use at the golf course is developed and all relevant information required to successfully conduct the risk assessment (see above) is gathered. In addition, the criteria used to judge the potential risks posed by the pesticides under consideration are defined. The criteria generally represent a concentration in the drinking water supplies or surrounding water bodies that pose a risk to human or ecological health. Selection of specific criteria are dependent upon the risk tiers. More conservative criteria are used in the early tiers.

Exposure Assessment - The exposure assessment provides information on the concentration of a pesticide in drinking water and surface water that results from application of the golf course. These expected concentrations are used to judge the relative risk of the pesticide to human and environmental health. The objective of the exposure assessment is to (1) quantify the amount and timing of pesticide release into the environment, (2) estimate the fate and transport of the pesticide within the golf course boundary and onto surrounding areas, and (3) quantify the exposure of individuals and biota to the resulting concentrations of pesticides in drinking water supplies and receiving water bodies. The specific methods used to generate the exposure concentrations are dependent upon the risk assessment tier under evaluation. In Tier 1, the exposure concentrations are generated in a manner that provides the most conservative concentration estimate (the highest concentration) that could reasonably be thought to occur. In Tier 2 and Tier 3, more accurate estimates of the exposure concentration are generated using detailed site-specific information in the exposure estimates.

Background concentrations of pesticides in groundwater and surface waters are checked. These background concentrations allow separation of the relative pesticide risk caused by those pesticides used at the golf course from other sources of pesticides.

Prior to golf course construction and operation, exposure concentrations can only be predicted with the use of ground water flow and surface water runoff models. After golf course operation has begun, actual concentrations in groundwater and surface receiving waters can be determined via laboratory chemical analysis.

Ecological considerations of pesticide exposure include bioaccumulation of pesticides up the food chain to higher trophic levels. In this context, the potential exposure of carnivores such as birds and foxes to magnified pesticide concentrations are considered.

Effects Characterization - Effects characterization involves generating a list of all organisms that may be exposed to pesticide concentrations resulting from golf course application. In addition, a review of the literature to establish toxic pesticide concentrations for each organism is conducted. For biota, LC_{50}, IC_{25}, or EC_{50} values generated from laboratory bioassay tests are recorded. For humans, health effects criteria, including drinking water and fish consumption levels, are generated. These data are used in combination with the exposure levels to generate estimates of risk. In addition, information gathered in the literature reviews provides a scientific basis for any potential risk to human health or the environment that may be found as a result of the risk assessment.

Risk Characterization - Information on exposure levels and effects are combined in the risk characterization stage to generate estimates of the potential risk of pesticide application to the golf course. The methods used in this stage are dependent upon the risk assessment tier under consideration. In Tier 1, conservative assumptions are used that effectively generate the highest probability of finding pesticide risk. If, using these conservative assumptions a pesticide is shown to have negligible risk levels, the risk assessment is ended. However, if the pesticide is shown to have the potential for environmental or human health risk, two responses are available: if surrogate pesticides are available the pesticide under evaluation can be dropped from further consideration and if surrogates are not available, a Tier 2 analysis can be conducted. The Tier 2 methods provide more accurate estimates of pesticide risk, but are more costly and require higher quality data to generate the risk estimates.

- Tier 1 Characterization:

  The screening level risk assessment generates the highest risk levels possible for a specific pesticide. A quotient is calculated that compares the maximum expected exposure concentration of the pesticide in the media of interest (drinking water, fish tissue, sediments, surface water) to a conservative benchmark dose representing a threshold for effect (i.e., EPA's water quality criteria, HAL, etc.). If the quotient is greater than 1 (one) the potential for risk is assumed.

  $$\text{Expected Risk} = \text{Maximum Expected Concentration} / \text{Effects Criteria}$$

  In a Tier 1 assessment, the maximum expected concentration of the pesticide and conservative estimates of effects are combined to generate the risk estimates. The Tier 1 results are used for screening those pesticides with no obvious human or environmental risk from those that require further study. The effects criteria represent a value that is protective of human or environmental health on a broad scale. Effects are evaluated for acute aquatic, chronic aquatic and human health. Expected risk was calculated as follows for each effects criteria:

Acute Aquatic = GEENEC (Peak Runoff)/LC_{50},

Chronic Aquatic = GEENEC (Ave 21 day runoff)/(LC_{50} * 0.1)

Human Health = SCI-GROW output/HAL

For exposure estimation at Tier 1, conservative screening models are used to generate the maximum expected pesticide concentration in drinking water or surface water at golf courses. These models are SCI-GROW (ground water) and GENEEC (surface water). These models have been adopted by the joint EPA task group on pesticide exposure modeling (for more detail on the models or the joint task group see http://www.femvtf.com on the world wide web). This task group is made up of EPA and industry personnel. These models were developed by EPA's Office of Pesticides and are considered the current best models for screening pesticides impacts to the environment (Parker and Rieder 1997, Barrett, 1997).

The SCI-GROW estimates are based on environmental fate properties of the pesticide, the application rate, and the existing body of data from EPA-required small-scale prospective ground water monitoring studies for all pesticides. Site-specific soil properties can be added to the model to increase the relevance of the model predictions. GENEEC assumes that runoff is sufficient to remove 10% of the dissolved pesticide from a 10 hectare field. The required inputs include application rate (lbs active ingredient./acre), the maximum number of applications per year, absorption rate of dissolved pesticide to soil organic matter, and others.

- Tier 2 Characterization:

For those pesticides shown to have a potential for effect in the Tier 1 assessment, a Tier 2 risk assessment may be implemented. Tier 2 uses high quality data and more accurate methods to generate estimates of pesticide risk. In addition, uncertainty analysis of both the model predictions of pesticide concentrations and effects criteria are used in the analysis to provide a scientifically valid method for assessing pesticide risk.

Tier 2 exposure models include PRZM2 (ground water, EPA 1993) and the Simulator for Water Resources in Rural Basins-Water Quality (SWRRBWQ, surface water runoff, Arnold and Williams 1994; Arnold et al. 1989; Williams et al., 1985). SWRRBWQ is a model that uses GLEAMS pesticide fate component, CREAMS daily rainfall hydrology model, and SCS technology for estimating peak runoff rates and newly developed sediment yield equations to simulate hydrologic and related processes in rural basins (Williams et al 1985; Arnold and Williams 1994). The objective of the model is to predict the effect of management decisions on water, sediment, nutrient, and pesticide yields at the outlet of a sub-basin or basin. SWRRBWQ is a comprehensive, continuous simulation model covering aspects of the hydrologic cycle, pond and reservoir storage, sedimentation, crop growth, nutrient cycling, and pesticide fate. This model was developed for row crop agricultural and has recently been evaluated for turf situations (Smart and Warren-Hicks 1996; Warren-Hicks et al. 1996).

Although other models are available for use, PRZM2 has become the model of choice for the EPA's Office of Pesticides for predicting transport and transformation of pesticides throughout the crop root and unsaturated zones. The model has a built-in Monte Carlo simulator for conducting an uncertainty analysis of sensitive model input parameters.

Exposure models in Tier 2 require a great deal more data to implement than the screening level models of Tier 1. For example, PRZM2 requires over 100 input parameters, including site-specific meteorological data, for successful implementation. Of course, many times the input values for a specific golf course are not available. At Tier 2, when input parameters are uncertain we employ generic values for the soil systems under evaluation. [note: Tier 3 requires site-specific studies to generate accurate input parameters].

Exposure estimates at Tier 2 are generated taking into account the uncertainty in the model inputs and the generic inaccuracy of the model. An uncertainty analysis that propagates the uncertainty of the model inputs into the expected error in prediction is called a Monte Carlo analysis. PRZM2 has a built-in algorithm for implementing the

Monte Carlo analysis. The model allows a Monte Carlo uncertainty analysis to be implemented on those parameters that have the most influence on the predicted exposure concentrations. Therefore, we can use the expected exposure concentration generated by the model (the mean value) and the uncertainty in the predictions (represented by a prediction interval or standard deviation) in the risk estimation procedure. Unfortunately, SWRRBWQ does not have a built-in Monte Carlo procedure. Therefore, we manually generate a prediction uncertainty by running the model several times using different values of sensitive input parameters. The range of model predictions are used to generate a prediction interval of the exposure estimates. Prior work with SWRRBWQ (Smart and Warren-Hicks 1996; Warren-Hicks et al. 1996) has shown that SWRRBWQ produces realistic predictions of pesticides in surface water runoff and that the described method of generating prediction intervals is sufficient in most applications.

Estimates of risk at Tier 2 can be evaluated using the following procedures:

1. For ecological risk, community level risk curves can be generated using the Water Environment Research Foundation's (WERF's) Aquatic Ecological Risk Procedures and Software (Parkhurst et al. 1995, Warren-Hicks and Parkhurst 1995). This method combines the distribution of exposure concentrations with a community level risk curve developed from laboratory toxicity test data to generate the probability of impact of one or more pesticides to the environment. This method is appropriate when sufficient laboratory toxicity data are available for a specific pesticide. In many cases, both acute and chronic community curves can be generated.

2. For both human health and environmental criteria, hypothesis testing can be employed. Here, we use the uncertainty in the exposure concentrations and risk criteria to statistically evaluate if a potential for risk is apparent. We test the hypothesis:

H_0: exposure concentration > risk criterion

H_1: exposure concentration < risk criterion

The test is a one-tailed evaluation of risk. We are only concerned if the exposure criterion is greater than the risk criterion.

In this approach, we attempt to use more realistic risk criterion than employed in Tier 1. The WERF method provides methods for generating realistic criterion for environmental impacts. For human health impacts, we use the geometric mean of the health effects criterion published for a particular pesticide.

Results of the Risk Assessment

As stated earlier, the screening level risk assessment incorporates conservative estimates of pesticide application rates, along with conservative exposure and risk characterization methods, to provide estimates of the potential of chemical risk. The Screening Concentration in Ground Water (SCI-GROW) and the Generic Expected Environmental Concentration Program (GENEEC) models have been used to estimate exposure concentrations of the pesticides. These models were developed by EPA's Office of Pesticides and are considered the current best models for screening pesticides impacts to the environment (Parker and Rieder 1997, Barrett, 1997). Exposure concentration estimates were compared with ecological (LC_{50}) and human health indicators of risk. For surface runoff we evaluated both acute and chronic expected concentrations.

Values greater than 1.0 were considered to indicate a potential for environmental impact, and those chemicals were subjected to a Tier 2 analysis.

Results of the Tier 1 assessment indicated that the following pesticides exceeded the level of acceptable risk as defined by the endpoints (acute aquatic toxicity, chronic aquatic toxicity, human health) for this assessment:

- Chlorothalonil,
- Trichlorfon, and
- Fenamiphos.

Results of the Tier 2 assessment also indicated that these pesticides exceeded acceptable risk levels. Chlorothalonil and Trichlorfon will not be used at the golf course. F-namiphos is a nematicide. This chemical is not expected to be used at the golf course. However, if needed it will be used no more than once per year, on greens only, and when no alternatives are available.

The results of the modeling exercises are given in Table 13. For each pesticide, the type of model exercise conducted, and the resultant restrictions are given. Data for these decisions are given in Attachment 2. In addition to the restrictions placed on pesticide use by modeling, use restrictions are to be imposed for those pesticides that have a HAL or LC_{50} that is less than or equal to 10.0. All proposed restrictions on pesticide use at The Preserve Country Club are presented in Table 15.

Table 13. Results of the modeling exercises for pesticide selection at The Preserve Country Club[a].

Pesticide	Model Exercise	Model Results Risk Ratios[b]			Results
		Acute Aquatic	*Chronic Aquatic*	*Human Health*	
Fungicides					
azoxystrobin	GENEEC, SCI-GROW	0.01	0.03	NDc	Aquatic endpoint, OK for use
chlorothalonil	GENEEC, SCI-GROW	2.60	2.04	2.46	Pesticide will not be used at the golf course
	Simulation	6.64	66.45	162.8	
chloroneb	GENEEC, SCI-GROW	0.00	0.00	0.21	No further action, OK for use
cyproconazole*	GENEEC, SCI-GROW	0.01	0.06	ND	Aquatic endpoint, OK for use
etridiazole	GENEEC, SCI-GROW	0.01	0.00	ND	Aquatic endpoint, OK for use

Table 13. Results of the modeling exercises for pesticide selection at The Preserve Country Club [a] (cont.).

Pesticide	Model Exercise	Model Results Risk Ratios [b]			Results
		Acute Aquatic	*Chronic Aquatic*	*Human Health*	
Fungicides (cont.)					
fenarimol*	GENEEC, SCI-GROW	0.03	0.04	0.02	No further action, OK for use
flutolanil	GENEEC, SCI-GROW	0.00	0.02	ND	Aquatic endpoint, OK for use
fosetyl-Al*	GENEEC, SCI-GROW	0.00	0.01	0.00	No further action, OK for use
iprodione*	GENEEC, SCI-GROW	0.01	0.01	0.04	No further action, OK for use
mancozeb	GENEEC, SCI-GROW	0.30	0.20	0.28	Degradation product is ETU; not used at the golf course
maneb	GENEEC, SCI-GROW	0.06	0.29	0.16	No further action, OK for use
metalaxyl*	GENEEC, SCI-GROW	0.00	0.01	0.00	No further action, OK for use
myclobutanil	GENEEC, SCI-GROW	0.01	0.03	0.01	No further action, OK for use
PCNB	GENEEC, SCI-GROW	0.04	0.02	0.1	No further action, OK for use
propamocarb*	GENEEC, SCI-GROW	0.00	0.00	0.00	Nor further action, OK for use
propiconazole*	GENEEC, SCI-GROW	0.00	0.00	0.02	No further action, OK for use
thiophanate-methyl	GENEEC, SCI-GROW	0.81	0.61	0.00	No further action, OK for use
thiram	GENEEC, SCI-GROW	0.80	0.51	0.02	Restriction based on toxicity
triadimefon	GENEEC, SCI-GROW	0.02	0.04	0.03	No further action, OK for use
vinclozalin*	GENEEC, SCI-GROW	0.00	0.00	0.00	No further action, OK for use

Brown Patch [July - Sep] - Controlling thatch levels and avoiding excess nitrogen will aid in controlling disease incidence. Use of several natural organic fertilizer/composts in the fertilization/topdressing programs have been shown to reduce the incidence of brown patch by up to 75% (Nelson, 1990). Avoid night watering and remove dew from putting greens. Daily scouting during periods of warm weather is highly recommended.

Dollar Spot [June - Sep] - Favored by low nitrogen levels. Use of several natural organic fertilizers/composts has also been shown to reduce incidence by up to 45% (Nelson, 1990). Avoid drought conditions, but avoid allowing the plants to be wet for long periods of time. Remove dew from the turf early in the morning. This disease is slow to develop and cause damage, therefore daily scouting during the months which favor disease development should preclude treatment except on a curative basis.

Leaf Spots and Melting Out [Apr - Oct] - There are several organisms which cause this disease. Cooler temperatures favor development, primarily during April and May. Avoiding heavy spring fertilization can reduce the damage.

Necrotic Ringspot [June - Sep] - This disease occurs in cool-wet weather and is most severe with excessive nitrogen fertilization and over- or under-watering. Therefore, this is an exception to the scouting and spot treatment approach in that a preventative strategy must be employed on areas with a history of disease development.

Pink Snow Mold [Nov - Apr] - This is most prevalent during cold temperatures (32° to 40°F) and wet conditions. Avoiding late fall nitrogen applications can reduce the severity.

Powdery Mildew [July - Sep] - This disease is favored by shaded conditions, especially if there is little air movement. It usually occurs during spring and autumn and is favored by cool (65°F), humid, cloudy weather. Most prominent on bluegrasses. Use of shade-tolerant grasses in the mixture when planting in shady areas can prevent this disease. Avoid excess nitrogen.

Pythium Blight [June - Aug] - This is a rapidly developing and devastating disease. It is favored by excessive nitrogen fertilization and very wet and hot weather. An attack can result in the death of an entire green, tee or fairway in a matter of hours. Because of the severity, a preventative approach is taken during weather conditions which favor disease development or curative upon detection of any disease incidence.

Pythium Root Rot [Mar - Nov] - Usually occurs where there is poor drainage and where there is little organic matter. As opposed to the blight form, symptoms do not include the cottony appearance of mycelium.

Rust [Jul - Oct] - Avoid nitrogen deficiency and water stress. Most prominent on Kentucky bluegrass.

Smut [Apr - Nov] - Resistant varieties are available. Avoid using excessive nitrogen in spring and avoid water stress during the hot summer months.

Summer Patch [July - Sep] - More common on Kentucky bluegrass and annual bluegrass. Over fertilization with nitrogen and excessive irrigation increase the likelihood of disease development. Damage to the plant occurs in April and May, prior to symptom development. A preventative fungicide program may need to be used on areas with a history of Summer Patch problems.

Take-All Patch [Mar - Jun, Sep - Nov] - Avoid heavy lime applications. Lower pH in top inch of soil, can be done using acid-forming nitrogen fertilizers. Improve drainage.

Typhula Blight or Gray Snow Mold [Nov - Apr] - This requires snow cover for the disease to develop. Winters with little or no snow fall usually have a low incidence of disease. Avoiding over fertilization with nitrogen in the mid-fall reduces the severity. A preventative fungicide program should be used before long lasting snow cover to ensure minimal turf damage. Peak snow cover occurs in December, January, February and March in this location.

Guidelines for Disease Management

No annual fungicide program can, nor should, be developed for The Preserve Country Club. Under the IPM approach, many diseases are treated curatively and not on a preventative basis. The need for excessive preventative and curative applications is minimized by sound cultural programs, practicing routine scouting and monitoring of turf and environmental conditions.

Research into the use of introduced biological control agents has yielded only minimal results in effectiveness. he EPA has recently registered a fungus, *Trichoderma harzianum* (Bio-Trek 22G) as a biological control agent for turfgrass. When added to turf, the granular formulation results in establishment of the organism on roots and suppresses *Sclerotinia homoeocarpa* (dollar spot), *Pythium* (Pythium blight) and *Rhizoctonia solani* (brown patch). However, the pathogens may survive in sufficient numbers to cause disease. Once the pathogens are established on the foliage, the soil-applied biocontrol agent no longer can protect the plant. The granular formulation can therefore result in disease reduction, but it must be used in conjunction with compatible chemical fungicides. The use of Bio-Trek 22G will be evaluated on putting greens at The Preserve Country Club to determine its effectiveness at suppressing disease.

The following thresholds under which disease management by use of fungicides may be initiated are provided for each area of the golf course for specific diseases:

Anthracnose - On greens and tees, curative upon detection of any incidence. On fairways, treatment upon detection of 2 to 3 incidences which are 2 to 4 inches in diameter per 100 sq.ft..

Brown Patch - On greens and tees, curative treatment upon detection of any incidence. On fairways, treatment upon detection of 2 to 3 incidences which are 2 to 4 inches in diameter per 100 sq.ft.. In roughs, only when incidences exceed 4 to 6 per 100 sq.ft. and are 4 to 6 inches in diameter and weather conditions are favorable for further disease development.

Dollar Spot - On greens and tees, curative treatment upon detection of any incidence. On fairways, treatment upon detection of 2 or more incidences which are greater than 0.5 inch diameter per square foot. In roughs, only when incidences with a diameter greater than 0.75 inch exceed 4 to 6 per sq.ft. and weather conditions are favorable for further disease development.

Leaf Spots and Melting Out - On greens and tees, curative treatment upon detection of any incidence which is forming patches or thinning the turf. On fairways, when incidences of patches exceed 2 to 3 per sq.ft. or when the turf appears to be thinning. In rough, only when incidences appear to be thinning the turf.

Necrotic Ringspot - Preventative treatments must be applied to greens and tees which have a previous history of infection when cool-wet weather occurs. On fairways and roughs, treatment should occur upon detection of any incidence.

Pink Snow Mold - On all areas, curative upon detection of any incidence prior to any snowfall. Preventative prior to snowfall which will provide prolonged cover.

Powdery Mildew - Curative treatment when incidences of patches exceed 2 to 3 per sq.ft. or when the turf appears to be thinning.

Pythium Root Rot and Pythium Blight - Upon detection of any incidence on any area. This disease is easily spread if in the blight stage. The root rot form is exceptionally damaging since it requires long recovery periods, often during summer months when temperature conditions are not favorable for root growth.

Rust - In roughs, only when incidences appear.

Smut - In roughs, only when incidences appear to be thinning the turf.

Summer Patch - Curative on any area where incidence is noted. Preventative on areas which have a previous history in April and May, prior to symptom development.

Take-All Patch - On greens and tees, curative treatment upon detection of any incidence which is forming patches or thinning the turf. On fairways, when incidences of patches exceed 2 to 3 per sq.ft. or when the turf appears to be thinning.

Typhula Blight or Gray Snow Mold - Preventative prior to snowfall.

Insect Control

The management of insect pests rarely relies on a single control practice; usually a variety of tactics are integrated to maintain pests at acceptable levels. The goal of IPM is not to eliminate all pests; rather the aim is to reduce pest populations to less than damaging numbers. The decision to use an insecticide, or take some other action, against an insect infestation requires an understanding of the level of damage or insect infestation which can be tolerated without an unacceptable loss. Suggested thresholds for specific areas of the golf course before chemical treatment is necessary are given in Table 17 and have been adapted from Hellman (1992), Bhowmik et al. (1991) and Villani (1992). Sampling is essential and must be conducted by a trained individual at regular intervals throughout the growing season.

Table 17. Suggested thresholds for treatment of insect problems at The Preserve Country Club.

Insects	Greens and Tees (#/sq.yd.)	Fairways and Roughs (#/sq.ft.)
Grubs		
Japanese beetle	1 to 2	6 to 20
European chafer	1	3 to 8
Asiatic garden beetle	1 to 2	5 to 18
Oriental beetle	1	5 to 7
Hyperodes weevil	1 to 8	10 to 80
Bluegrass Billbugs	1 to 2	5 to 18
Black Turfgrass Ataenius Beetle	1 to 2	6 to 12
Cutworms	1	4 to 8
Sod webworm	1	3 to 5
Chinch bugs	X	30 to 50 nymphs

Insect problems at this course will be minimal and will include, primarily, root feeding grubs. Routine scouting and sampling of turf for adults and grubs can isolate areas of concern and target control measures.

Insecticides may be divided into two broad categories: (a) conventional/chemical/synthetic materials; and (b) biorational materials. Conventional or chemical insecticides have a broad spectrum of activity and are more detrimental to natural insect enemies. In contrast, insecticides that are more selective because they are most effective against insects with certain feeding habits, at certain life stages, or within certain taxonomic groups, are referred to as "biorational" pesticides.

Biorational pesticides are generally less toxic and more selective, and are generally less harmful to natural insect enemies and the environment. These include microbial-based insecticides such as *Bacillus thuringiensis* products, chemicals such as pheromones that modify insect behavior, insect growth regulators and insecticidal soaps.

While nonchemical treatments such as parasitic nematodes and bacteria for insect control are available, they do not give the degree of consistency, reliability and versatility and have proven ineffective in many circumstances (Potter, 1993). Biorational materials which could be considered for use in Connecticut include 1) Milky spore disease, a bacteria that infects Japanese beetle grubs and has been applied extensively on turfgrass in the Northeast for many years, but is of questionable value because (a) the bacteria is most infective to Japanese beetle grubs and is of limited value against other common grub species infesting turfgrass in Connecticut; (b) soil temperatures are often too cool for rapid disease buildup; and (c) milky disease bacteria can only multiply within the living bodies of grubs; thus one must be willing to tolerate a period of relatively high grub populations to obtain disease levels sufficient to control grubs. The use of entomogenous (insect parasitic) nematodes as a control cannot be given unqualified endorsement at this time. Nematodes have provided grub control equal or superior to that of currently labeled turf insecticides, but the number of failures is sufficient to caution their use. Failures have been traced to the use of nematodes in poor physical conditions; the use of nematode strains not well suited for control of grubs; and soil conditions that prevent nematodes from surviving, reproducing, or persisting in the field.

Insecticides which are recommended and approved based on the selection guidelines previously noted are presented in Table 18. Recommendations for the timing of insecticide applications are provided in Figure 7.

Table 18. Insecticides[†] recommended for control of specific turfgrass insects at The Preserve.

Insect	Greens/Tees
Hyperodes weevil	bifenthrin[1], cyfluthrin[1], lambda-cyhalothrin[1], chlorpyrifos[2], isofenphos[3]
White grubs	imidacloprid[1], carbaryl[2], chlorpyrifos[2], bendiocarb[2], isofenphos[3], halogenozide
Black Turfgrass Ataenius beetles	imidacloprid[1], chlorpyrifos[2], bendiocarb[2], isofenphos[3], halogenozide
Bluegrass billbugs	carbaryl[1], chlorpyrifos[2], isofenphos[3]
Sod webworms & Cutworms	cyfluthrin[1], carbaryl[2], fluvalinate[2], chlorpyrifos[3], bendiocarb[4], halogenozide
Chinch bugs	cyfluthrin[1], acephate[2], carbaryl[2], fluvalinate[2], chlorpyrifos[3], bendiocarb[4]
Cutworms	cyfluthrin[1], carbaryl[2], chlorpyrifos[3], halogenozide

Table 18. Insecticides[†] recommended for control of specific turfgrass insects at The Preserve (cont.).

[†] *All materials must be applied at rates and under conditions prescribed by the label. Ecological risk assessment protocols were used to select pesticides. Pesticides are numbered based on Environmental Impact Quotient protocols (Kovach et al., 1992) and pesticides with the lowest number are preferred.*

Hyperodes weevil - This insect attacks only the annual bluegrass plant. Therefore if the annual bluegrass weed control program is effective a minimum of damage will occur with this insect. Sampling of the adult population in the spring can determine if selected areas need to be treated.

White grubs - Several species of insects have larval forms as white grubs that feed on the turfgrass roots at the soil/thatch interface. They can be extremely destructive, especially in the advanced larval stage. The key to successful control is identifying threshold levels and treating when larvae are in the earliest stages, this would be in July for May or June beetles, and August or September for most others. Recent surveys and reports indicate that the distribution of white grubs is changing in the Northeast. The European chafer is much more widespread than had previously been noted, being found in damaging numbers on turf. This insect is more damaging than most other grub species in part because it tolerates cooler soil temperatures and returns to the root zone to feed in the spring earlier than other species. It also remains in the root zone longer in the fall. In addition, it is less vulnerable to insecticides than most other species, in part because it is a larger grub. However, it predominantly has a 1-year life cycle so control of egg-hatch in the fall will successfully control the problem. The highest populations of grubs are found out to a radius of about 75 feet from the trees to which adult beetles have flown. Fewer grubs are found at locations farther from trees. Scouting should concentrate in heavily shaded areas. This has led to a risk rating system for European chafer larvae on residential lawn areas which can be transferred to golf course roughs. Table 19 will be used to categorize relative risk of European chafer problems in the roughs at The Preserve Country Club and the need for scouting/monitoring.

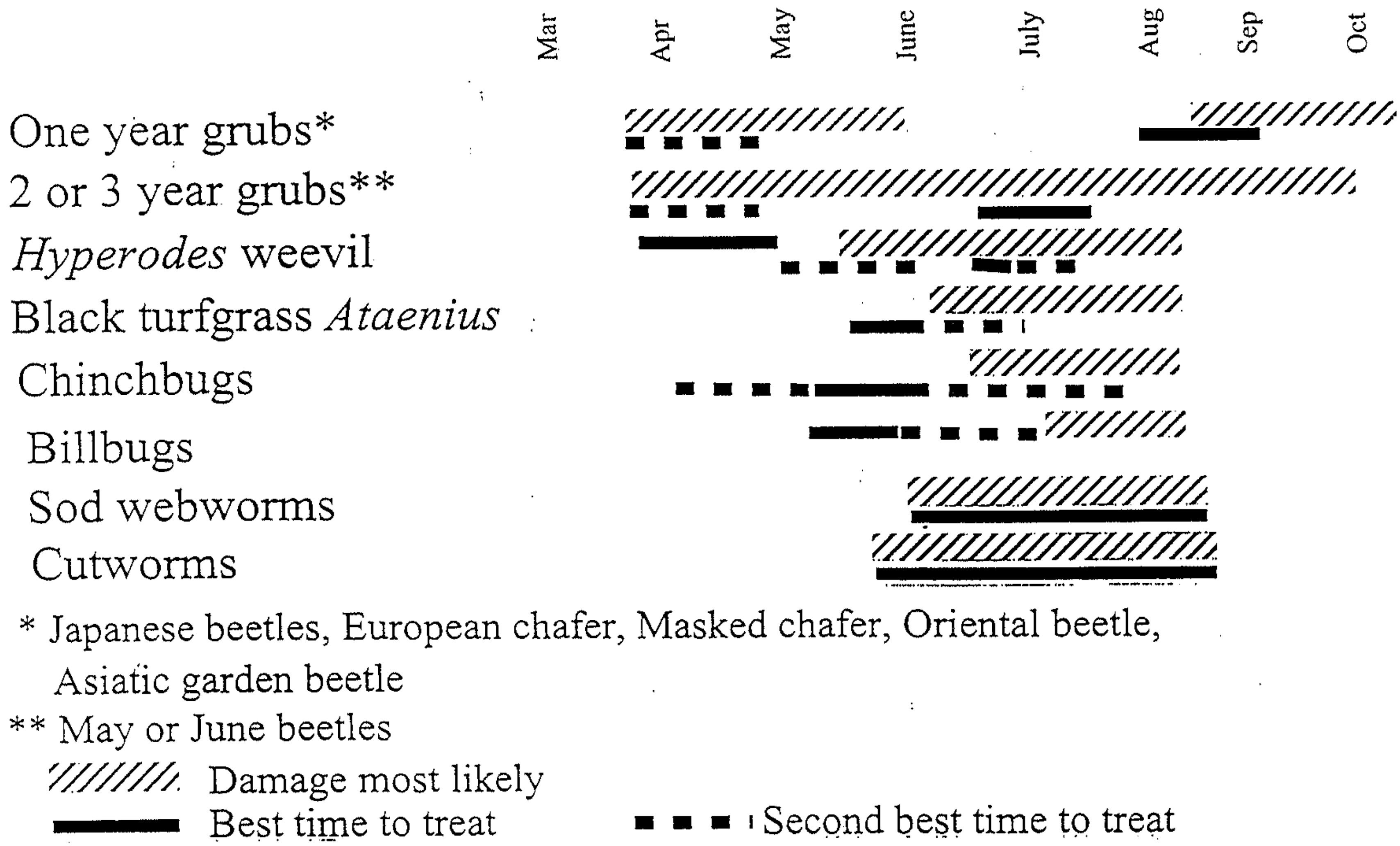

Figure 7. Recommended timing of insecticide applications for optimum efficacy.

Timing of insecticide application for most materials should be when larvae are still active at the soil surface. The exception is the use of imidacloprid which can be applied early in the season and will be effective when egg-hatch occurs in the fall. There is a serious concern that this product can be overused and it should be restricted to only those areas where scouting has indicated a major infestation is expected.

Table 19. Risk rating system for European chafer larvae in roughs.

% of Turf in Shade	% of Turf that is Kentucky Bluegrass	Risk Category	Need to Sample?
> 60%	< 30%	1	no
> 60%	30 - 60%	2	no
30 - 60 %	< 30%	3	no
30 - 60%	30 - 60%	4	marginal
>60%	> 60%	5	yes
30 - 60%	> 60%	6	yes
< 30%	< 30%	7	yes
< 30%	30 - 60 %	8	yes
< 30%	> 60%	9	yes

Adapted from Villani and Nyrop, 1997 Cornell IPM Annual Report.

Sod Webworms - These are caterpillar larvae of several species of moths. They can be very destructive if not diagnosed and treated early. The adult moths are inactive in the daytime and can be observed resting on the turfgrass, weeds, or on the leaves and stems of trees or shrubs. Likewise, the larvae are night feeders on the leaves of the grass. Scouting for both adults and larvae burrowed down in the grass can determine if damaging numbers are present. While summer months are when the moth activity is most active, several species have 2 or 3 life cycles per year. Monitoring is critical to ensuring timely treatment. Evening treatment is required since that is when the larvae are active.

Weed Control

The most effective weed control is a dense healthy turf. Therefore, after the first year and the turf is fully established weed problems will be minimal. Paying strict attention to optimum cultural practices to maintain an aggressive turf is the first requisite in weed control. Guidelines under which weed management by use of herbicides may be initiated are provided for each area of the golf course in Table 20.

Table 20. Guidelines for initiation of weed control at various locations at The Preserve Country Club.

Golf Course Area	Grassy Weeds (%)	Broadleaf Weeds (%)
Greens	0-1	0-1
Tees	2-6	1-4
Fairways	3-8	2-7
Roughs	7-12	8-13

Annual bluegrass - While the common name implies this is an annual weed problem, the sub-species (*Poa annua* spp. *reptans*) of this pest problem is actually a perennial. Growth and persistence of annual bluegrass is favored by compacted and/or wet soils, high soil pH, and high soil phosphorus levels. Keeping cultural practices current to prevent these conditions and favor the growth of the preferred grasses will minimize the competition.

Clover and other broadleaf weeds - Clover can be a problem in any area because of its aggressive nature. Other broadleaf weeds will only invade weakened or thin turf, especially if they are annuals.

Crabgrass - This is an annual grassy weed that invades thin turf. Crabgrass seed require light for germination. Thus an effective control is to maintain a dense stand of grass. Crabgrass seed is known to germinate when soil temperatures reach 53 to 58 F at a 4-inch depth.

Thus, timing of the herbicide application should be just prior to soil temperatures reaching this range.

Herbicides which are recommended and approved for use at The Preserve Country Club, based on the selection guidelines previously noted, are presented in Table 21.

Table 21. Herbicides[†] recommended for control of specific turfgrass weeds at The Preserve Country Club.

Weed	Greens	Tees	Fairways	Roughs
Annual Grassy Weeds	bensulide, bensulide+oxadiazon dithiopyr	bensulide, bensulide+oxadiazon dithiopyr	pendimethalin, bensulide, benefin+trifluralin dithiopyr[a], prodiamine,	pendimethalin, bensulide, benefin+trifluralin dithiopyr[a], prodiamine, oxadiazon
Broadleaf Weeds	2,4-D+dicamba+ MCPP (bentgrass formulation)	2,4-D+dicamba+ MCPP (bentgrass formulation)	triclopyr+clopyralid, 2,4-D+dicamba+ MCPP (bentgrass formulation), dicamba, MCPP	triclopyr+clopyralid, 2,4-D+dicamba+ MCPP (bentgrass formulation), dicamba, MCPP, 2,4-D+triclopyr
Sedges			bentazon, halosulfuron[b]	halosulfuron[b]

[†] *All materials must be applied at rates and under conditions prescribed by the label.*
[•] *Ecological risk assessment protocols were used to select pesticides.*
[a] *indicates that an EIQ (Kovach et al., 199) has not been determined.*
[b] *indicates that the herbicide is effective for treatment, but has not yet been approved for use pending additional environmental information.*

Lake and Pond Weed Management

Aquatic sites are dynamic and responsive and as the availability and nature of the resources change, so will the species diversity and/or amounts of aquatic vegetation. However, at some point a healthy aquatic plant population may actually become an aquatic weed situation detrimental to the lake or pond's ecosystem balance.

The physical environment of lakes coupled with water quality will determine the response of the aquatic ecosystem and influence whether or not aquatic plants will become weed problems. The primary factors involved at The Preserve Country Club are the following:

Light - the quality and amount of light is a most important physical requirement for all aquatic plants. Water clarity will be an important, influencing factor for growth of algae and submerged vegetation;

Nutrients - while aquatic plants have the same nutrient requirements as land plants, many species can absorb nutrients directly from the water. This means lakes can be used as aquatic filters in certain instances. Freshwater lakes and ponds are particularly sensitive to phosphorus;

Gases - both oxygen and carbon dioxide are vital to aquatic plants. Daily fluctuations may occur in water oxygen levels in response to photosynthesis. Dissolved oxygen levels at night can be low enough to cause fish kills and extremely low oxygen levels can occur in lakes with extraordinarily dense aquatic vegetation. Low oxygen levels may also occur with decomposition of dead plants by bacteria and fungi, especially after treatment with a herbicide; and

Temperature - water serves as an excellent buffer against rapid temperature changes and plants growing under water are insulated from the shocks of extreme temperature changes.

Aquatic plants are of four main types including algae, floating weeds, emergent weeds, and submergent weeds. Each has distinct growth characteristics resulting in varying control techniques. However, additional factors besides growth habit must be considered in control practices. Besides proper identification of the weed species, the relative abundance, location within the lake, and age of infestation are important, since these may determine the extent of the problem and how and when to proceed with control measure. Use of the site and fate of the water will determine the appropriate control. Time of year will determine how effective different treatment approaches will be. There are a number of distinct strategies for aquatic weed control. These are summarized below:

Standard Aquatic Nuisance Plant Control Methods	
Method	**Description**
Prevention	Eliminate nutrient loading. Install aerators to increase water movement and oxygen.
Physical Removal	Hand harvest aquatic vegetation by pulling. rolling, cutting, or digging.
Mechanical Removal	Use specialized mechanical equipment to cut and harvest aquatic weeds.
Environmental Controls	
Bottom barriers	Made of plastic, rubber, or fiberglass, these can be used to inhibit or prevent rooted growth in selected areas.
Shading	Use of black plastic, soluble dyes, or artificial structures will inhibit or shade out aquatic plant growth. Trees can be used to permanently shade certain areas.
Drawdown	Periodic lowering of water levels will expose bottom sediments; can control some weeds by desiccating or freezing.
Dredging	Remove existing rooted plants and nutrient rich sediments to reduce nutrient accumulations and create greater water depth to control aquatic growth.
Biological Controls	
Insects	Adults and/or larvae of certain moths and weevils have been introduced to selectively eat plant populations. This method has worked for water hyacinth and alligator weed.
Plant Diseases	Introduction of pathogens such as bacteria, viruses, fungi, and other micro-organisms is a new approach that is working on many courses.
Chemical Controls	The use of chemicals is the most common and versatile management strategy for controlling nuisance aquatic plant populations. However, chemical management often treats the symptom and not causes of weed and algae populations. Chemical controls should be used in conjunction with strategies to control the problem.

Scouting Program For The Preserve Country Club

The IPM scouting plan for The Preserve Country Club relies on the following tenants. In developing the program, there are specific items which need to be addressed in order to ensure the program will be successful. The superintendent must ensure that the following steps are followed:

1. Assign individual(s) to conduct the scouting, record the results, evaluate the information and make the decisions once the information is recorded. This may be done in a team approach with the scout consulting with specific members of the staff, or it may be an individual.

2. Provide proper education and training to all involved i any aspect of the IPM program. This should include formal seminars, workshops, conferences, short courses, and training for the superintendent and assistant superintendent. State, regional, and national conferences are excellent formats from which to obtain these types of programs. In-house training sessions for the maintenance crew should be held to inform them of IPM strategies.

3. Review, at least annually, the complete program and evaluate its effectiveness. Changes will constantly be made as the golf course matures, changes in design are made, or as new information concerning handling of turf management or pest problems becomes available.

4. Tools necessary to conduct the scouting program will be determined by the level of intensity of the scouting. At a minimum the following items are required: hand lens (10x), collection vials, soil probe, paper bags, pocket knife, small ruler, small spade, notebook, cup cutter, field identification guides, tweezers, small camera.

Table 22 is a Turf Pest Damage Monitoring Chart which indicates which pest problems are most likely to occur at specific times of the year. Symptoms of typical damage are also included in the table.

Table 22. Turf Pest Damage Monitoring Chart

This chart indicates when peak periods of damage are most likely to occur in the case of diseases and insects, and when weeds will begin to germinate in the case of weeds. It is NOT intended to indicate when applications of pesticides should occur, if at all. Consult the appropriate pest section in this guide for cultural management techniques and appropriate pesticide application recommendations. Consult TURF IPM FACTS (see ordering information in the resources section of this guide) for additional information on the timing and methods of monitoring turfgrass pests.

Group	*Causal Agent*	*Symptoms of Damage*
Diseases that cause irregular damage	Fusarium Leaf Blight/ Crown and Root Rot	Irregular dull tan leaf spots with dark margins, oval or eye shaped.
	Leafspots, Blights, and Melting Out	Oval or eye shaped dark bordered spots, dark specks present in older diseased tissue.
	Powdery Mildew	White to powdery gray mold which is easily wiped off, often found in shade. No leaf spots present.
	Red Thread/Pink Patch	Irregular pattern of pink to reddish leaves with gelatinous mycelium. Red "thread" like growths beyond tips may be present.
	Rusts	Irregular pattern of bright orange, yellow, reddish brown pustules on the grass blades.
	Slime Molds	Slimy superficially whitish gray to yellow fungus, turning powdery later.
	Stripe Smut	Gray to black streaks of black powdery spores in leaves. Usually in turf 3 or more years old.
Diseases that cause circular damage	Anthracnose	Leaves yellow and wilting, black spiny hairs in tufts may be visible by hand lens.
	Brown Patch	1-3' patches of light brown grass. Gray mycelium may be present in moist conditions.
	Dollar Spot	Whitish tan leaf spots with brown, reddish brown, or purplish borders.
	Downy Mildew	Yellow patches or tufts < 1" across. Plants easily pulled from turf.
	Necrotic Ring Spot	Patches, rings, "frog eyes" approx. 6-8" across, enlarging later. Common in Kentucky Bluegrass and annual bluegrass.
	Pythium Root Rot	Turf wilted, killed, or rotted. Often in poorly drained areas.
	Pythium Blight	Circular pattern with tan spots lacking dark borders on the leaves. Leaves matted and slimy with dense white mold.
	Snow Mold (Pink and Gray)	Wet grass covered with white, pink, bluish gray mold. Small reddish, brown or yellow sclerotia present on leaves in gray variety.
	Summer Patch	Circular patches of straw colored grass 6 - 8" across. Center may be green. (Identical to Necrotic Ring Spot)
	Take All	Yellow turning reddish, then brown, and later sunken patches occur. Centers often invaded by weeds.
	Yellow Patch (Cool season Brown Patch)	Yellow to straw colored grass often sunken in high cut areas.
	Fairy Ring	Rings or arcs up to 15' across often with outer ring of dark green grass. Mushrooms may be present in ring.
Insects	White Grubs • Japanese beetle, Eur. chafer, Masked chafer, Oriental beetle	Turf appears to suffer drought stress. Skunks, raccoons, and crows may tear up the turf. Turf may pull up "carpet like."
	• May or June beetles	Three year life cycle — damage occurs throughout growing season of "Year 2."
	Billbugs	Areas wilt and do not respond to watering. "Sawdust" like material in thatch. Turf is easily tugged loose.
	Black Turfgrass Ataenius	Similar to white grubs above.
	Chinch Bugs	Wilted or browned areas, most severe in sunny or sandy areas.
	Cutworms	Burrows surrounded by brown patches, green frass may be present.
	Hyperodes Weevil	Yellow patches beginning near collars and fairways. Damaged areas may appear water soaked. Usually two generations per year.
	Sod Webworm	Discrete browned areas which coalesce later. Most common in sunny areas. May cause damage in late spring.
Weeds	Crabgrass and other Annual Grasses	Period of peak germination. When soil temperatures are 12-14.5°C(53-58°F) at a depth of 10 cm. (4 inches).
	Annual Bluegrass and Winter Broadleaves	Period of peak germination. May develop seed heads earlier in season if weather is favorable.
	Perennial Broadleaves	Period of peak germination.
	Annual Broadleaves	Period of peak germination.
	Weed Scouting Period Optimum	Most weeds are large enough for easy identification.
	Secondary	

The recommended scouting program for The Preserve Country Club includes daily, weekly, monthly, and annual activities as follow.

Daily Scouting Activities

- Record data from weather station and calculate degree days.

- Refer to models for Brown Patch and Pythium for calculation of degree of risk of disease outbreak. Refer to models for insects for possibility of problems and windows for insecticide application.

- Examine the quality of cut. While this is dependent on species and cultivars of grass, cutting height, mowing speeds, clips per inch and type of mower, it is an excellent indicator of the overall health of the turf. Additionally, since mowing creates an open wound, it is desirable it heal quickly, and torn or ragged edge is indicative of poor cutting quality which will need to be addressed.

- Examine soil moisture. Whether using a soil moisture meter or simply pulling a core with a probe, the soil moisture should be wet, but not saturated, to prevent moisture stress. This is a gauge from which to help guide the irrigation program.

- Check for disease outbreaks. This is especially critical during periods of warm, moist weather as these are important requisites for disease development. Early morning is the best time for walking the green by separating paths into six foot segments to note any small spots or white threads of fungal hyphae. A closer examination with the hand lens or a sample to take to the field laboratory for microscopic analysis can be collected to confirm disease presence.

- Check weed development. Similar to inspection for disease problems, look for any differences in color or texture of leaves, particularly in thin turf areas or where ball marks have damaged the turf. With this approach, many weeds can be hand picked or mechanically controlled before they become mature enough to create a problem.

- Check for insects. Leaf eating insects should be detectable in the same manner as looking for disease and weed problems. On closely mowed turf, a scouting of the surface and thatch lay.. should be sufficient. Specific insect problems should be intensively scouted during peak activity periods.

Weekly or Bimonthly Scouting Activities

- Soil temperature - root growth, seed germination (including weeds), disease and insect activity and other factors which impact turf growth are tied closely to soil temperatures.

- Plant tissue analysis - will help guide fertilization programs.

- Identify aquatic growth that is over-abundant or a nuisance. Scouting should begin in the spring (when water temperatures warm) and end in fall (when water temperatures decrease). Early detection will allow appropriate treatment. Biological controls are a good alternative to chemical treatment of submerged aquatic plants. If chemicals are required, treat only one-third of the lake/pond at a time. Should plant problems continue and recur each year, steps should be taken to determine the reason for the nuisance conditions. Once determined, effective solutions can be implemented.

- Scout for signs of algae, molds or moss. These can be observed growing in the mat layer on the soil surface or in the soil profile. Their growth is encouraged by soil acidity and saturated soil profiles. When this scum appears, a light dusting of hydrated lime at 2 to 5 pounds per 1000 sq.ft. will kill the algae. Plugging or sodding along with topdressing can be done if necessary as soon as the soil dries out. Vertical mowing can also be performed to break up the scum formed once it has dried if it has formed a thick layer.

- Check for hydrophobic soil conditions by inspecting for areas that turn blue or gray. This condition may be caused by excessive surface compaction or because of the coating of the sand soil particles with a hydrophobic layer of organic matter. A soil probe can be used to extract a column of soil and water droplets can be placed at 2-inch increments along the soil column. If the water beads and does not infiltrate into the soil, a true hydrophobic condition exists. Spot aerification, along with lime and fertilizer and use of a wetting agent can help rectify this problem.

- Scout for visual signs of disease, weed and insect problems at least weekly. Dividing the fairways into 15 to 20 foot strips and observing while riding in a golf cart or utility vehicle, scout for signs of pest problems. If symptoms are present, use the thresholds predetermined for a decision on whether to treat with a pesticide. Scouting for insects could include use of pitfall traps, light traps, pheromone traps, cup cutter samples or drenching with soap solutions to flush them to the surface. Once detected, use a grid to quantify the numbers present per sq.ft. or sq.yd. for threshold determination.

- Mapping of the pest problems observed should be done on a grid system of specific locations on the course to develop a history of pest infestation. This will be useful for future control options.

Monthly Activities

- Sample the soil profile to check for layering. Examine the condition of the roots (should be white and fibrous), smell for indications of anaerobic conditions, probe to check for soil compaction, and measure thatch amounts. A soil analysis in areas where the turf is not performing well for pH and soluble salts can be useful.

- Spot check irrigation system uniformity on at least 4 to 5 greens. Use containers spaced two feet apart from sprinkler head-to-head in a straight line. Operate the system for 15 minutes and check volumes in each container. Multiply by 4 to gauge the irrigation system inches per hour and determine if it is within specification guidelines.

Semi-Annual Activities

- Soil test for nutrient levels including macro nutrients, micro nutrients, pH and soluble salts.

- Scout for drainage and seepage problems. Presence of moss or algae is a certain sign of poor drainage. Puddled soil and signs of scald note excessive soil wetness. If seepage is suspected, dig a hole two feet deep with a spade or post hole digger and allow 24 hours for it to refill. If it does so, it indicates seepage from below ground either vertically or laterally. Installation of drainage lines may be a way to resolve this problem.

- Monitoring in both mornings and afternoons will determine if tree shade azimuths are creating low light conditions for grass growth and the need to thin trees. This could also help determine wind movement patterns which are important in drying turf areas and preventing disease problems.

RECORD KEEPING

Recording the information collected during scouting activities on forms such as those which are in Attachment 3 will help build a record for each area on the course. This will be useful in determining if certain pest problems are recurring. This approach will allow subsequent "fine-tuning" of the IPM program as the course matures.

Proper records of all pesticide applications will be kept according to government requirements. These records will help establish proof of proper use, facilitate comparison of results of different applications, and/or find cause of an error. Records are to include the following information:

1. Data and time of application.
2. Name of applicator.
3. Person directing or authorizing the application.
4. Weather conditions.

5. Target pest.
6. Pesticide used (trade name, active ingredient, amount of formulation, amount of water).
7. Adjuvant/Surfactant and amount applied, if used.
8. The area of the golf course treated.
9. Total amount of pesticide used.
10. Application equipment.
11. Additional remarks, such as severity of the infestation.

A sample pesticide use record is included in Attachment 3. Originals of all pesticide use records are to be maintained at the office of the golf course superintendent for a period of at least seven years. Copies of all pesticide use records for a given year shall be submitted annually to the inland wetlands and watercourses enforcement officer in the Towns of Old Saybrook, Essex, and Westbrook by February 28 of the subsequent year.

MANAGING THE PROGRAM AND PERSONNEL

The success of this golf course Integrated Pest Management plan depends, to a large extent, on the manner in which the program is carried out. Since The Preserve Country Club is located in a locale that has environmentally sensitive areas, it is imperative that the selection of personnel be made very carefully. The golf course will need a cadre of highly qualified key people to see that daily operations are carried out properly and in a timely manner.

Superintendent

Because turfgrass management has become more scientific in the past few years, it is desirable for the superintendent to have a degree in agronomy, horticulture, or plant or soil sciences, as well as experience in all phases of golf course management. Since it is their management ability and day-to-day decisions based on sound agronomic principles and practices that make a successful program, they should have a thorough knowledge of Best Management Practices (BMP), exhibit an understanding of the principles of Integrated Pest Management (IPM), and have a license to apply restricted use pesticides. A participating knowledge of the game of golf and the ability to train and effectively supervise employees are also important.

Assistant Superintendent

As with the superintendent, the assistant superintendent should have a degree in agronomy, horticulture, or plant or soil sciences. The assistant(s) should be licensed in pesticide usage, have a working knowledge of golf course maintenance practices, and the ability to schedule and supervise work to achieve the most efficient utilization of employees and equipment.

Irrigation Technician

Because of the highly sophisticated irrigation system to be used on the course and the importance of proper monitoring of water usage, the selection of this technician is critical. The person employed must have a working knowledge of computerized control systems as well as basic electricity, hydraulics, valves, pumps, sprinkler heads, etc. Since efficient water use and conservation of irrigation water are the responsibility of the system operator, a knowledge of turfgrass water requirements and the capabilities of the irrigation system will be needed, also.

Pesticide Technician

Because the appropriate use of pesticides depends not only on proper selection but also on proper equipment maintenance and calibration and application techniques, it is strongly recommended that this person be licensed in restricted pesticide usage and experienced in handling pesticides.

Mechanic

The success of all cultural practices is dependent, to a large degree, on the condition of the equipment and tools used. Therefore, it is essential to have a person knowledgeable and capable in the maintenance and repair of the various types of equipment used on golf courses. Their responsibilities include not only keeping all equipment in operational condition at all times, but also keeping the service area and maintenance building clean and in accordance with all environmental regulations.

PESTICIDE SAFETY

An important part of pesticide safety is the maintenance facilit that includes appropriate storage, handling, washing and mixing areas.

Pesticide Storage

Pesticides will need to be stored in a separate room designated for these materials only and located away from water sources (ponds, streams). The room will be kept locked and posted as required by law, including the courses, 'Hazard Communication Program' (See samples in Attachment 4). All pesticides will be stored in their original containers with visible labels.

To be prepared for spills and/or leaks, absorbent floor-sweep materials, sawdust or cat litter and activated charcoal will be kept on hand. An inventory of pesticides and other chemicals will be kept, and MSDS and labels for each pesticide used will be readily accessible. A fire extinguisher, protective clothing, respirator and first aid supplies will be kept in an attainable place and in ready condition. Water will be available for both routine and emergency chemical removal, including showers and eye wash facilities. A detail of the pesticide storage facilities to be constructed at The Preserve Country Club is presented on in Volume 2A of the Environmental Management Report.

Pesticide Handling and Application

When handling pesticides, special attention will be given to warnings and precautions on the label. Applicators should always wear personal protective gear which includes rubber gloves, goggles or face shields, respirators, protective clothing, and rubber boots when mixing and applying pesticides. Chemicals should always be measured out below eye level; and applicators should not stand directly over the tank when adding chemicals, as they frequently splash and emit dusts.

Mixing and loading will be done in the pesticide storage room near the containment sump (see description of storage room herein under the heading MAINTENANCE FACILITY). A system of rinse water tanks will be used to store excess water from the filling or rinsing of sprayers. This is an effective way to deal with the rinse water. The rinse water will be pumped into the holding tanks and reused as make-up water for the next time that type of material is applied to the country club property. Three different tanks are to be used: one for herbicides, one for insecticides, and one for fungicides. The rinse water from herbicide applications is to be pumped to the herbicide tank, rinse water from insecticide applications is to be pumped to the insecticide tank, and rinse water from fungicide applications is to be pumped to the fungicide tank. The tanks will be located above the mixing/wash area on metal or non-absorbent shelves.

Before mixing chemicals together, their compatibility will be checked as chemical incompatibility could result in reduced effectiveness, increased toxicity to the applicator, or phytotoxicity to the turfgrass. The "quart jar method" may be used to determine compatibility. Spray adjuvants (such as wetting agents, emulsifiers, foaming agents, and stickers) must be used in accordance with label recommendations. Care is to be taken to mix only the amount of pesticide needed for the current application. As soon as pesticides are loaded, all equipment and apparel used is to be washed, rinsed and air dried. Water used in the cleaning process is to be dumped into the spray tank.

After the pesticide is applied, the sprayer tank, boom and nozzles are to be washed in the designated wash area where the tank will be refilled with water. The rinsate is to be stored in appropriate holding tanks, as described herein under the heading MAINTENANCE FACILITY.

SPILL PREVENTION AND RESPONSE

The following spill prevention and response protocol will govern the handling of all hazardous substances at The Preserve Country Club. The protocol addresses personnel training, spill prevention, and spill containment.

Training

- A current pesticide operators license will be maintained by the Golf Course Superintendent, Assistant Superintendent, and the Pesticide Spray Technician.
- Safety plans including proper handling and storage as indicated on Material Safety Data Sheets (MSDS) will be followed.
- Training in proper storage, handling, mixing and containment of spills of chemicals will be conducted.

Prevention

- Mixing of chemicals is to occur only at the designated chemical mixing area that is designed to contain any spillage until it is properly treated with the filtration unit.
- Prescribed routes for the transport of mixed, diluted chemicals are to be chosen to minimize the likelihood of spills (e.g., steep slopes are to be avoided) and to avoid sensitive areas (e.g., wetlands), and the routes are to be known to the applicators.
- Chemicals used on the course are to be dilute. Concentrated chemicals are to be stored in a locked storage facility (see in Volume 2A of the Environmental Management Report), and are to be mixed only in a specially designed mixing area.
- The least toxic materials with the shortest half-life and greatest affinity for soils are to be used at the course in order to minimize the potential effects of a spill.

Containment

- Spill containment materials are readily available. Commercially available spill containment kits (containing for example, foam pillows and absorbent material) are to be kept readily available in the chemical mixing area and in the chemical storage area. Any used kits are to be correctly disposed of based on the type of chemical.

- A spill or hose leak on the course will result in the following actions.

  - ✓ spray technician contacts the superintendent or assistant superintendent.
  - ✓ appropriate containment measures are immediately instituted; e.g., use containment kit, create a berm with a shovel, and isolate the area.
  - ✓ contact appropriate local and state officials.

- Based on the amount of dilute (mixed) chemical released the following will occur:

  - ✓ < 10 gallons - Follow actions as listed above.
  - ✓ 10 - 50 gallons - Follow actions as listed above. Additional actions will depend on the chemical's toxicity and location of release.
  - ✓ >50 gallons - Follow actions listed above. Monitor down-gradient and in potentially affected waters. Monitoring duration will depend on degradation properties of the chemical, but will include sampling at the time of release, and at appropriate intervals. Results of the monitoring will dictate future actions. The results of all such monitoring are to be provided to the inland wetlands and watercourses enforcement officers in Old Saybrook, Essex, and Westbrook, Connecticut and to other appropriate state and local officials.

MAINTENANCE FACILITY

The golf course superintendent and his/her support staff maintenance department are responsible for irrigation, mowing, fertilization, pesticide application and general upkeep of the country club grounds. The maintenance area is where pesticides are loaded into application equipment; mowers and other pieces of equipment are serviced; and pesticides, fuel, fertilizer, and cleaning solvents are stored. Contamination of soils, surface water, and/or groundwater can occur when pesticides are spilled, containers or equipment cleaned and the rinse water dumped on the ground or discharged into surface water, or improperly cleaned containers are stockpiled or buried. Proper management of the maintenance facility is an important part of responsible chemical and pesticide use.

Management practices must be implemented at the maintenance facility that will prevent the contamination of natural resources by the materials that are stored or handled at these sites. The general approach to management of golf course maintenance facilities involves three principles:

1. Isolate all potential contaminants from soil and water.

2. Do not discharge any material other than clean stormwater onto the ground or into surface water bodies.

3. Minimize irrigation, fertilizer, and pesticide use through use of Integrated Pest Management.

The first principle involves identifying all the materials to be stored or handled in the maintenance area along with practices that could cause environmental contamination. The next step is to develop management practices which isolate those materials from soil and water during storage, handling, and disposal. Storing these materials in covered, lockable storage areas, handling them over impermeable surfaces, cleaning up spills promptly and properly, recycling these materials where possible, and otherwise properly managing wastes will keep these materials from contaminating soil or water.

The second principle is an extension of the first: it includes preventing contamination of stormwater and eliminating the discharge of materials such as equipment wash water to ground or surface waters. Discharges to surface or ground water are to be eliminated through the containment and collection of equipment wash waters and proper management of collected material.

The third principle, that of minimizing fertilizer, pesticide and irrigation use through use of Integrated Pest Management, directly impacts the amount of material handled annually, reduces the annual maintenance budget, and encourages good environmental stewardship.

The Preserve Country Club maintenance facility will incorporate the following best management practices systems and processes. A detailed layout of the proposed maintenance facility is presented on in Volume 2A of the Environmental Management Report.

Pesticide Storage and Mixing Facilities

Pesticide storage and mixing are to occur in a separate room designated for these materials only. The room shall have a concrete floor with a containment lip extending upward into the concrete block walls. The floor will slope to the center and a concrete sump will be located at the low point. This area is for mixing and will provide full containment for any inadvertent spills. The room is to be kept locked and posted as required by law. A copy of The Preserve "Hazard Communication Program" (see examples in Attachment 4) will be posted. Adequate ventilation will be provided by continuous circulation fans and chemicals are to be kept away from direct contact with the concrete floor. Storage will be provided on non-wooden shelving. Switches for lights, and the fuse box, will be located on the outside of the room and explosion proof lights and fans will be installed. All pesticides are to be stored in their original containers with visible labels.

To be prepared for spills and/or leaks, absorbent floor-sweep materials, sawdust or cat litter and activated charcoal are to be kept on hand. An inventory of pesticides and other chemicals is to be kept, and MSDS and labels for each pesticide used are to be readily accessible. The pesticide storage facility will have a complete alarm system, with battery backup, for burglary and fire. An emergency equipment box is to be located on the outside of the room. Such things as a fire extinguisher, respirator, first aid supplies, goggles, respirators, gloves, rubber boots, and a coverall (perhaps a tyvek suit) are to be stored in the emergency equipment box so they are available in case they are needed. Water will be available for both routine and emergency chemical removal, including showers and eye wash facilities.

Equipment Wash Pad

Washing of equipment, other than pesticide application equipment, will take place at a specially constructed wash pad (see Volume 2A of the Environmental Management Report). The wash pad is a concrete pad that is covered and sloped to a center collection area. Grass clippings and sediments are collected in the central collection area. Wash pad operations shall include the following.

- All water used to wash equipment is to be recycled and contaminating materials such as grease, oil and gasoline will be filtered from this recycled water.
- The wash-down area will be under a roof to keep rain off the pad and prevent excessive water from going into the recycling system.
- The pad will have triple screen baskets, weighing less than 40 pounds each, to prevent an excess of grass clippings and debris from entering the recycling system.
- Hoses with attachable spray bottles of liquid wax can be utilized so valuable equipment can receive a brief application of liquid wax (cut with water) after each use.
- Concrete in the pad will be impermeable to prevent leaching of any contaminants.

AMENDING THE MANAGEMENT PLAN

This Integrated Turf and Pest Management Plan (i.e., the Plan) may be amended from time to time by the Town of Old Saybrook inland wetlands and watercourses commission and zoning commission so as to permit appropriate modifications to provisions addressing the use and/or monitoring of chemical pesticides in the management of the golf facilities. The procedure for amending the provisions of the Plan are as follows.

The golf course superintendent shall submit a request to the inland wetlands and watercourses commission and zoning commission defining the proposed amendment. This request shall specify what the proposed change is, the reason for the change, and any site-specific restrictions to be considered in reviewing the change. If the proposed change involves the addition of a pesticide (not included in the then current Plan) for use on the course, the request shall include the results of a site-specific risk assessment. The request also shall define any modifications to the surface and ground water quality monitoring programs, specified in Volume 3 of the Environmental Management Report, which the superintendent believes is appropriate should the proposed amendment be implemented. The inland wetlands and watercourses commission and the zoning commission shall consider a request submitted by the golf course superintendent at its next regularly scheduled meeting following the receipt of the request. The commissions may seek the advise of an expert in the use of chemical materials on golf courses to assist it in the review of the request. The Preserve Country Club shall reimburse the commissions for the reasonable and appropriate costs associated with the review of a request. The inland wetlands and watercourses commission shall either approve or deny the request for amendment within 60 days of the receipt of the request. The zoning commission shall either approve or deny the request for amendment within 30 days of the decision of the inland wetlands and watercourses commission.

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