# APPENDIX J

# INTEGRATED TURF HEALTH MANAGEMENT (ITHM) PLAN

## EQGC

6/24/16
*(appendices on accompanying CD)*

NELSON POPE & VOORHIS, LLC
ENVIRONMENTAL • PLANNING • CONSULTING

# Integrated Turf Health Management Plan for the Hills at Southampton, East Quogue, NY

Prepared for DLV Quogue, LLC

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## Abbreviations

| | |
|---|---|
| BET | Best Available Technologies |
| BMP | Best Management Practices |
| CEC | Cation Exchange Capacity |
| CGA | Compatible Growth Area |
| EIFG | Environmental Institute for Golf |
| EPA | United States Environmental Protection Agency |
| GCSAA | Golf Course Superintendent Association of America |
| IPM | Integrated Pest Management |
| ITHMP | Integrated Turf Health Management Plan |
| LICPB | Long Island Central Pine Barrens |
| MCL | Maximum Contaminant Level |
| MGD | Million Gallons per Day |
| Mg/L | Milligrams per liter (parts per million) |

| | |
|---|---|
| N | Nitrogen |
| $NH_4^+$ | Ammonium (positive ionic charge) |
| $(NH_2)$ 2CO) | Urea (neutral ionic charge) |
| $NO_3^-$ | Nitrate (negative ionic charge) |
| NTEP | National Turf Evaluation Program |
| NVDI | Normalized Difference Vegetation Index |
| NYSDEC | New York State Department of Environmental Conservation |
| ppm | Parts per million |
| SCDHS | Suffolk County (NY) Department of Health Services |
| USGA | United States Golf Association |
| USGS | United States Geological Survey |

## Executive Summary

The ITHMP (June 20, 2016) has been edited in response to the comments received during review of the *revised April 2016 DEIS for the Hills at Southampton MUPDD.* The revisions address comments prepared by A. Martin Petrovic, PhD, last dated May 23, 2016, submitted on behalf of the Town of Southampton, Department of Land Management.

The Integrated Turf Health Management Plan (ITHMP) is an analysis conducted for the purpose of identifying golf course management and operational procedures to minimize or avoid potential adverse environmental impacts from the golf course proposed as a component of the Hills MUPDD, East Quogue, Town of Southampton, New York. The original (January 2015) ITHMP was required by the Town of Southampton and submitted with the Final PDD application. The ITHMP was revised (November 2015 and March 2016) in response to the Lead Agency's SEQRA Final Scope prepared for the Draft Environmental Impact Statement, and included in the DEIS as Appendix H. The ITHMP included an assessment of proposed pesticides based on the USEPA Pesticide Root Zone Model (PRZM) and Field Environmental Index Quotient (FEIQ) model each evaluated by Environmental Turf Services (ETS) and included in the ITHMP as Appendix 13. This revised ITHMP (June, 2016) addresses comments to DEIS PRZM results, pesticide use, includes additional details regarding the ITHMP strategies, Integrated Pest Management Plan (IPM), and turf nutrient program for the golf course and non-golf course areas. Summarized below are commitments offered by the applicants, who shall:

- **Design and Manage the Golf Course in Accordance with <u>Best Management Practices for New York State Golf Courses</u>, (BMPNYS) February, 2014**

In response to the Town of Southampton's requirement to provide an Integrated Turf Health Management Plan, the Hills' applicants propose the golf course design and management will meet or exceed the <u>Best Management Practices for New York State Golf Courses</u> (NYSBMP). The BMP was developed with Cornell University, New York State's golf course superintendents, the NYSDEC and other stakeholders. It is a new State standard for turf management practices, designed to protect natural resources, with an emphasis on water quality. The BMP is a decision making tool with additional tools for post decision monitoring and record keeping, conducted to evaluate and adjust applied turf management strategies. The course final design, construction, and operations will meet the BMP principals and additional healthy turf management strategies. The Hills will exemplify environmental stewardship, and coexist with other forms of land uses without negative impacts to the environment.

- **Implement an Integrated Turf Health Management Plan (ITHMP)**

The ITHM approach uses plant health science based technologies coupled with an Integrated Pest Management (IPM) program. The basis of ITHM protocol is to *manage healthy turf* by using science, technological resources and cultivation practices to grow healthy turfgrass. Healthy dense turf is the cornerstone of minimizing inputs. The applicants will implement the ITHM program as an effective management tool to minimize inputs, thereby reducing potential impacts. The ITHM program is implemented through course design; soil design; irrigation system; turf equipment; support technologies; proper turf types; daily scouting for pests and turf

conditions, monitoring pest thresholds; laboratory based disease/pest identification; recordkeeping and monitoring; timing and characteristics of selected and applied fertilizers and pesticides. All are factors and tools to be used by the Hills to accomplish the goal of minimizing impacts. The applicant's turf managers will promote healthy turf with improved soil health (maintaining types and quantities of microbes; maintaining adequate oxygen; sustaining correct water retention and organic matter, etc.). Management will improve the surface conditions for turf health by managing shade, improving air circulation, controlling light exposure and minimizing wear.

Decision making within the ITHM approach gives priority to cultural practices and natural methods of turf care. The applicants will analyze the soil for physical, chemical and microbial properties prior to the final design of the project, to determine soil conditions with respect to the selected turf species. The applicants will refine the ITHM plan during the golf course's final design, and implement the practices during construction and long term operation of the course. The revised ITHMP (June, 2016) includes details of the Integrated Pest Management Plan (IMP) using preventative pest and disease strategies of an integrated organic pest management approach, and offers a reduction in non-organic pest treatment technologies commonly used on Suffolk County golf courses and residential properties.

Non-organic pesticide use is limited to applications during extreme pest pressure conditions, when organic treatments fail to prevent or cure the pest problems whereby turf loss would be catastrophic, restricted to spot treatments and primarily restricted to the lined greens. These applications follow *Emergency Protocols* for limited use based on Field Environmental Index Quotient (FEIQ), toxicological assessments, notification to the Town of Southampton Department of Land Management, and restrictions based on pesticide type, area(s) of application, and number of applications per year. Preventative and curative pest treatment technologies will be reviewed with input from Southampton Town every three years. The list of products and technologies may be amended based on ground and surface water monitoring results, evaluation of technology efficacy, and best available technologies (BET).

The nutrient inputs have been reduced to a not-to-exceed limit of 2.5-pounds of total nitrogen per 1000 SF per year and no more than 0.4 pounds of soluble nitrogen per 1000 SF applied at any time, throughout the golf course turf area, excluding the roughs. (Suffolk County Fertilizer Law-Appendix 16- was enacted to reduce nitrogen impacts to ground and surface water allows the Hills to apply 3-pounds of nitrogen per 1000 SF per year including the roughs).The Hills will limit nutrients to a maximum of 1-pound of total nitrogen per 1000 SF per year throughout the non-golf areas (where the Suffolk County Law would permit 3-pounds of nitrogen applied per year). This represents a 66% reduction in applied nitrogen compared to the allowable amount designed to protect ground and surface water. Applied nutrients to golf course roughs are minimized, with grass clippings from tees and greens dispersed in the roughs to provide nutrients stored in the grass clippings and accounted for in the overall nitrogen mass balance equation. The golf course will incorporate a fertigation/chemigation system used to add and manage liquid nutrients via the irrigation system. The fertigation system is accurate to within 0.01 of a pound for applied nitrogen. The system will be used for grow-in, establishment of turf, and for the post grow-in operation of the golf course's nutrient management program.

- **Develop Ground and Surface Water Monitoring Protocols (G&SWMP)**

With input from the Town of Southampton, the Hills will participate in a voluntary program to provide technical expertise and funding to develop Ground and Surface Water Monitoring Protocols (G&SWMP), to demonstrate how the Hills' inputs and turf management influence local water quality. The monitoring program will incorporate groundwater monitoring wells, lysimeters and surface water sampling locations to identify impacts of the development on the local surface and groundwater. Baseline monitoring will begin prior to construction to establish existing condition criteria against which post development data will be compared. Sampling points will be located to identify upstream conditions, impacts of golf course turf maintenance, and impacts from onsite septic systems as part of the housing component of the development. The Hills in cooperation with the Town will establish reasonable threshold limits for prescribed pesticides and nutrient analytes. These limits will act as "triggers" and elicit immediate response by the Hills (resampling and/or turf management responses) to address exceedances. The program will be used to evaluate the actual post construction impact of applied pesticides and nutrients. The threshold limits, determined with stakeholder technical input are science based, applied to select compounds, and are used to adjustment turf management. These limits will be used to provide continuous feedback as to the efficiency of fertilizer and pesticide applications to minimize environmental impacts and maximize turf health.

Southampton has requested similar post construction quarterly water quality monitoring at two golf courses, specifically at Sebonack Golf Club and Golf at The Bridge. Water sample results from each course have shown no significant impact to ground or surface water, thus reducing the frequency of water quality monitoring from quarterly to twice annually. The Hills and the Bridge have approximately the same areas of managed turf. The total allowable fertilized/input managed area of the Bridge is 80.38 acres and the proposed Hills golf course managed turf area is approximately 78.0 acres (tees: 2.62 acres, greens: 3.62 acres, fairways: 35 acres and roughs: 36.72 acres) plus 2.31 acres at the clubhouse and 8.22 acres of non-golf residential landscaping (a total of 88.53 managed acres or 14.98% of the site area). The Bridge serves as a reasonable model for the expected water quality impacts from the Hills.

These existing developments comply with water monitoring protocols through an agreement between the Town and course developer/owners. The G&SWMP must consider existing conditions and future local ground and surface water quality impact potential generated through up-gradient land use, agricultural runoff, and area wide sanitary discharges. The background water quality data will require careful evaluation to establish the parameters for the monitoring program and the thresholds for the concentration of compounds (triggers) and potential sources. The anticipated G&SWMP will involve installation of groundwater monitoring wells (couplets), suction lysimeters, sampling points at Weesuck Creek, and possibly coordination with other involved agencies (SCDHS, NYSDEC).

The G&SWMP will be provided as a separate document that details the location and construction of the lysimeters and groundwater and surface water monitoring points. These details will ensure that the sampling locations provide samples that are representative of actual conditions and are not subject to inadvertent contamination. QA/QC procedures for sampling and laboratory analysis will also be detailed. The sampling parameters will also be identified for

nutrients and pesticides. A list of acceptable pesticides that may be used on the site will be provided. Other pesticides would not be used without agreement by the Town.

- **Utilize Bio-Filters to Reduce Sediment and Stormwater Generated Pollutants**

Where practicable (determined by topography, clearing limits, and peak flow analyses) stormwater from the golf course will be pre-treated using bio-filters (grassed swales; small constructed wetlands and rain gardens) prior to discharge to the detention pond or leaching pools. The bio-filters will collect and retain sediment and absorb nutrients from the stormwater before it reaches the detention pond and/or leaching pools. Bio-filters include rain gardens designed to capture and treat stormwater runoff generated at the golf course as well as throughout the developed property.

- **Install HDPE Synthetic Liners Below the Greens**

The golf course greens areas typically require the most intensive inputs. Together with the ITHMP and G&SWMP, the applicant's environmental design feature includes placement of liners below the USGA recommended green designs. Each drainage layer beneath the greens will be isolated from the native subsoil by placement of an impermeable (HDPE) synthetic liner, which serves as a barrier and prevents conveyance of recharged water from the green areas. The system will capture water percolating through the green's soil profile and drainage layer, and direct the flow through a closed collection system. The liner and greens drainage design will be consistent with other golf course green designs utilized within Southampton (i.e. Sebonack Golf Club). The liner systems have proven to be an effective measure to avoid potential adverse groundwater impacts. Groundwater monitoring and reporting will be used as a metric for the ITHMP practices and the liners will provide additional assurance of groundwater quality protection.

- **Collect & Recycle On Site Stormwater Runoff**

The site's proposed infrastructure provides a stormwater collection system that will route the majority of the surface runoff to an impermeable (lined) 3.8 acre detention pond. This reservoir of stormwater will include a fringe wetland area designed to improve pond water quality. The pond will receive additional clean water from the onsite irrigation supply well. The stormwater will be recycled as supplemental irrigation water for the golf course, as water is withdrawn from the pond. The project includes strategic positioning of rain gardens placed to capture and treat runoff.

- **Voluntary Participation in and Compliance with the Standards of The Peconic Estuary Nitrogen Management Challenge for Golf Courses**

This voluntary program was developed with Cornell University, USEPA, Peconic Estuary Program stakeholders, SCDHS, USGA, and local east end golf course superintendents. The program limits the long term average nitrate in groundwater to $\leq$ 2.0 ppm; well below the New York and Federal Standard for groundwater of 10 ppm.

- **Utilize State of the Art Irrigation Control Systems**

Golf course irrigation systems today use computer controlled irrigation sprinklers and drip irrigation that are managed by in-ground soil moisture meters, hand held moisture meters and above ground weather stations. These technologies maintain soil moisture levels near field capacity. High efficiency electric variable frequency drive (VFD) pumps and individual sprinkler head controls allow water to be applied where and when it is required, without sequencing of entire zones. This reduces over and under watering which can decrease plant health, increase stress and disease pressure, and hold potential for pesticide and nutrient runoff and leaching concerns. Turf areas that comprise the bunker surrounds will be irrigated by subsurface "drip" irrigation to minimize water entering the sand bunker. The system reduces the watering time, minimizes and conserves water resources. When necessary, wetting agents will be used to reduce water inputs and improve water dispersion to the root zone.

- **Develop Cultural Practices for Promoting Turf Health**

The selection of turfgrasses, and management practices will include implementing a schedule of cultivation to promote healthy turf and improved soil conditions. The program includes aerification with topdressing soil (sand/soil/peat) as prescribed by physical soil tests; aerification to relieve compaction and to improve drainage and soil gas exchange; verti-cutting to remove excessive thatch (organic matter); drill and fill (deep soil coring to improve soil conditions); mowing height adjustments to relieve turfgrass wear and stress. Cultivation will be used to improve air circulation and provide proper soil gas exchange and soil moisture levels throughout the course.

- **Utilize State of the Art Equipment and Resources and Trained Personnel for Turf Management**

The turf industry offers improved technologies for equipment and continuing education programs for its industry members. Hybrid fairway mowers and battery powered hand green mowers, and greens rollers have significantly improved energy conservation goals and reduced the golf industry's fossil fuel use. Powered turf boom sprayers, spray nozzle boom curtains, GIS application systems and computerized application controls are designed to specifically apply inputs within the GIS mapped areas and direct nozzle spray downward with zero to minimal drift potential. Turf management facilities are equipped with emergency response and spill cleanup kits, trained personnel, wash down and wastewater recycling equipment; fuel and chemical storage and handling equipment that exceeds the minimum standards for SCDHS and NYSDEC. Experiments with drones for scouting and monitoring nighttime turf conditions use video cameras to assess irrigation coverage and disease outbreaks in the absence of the superintendent's staff. Equipment mounted Global Positioning Systems (GPS) are used to delineate the limits of each turf area (tees, greens, fairways and roughs). Each area is programed into the turf boom sprayer's on-board computer. The system minimizes unintentional applicator error, (over and under sprays) and conserves inputs by treating only areas of specific need. The turf sprayer equipment includes boom shrouds designed to minimize drift potential. Mowers and irrigation system controls can be connected to this overall computerized GPS- turf management system. Turf and soil samples will be routinely collected and analyzed by qualified laboratories to determine nutrient levels, plant physiological conditions, physical properties of soils and turf pathogen identification. Daily record keeping is performed using turf management specific software and hand held or desk top computers.

- **Operate and Maintain a Sustainable Golf Course Facility**

Today's professional golf facility management is based on sustainability. Clubhouse menus are designed around local food sources and season availability. Clubs often grow their own herbs and vegetables, install solar panels to recharge batteries in electric golf carts and turf equipment, and supply heated water for pools, showers and buildings. Several facilities recycle their kitchen and golf course organic waste for compost, compost teas, topdressing and landscape garden mulch. Integrated with these programs are ornamental gardens with selected plants to attract and maintain populations of butterflies, bees, and hummingbirds, bluebirds, bats, purple martins, and provide wood duck houses that are installed throughout the course and grounds. Ponds can be stocked with trout from local fish hatcheries. Sustainability reduces operating costs and provides users a connection to the local environment.

- **Provide Public Outreach Programs for Turf Management**

Turf and ornamental plantings are mainstays of local residential properties. The Hills will offer its professional and technical support to the local community. Using website communications and local presentations the Hills will educate the community on how to improve turf health and its quality with minimal inputs to protect water quality. Local students will be invited to observe and participate in natural resource restoration projects, birding and similar educational forums.

- **Irrigation Well System and the Phyto-remediation of Groundwater**

Results from upper glacial groundwater samples collected from beneath the site and analyzed by a qualified laboratory, reported elevated concentrations of nitrogen. To remediate local groundwater conditions, the Hills golf course will engineer the location(s) of the course irrigation well and screen heights to maximize the capture the elevated nitrogen levels in the groundwater. This approach is a common practice in groundwater remediation and engineering used by hydrogeologists to "capture" a contaminant plume, draw it to the land surface, and apply treatment technologies. To improve groundwater quality by reduction in nitrogen levels, the Hills will use the dense golf course turf as the treatment technology. This method is a form of *phyto-remediation* whereby plants will uptake and utilize the nitrogen directly from the groundwater (as a replacement/supplement to fertilizer applications) and recharge unused (irrigation) water to the hydrologic system. The irrigation well placement will be designed as a long term continuation of this process for groundwater treatment and its recycling. The G&SWMP will be used to monitor and adjust the groundwater cleanup activity. The USEPA has long recognized phyto-remediation as a recommended groundwater cleanup method because of its lower long term operational costs compared to other remedial action methods, effectiveness in contaminant reduction, and relative simplicity in management and monitoring. Essentially the Hills golf course will offer its turf as the media to reduce existing groundwater nitrogen concentrations and return water with improved quality back to the aquifer. The system is designed to reduce nitrogen concentration before groundwater flows to downgradient wells and to estuarine waters. The golf course will require approximately 24-30 MG of irrigation water annually.

- **Residential, Ornamental Plant Turfgrass and Natural Area Management**

The Hills at Southampton includes individual and mixed use residential lots, recreational areas, club house grounds, infrastructure buffers and preserved-undisturbed areas with strong ecological value. The managed turf and ornamental plantings in the non-golf areas will include planting of low input and native plant compatible landscapes, endophytic tall fescue, creeping

fescue and fine fescue. Management and record keeping will be conducted by professionally trained staff of the golf course maintenance department. Protocols will follow recommended guidelines described the *Perfect Earth Project Toxin-Free Lawn and Landscape Manual* (2015). Qualified staff will manage the natural resource areas of the site to identify and remove invasive plant species, coordinate with NYSDEC's pitch pine forest management for southern pine beetle infestations, and coordinate fire suppression with NYSDEC and the East Quogue Volunteer Fire Department.

- **Qualified, Professional Management**

The ITHMP and land management program for the golf course, recreational amenities, residential landscapes, habitat restoration areas and natural/preserved lands will all be managed by the applicant's designated Qualified Professional(s). Within their area(s) of expertise, these professionals will possess the demonstrated experience, academic achievement, professional training/continuing education, certifications, and licenses required to maintain and manage the properties. Qualified staff will understand low input turf management, water quality monitoring programs, report keeping, natural resource management, disease and pest identification, and protocols described in this ITHMP. Where required, management and staff will obtain and maintain all licenses and professional credentials specific to managing the developable and non-developable areas of the site. These credentials will be made available to the Department of Land Management, Town of Southampton. The professional manager(s) will be responsible for the administration, coordination, environmental stewardship, reporting and record keeping as described in the ITHMP and shall be made available to the Department of Land Management for review of the reports and recommended adjustments to the plan as may be necessary.

## Introduction

This analysis is conducted for the purpose of identifying golf course management and operational procedures to minimize or avoid potential adverse environmental impacts from the proposed Hills Golf Course, East Quogue, Town of Southampton, Long Island, New York. Among the Top 100 Golf Courses in America listed by Golf Digest, eight (8) are on Long Island and six (6) of these are located in eastern Suffolk County: National Golf Links of America, Shinnecock Hills, and Sebonack Golf Club in Southampton; Maidstone, in East Hampton; Fishers Island, Town of Southold; and Friar's Head located in Riverhead. Long Island golf courses have hosted the national championships for men and women, PGA and LPGA tournament events, offer recreational golfers opportunity for play, and support local recreational based economies. The well drained, sandy soils and excellent water quality of Long Island offer superior conditions for the design and construction of world class golf facilities.

In response to the Town of Southampton's request to provide an ITHM plan, the Hills' applicants propose to design and manage the golf course in accordance with the NYSBMP (Appendix 1). The document, released in February 2014[1] is "the tool" by which all golf courses in New York are to be managed to maximize environmental stewardship, meet regulatory compliance, protect the State's watershed and successfully manage fine turf and natural resources. Revisions and updated information made to the (June 2016) ITHMP are in response to the Town of Southampton's (acting as SEQRA Lead Agency) comments to the Hills' Draft Environmental Impact Statement (DEIS), as submitted in April, 2016.

In addition to the NYSBMP the applicants have developed a site specific Integrated Pest Management program (IPM) and ITHM plans. These programs will be reviewed and revised in more detail during the final design and construction phases of the golf course. Each of these programs (IPM and ITHM) are offered herewith as preformats until specific turf pest and disease thresholds as established in Appendix 14, soil sampling and analytical results of soil properties and chemistry can be established for critical turf areas, and vegetation clearing lines have been refined. The foundation of the IPM and ITHM programs is based on using industry trained golf course personnel to provide daily scouting, monitoring, recordkeeping, and decision making in response to the maintenance of healthy turf. The ITHMP will be reviewed and potentially amended throughout the maintenance life of the facilities to adjust the management plans in response to BET and monitoring results.

The Town of Southampton has requested two prior golf course development projects to develop IPM/ITHMP for turf management and required post construction environmental monitoring programs as conditions of the Town's planning and permitting processes. Included in these requests were groundwater sampling programs utilized to verify impact from turf management programs; and IPM/ITHMP and biological improvements to soils as efforts for the applicants to reduce inputs and avoid or minimize negative impacts, particularly impacts to ground and surface water qualities. The results of the groundwater monitoring programs have

[1] Authored by: Robert E. Portmess PhD, Department of Horticulture, Cornell University; Jennifer A. Grant PhD, New York State Integrated Pest Management Program, Cornell University; Barry Jordan, RLA, Golf Course Architect; Anthony M. Petrovic PhD, Department of Horticulture, Cornell University; Frank S. Rossi PhD, Department of Horticulture, Cornell University

indicated there is no significant impact on water quality as a result of professionally managed golf course developments and operations (Petrovic). The Hills project will also establish baseline water quality data from shallow and deep groundwater wells and continue to conduct groundwater monitoring post golf course construction. The groundwater sampling points will be determined with the Town of Southampton and, at a minimum, provide:

- up-gradient and down-gradient well clusters;
- groundwater monitoring well installation methods (i.e. Geo-Probe with soil sample cores at a predetermined interval),
- a list of compounds for analyses;
- protocols for QA/QC water sample collection, preservation and lab work;
- lysimeter installations at key locations for upper surface level sampling points;

The frequency of the sampling program (quarterly or less frequently) and recordkeeping of the results are described in the DEIS. Maximum limits for select compounds will be established and used as "triggers" to determine appropriate management responses when limits are exceeded.

The two previously constructed golf course projects, Golf at the Bridge (the Bridge) and Sebonack Golf Club (Sebonack) serve as demonstration, and as validation, to the mitigation measures proposed in each project's environmental impact statement. Each golf course has served as a "living laboratory" for understanding turf management practices relevant to golf course management within Southampton and examples of turf management impacts on the environment. The post construction water quality data agree with findings from university research conducted on turf management practices and environmental impact since the 1980s.

The current philosophies and practice of professional turf management are directed toward a sustainable environment and development of "healthy turf." The elemental idea is, healthy turf will defend itself against biotic and abiotic influences. The ITHMP will evaluate the soil organic and inorganic chemistries and physical properties to determine what compost, soil amendments and microbial levels are necessary to improve soil quality for turfgrass. The dominant site soil series types are Carver, Plymouth, and Riverhead with occasional areas of Haven. For these soils fertility and moisture holding capacities is generally low.[2] Additional information on soils can be located in sections of the DEIS and in the appendix of the ETS report.

The breeding of turfgrass cultivar has advanced significantly in the past decade. Breeders are capable of combining genetic advantages of turf species and sometimes across genus to selectively introduce cultivars with disease resistance, low growth heights, high densities, color, drought tolerance, and low fertility demands. Furthermore blending cultivars has become more widely accepted by the industry rather than cultivating a mono-culture. Mono-cultures were popular because each offered a "pure" stand of turf and provided a uniform conditions for playing golf (hence truly a level playing field). However, pathogenic genetic re-combinations tend to selectively cull out the most advantageous populations of pests that can overcome disease

[2] USDA/SCS, Soil Survey of Suffolk County, April, 1975.

resistant turf species in stands of mono-cultures with often dramatic effect. One example is perennial rye grass, used on fairways for its general resistance to wear, good color, rapid germination and low production of thatch. However many rye grass cultivars planted as fairways were susceptible to gray leaf spot, a pathogenic disease which can quickly kill large areas of turf in 24 to 36 hours.

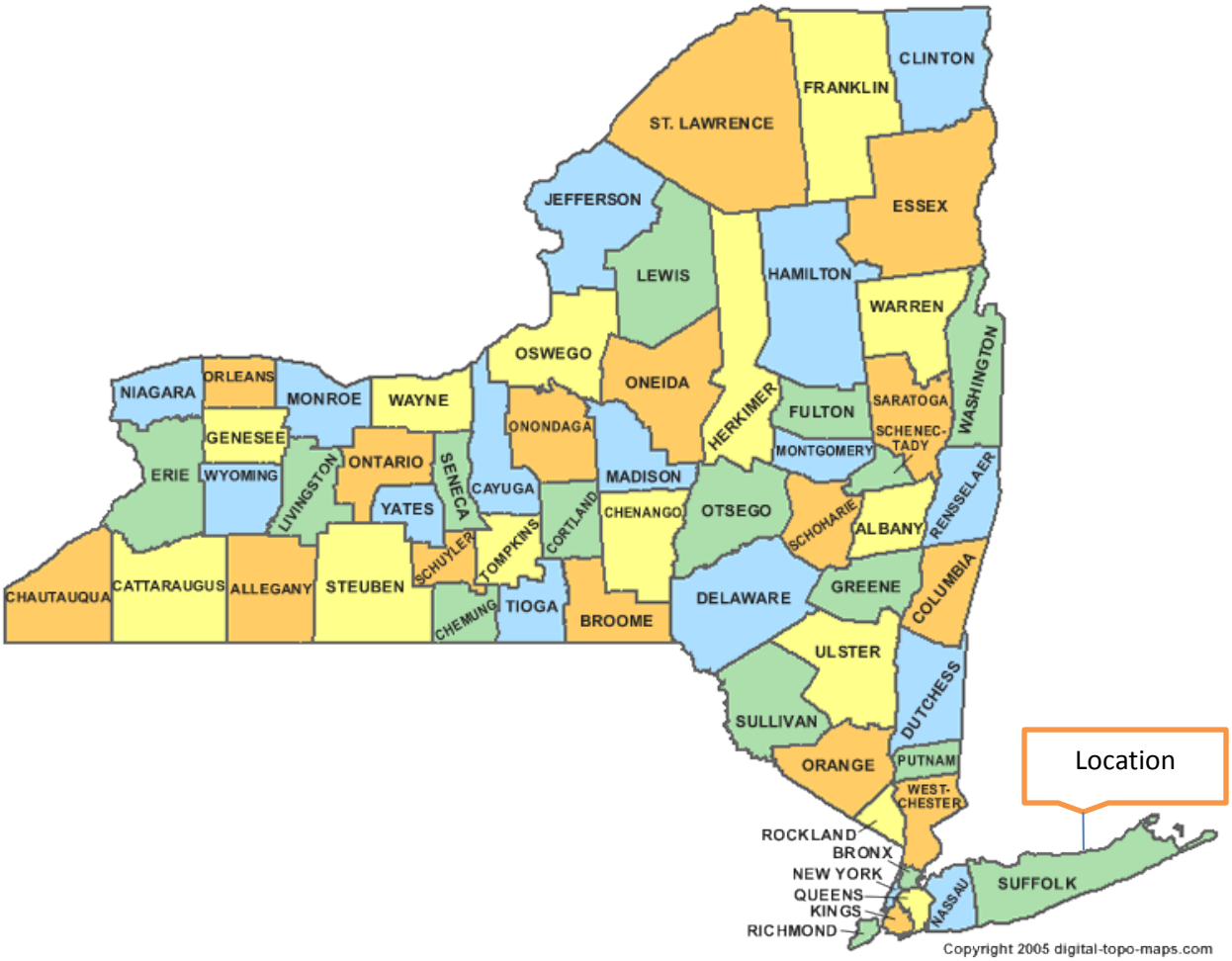



**Figure 1. Location Map: The Counties of New York State**

To minimize inputs and sustain a healthy, high quality playing surface, the Hills will continue to research the selection of turf grasses most suited for the existing environmental conditions of the site and species that require low inputs. One blend that matches these qualities for the 35 acre fairways, is a combination of colonial bentgrass (*Argrostis capillaris* L.) (Tiger 2) and chewing fescues (*Festuca rubra* L. ssp *comutata*) (Longfellow II), and each can tolerate low (0.500-inches) mowing heights. A research article on this blend is included in Appendix 2. Although greens typically require more intense management, fairways occupy 20 times the area of greens, and a greater reduction of inputs on fairways can have a significant effect on overall turf management. Fairways are typically constructed from native soils with amendments added as determined from soil analyses of physical and chemical properties. In high wear areas (created by cart traffic, mowing equipment patterns and foot traffic) creeping bentgrass (*Agrostis stolonifera L.*) may be added to the seed mix to strengthen turf in high wear areas. The Hills is expected to have rounds below 10,000 per year, which is considered low for an 18-hole course and many players may choose to walk rather than ride in a golf cart. Both conditions minimize turf wear.

Greens, with an area of 3.62 acres, will be constructed in accordance with USGA recommended specifications that identify limits of soil physical properties based on particle size distribution for root zone mixes (Appendix 3). The HDPE impermeable liners and drainage collection system will be installed beneath the green's gravel layer and the native sub-soil. The liner system will capture all of the water and residual inputs within the green area and prevent the solutes from recharging to groundwater. The USGA recommended saturated hydraulic conductivity of the green's root zone mix is a minimum of 6-iches per hour. Studies on green construction using one hundred percent sand based greens have been shown to increase the nutrient leaching potential. The USGA standards for green construction recommends adding organic matter, which studies have shown to reduce input leaching potential. A typical "dirty-sand" root zone mix is "85-5-10" consisting of 85 percent sands and 5 percent soil and 10 percent organic matter (peat)[3]. The root zone mix will be blended off site under strict quality control standards and require sample testing by a qualified soil testing laboratory. Dollar spot is a common and persistent turf disease on Long Island. Disease resistant bent grass cultivars (such as "Declaration" and "Proclamation") help to reduce fungicide inputs used in response to dollar spot. Cultivation practices including verti-cutting, top dressing (with a 90-10 or 85-5-10 mix) daily rolling (including rolling of fairways) and removal of guttation have been proven to be highly effective methods to control dollar spot without the need for chemical inputs. Regardless of the method of management selected for disease and pest controls, the Hills use of the greens subsurface liners will avoid potential impacts to groundwater, even if a misapplication of inputs to the greens occurs (i.e. inputs were applied prior to an unpredicted weather event).

For the 35-acre fairways, 2.62-acres of tees, and 36.76-acres of rough construction, Landschoot provides recommendations for additions of compost to improve soil conditions to support turfs (Appendix 4). Compost sources and quality must be carefully selected and samples tested to establish qualitative characteristics.[4] Biotic inoculants (fungal and bacteria species) are necessary for supporting soil in the ITHM program. Suggested microbial levels for turfgrass

[3] USGA, Recommendations for a Method of Putting Green Construction

[4] Landschoot, P., Using Compost to Improve Turf Performance, Penn State Extension.

species and mixes was provided in the EIS prepared for the Bayberry Project (Sebonack Golf Club) and is shown in Table 9.

Long Island's general geology is dominated by glacial till, comprised of gravel and sandy soils; and its public drinking water supply is from the sole source aquifer that is situated beneath the Island. The NYS Drinking Water Standards has allowed a maximum contaminant level (MCL) of nitrogen (N) of 10 mg/L to protect human health and the environment. University research conducted by marine scientists indicate lower MCL values for N is suggested to protect marine resources. On Long Island, the source of increased concentration of N in the local surface water is groundwater outflow discharge to the Island's bays[5]. Sanitary systems, especially residential systems installed in close proximity to the shoreline are a primary source of N however, N leaching and runoff from golf courses has again come into view as a potential source for N impacts to groundwater quality within Suffolk County, NY.

The Hills approach to address potential impacts included review of scientific literature pertaining to golf turf management practices and environmental impact. The research identified methods and historical records used to assess the significance of turf management on water quality; identified the best management programs developed for New York State golf courses most applicable to the Hills golf course; and provided golf course development engineering controls to monitor and reduce potential for turf chemical releases to the environment. The following narrative provides management guidelines for turf managers to minimize potential leaching and runoff of nitrates, nutrients and other turf inputs; appropriate monitoring for pest control; techniques to improve turf health and performance; and recommends establishing thresholds for pest populations and or turf damage to balance acceptable playing conditions coupled with appropriate pest control responses designed to protect the ground and surface waters.

The Hills golf course turf management strategies include: annual soil and monthly tissue testing as measures for assessing the nutrient status of turf; a weekly monitoring program of clipping yield to assess turfgrass growth and density; control of thatch and mat accumulation; water quality monitoring of groundwater and ponds, streams, or other water bodies for determining if runoff and leaching are occurring; lysimeter installation as sample collection points; soil moisture metering and advanced irrigation system design and controls for improved water conservation and irrigated area controls; use of cultural practices to reduce turf stress and disease pressure; and impact potential from variations in the formulation of supplemental nutrients, and species of turf grasses selected.

The golf course will occupy approximately 98.13 of which 78 acres will be managed as with inputs as fairways: 35-acres, tees: 2.62-acres, and roughs: 36.76-acres and greens: 3.62 acres; and the balance comprised of bunkers, native plantings, ponds, and maintenance areas. The site is subjected to the Long Island Central Pine Barrens (LICPB) core and compatible growth area (CGA) land use regulations where no more than 15% of the entire development project may include "fertilizer dependent vegetation."

[5] Gobler, C. "Is There a Connection Between Groundwater Seepage and Brown Tide In Long Island Embayments?"

The Pine Barrens legislation reduces the overall (nitrogen) inputs throughout the CGA. This restriction is significant when estimating the overall nitrogen loads generated by the project's nutrient programs. Methods to estimate nitrogen loading were developed by the USEPA, USGA, Peconic Estuary Program stakeholders and Eastern Long Island golf course superintendents in a program called the "East End Nitrogen Reduction Program for Golf Courses." This program has been in place for more than a decade, has specifically targeted a reduction of golf course generated nitrogen limited to 2.0 mg/L, is still active and administered by Cornell Cooperative Extension. Cornell calculates the nitrogen loading from participating golf courses by using the quantity (expressed in pounds) of applied nitrogen to the area of fertilized as well as unfertilized land within the entire golf property boundaries (expressed in square feet or acres). Therefore, when nitrogen applications are measured as a mass per unit of area the potential of nitrogen loading from properly managed turf within the CGA is expected to be much less than managed turf in areas of Suffolk County where 100 % of the development project can establish fertilizer dependent vegetation.

There are clearing limit restrictions for any proposed development within the boundaries of the CGA. The clearing is necessary for the golf course, stormwater control/irrigation pond, maintenance facility, clubhouse and golf related infrastructure. Relevant Pine Barren policies are included as Appendix 5.

The industry has developed selected blends and many turf cultivars that do not require significant amounts of inputs including nitrogen. With early planning, design and selection of the most appropriate turfgrasses, a further reduction in predictive supplemental nitrogen and inputs is expected. Coupled with the selection of cultivars and a mandatory reduction in overall fertilized vegetation required within the CGA, the selection of turf cultivars will be based on drought tolerance and low water inputs. The turf industry has responded to the need to conserve water resources by breeding turf grasses for golf courses that require less water. Again using the mix example of colonial bentgrass and chewing fescues; fescues are highly desirable for resistance to drought conditions, "green-up" best in cool (spring and fall) conditions and are a bunch-type grass; and colonial bentgrasses tolerate higher temperatures (summer), increase density by growth via stolons, produce less thatch due to growth habits; are less aggressive than creeping bentgrass, and are moderately drought tolerant. Each is highly wear resistant, exhibits good disease resistance, and requires well drained low fertility soils.[6] Selecting a blend of cultivars that are most adaptable to the existing site specific environmental conditions provides a sustainable approach to turf management. The turfs selected become an eco-tone within the dominant surrounding ecology rather than an overly demanding, unwanted "step-child." The playing surfaces (tees, greens, fairways and primary roughs) transition out to the secondary roughs (comprised of native planted species), and finally the indigenous native vegetation. This "organic" course design is advocated by the USGA to emphasize sustainable golf course management; improved golfer connection to the natural environment; and conservation of resources.

Grasses are part of the Pine Barrens ecology, and introduction of the grass cultivars for golf turf and secondary roughs must closely reflect the successful qualities of these native grass

[6] Horgan, et al, "Fine fescues and Colonial Bentgrasses for Fairways," Environmental Institute for Golf.

species. This would tend to minimize environmental impact, reduce management inputs, and reduce turf management operational costs. The applicants will continue to work with cool season turf breeders and university researchers from Cornell, Rutgers, Ohio State and Penn State to select the most appropriate cultivars primarily for the fairways, as the fairways will comprise the largest areas of managed turf within the golf course boundaries. Inputs of irrigation water, mowing, turf nutrients and pesticides would not extend beyond the primary roughs to avoid disrupting the native vegetation and minimizing potential to cause other plant species to become competitive.

During the past decade there have been significant developments in the turf industry in response to the reduction of inputs. These include improving native soil conditions by adding composts and microbe inoculations, new turf varieties derived through the sciences of plant genetics and breeding; online websites for monitoring and predicting local disease outbreaks driven by environmental conditions (temperature, humidity, etc.); guidance from the USGA to develop and manage courses using less natural resources; regulatory actions; and a greater separation between scientific models and researcher understanding of turfgrass and agricultural crop science. It is significant to understand that past research on crops such as wheat was historically used as the "model" for determining impacts, symptoms and curative/preventative controls for turfgrasses. This has changed. Turf science has evolved as an independent science within agricultural science and the older models. The understanding of treatment of disease and pests affecting turfgrass has been greatly improved. Maintaining the overall nutrient balance is still essential to optimal plant health.

The results from nearly 15-years of groundwater monitoring studies at the Bridge in Bridgehampton, NY and 10-years of monitoring at Sebonack Golf Club in Southampton, has provided the Town of Southampton with a history of baseline results on nitrogen and pesticide fate generated at local golf courses. The Bridge was requested to monitor groundwater as a post construction condition of its approval. The facility has nine (9) groundwater monitoring wells and one (1) background groundwater well. The wells are used for water sampling and analyses to determine the course's nutrient and pesticide concentration impact to local groundwater. Lysimeters are also used as collection points and as early warning sample locations. The long term average goal for nitrate in groundwater is limited to 2.0 mg/L. To achieve these goals the Bridge is limited to a total nitrogen fertilizer application rate of 3000 pounds per year or the equivalent of 0.9 lbs. N/1000 SF (based on total property land area) (Appendix 6).

The Bridge's groundwater monitoring program includes analyses for pesticides. The 2011 technical review found the, "the overall quality of the groundwater has not been significantly affected by the golf course pest management operations at the Bridge golf course."[7] The report also evaluated the course's use of bio-fungicides and recommended evaluation of additional fungicides rated as "Low Risk" by the USEPA (Appendix 7). The 2013 report resulted in the same conclusion of the Bridge having no significant impact to groundwater (Petrovic).

[7] Petrovic & Cambareri, Technical Review of Test Results and Implementation of the Groundwater Monitoring Protocol the Bridge Golf Course, Southampton, NY Part 1 and Review of Protocols Modification Proposals and Recommendations Part 2, April 18, 2011.

Similar water monitoring programs conducted at Sebonack Golf Club indicate local water quality was not significantly impacted by the golf course operations (Petrovic 2014).

## New York State Best Management Plan for Golf Courses

In February 2014 Cornell released Phase One of the NYSBMP for Golf Courses. The document is a guidance/standards of practice document for managing golf turf and facilities. It offers information within the following categories:

- Environmental Concepts
- Water Quality Management
- Site Analysis and Water Quality Protection
- Irrigation
- Nutrient Management
- Cultural Practices
- Integrated Pest Management
- Pesticide Storage and Handling and Applications
- Maintenance Facilities
- The NYSBMP initiative has many goals but its main objective is protecting water quality.

Developing the website content was the primary goal of Phase One. Phase Two's purpose is to validate what is stated in the NYSBMP manual by quantifying how New York State Superintendents' are applying and confirming their adherence to the NYSBMP, thus ensuring the golf course management is protecting water quality. Phase Two is an on-line self-assessment tool that records and documents on-going turf management practices for compliance to the standards set forth in the NYSBMP manual. The release of Phase One (February 2014) of the NYSBMP had envisioned incorporating a self-assessment tool, to be implemented at a future date. Completed Phase Two reports will be available for review by NYSDEC and Cornell University.

The NYSBMP preparers reviewed the content of the Phase Two on-line assessment tool in January 2015. From March 2015 through the fall of 2015 program developers designed the web-based self-assessment tool, educated future users and implemented the program via a series of articles and speaker symposiums. The program developers planned to have the Phase Two initiative in full operation by the end of 2015.

The Hills golf course designs and turf management will conform to the NYSBMP initiative. The Phase Two provides an excellent opportunity for the Hills to implement the record keeping and assessment tools during course construction, grow-in and long term maintenance beginning in 2016-17 (the anticipated date of golf course construction). The Hills will, on an on-going basis, complete the Phase Two assessment tool and upon request, provide the Phase Two information to the Town of Southampton. The approach provides additional monitoring and record keeping of turf management practices and confirms compliance with the NYSBMP.

A summary of key points from the NYSBMP are quoted below. The complete BMP is contained in Appendix 1.

"Golf courses rely on a healthy environment that includes water and wildlife. It is of paramount importance to enhance and protect water quality. A significant body of research exists that indicates successful implementation of BMPs virtually eliminates the golf course risk to water quality. In fact, several studies have shown that implementing BMPs enhances water quality on its journey on and through the golf course property.

Additional incentives for golf courses in New York State to implement BMPs include the following:

- potential for more efficiently allocating resources by identifying management zones
- cost savings associated with applying less fertilizer and pesticide
- improved community relations
- recognition by club members and the community at large as environmental stewards

Through a cooperative approach between the golf industry and friends and neighbors outside the industry, practices have been developed that benefit all parties. Golf course BMPs are designed to minimize the transport of potential water quality contaminants (such as nitrogen and phosphorus) from the golf course into surface waters and groundwater. A decade of public and privately funded research concerning the fate of fertilizers and pesticides applied to turf has concluded that golf courses using BMPs pose little to no risk of contributing to water pollution. Specifically, several studies investigated the movement of nutrients and pesticides through the perennial turfgrass system and found that maintaining a dense, vigorous turf, identifying environmentally sensitive areas, and recognizing potential risks of certain soils and climatic conditions are essential to protecting water quality.

Regulatory compliance is the first step in aligning golf course management with BMPs. New York has some of the nation's strictest state regulations on pesticides and fertilizers. Golf course superintendents must be aware not only of regulations on the purchase, storage, handling, and application of fertilizers and pesticides, but also of the potential water quality contaminants, sources, and impacts associated with these compounds.

The next step in successful BMP implementation is to recognize the many management decisions that involve potential contamination of surface waters and groundwater and address course management practices in a systematic fashion. Once course management becomes aligned with regulations and water quality protection BMPs, additional value can be gained by using water quality monitoring as a final step to assess the actual water quality entering and leaving the course."

It is easy to understand the importance of the NYSBMP to turf managers and the community of stakeholders. Designing the golf course and constructing the facilities within the frame work of the NYSBMP leads directly to predetermining its turf management. Once approved, the Hills course may be among the first golf courses in New York to have been designed and constructed using the NYSBMP as a guide.

The Hills' 98.13-acre golf course component is distributed in the northern, southern and eastern portions of the South Parcel. The golf course is proposed to be an 18-hole, Par-71, Championship-grade facility with 78 acres or irrigated/fertilized turfs, a 0.5-acre maintenance area, and a 3.8-acre irrigation pond/pond house area affecting play on two holes. The Clubhouse area will occupy a separate 2.8 acres. The course will be designed to incorporate the site's existing rolling topography as much as practicable, thereby minimizing the acreage of land clearing and volume of soil affected by grading. The majority of the site's natural vegetation will be retained, to act as a visual and noise buffer between fairways, and between the site and its neighbors. As illustrated in the Hills' golf course design imagery, as well as on the Master Plan (South Parcel), fairways are narrow, adjacent "rough" areas are limited, and greens and tees occupy small areas of the golf play area. There are areas where "playover" is a design feature of the course. These areas involve retaining existing topography and groundcover vegetation in the alignment of the ball track, but golfers would "playover" the natural areas. In these areas, trees would be removed; however, the remaining natural habitat will be enhanced and restored and topography would be retained. All efforts have been made to design the course such that it has the least environmental impact and the greatest habitat retention possible.

The proposed Clubhouse would have a total floor area of about 53,705 SF (divided into 29,705 SF of Clubhouse facilities and 24,000 SF in the 10 Clubhouse Units), with below-grade parking. This structure would have a complement of amenities typical of such a feature, and include men's and women's lockers, a dining room, lounge, spa and pool area. The clubhouse will not be available for public use, except for special fundraising activities described as "public benefits." The facilities will be primarily reserved for use by its private membership.

## Stormwater Management System

In conformance with Southampton Town Code, stormwater runoff generated from the proposed project will be retained on-site and recharged to groundwater. The drainage system will be designed for storage of stormwater generated from an appropriate rainfall event, as determined by the Town. It is anticipated that subsurface leaching pools will be used for containment and recharge of stormwater; however, fully engineered site plans (grading and drainage) have not yet been prepared. Innovative stormwater handling methods may be incorporated where appropriate and feasible. The systems will be designed to comply with General Permit for Stormwater Discharges from Construction Activity (GP 0-10-001 or "General Permit") and Chapter 285 of the Town Code. Under these requirements, a site-specific Stormwater Pollution Prevention Plan (SWPPP) must be prepared and submitted to the Town for review and approval as a condition to final subdivision approval. The SWPPP evaluates the proposed drainage system to ensure that it meets the NYSDEC and Town requirements for treatment and retention of stormwater runoff. The SWPPP must demonstrate that the proposed stormwater management system is sized adequately to ensure that there is no net increase in peak stormwater discharges from a property once developed.

Additionally, the SWPPP will include details of erosion controls to be employed during construction to contain stormwater runoff on site during construction and ensure that there is no

transport of sediment off site. The Erosion Control Plan will be prepared in accordance with the recommendations of the NYSDEC Standards and Specifications for Erosion and Sedimentation Control and the NYSDEC Technical Guidance Manual. SWPPP measures include:

• Silt fencing and temporary diversion swales installed along the perimeter of the limits of clearing within the site to minimize/prevent sediment from washing into the natural buffer areas, adjacent streets and properties.
• Inlet protection installed around all grated drainage inlets to trap sediments in stormwater runoff.
• Dust control and watering plan and a stabilized construction entrance to minimize the tracking of dirt and debris from construction vehicles onto adjacent roadways.
• Designation of material and topsoil stockpile areas as well as use of silt fencing and anchored tarps to prevent/reduce wind-blown dust and erosion from rainwater.
• Establishment of a stabilized stone vehicle washing station which drains into an approved sediment-trapping device.

The proposed locations, sizes, and lengths of each of the temporary erosion and sediment control practices planned during site construction activities, and the dimensions, material specifications, and installation details for all erosion and sediment control practices will also be provided on the Erosion Control Plan. Concerns for stormwater runoff laden with nitrogen can be mitigated by the use of buffer zones and where severe drainage flow volumes are present, construction of freshwater wetlands. The Hills has proposed rain gardens as an effective treatment method to reduce pollutants and sediment generated by stormwater.

The golf course greens typically require the most management and intensive inputs. Together with the ITHMP and G&SWMP, the applicant's environmental design feature includes placement of impermeable liners below the USGA recommended specifications for greens. Each drainage layer beneath the greens will be isolated from the native subsoil by placement of an impermeable (HDPE) synthetic liner, which serves as a barrier and prevent conveyance of recharged water from the green areas. An example of the system as shown in Appendix 12, captures water percolating through the green's soil profile and drainage layer, and directs flow through a closed collection system. The liner and greens drainage design will be consistent with other golf course green designs utilized within Southampton (i.e. Sebonack Golf Club). The liner systems have proven to be an effective measure to avoid potential adverse groundwater impacts. Groundwater monitoring and reporting will be used as a metric for the ITHMP practices and the liners will provide additional assurance of groundwater quality protection.

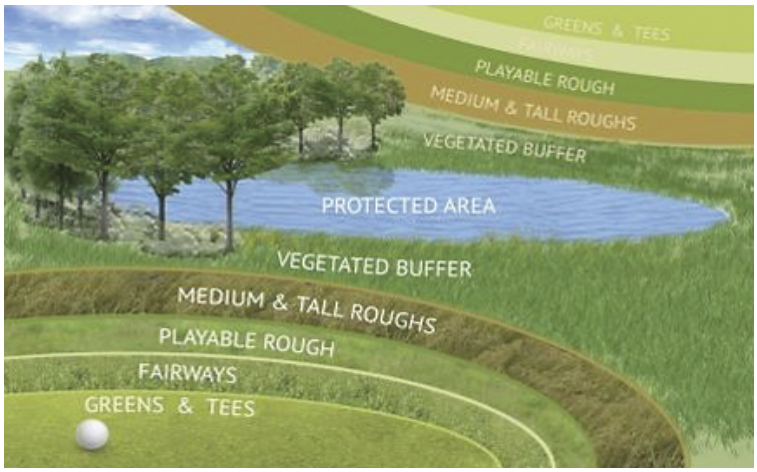



**Figure 2. Buffer Zone Concept for Golf Courses**

*Source: NYS BMP Website, Cornell Cooperative Extension, Feb. 2014*

Stormwater control using constructed wetlands is also an option. The approach includes a fore-bay, basically an earthen pool that collects the first flush of runoff, allows the sediments conveyed from the flow to settle (by gravity); and the runoff water to discharge to the constructed wetland at a controlled rate (determined by the elevation of the outflow pipe or channel). These wetland(s) will be constructed accurately and planted with vegetation selected for soil and water conditions. Wetland plants exhibit zonation; meaning where they inhabit the landscape is largely based on their duration of exposure to water (permanently flooded; temporarily flooded; seasonally flooded; etc.). Wetland plants take up their nutrients from the water and can take up large quantities of nitrogen laden runoff waters because of their vascular systems. Wetlands provide a valuable habitat and add to golf course aesthetics. The Hill's civil engineers and freshwater wetland design consultants will provide criteria for a successful constructed stormwater wetland(s) during the design phase of the project.[8] The rain gardens utilize similar design strategies as constructed wetlands and are recommended for reduction of stormwater generated contaminants and sediment.

## Soil Mixing and Erosion Control

During the construction of the golf course, disturbed areas around greens, tees and bunkers are stabilized with sod, silt fence and hay bales. Sod imported to the site will only be accepted from vendors who have grown the sod on fields located in Suffolk County. The soils on the golf course are specific to the areas of play and engineered for proper drainage, pore space, saturated hydraulic conductivity and fertility. Greens will be constructed as per USGA recommendations for soil characteristics that involve soil particle size and distribution (Appendix 3) and seeded. Soil erosion within the footprint of the golf course and bunker areas is strictly controlled to avoid mixing soils and disrupting the design characteristics of the soil types.

[8] NYSDEC, Division of Water. (April 1993). Reducing the Impacts of Stormwater Runoff from New Development, Soil and Water Conservation Society, Syracuse, NY.

Soil characteristics will be controlled by implementing a quality control/quality assurance (QA/QC) program that will require soil sample collecting and analyses by an independent qualified soil laboratory.

Fairways are typically constructed with native soils providing the soils possess suitable qualities and can be amended as needed and then hydroseeded. Ideal soil properties that resemble loam are best for fairways and can be blended at the site. Clay layers that may be discovered during earthwork do not provide good properties for golf course construction. If necessary, the clay can be excavated and placed in the proposed stormwater detention pond as an added impervious liner below the synthetic liner. Soil samples will be collected and analyzed by qualified soil labs to report physical and chemical properties. Amendments if needed will be determined after lab reports have been reviewed. Appendix 21 provides generally acceptable standards and recommended specifications for the production of fairway soils. Advantages of hydroseeding are inclusion of nutrients and tackifiers that can feed and mulch the turf during grow-in and establishment.

On site sands cannot be used for the greens mix because of the potential for cross-contamination by soils of different physical properties, soils that contain dormant weed seed, a lack of control of the soil mixing machine and contamination from site construction debris all impact native soil quality. The greens drainage and root zone mixes will be mixed off site and placed within the green as each green is constructed. The greens root zone mix quality control will include sampling of the mix and testing by a qualified soils laboratory. Typical samples are collected from soil mix stockpiles at 500 yard increments, with several preserved samples retained indefinitely. The specifics of the root zone and drainage layer QA/QC program will be specified in the golf course construction documents.

Tee mix soils will closely mimic the greens root zone mix. There is a possibility to use some screened on-site native soils for tee construction. However the risks of producing a soil of less than adequate quality remains. The recommendation is to prepare the tee mix soil off site at an approved source, with samples collected and tested for quality control purposes. The specifics of the root zone and drainage layer QA/QC program will be specified in the golf course construction documents. Tees will be either hydroseeded or seeded with sod installed at perimeters to stabilize slopes and define the teeing ground area.

Fairway soils will be blended from on-site native sands and incorporate the existing albeit thin layer of organic matter (OM). During clearing, grubbing and rough shaping (grading), the upper soil horizon will be stockpiled. These materials will be screened to remove tree roots, brush, large stones and other debris. Some of the organic debris may be useful for processing on site and incorporated into the roughs and fairway areas as an organic amendment. The prescribed bentgrass and fescues favor soils with a slightly lower soil pH, sandy soils, good drainage, and will germinate in soils with naturally low organic content.

As the golf course ages, the Hills' fairways and roughs will generate an organic mass within the soil profile. The initial amendment to fairway and rough native soils may require addition of organic (leaf) matter compost to be blended with native soils to aid in soil moisture holding capacity and provide organic matter as a food stock for soil micro-organisms. Once the

population of soil microbes becomes established, the organisms and thatch generated from grass clippings will provide a sustainable soil mix. The cultivation practices applied to the fairways will manage the organic matter content through verti-cutting, dethatching, aeration and top dressing.

The amended native soils will require sampling and analyses for physical properties, (particle size distribution, bulk density, organic matter content, porosity and saturated hydraulic conductivity) to evaluate how the soil properties influence the fate of applied water, chemical inputs, nutrient uptake, soil biological activity and the fate of inputs with respect to groundwater. At a minimum of once per year, post grow-in, the Hills will collect soil samples for analyses and cross reference the results with the ground and surface water monitoring programs.

The soil sampling information will be used to evaluate the impacts(s) that post construction soils may or may not have on ground and surface water quality, and what mechanisms (cultivation, soil amendments, changes in turf management) may be implemented to minimize or avoid potential negative impact and/or document how post construction soils have affected the phyto-remediation design technology and predicted improvement in overall water quality, as compared to the pre-construction existing conditions.

It is not advisable for large pieces of land clearing/organic debris to be buried within the playing areas of the course. As the debris decomposes and the land settles it creates uneven surface conditions, and may encourage fungus problems that interfere with fine turf management. There is opportunity to process and till some of the debris into the roughs, practice area of naturalized/restored areas. Excess land clearing debris will be removed from the site and processed at an approved facility.

Residential areas and non-golf areas are expected to tolerate greater quantities of organic compost. Organic leaf compost will be used to amend the nutrient weak sandy soils within these areas. The selection of all compost materials will be in accordance with the recommendations referenced in Appendix 4. “Using Compost to Improve Turf Performance,” (Landschoot).

## Habitat Restoration/Invasive Species Control

Disturbed areas of the site, may give rise to opportunistic and invasive plant populations that can influence the site’s native ecological balance. To avoid or minimize the potential for this impact, disturbed areas will be restored by the applicant with native plants; and planted areas will be monitored for invasive plants which will be eradicated. Within the golf course, secondary roughs comprised of grasslands will be mowed twice annually (spring and fall) to reduce and control populations of woody plants.

Restoration plant selections will include those which match the localized Pine Barrens ecology and may in some situations be transplanted from within the site limits to sustain local genotypes. A listing of the approved Pine Barrens plant materials is included as Appendix 5.

The Long Island Pine Barren Plan describes typical vegetative habitats being comprised of: "dominant trees: scarlet oak (*Quercus coccinea*), white oak (*Q. alba*), black oak (*Q. velutina*) or red oak (*Q. rubra*). The relative proportions of pines and oaks are quite variable. The shrub layer consists of scattered clumps of scrub oak (*Q. ilicifolia*) and a nearly continuous cover of low heath shrubs such as huckleberry (*Gaylussacia baccata*) and blueberries (*Vaccinium pallidum, V. angustifolium*). Herbs such as: Bracken fern (*Pteridium aquilinum*), wintergreen (*Gaultheria procumbens*) and Pennsylvania sedge (*Carex pensylvanica*) are sparse. Scrub oak coverages tend to be highest in the pine-dominated stands and lowest in oak-dominated stands. (Reiners 1967). Heath shrub abundance decreases with increasing cover by scrub oaks and tree oaks. Forests dominated by oaks have been considered to be a separate forest type (oak-pine forest) by McCormick and Jones (1973), Olsvig et al. (1979), Whittaker (1979), and Windisch (1992)."

## Cultivation Practices

The selected turfgrass will require scheduled cultural practices to promote healthy turf and improved soil conditions. The program includes topdressing with soil (sand/soil/peat) as prescribed by physical soil tests, aerification to relieve compaction and improve drainage and soil gas exchange; verti-cutting to remove excessive thatch (organic matter); drill and fill (deep soil coring to improve drainage and soil gas exchange); solid and hollow coring to improve soil drainage and gas exchange; mowing height adjustments to minimize stress; rolling of managed turf areas; and over/inter-seeding programs to enhance turf density. Soil moisture levels will be monitored and controlled by soil moisture meters connected to the irrigation controls.

Cultivation programs relieve turfgrass wear; maintains and improves air circulation and proper soil moisture throughout the course. Monitoring thatch levels (organic matter) in greens to ($\leq$ ) 3/8-inch in creeping bent grass greens typically requires verti-cutting greens each 7-10 days and topdressing with sand. Improved greens speeds can be achieved with daily rolling, which university research has determined to reduce dollar spot, a persistent disease of Long Island turfgrass.

Dollar spot is also controlled by daily removal of guttation from the plant tissue and reduce the severity of the disease. Methods of removal include whipping/poling (wiping the greens with a flexible pole); dragging a hose or mat across the turfs; rolling the turf and light syringing.

## Turf Management Facility

The turf management facility will occupy approximately 20,000 square feet within the golf course facilities. The facility will be equipped with SCDHS Article XII approvable pesticide storage building and above ground fuel tanks that shall be in compliance with SCDHS, NFPA and local Fire Codes and NYSDEC permitting regulations. Fertilizers, other plant nutrients and plant bio-stimulants will be stored in a building and separated from the pesticide storage and mixing facilities. These nutrient products will be maintained in a building constructed with a

concrete floor, with no floor drains, whereby the products are completely sheltered from the weather.

The maintenance area will include an equipment wash-down pad where wash water will be captured, treated and recycled. This equipment (Appendix 8) is currently in use on New York golf courses and is manufactured and supplied by EDS. After washing equipment, a series of settling tanks remove solids (soil, grass clippings), cyclones reduce particulate matter, and carbon activated filters clean the wash water prior to water reuse. Solids from the wash water treatment system are collected from the tanks, removed to a secure temporary storage area, placed on an impermeable surface, and covered with plastic sheets to minimize runoff. The wash down solids are transported off site and disposed of at an approved NYSDEC solid waste facility. The Hills will also utilize the EDS chemical pad and collection system for turf sprayer wash out and recovery. The State's BMP for golf courses cites the importance of turf management facilities as emergency response centers for accidental spills of fuels and chemicals. Typical facilities provide staff break rooms, locker rooms, mechanical repair/parts areas, soil and sand topdressing storage areas, equipment warehousing and act as informational centers for turf employee records, OSHA and MSDS and turf related communications.

## Pesticide Applications

The NYSDEC is in the process of developing a pesticide strategy for Long Island (Appendix 9). Applications of pesticides are performed only by persons possessing valid NYS Commercial Pesticide Licenses. Licensure requires classroom and field training, passing of the NYSDEC examination and mandatory/verifiable continuing education. Applicators are required to maintain daily records of pesticide applications and submit the records to NYSDEC each year. The ITHM program uses IPM options other than chemicals (unless as an emergency response) to solve turf health problems. Pesticide applications may be required once alternative (non-pesticide) treatments have become unsuccessful or when emergency uses are necessary. The NYSDEC and the USEPA have developed lists of reduced risk pesticides. In compliance with the NYSBMP, the applicants have available for use the following assessment tools for predicting potential impacts and decisions regarding pesticide use.

### Pesticide Environmental Impact Quotient

The applicants will utilize an IPM program that may require treatment methods using pesticides. Progressive IPMs depend on a hierarchy of solving pest problems. The IPM establishes thresholds for pest tolerances (insect counts from traps, weed counts, disease impact measured by square foot areas and locations of turf damage). Pest problems can often indicate other agronomic issues that, once corrected can reverse the problems. For example, crabgrass often invades areas where soils are compacted, turf has been removed and where drainage is poor. Improving the soil compaction by solid tine or hollow tine aerification, adding soil amendments with organic matter, seeding with turf grass and providing supplemental irrigation will establish a dense stand of turf which will out compete the crabgrass for space. The cultural practices would minimize or eliminate the need for treating the crabgrass only with herbicides.

The Environmental Impact Quotient (EIQ) was developed to rate the risk of pesticides to human health and non-target organisms. The EIQ value is derived from mathematically weighting all the risk factors into a quotient. The EIQ is multiplied by the rate of application and percent active ingredient (% AI) to calculate the Field Use EIQ Rating (FUEIQ):

FUEIQ = EIQ x Rate (lbs. /acre) x % AI

The FUEIQ provides a measure of the weighted risk or toxicity of a pesticide expressed as a value per acre. Multiplying the FUEIQ by the number of acres treated provides a risk/toxicity rating for the treated area. Summarizing all applications in this manner provides a summation of risks/toxicity for the entire property over a period. Cornell provides an online EIQ calculator to compare FUEIQ results (http://www.nysipm.cornell.edu/EIQCalc/input.php). A FUEIQ under 25 is desirable. Any value over 100 poses high risks to applicators and the environment.

The *2015-16 Cornell Guide for Commercial Turfgrass Management* lists the range of FUEIQs for the rate range on each pesticide registered for use in New York. The Cornell publication *Reducing Chemical Use on Golf Course Turf: Redefining IPM* describes the methodology to evaluate pesticide environmental toxicity using EIQ. The Hills will operate the golf course on the basis of the ITHM program. Before applications of pesticides are considered, the turf manager will (in accordance with the BMP and the protocols described in this ITHMP uder the "*Emergency Protocols: Treatment Plan: Application of Pesticides Comprised of Non-Organic and Field EIQ ≥ 25 for Conditions When Organic Preventative Controls and Application of Pesticides with ≤ 25 Field EIQ Treatment has Failed*) calculate the FEIQ for the pesticides under review and compare the FUEIQ results to select the treatment that is suitable for pest control with the lowest FUEIQ; and a goal of less than 25. The FEIQ model was used to screen pesticides for the Hills project site.

## Windows Pesticide Screening Tool

A second model uses the Windows Pesticides Screening Tool (WIN-PST), which is an environmental risk screening tool developed by USDA-NRCS for pesticides. This tool uses site-specific information to evaluate the potential of pesticides to move with water and eroded soil/organic matter and affect non-targeted organisms. The risk of pesticide contamination of either surface water or groundwater is mostly affected by the properties of the pesticide, the properties of the soil, and the amount of rainfall after application. Unlike the EIQ and GUS (groundwater ubiquity score), WIN- PST can be tailored to site-specific soil conditions and management practices. The method uses standard soil properties provided by the NRCS data base or can be adjusted to site-specific soil factors that affect the movement of pesticides, such the depth of the root zone and the organic matter content. The environmental risk can also be evaluated based on anticipated weather (rainfall).

## USEPA Pesticide Root Zone Model PRZM-3

This model is used by the EPA for determining pesticide fate and exposure and must be adjusted for golf courses in accordance with the EPA guidance memorandum regarding Golf Course Adjustment Factors (GCAF). The Pesticide Root Zone Model PRZM-3, is a model for predicting pesticide and nitrogen fate in the crop root and unsaturated soil zones. It provides a tool for evaluating pesticide exposure, with expanded capabilities to include nitrogen simulation. PRZM-3 simulates the fate and transport of field-applied pesticides in the crop root zone down throughout the vadose zone, taking into account the effects of agricultural management practices. The model provides estimates of probable exposure concentrations by taking into account the variability in the natural system and the uncertainties in system properties and processes. To enable evaluation of nitrogen (particularly nitrate) exposure via groundwater, PRZM-3 includes a septic system module and capabilities for modeling soil nitrogen fate and transport. The Pesticide Root Zone Model was used to screen pesticides for use at the Hills site.

## Groundwater Ubiquity Score (GUS) Method

Gustafson (1989) evaluated the difference between leachable and non-leachable pesticides by jointly considering their persistence and mobility in soil. Gustafson found pesticides already detected in groundwater samples were noted as "Known Leachers" and were more mobile and/or more persistent pesticides and developed a hyperbolic function:

$$GUS = \log_{10} (T^{soil} 1/2) \times 4 - \log_{10}(K_{oc}))$$

Pesticides having GUS values greater $\geq$ 2.8 were leachers. Pesticides having a GUS between 2.8 and 1.8 were defined as transitional with an uncertain potential to leach. Pesticides with GUS values less than 1.8 were defined as non-leachers. GUS method will be used to select turf care products with the lowest GUS values. [9]

The following is an excerpt from the NYS BMP, Appendix B: Groundwater quality of Eastern Long Island, NY, golf courses:

"In New York, groundwater quality has been tested on 27 golf courses in Suffolk County by the Suffolk County government. From 1999 to 2010, up to 42 wells were sampled for a total of 366 sampling events. The samples were tested for a wide range of compounds from nutrients like nitrate and ammonia; metals like arsenic, cooper and cadmium; and 54 organic compounds, including pesticides and metabolites. These sample tests resulted in over 20,000 individual results. These test results are provided on the next page and as a download from the NY BMP web site.

Nitrate was found to be a common contaminate of groundwater in some areas, although 57% did not have a detectable level of nitrate. Twenty nine percent had nitrate concentrations of less than 5 mg/L, 10 % had concentration from 5 to 10 mg/l and only 4 % were greater than 10 mg/L, the drinking water standard. The Nitrogen Challenge with Suffolk County golf courses and the Peconic Estuary Program has set a target goal of groundwater of no greater than 2 mg nitrate/L. Sixty eight percent of the samples tested were below this goal level.

[9] Primi, P et al. "Leaching potential of Turf Care Pesticides: A Case Study of Long Island Golf Courses," Summer 1994 GWMR.

The most commonly detected golf course pesticide was metalaxyl. Fourteen percent of the samples tested had detectable levels of metalaxyl, with concentration ranging from 0.1 to 2.74 ppb (ug/L). An old no longer used herbicide dacthal (the acid metabolite) was detected in 9% of the samples, at concentration as high as 272 ppb. Imidacloprid was detected in 6% of the samples in concentrations no greater than 10 ppb. Several other pesticides (PCNB, propiconazole and iprodione) were occasionally detected at very low concentrations (<1 ppb). The results of this testing would suggest that golf courses are having at most a minor impact on the groundwater quality of eastern Long Island."

The groundwater monitoring programs performed at the Bridge and Sebonack, reported analytical groundwater quality results that are consistent with the above referenced quote from the NYSBMP. As an example, quarterly water samples collected from lysimeters and groundwater wells at the Bridge (Jul. 1998 through Mar. 2009)[10] and analyzed for organic and inorganic compounds reported the following ranges for tested compounds:

| | |
|---|---|
| *Fungicides (NYS Guidance value: 50 ppb)* | |
| Chlorothalonil | 0.10 ppb-0.20 ppb |
| Ethofumesate | not detected |
| Fenarimol | not detected |
| Myclobutanil, | 0.10 ppb-0.40 ppb |
| PCNB | not detected |
| Propiconazole | 0.10 ppb-0.40 ppb |
| *Herbicides (NYS Guidance value: 0.44 ppb)* | |
| Dicamba | not detected |
| MCPP | not detected |
| *Nutrients* | |
| Nitrate | 0.1 ppm-3.7 ppm |
| TKN | 0.54 ppm-1.1 ppm |
| Phosphorous | 0.05 ppm-0.23 ppm |

The high degree of water quality collected and analyzed from Sebonack Golf Club and Golf at the Bridge represent how extremely well the course designs, construction, turf management and water monitoring programs function to avoid significant ground and surface water impacts. The data supports the Town of Southampton's independent contractor's revisions to the original water quality monitoring protocols, resulting in a reduction in the frequency of sample collection and analyses from quarterly reporting to twice annually. Based on the implementation of similar turf management programs and the NYSBMP practices it is expected that the Hills project will be consistent with these water quality historical results.[11] Disease and insect pressure forecasting is available from Cornell University and UMass via their respective

[10] Environmental & Turf Services, Inc. Memorandum dated June, 19, 2009 "The Brdige-1st 2009 Quarterly Monitoring Results," Town of Southampton Town Clerk Files, Southampton, NY.

[11] Note: (water quality laboratory results for Sebonack Golf Club were not available from the Town Clerk at time of this report preparation.)

websites. The disease and insect forecasts are determined by field station monitoring; environmental conditions, primarily rainfall, humidity, temperature and hours of sunlight to predict when diseases and insect populations are likely to occur on turfgrass. Using the forecast models provides for more accurate timing of applications of controls, both preventative measures and curatives. The disease and insect models most likely to benefit the Hills will be used to predict pressure from annual bluegrass weevil, pythium, anthracnose and dollar spot (all fairly prevalent on Long Island. The Hills will also utilize an onsite weather monitoring station that will monitor wind direction and speed, precipitation, temperature, and humidity. The system will record the daily data and be used to augment the online disease forecasting model and the irrigation control system. Pesticide selection for emergency use on site will be determined by the turf manager and selected from the following lists in Tables 1 and 2.

The January 2015 and March 2016 versions of the ITHMP offered an initial list of NYSDEC registered pesticides permitted for use on golf courses in Suffolk County with potential for use at the Hills golf course. In response to the July 1, 2015 Final Scope for the environmental impact statement, a screening technique was required to further refine potential pesticide selection. The approach used the Pesticide Root Zone model (PRZM-3) as a primary determinant for pesticide fate in the root zone and leaching potential and the Field Environmental Impact Quotient (FEIQ) for assessment of risk/toxicity of a pesticide over time. The original list of pesticides from the January 2015 ITHMP which exhibited low leaching potential is shown in Table 1.

## Table 1. Pesticide Selection List (Low leaching potential)[12]

| | | |
|---|---|---|
| Cholorthalonil | Vinclozolin | |
| Propamocarb | Triexapac-Ethyl | |
| Metaconazole | Boscalid | Paclobutrizol |
| Sethoxydim | Carefentrazone-Ethyl | Prodiamine |
| Bensulide | Spinosyn A | Fluazifop-P-Butyl |
| Etridiazole | Flutolanil | Ethephon |
| Bacillus subtilis | Fenarimol | Mefanoxam |
| Mesotrione | Bispyibac-Sodium Civitas | |
| Polyoxin D | Propoconazole | Myclobutanil |
| Azoxystrobin | Dimethylamine salt of propionic acid | |
| Pyraclostrobin | Siduron | Triadimefon |
| Dimethylamine salt of dicamba | | Aluminum tris O-ethyl |
| Dimethylamine salt of 2.4-Dichlorophenoxyacetic acid | | |

[12] "Updated Groundwater Monitoring Plan, The Bayberry Project, Southampton", NY. P.W. Grosser Consulting, April 2013.

## NYSDEC Reduced Risk Pesticides and Bio-pesticides

The United States Environmental Protection Agency (EPA) determines which pesticide active ingredients qualify as Reduced Risk. A Reduced Risk decision is actually made at the use level, for a pesticide/use combination.

The following are the Reduced Risk active ingredients registered in New York State for turf and ornamentals. The EPA Pesticide Chemical (PC) Code is a unique chemical code number assigned by the EPA to a particular pesticide active ingredient and can be used in product registration searches. Any pesticide product used in New York State must be registered with NYSDEC.

### Table 2. Active Ingredients Considered Reduced Risk for Use on Turf

| Active ingredient | PC code | Special Long Island Language |
|---|---|---|
| Azoxystrobin | 128810 | |
| Boscalid | 128008 | |
| Bispyribac-sodium | 078906 | |
| Carfentrazone-ethyl | 128712 | |
| Chlorantraniliprole | 090100 | Not for Sale, Use or Distribution in Nassau, Suffolk, Kings or Queens Counties |
| Fludioxonil | 071503 | Not for Sale, Use or Distribution in Nassau or Suffolk Counties |
| Mefenoxam | 113502 | |
| Mesotrione | 122990 | |
| S-Metolachlor | 108800 | Not for Sale, Use or Distribution in Nassau or Suffolk Counties |
| Penoxsulam | 119031 | |
| Spinosad | 110003 | |
| Trifloxystrobin | 129112 | |

The list of USEPA reduced risk pesticides is included in Appendix 7. Oral toxicity of fungicides used on golf courses are compared to oral toxicity of common substances in Table 3.

## Table 3. Oral Toxicity of Common Turf Fungicides Compared to Known Substances*

| Product | Active ingredient | Typical Target Organism | Oral toxicity (mg/kg of body weight) |
|---|---|---|---|
| *Caffeine* | *NA* | *NA* | *250* |
| Subdue Maxx | Metalaxyl-M | Pythium | 669 |
| *Aspirin* | *NA* | *NA* | *780* |
| Koban | Ethazole | Pythium | 1040 |
| Bayleton | Triadimefon | Snow Molds | 1470 |
| Banner | Propicpnazole | Dollar Spot | 1517 |
| Eagle | Myclobutanil | Grey Leaf Spot | 1600 |
| PCNB | Pentachloronitrobenzene | Snow Molds | 1700 |
| Banol | Propamocarb | Dollar spot | 2000 |
| Signature | Fostyl-Al | Pythium | 2000 |
| Rubigan | Fenarimol | Poa annua | 2500 |
| *Salt* | *NA* | *NA* | *3320* |
| Chipco 26 GT | Iprodione | Dollar spot | 3500 |
| *Ethyl Alcohol* | *NA* | *NA* | *3800* |
| Fore | Mancozeb | Pythium | 4500 |
| Heritage | Azoxystrobin | Pythium | 5000 |
| Clearys 3336 | Thiophanate-methyl | Pythium | 7500 |
| Daconil Ultrex | Chlorothalonil | Dollar spot | 10,000 |
| Prostar | Flutolanil | Fairy Ring | 10,000 |
| Vorlon | Thiabendazole | Fusarium | 10,000 |

*Vargas, J. Management of Turfgrass Diseases

Environmental Turf Services, Inc. (ETS) provides environmental services to the turf and crop industry, with recognized expertise in pesticide and nutrient fate modeling. ETS analysis *Comprehensive Risk Assessment for Pesticides for the Proposed Golf Course at the Hills of Southampton: Environmental & Turf Services, Dec. 2, 2015* is included as Appendix 13.
A summary of the ETS work is described below.

### Preliminary List of Pesticides to be Evaluated

An initial list of 58 pesticide active ingredients was assembled for evaluation. The chemical inputs were chosen based on the anticipated pests, Cornell recommendations, and use

on nearby golf courses. The 58 pesticides were reduced to 48 in a preliminary screen based on redundancies and regulatory considerations, as shown in Table 3 below.

## Table 4. Pesticide Risk Screening: Initial Pre-Modeling Screen (n=58)

| Pesticide | Trade Name | Chemical Abstract # | Reason for Deletion |
|---|---|---|---|
| **Fungicides** | | | |
| Aluminum tris O-ethyl (Fosetyl-Al) | Aliette®, Signature® | 39148-24-8 | |
| Azoxystrobin‡ | Heritage® | 131860-33-8 | |
| Bacillus subtilis* | Companion® Liquid or Rhapsody® | 68038-70-0 | |
| Boscalid‡ | Emerald® | 188425-85-6 | |
| Chloroneb | | | Duplicative with etridiazole. |
| Chlorothalonil | Daconil Ultrex® | 1897-45-6 | |
| Chlorothalonil + Acibenzolar | Daconil Action™ | 135158-54-2 (acibenzolar) | |
| Ethazole | | | Duplicative with etridiazole. |
| Etridiazole | [Banrot products only] | 2593-15-9 | [Only the Banrot products are allowed on Long Island turf.] |
| Fenarimol | | | No longer registered in New York |
| Fluazinam | Secure® | 079622-59-6 | |
| Fludioxonil | | | Not registered for use on Long Island |
| Flutolanil | ProStar WP® | 66332-96-5 | |
| Fluxapryroxad | | | Not registered in Nassau and Suffolk Counties |
| Iprodione | Chipco 26019®, 26GT, Chipco GT® | 36734-19-7 | |
| Mefenoxam‡ | Quell®, Subdue® Maxx® | 70630-17-0 | |
| Metconazole | Tourney® | 125116-23-6 | |
| Mineral Oil + Pigment* | Civitas® | | |
| Myclobutanil | Eagle® | 88671-89-0 | |
| Penthiopyrad | Velista® | 183675-82-3 | |
| Polyoxin D* | Endorse® | 146659-78-1 | |
| Propamocarb hydrochloride | Banol® | 25606-41-1 | |
| Propiconazole | Banner Maxx® | 60207-90-1 | |
| Pyraclostrobin | Insignia® | 175013-18-0 | |
| Thiophanate-methyl | Cleary 3336® | 23564-05-8 | |
| Thiram | 42-S Thiram | 137-26-8 | |

| Pesticide | Trade Name | Chemical Abstract # | Reason for Deletion |
|---|---|---|---|
| Triadimefon | Bayleton®25 (wsp) | 43121-43-3 | |
| Trifloxystrobin‡ | Compass® | 141517-21-7 | |
| Vinclozolin | | | potential endocrine disruptor; use is being phased out |
| **Herbicides** | | | |
| Bensulide | Betasan® | 741-58-2 | |
| Bispyribac-sodium | Velocity® | 125401-92-5 | |
| Carfentrazone-ethyl | Speed Zone® and Power Zone® | 128639-02-1 | |
| Dimethylamine salt of 2,4-dichlorophenoxyacetic acid (2,4-D) | a component of Trimec Classic® | 94-75-7 | |
| Dimethylamine salt of dicamba | Banvel® | 1918-00-9 | |
| Dimethylamine salt of methyl-chlorophenoxy propionic acid (MCPP) | a component of Trimec Classic® | 7085-19-0 | |
| Dithiopyr | | | The maximum rate allowed in New York, 0.25 lb/A is too low to be efficacious |
| Ethofumesate | Progress® | 26225-79-6 | |
| Fenoxaprop | Acclaim® | 66441-23-4 | |
| Fluazifop-P-butyl | Fusilade® | 69806-50-4 | |
| Foramsulfuron | | | Warm season grass only |
| Glufosinate | | | Not allowed in Suffolk and Nassau Counties |
| Glyphosate | Roundup Pro® | 1071-83-6 | |
| Halosulfuron | Manage® | 100784-20-1 | |
| Mesotrione | Tenacity® | 104206-82-8 | |
| Prodiamine | Barricade® | 29091-21-2 | |
| Quinclorac | Drive® | 84087-01-4 | |
| Sethoxydim | Vantage® | 74051-80-2 | |
| Siduron | | | The cost, and limited applicability don't justify its inclusion |
| **Plant Growth Regulators** | | | |
| Ethephon | Proxy® | 16672-87-0 | |
| Paclobutrazol | Trimmit® 2 SC | 76738-62-0 | |
| Trinexapac-ethyl | Primo® | 95266-40-3 | |
| **Insecticides** | | | |
| Bifenthrin | Talstar® | 82657-04-3 | |
| Carbaryl | Sevin® | 63-25-2 | |
| Chlorantraniliprole | | | Not allowed in Suffolk |

| Pesticide | Trade Name | Chemical Abstract # | Reason for Deletion |
|---|---|---|---|
| | | | County |
| Chlorpyrifos | Dursban® | 2921-88-2 | |
| Deltamethrin | DeltaGard® | 52918-63-5 | |
| Imidacloprid | Merit 75® | 138261-41-3 | |
| Lambda cyhalothrin | Battle®<br>Scimitar® | 91465-08-6 | |
| Spinosad*‡ | Conserve® | 168316-95-8 | |

*These products are generally considered to be "natural" and/or "organic" and/or biological in origin.

‡ These products are on EPA's "Reduced Risk" (Safer Pesticide) Program and are considered safer than alternative pesticides for the same use.

## Modeling Purpose

The purpose of using PRZM-GW is to conservatively calculate drinking water concentrations in a vulnerable shallow aquifer environment. PRZM-GW is a recent innovation by the US EPA's Office of Pesticide Programs (Baris et al., 2012). It is highly conservative and it tends to over-predict actual concentrations.

Several presentations at the US EPA's Environmental Modeling Public Meeting (http://www2.epa.gov/pesticide-science-and-assessing-pesticide-risks/organizational-statement-epa-sponsored-public) have documented that it tends to be at least as conservative as the SCI-GROW model. The latter typically predicted the upper 98$^{th}$-99$^{th}$ percentile of ground water residues.

## Model Description

Figure 3 depicts the conceptual model of PRZM-GW. The following descriptive text was taken from EPA's guidance on the use of PRZM-GW (http://www.epa.gov/oppefed1/models/water/przm_gw/wqtt_przm_gw_guidance.htm).

"The model represents vulnerable private drinking water wells in the vicinity of agricultural environments. In this conceptualization, the pesticide is applied to the soil surface or plant canopy, and precipitation or irrigation drive pesticides into the soil. Meteorological, crop, biological, chemical, and management processes affect the transport of the pesticide as it moves through the soil and into a saturated zone. Horizontal surface movement of a pesticide (via runoff or erosion) and subsequent removal is assumed negligible for this model.

The saturated zone of the conceptual model is a shallow unconfined aquifer with a water table depth that corresponds to the scenario location. The well-screen extends from the aquifer surface to 1 meter below the surface, but this length is also adjustable according to common practices. The default well-screen length of 1 meter was chosen to sample the higher concentrations expected to be closest to the water table; however, this can be adjusted based on site-specific data. Pesticide concentrations in the well are taken as the average concentration in the screened zone.

The conceptual model includes meteorological events that can significantly affect pesticide transport, including precipitation, evaporation, snow, temperature, and wind. These weather processes vary and are simulated with daily resolution. Daily resolution is required by risk assessment applications within OPP's and PMRA's Health Effects Division."

USEPA's conceptual model for estimating pesticide concentrations in drinking water in an unconfined aquifer when PRZM-GW is implemented.

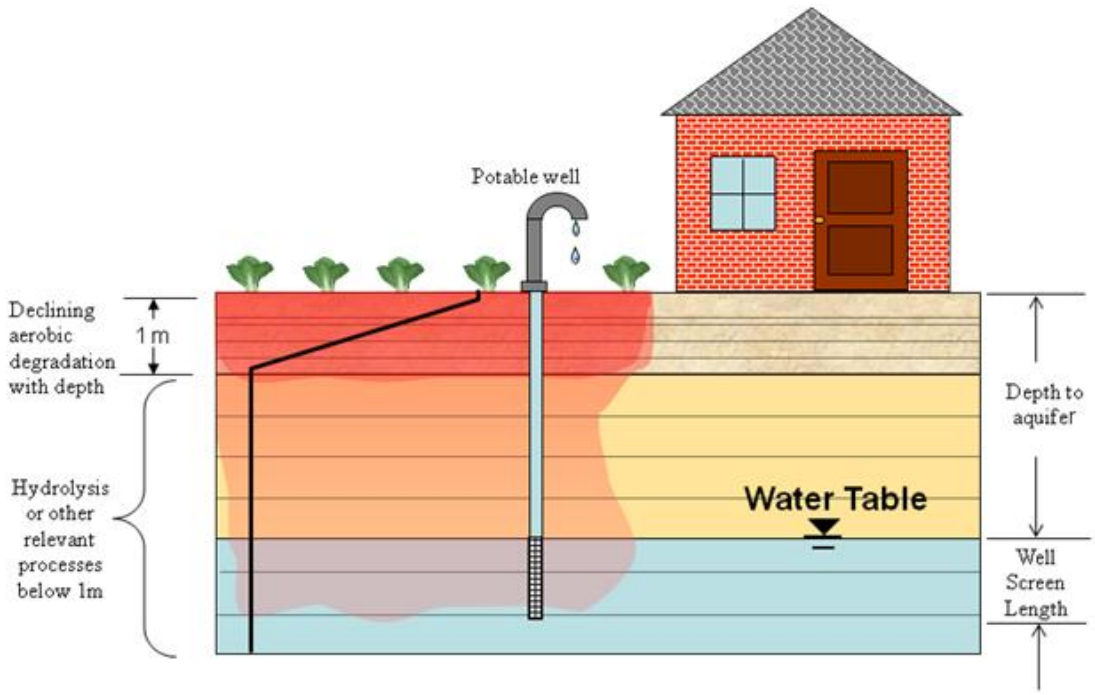



**Figure 3. USEPA's PRZM-GW Conceptual Model**

*(http://www.epa.gov/oppefed1/models/water/przm_gw/wqtt_przm_gw_guidance.htm)*

## Model Input: Pesticide Application and Environmental Chemistry (Fate)

This section contains the chemical-specific model input parameters. Maximum legal pesticide use rates are listed in Table 5. They are based on the information contained in the pesticide product labeling, ***which is legally enforceable under federal and State law.***

Table 6 lists two of the more important pesticide environmental fate input parameters, the soil organic carbon/water partition coefficient - - Koc, and the aerobic soil metabolism half- life. These are characteristics of sorption to the soil, i.e., mobility, and degradation by naturally occurring bacteria in the soil, respectively. Due to the very large number of pesticides ETS modeled in this second stage of screening, ETS took a conservative approach and assumed the pesticides would neither hydrolyze (break down in water) nor volatilize into the air. In the next phase, ETS refined the modeling by incorporating considerations for hydrolysis and volatilization for those pesticides that raised a concern in the initial stage of modeling.

### Table 5. PRZM-GW Pesticide Loading Input

| Chemical | Example Trade Name | Max Number of appl'ns per year | Rate[§] lb a.i./ac | Month/Day of Application |
|---|---|---|---|---|
| **Herbicides** | | | | |
| Bensulide | Pre-San, Betasan | 2 | 8-15 | 4-1, 5-15 |
| Bispyribac-sodium | Velocity | 2 | 1.32 | 6-1,7-1 |
| Carfentrazone-ethyl‡ | Speedzone | 2 | 0.026 | 4-1,5-1 |
| Ethofumesate | Prograss | 1 | 1.5 | 10-1 |
| Fenoxaprop | Acclaim | 1 | 0.071 | 7-1 |
| Fluazifop-P-butyl | Fusilade | 1 | 0.375 | 7-15 |
| Glyphosate | Roundup Pro | 2 | 0.16 | 5-1, 6-1 |
| Halosulfuron-methyl | Sedgehammer | 2 | 0.062<br>0.124 | 7-1, 8-1 |
| Mesotrione | Tenacity | 1 | 0.25 | 6-1 |
| Prodiamine | Barricade | 1 | 0.98 | 4-15 |
| Quinclorac | Drive | 1 | 0.5 | 6-1 |
| Sethoxydim | Segment | 1 | 0.018 | 7-15 |
| 2,4-D | Trimec Classic | 2 | 1.23 | 5-1, 10-1 |
| MCPP | | 2 | 0.65 | 5-1, 10-1 |
| Dicamba | | 2 | 0.12 | 5-1, 10-1 |
| **Insecticides** | | | | |
| Bifenthrin | Talstar | 2 | 0.1 | 5-15, 7-15 |
| Carbaryl | Sevin | 1 | 2.75 | 6-15 |
| Chlorpyrifos | Dursban | 1 | 16 | 7-1 |
| Deltamethrin | DeltaGuard | 1 | 0.13 | 8-15 |
| Imidacloprid | Merit 75 (wsp) | 1 | 0.3 | 6-15 |
| Lambda-cyhalothrin | Battle, Scimitar | 3 | 0.36 | 5-1, 7-1, 9-1 |
| Spinosad[†]* | Conserve | 2 | 0.50 | Not modeled (biochemical) |
| **Fungicides** | | | | |
| Azoxystrobin[†] | Heritage 50 WG | 2 | 0.95<br>1.1 | 6-1, 8-1 |

| Chemical | Example Trade Name | Max Number of appl'ns per year | Rate[§] lb a.i./ac | Month/Day of Application |
|---|---|---|---|---|
| Bacillus subtilis* | Companion Liquid and Rhapsody | - - | - - | Not modeled (biological) |
| Boscalid[†] | Emerald | 2 | 0.4<br>0.56 | 5-15, 9-1 |
| Chlorothalonil & Acibenzolar-S-methyl | Daconil Action | 1 | 0.008 (acibenzolar)<br>6.1 (chlorothalonil) | 6-1 or 7-1 |
| Chlorothalonil | Daconil | 6 | 8.25 | 4-1, 5-1, 6-1, 7-1, 8-1, 9-1 |
| | | | | |
| Etridiazole | [Only Banrot products allowed on L.I.] | 1 | 4.125 | 7-15 |
| Fluazinam | Secure | 1 | 0.71 | 7-1 |
| Flutolanil | ProStar WP | 2 | 8.0<br>17.32 | 7-15, 8-15 |
| Fosetyl-Al (Aluminum tris) | Alliette | 1 | 17.42 | 7-1 |
| Iprodione | Chipco | 2 | 2.72 | 5-15, 7-15 |
| Mefenoxam[†] | Subdue | 1 | 0.60 | 8-1 |
| Metconazole | Tourney | 1 | 0.50 | 7-1 |
| Mineral oil + pigment* | Civatas | | | Not modeled |
| Myclobutanil | Eagle | 2 | 0.65<br>1.32 | 5-1, 9-1 |
| Penthiopyrad | Velista | 1 | 0.95 | 7-15 |
| Polyoxin D* | Endorse | 1 | 0.272 | 7-15 [Not modeled – biochemical] |
| Propamocarb | Banol | 1 | 3.65 | 7-15 |
| Propiconazole | Banner Max | 2 | 1.1<br>0.78 | 7-1, 9-1 |
| Pyraclostrobin | Insignia | 2 | 0.5<br>1.0 | 7-1, 12-1 |
| Thiophanate methyl | Fungo 50 | 1 | 4.2 | 7-15 |
| Thiram | Spotrete | 1 | 5.1 | 12-1 |
| Triadimefon (triadimenol-90% application of parent) | Bayleton 50 | 2 | 0.25<br>2.36 | 5-1, 9-1 |
| Trifloxystrobin[†] | Compass | 2 | 0.4<br>0.55 | 6-1, 8-1 |
| **Growth Regulators** | | | | |
| Ethephon | Proxy | 1 | 1.25 | 4-1 |
| Paclobutrazol | Trimmit 2 SC | 4 | 0.5<br>1.0 | 4-1, 5-1, 9-1, 10-1 |
| Trinexapac-ethyl | Primo | 4 | 0.25<br>1.0 | 5-15, 6-15, 7-15, 8-15 |

[§]The highest application rate was modeled if two are listed.
* These products are generally considered to be "natural" and/or "organic" and/or biological in origin.

†These products are on EPA's "Reduced Risk" (Safer Pesticide) Program and are considered safer than alternative pesticides for the same use.

## Table 6. PRZM-GW Pesticide Environmental Fate Input**

| CHEMICAL | Example Trade Names | $K_{oc}$ | Soil aerobic t½ (days) |
|---|---|---|---|
| **Herbicides** | | | |
| Bensulide | Betasan | 3900 | 365 |
| Bispyribac-sodium | Velocity | 114 | 58 |
| Carfentrazone-ethyl (+ its acid metabolite) | Speed Zone/Power Zone | **866** | 1.3<br>0.5 |
| Dimethylamine salt of 2,4-dichlorophenoxyacetic acid (2,4-D) | Trimec Classic | 109 | 6.0 |
| Dimethylamine salt of dicamba | Banvel | **32** | 28<br>3.9<br>9 |
| Dimethylamine salt of methyl-chlorophenoxy propionic acid (MCPP) | | 47<br>32 | 8.2<br>9 |
| Ethofumesate | Prograss | Kd of 0.73 in sand | 3 |
| Fenoxaprop-ethyl | Acclaim | 9490 | 1<br>4 |
| Fluazifop-P-butyl | Fusilade | 3394 | 7<br>8.2 |
| Glyphosate | Roundup Pro | 2100 | 2 |
| Halosulfuron-methyl | Sedgehammer | 100 | 18 |
| Mesotrione | Tenacity | 122 | 5 |
| Potassium Salts of Fatty Acids | M-Pede | N/A | N/A |
| Prodiamine | Barricade | 5,500 | 63 |
| Quinclorac | Drive | Kd <1<br>50 | 450 |
| Sethoxydim | Vantage | 75 | 5-25<br>5 |
| **Insecticides** | | | |
| Bifenthrin | Talstar | 237,00 | 104 |
| Carbaryl | Sevin | 288 | 17 |
| Chlorpyrifos | Dursban | 13,400[l] | 10[l] |
| Deltamethrin | DeltaGard | 10,240,000 | 7-14<br>21 |
| Imidacloprid | Merit 75 (wsp) | 530 | 306 |
| Lambda-cyhalothrin | Battle, Scimitar | 333,000 | 38 |
| Spinosad | Conserve | N/A | N/A |
| **Fungicides** | | | |
| Aluminum tris O-ethyl (Fosetyl-Al) | Alliette | ***166*** | 0.12 |
| Azoxystrobin | Heritage 50 WG | 720 | 28 |

| CHEMICAL | Example Trade Names | $K_{oc}$ | Soil aerobic t½ (days) |
|---|---|---|---|
| Bacillus subtilis | Rhapsody/ Companion Liquid | N/A | N/A |
| Boscalid | Emerald | 1,622 | 337 |
| Chlorothalonil | Daconil | 2,680 | 13 |
| Daconil Action: chlorothalonil + acibenzolar (see the individual entries) | Daconil Action | See individual chemicals | See individual chemicals |
| Etridiazole | [Banrot products only] | 1,000 | 20 (typical) |
| Fluazinam | Secure | 1705-2316 | 132 |
| Flutolanil | ProStar WP | 681 | 81 |
| Iprodione | Chipco 26019 Flo | 381 | 30 |
| Mefenoxam [the R-enantiomer of metalaxyl; data are for metalaxyl] | Quell, Subdue Maxx | 16 | 16, 5-6<br>Use 11 |
| Metconazole | Tourney | 1026-2723‡ | 192.5-660<br>265 |
| Mineral oil + pigment | Civitas | N/A | N/A |
| Myclobutanil | Eagle | 500 | 20 |
| Penthiopyrad | Velista | 804 | 9.2 |
| Polyoxin D | Endorse | N/A | N/A |
| Propamocarb | Banol | Koc is inappropriate; use Kd=6 | 36 |
| Propiconazole | Banner Max | 682 | 60[j] |
| Pyraclostrobin | Insignia | 12,521 | 14.5 |
| Thiophanate methyl (+ its MBC metabolite) | Cleary 3336 | 1830 (parent), 225 for MBC metab | 1 (parent)<br>40[t] for MBC metab |
| Thiram | 42-S | 383 | 15<br>15 |
| Triadimefon (+ its triadimenol metabolite) | Bayleton 50 | 319 **(**metabolite: **555)** | 6 **(**metabolite: **183)** |
| Trifloxystrobin | Compass | 2,709 | 1.0 |
| **Growth Regulators** | | | |
| Ethephon | Proxy | 1870 | 9 |
| Paclobutrazol | Trimmit 2 SC | 500 | 214 |
| Trinexapac-ethyl | Primo | 278 | 0.16 |

** Unless otherwise noted, the numbers in this table were obtained from US EPA Reregistration Eligibility Decisions, Pesticide Fact Sheets, environmental risk assessments by the Environmental Fate & Effects Division, Office of Pesticide Programs, US EPA, and four papers published in the open literature, as follows ***[partial list***]: Durborow et al. (2000); NY DEC (2003); US EPA (2007a); EXTOXNET; Ahrens (1994); US EPA (2007); US EPA (2003); US EPA (2000); Branham & Gardner (2002); Horst et al. (1996); FAO (1998). NOTE: Specific citations and references can be provided on request.

## Model Input: Field Parameters and Weather File

The numbers in Table 7 below are based on the analyses of samples ETS collected from the site in August as described in III (B) above.

The average values for samples were calculated for all parameters. The samples collected from the sand pit (#37804 & #37848) were not used to determine the averages for any of the

parameters used in the modeling. ETS also did not take credit for a thatch layer. A thatch layer and the results from the gravel area (which had no vegetation) would lower the pesticides concentrations. Using the site-specific soil input parameters for the modeling produces highly conservative pesticide concentrations (i.e., higher concentrations).

ETS selected a weather file from the U.S. EPA database in the northeast that has a similar annual average rainfall to The Hills site. The weather file selected is Atlantic City, New Jersey. That area has an average annual rainfall between 42-45", which is similar to the Long Island area near The Hills of 44" (http://www2.epa.gov/exposure-assessment-models/meteorological-data).

## Table 7. PRZM-GW Soil Input Parameters

| Sampled Depths (in) | Modeled Depths (m) | Bulk Density (g/mL)*† | Max Water Capacity** (FC; 1/3 bar) | Min Water Capacity‡‡ (WP; -15 Bar) | OC %§ |
|---|---|---|---|---|---|
| 0-4 | 0-0.1 | 1.208 | 16.00 | 12.67 | 1.41 |
| 4-8 | 0.1-0.2 | 1.236 | 6.33 | 3.33 | 0.41 |
| 8-12 | 0.2-0.4 | 1.236 | 6.33 | 3.00 | 0.6 |
| 12-24 | 0.4-0.6 | 1.236 | 5.67 | 2.67 | 0.46 |
| No Sample | 0.6-0.8 | 1.236 | 5.67 | 2.67 | 0.46 |
| No Sample | 0.8-1.0 | 1.236 | 5.67 | 2.67 | 0.46 |
| No Sample | 1-11 | 1.236 | 5.67 | 2.67 | 0.46 |
| No Sample | 11 to (11+1) | 1.236 | 5.67 | 2.67 | 0.46 |

***Bulk Density (g/ml):** ETS used the average bulk density for this parameter from site-specific soil samples collected. Bulk Density samples were collected from 0-4" and 4-8"depths. ETS assumed the BD for remaining profile below 8" was the same as the 4-8" depth since it is a sandy soil.

†One additional sample was collected for BD at 10-14" in one area where there appeared to be a zone that was somewhat compacted: BD = 1.365. It was not used in the average bulk density.

****Max. Water Capacity:** ETS used the average field capacity (FC) for this parameter from site-specific soil samples collected. ETS assumes that FC in the soil profile below 24" is the same as the 12-24" value. The sample collected from the sand pit (#37804 & #37848) was not used to determine the average since there was no vegetation.

‡‡**Min. Water Capacity:** ETS used the average wilting point (WP) for this parameter from site-specific soil samples collected. ETSs assumes that the WP in the soil profile below 24" is the same as the 12-24" value. The sample collected from the sand pit (#37804 & #37848) was not used to determine the average since there was no vegetation.

§**OC %:** ETS calculated the %OC (percent organic carbon) from the organic matter of the site specific soil samples collected. OC% = OM%/1.724. ETS assumes that there is not much organic carbon in the soil profile below 24". Therefore, ETS used the OC% value as determined in the 12-24" sample for depths below 24". The sample collected from the sand pit (#37804 & #37848) was not used to determine the average OC% since there was no vegetation.

### Results

In this section, ETS produced peak and mean ground water concentrations predicted by the conservative PRZM-GW modeling runs.

Table 8 lists the peak and chronic ground water concentrations predicted by the PRZM-GW modeling runs. A CD is attached that contains the output of all 46 modeling runs. These results are compared with human and aquatic toxicologic endpoints in section H below.

## Table 8. PRZM-GW Results

| CHEMICAL | Peak Concentration (ppb) | Entire Simulation Mean Concentration (ppb) |
|---|---|---|
| **Herbicides** | | |
| Bensulide | 4.68E-19 | 1.77E-20 |
| Bispyribac-sodium | 58.6 | 31.8 |
| Carfentrazone-ethyl | 1.17E-20 | 2.72E-22 |
| 2,4-D (Dimethylamine salt of 2,4-dichlorophenoxyacetic acid) | 0.031 | 0.0105 |
| Dicamba (Dimethylamine salt of dicamba) | 1.31 | 0.583 |
| MCPP (Dimethylamine salt of methyl-chlorophenoxy propionic acid) | 7.09 | 3.16 |
| Ethofumesate | 5.11E-05 | 9.9E-06 |
| Fenoxaprop | 0 | 0 |
| Fluazifop-P-butyl | 0 | 0 |
| Glyphosate | 0 | 0 |
| Halosulfuron-methyl | 0.883 | 0.396 |
| Mesotrione | 0.00107 | 0.000406 |
| Potassium Salts of Fatty Acids | Not modeled | |
| Prodiamine | 0 | 0 |
| Quinclorac | 74.2 | 53.5 |
| Sethoxydim | 0.123 | 0.0459 |
| **Insecticides** | | |
| Bifenthrin | 0 | 0 |
| Carbaryl | 0.0378 | 0.00537 |
| Chlorpyrifos | 0 | 0 |
| Deltamethrin | 0 | 0 |
| Imidacloprid | 0.0372 | 0.00285 |
| Lambda-cyhalothrin | 0 | 0 |
| Parasitic Nematodes | Not modeled | - - |
| Spinosad* | Not modeled | - - |
| **Fungicides** | | |
| Aluminum tris O-ethyl (Fosetyl-Al) | 0 | 0 |
| Azoxystrobin | 1.75E-07 | 1.15E-08 |
| Bacillus subtilis | Not modeled | - - |
| Boscalid | 1.11E-10 | 5.22E-12 |
| Chlorothalonil | 0 | 0 |
| Chlorothalonil + acibenzolar (Daconil Action) | 1.44E-20 (Acibenzolar) | 3.46E-22 (Acibenzolar) |
| Etridiazole | 3.31E-11 | 1.81E-12 |
| Fluazinam | 9.09E-15 | 4.31E-16 |
| Flutolanil | 0.00202 | 0.000139 |
| Iprodione | 0.0342 | 0.00372 |
| MBC (TM metabolite) | 4.44 | 1.11 |
| Mefenoxam | 32.5 | 11.2 |
| Metconazole | 2.64E-12 | 1.19E-13 |

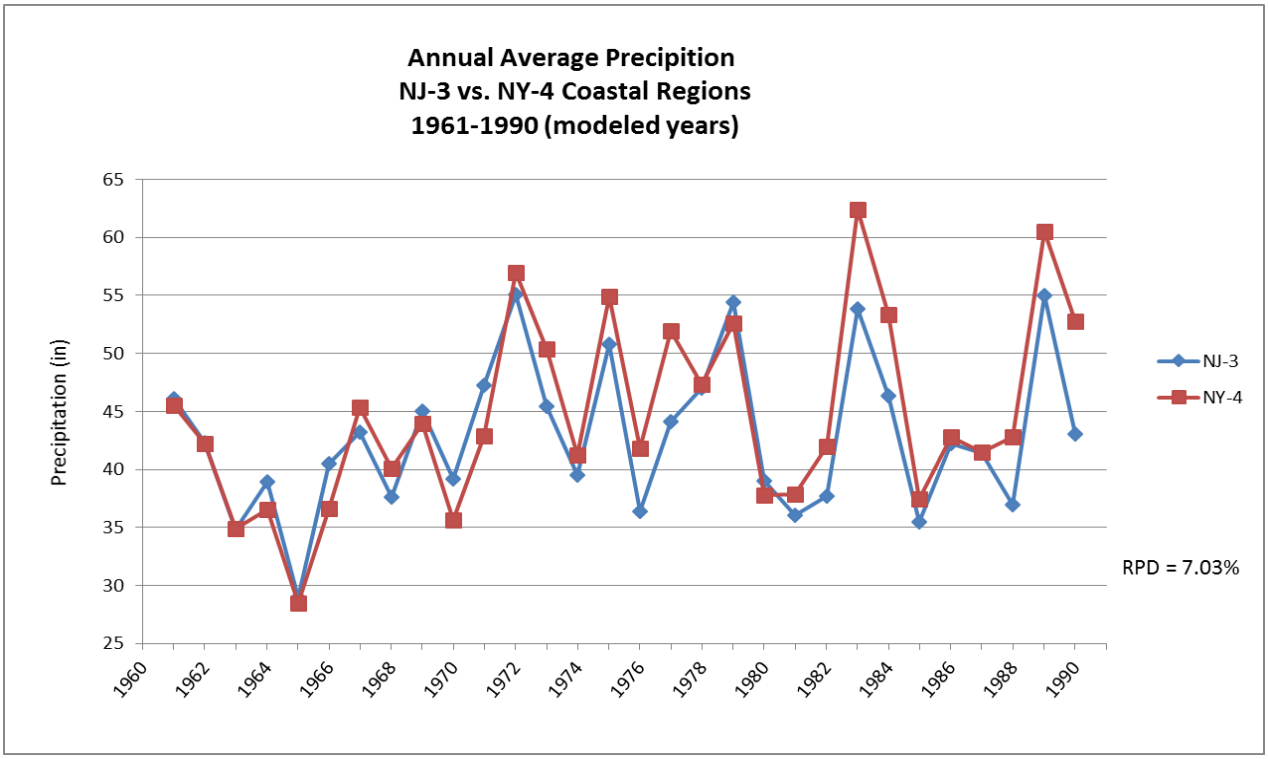
| CHEMICAL | Peak Concentration (ppb) | Entire Simulation Mean Concentration (ppb) |
|---|---|---|
| Mineral oil + pigment | Not modeled | - - |
| Myclobutanil | 2.08E-05 | 1.76E-06 |
| Penthiopyrad | 1.11E-09 | 6.4E-11 |
| Polyoxin D | Not modeled | - - |
| Propamocarb | 9.24E-11 | 5.12E-12 |
| Propiconazole | 2.86E-05 | 1.99E-06 |
| Pyraclostrobin | 0 | 0 |
| Thiophanate methyl‡ | 0 | 0 |
| Thiram | 0.000124 | 1.53E-05 |
| Triadimefon | 2.68E-05 | 3.23E-06 |
| Triadimenol* (Triadimefon metabolite) | 0.105 | 7.93E-03 |
| Trifloxystrobin | 0 | 0 |
| **Growth Regulators** | | |
| Ethephon | 0 | 0 |
| Paclobutrazol | 0.56 | 0.0458 |
| *Trinexapac-ethyl* | *0* | *0* |

‡Thiophanate methyl was not modeled in PRZM-GW because of the very low half-life of 1 day (see Table 6).
*Triadimenol was modeled at 90% of the parent application rate.

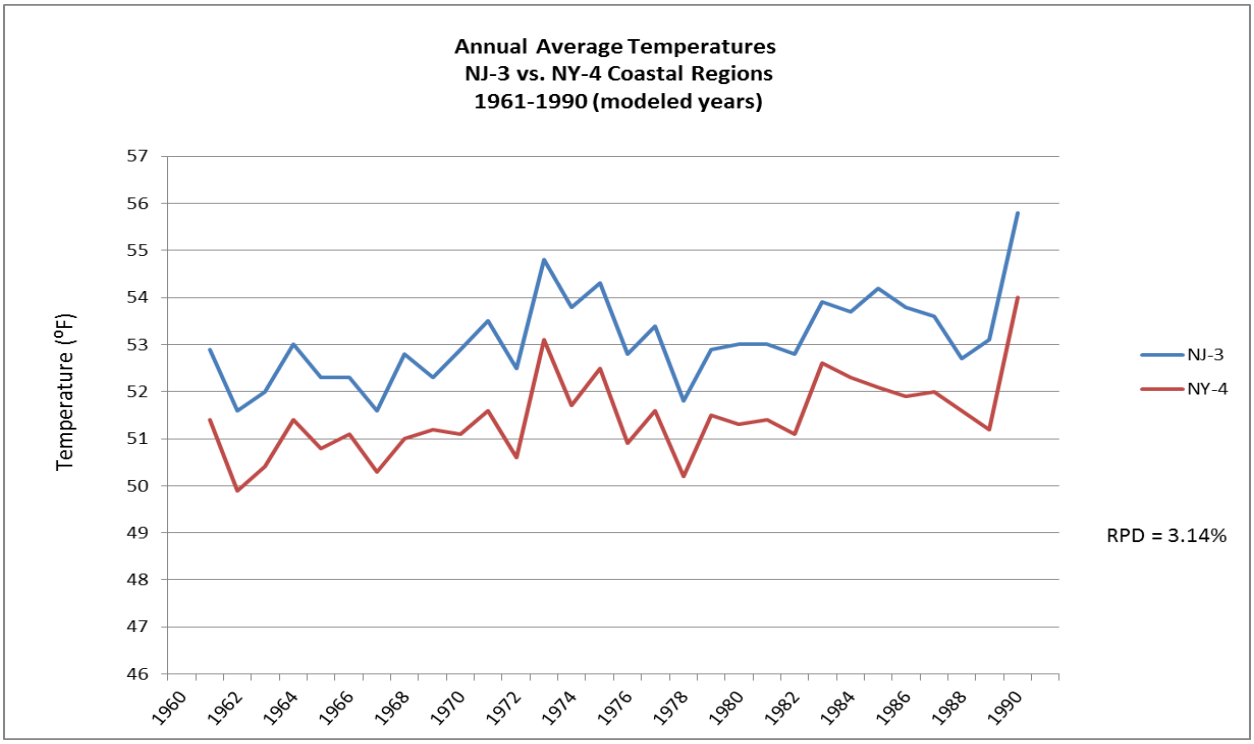
ETS selected a weather file from the U.S. EPA database in the northeast that has a similar annual average rainfall and temperature to The Hills site. The weather file selected is Atlantic City, New Jersey, and the EPA provides it in the specialized format required to run the PRZM-GW model (http://www2.epa.gov/exposure-assessment-models/meteorological-data). The Atlantic City weather data for the PRZM-GW modeling was used because it is a coastal environment similar to Long Island. However, in response to comments received from Dr. A.M. Petrovic during the completeness review, ETS quantitatively compared the precipitation and temperatures for Atlantic City and Long Island, as follows.

ETS compared the Atlantic City (NJ-3 coastal) and Long Island (NY-4 coastal) precipitation and temperature for the 30 modeled years (1961-1990) using the regional data tables from the NRCC (National Regional Climate Center; Cornell University) to show the similarities (Figures 1 and 2 below). The data show that the 30-yr average precipitation for the NY-4 coastal (44.69") is slightly higher than the NJ-3 coastal (42.79") for the same years; NY-4 is only 4.4% higher.

The RPD (relative percent difference) is only 7% for the 30 year period, which indicates consistency between the amounts. In addition, we compared the temperatures for those stations for the same time period. The average temperature for the NY-4 coastal is 51.46ºF compared with NJ-3 coastal of 52.10ºF, a 3% RPD, also a very minor difference (http://www.nrcc.cornell.edu/regional/tables/tables.html). Therefore, the Atlantic City weather file that was selected and provided by the US EPA in the correct format for the PRZM-GW modeling is comparable to Long Island weather. In addition, the US EPA does not offer datasets for Long Island or coastal NY for modeling. In any case, the differences in weather between NJ-3 coastal and NY-4 coastal are insignificant, i.e., RPDs are very low for precipitation and temperatures.




**Annual Average Precipitation NJ-3 vs. NY-4**




**Annual Average Temperature NJ-3 vs. NY-4**

ETS assumed that "*legalistic value"* mentioned in comments during the DEIS review process should be "realistic value." The model input parameters for the soil were based on the analytical results of the soil samples collected on-site as indicated in the ETS report. However, ETS adjusted the field capacity (FC), wilting point (WP), and organic carbon (OC) for three pesticides: 2,4-D, dicamba, and MCPP (see results below). The average of the three samples collected to determine FC and WP at the 0-4 inch depth used in modeling pesticides was 16% at 1/3 bar [(7+14+27)/3=16%] and 12.67% at -15 bar [(5+8+25)/3=12.67%], respectively (see Soil Results, Table 3 in our March report). Although the results for the one sample appeared to be relatively high, it is within the range of values for PRZM-GW modeling for sand and sandy loam soils. The FC range of values for sand is 0.018 to 0.164, and for WP the range for sandy loam is 0.031 to 0.159 (Suarez, 2005). The average values used were within these ranges. In addition, the Northeast Regional Certified Crop Advisor (NRCCA) Study Resources from Cornell University state that the "moisture content remaining at FC is about 15 to 25% for sandy soils" (http://nrcca.cals.cornell.edu/soil/CA2/CA0212.1-3.php). The 16% we used for FC is on the low end of that range. The NRCCA study also shows that the range for WP in sandy soils is 5 to 10%. We were only slightly outside the high end for WP. However, the RPD for the 27% FC and 25% WP sample is only ~8% compared with the other samples with lower FC and WP values (i.e., RPDs = 33 and 55% for the two lower values, respectively). Therefore, the average values used for the original modeling for FC and WP at the 0-4" depth are well within the appropriate ranges for water holding capacities for The Hills soils.

Nonetheless, ETS remodeled three pesticides using the PRZM-GW model, omitting the higher FC and WP values, and averaged two samples instead of three, which lowered the FC and WP values: FC = 10.5 [(7+14)/=10.5%] instead of 16.0 and 6.5 [(5+8)/=6.5%] instead of 12.67 for WP (see below; 7b in our revised report). In addition, we used 0.0 OC% (i.e., no organic matter) for the input parameter at depths >24" as requested. Table 3 below shows the input parameters that were changed (bold).

Reference: Suarez, L.A. September 2005. PRZM-3, A Model for Predicting Pesticide and Nitrogen Fate in the Crop Root and Unsaturated Soil Zones: Users Manual for Release 3.12.2. EPA/600/R-05/111. U.S. Environmental Protection Agency, Office of Research and Development, Washington DC.

**Revised PRZM-GW Soil Input Parameter for Remodeling (From Table 7-b of the ETS revised report)**

| Sampled Depths (in) | Modeled Depths (m) | Bulk Density (g/mL)*† | Max Water Capacity** (FC; 1/3 bar) | Min Water Capacity‡‡ (WP; -15 Bar) | OC %$ |
|---|---|---|---|---|---|
| 0-4 | 0-0.1 | 1.208 | **10.5** | **6.5** | 1.41 |
| 4-8 | 0.1-0.2 | 1.236 | 6.33 | 3.33 | 0.41 |
| 8-12 | 0.2-0.4 | 1.236 | 6.33 | 3.00 | 0.6 |
| 12-24 | 0.4-0.6 | 1.236 | 5.67 | 2.67 | 0.46 |
| No Sample | 0.6-0.8 | 1.236 | 5.67 | 2.67 | **0.0** |
| No Sample | 0.8-1.0 | 1.236 | 5.67 | 2.67 | **0.0** |
| No Sample | 1-11 | 1.236 | 5.67 | 2.67 | **0.0** |
| No Sample | 11 to (11+1) | 1.236 | 5.67 | 2.67 | **0.0** |

The three pesticides remodeled were 2,4-D, dicamba, and MCPP. Table 4 below shows our original results. We changed the values of three input parameters (FC, WP, and OC) at specific depths, as noted above. In addition, the application timing was changed to reflect a spring and fall application as recommended. The results for the remodeling indicated below show only a slight increase in the risk ratio (RR) to humans for 2,4-D: the original modeling result for the human RR = 2.10E-4 (Table 4) compared with the remodeling RR = 2.12E-4 (Table 5), basically no change for 2,4-D. However, there was an increase in the RRs (less conservative) for dicamba and MCPP (see the tables below to compare the results). Note that a very old standard for these two chemicals was used to determine the risk ratio (i.e., old/"former" NYDEC standard of 0.44 ppb).

**Risk Quotient Calculations – original results (Table 11-a: ETS revised report)**

| CHEMICAL | Peak Conc. (ppb) | Did the Result Exceed One of the Acute Values in Table 10? | Entire Simulation Mean Concentration (ppb) | Did the Result Exceed One of the Chronic Values in Tables 10 or 9? | Risk Quotient | | |
|---|---|---|---|---|---|---|---|
| | | | | | Human | Aquatic | |
| | | | | | | Acute | Chronic |
| 2,4-D | 0.031 | No | 0.0105 | No | 2.10E-4 | 2.37E-03 | 7.39E-07 |
| dicamba | 1.31 | No | 0.583 | 0.44 (old/"former" NYDEC std) | 1.33 | 2.15E-02 | 5.30E-02 |
| MCPP | 7.09 | No | 3.16 | 0.44 (old/"former" NYDEC std) | 7.18 | 5.06E-01 | 6.22E-05 |

**Risk Quotient Calculations – remodeled results (ETS revised report: Table 11-b.)**

| CHEMICAL | Peak Conc. (ppb) | Did the Result Exceed One of the Acute Values in Table 10? | Entire Simulation Mean Concentration (ppb) | Did the Result Exceed One of the Chronic Values in Tables 10 or 9? | Risk Quotient | | |
|---|---|---|---|---|---|---|---|
| | | | | | Human | Aquatic | |
| | | | | | | Acute | Chronic |
| 2,4-D | 0.454 | No | 0.106 | No | 2.12E-4 | 3.47E-02 | 7.46E-06 |
| dicamba | 11.5 | No (dicamba acid chronic invertebrate = 11 ppb) | 7.76 | 0.44 (old/"former" NYDEC std) | 17.6 | 1.89E-01 | 7.05E-01 |
| MCPP | 14.1 | No (MCPP-P DMAS nonvascular plants acute = 14 ppb) | 6.3 | 0.44 (old/"former" NYDEC std) | 14.3 | 1.01E+00 | 1.24E-04 |

The ITHMP incorporates agronomic methods that are specifically developed for low input turf management programs. A response plan for *Emergency Treatment and Application of Pesticides* comprised of non-organic and Field EIQ $\geq$ 25 for conditions when organic preventative controls and application of pesticides with $\leq$ 25 Field EIQ treatment has failed as per the following:

*Description of Failure Conditions:*

When, during daily turf grass monitoring by qualified staff, trained in Progressive Integrated Pest Management and pest identification methods, report the following conditions:

Fairways & Tees:

Any area of 600 SF of the fairways or tees represented by severe damage where the cause of turf damaged is verified as pest damage, leading to eminent loss of turf, where the fairways and tees had been managed using the cultivation practices, preventative and curative treatments with pesticides having a Field EIQ of $\leq$ 25.

Greens:

Any area of 20 SF of the greens represented by severe damage where the cause of turf damaged is verified as pest damage, leading to eminent loss of turf, where the greens had been managed using the cultivation practices and preventative, curative treatments using pesticides having a Field EIQ of $\leq$ 25.

Roughs and Native Areas:

Any area of 600 SF of the primary or secondary roughs represented by severe damage where the cause of turf damaged is verified as pest damage, leading to eminent loss of turf where the roughs had NOT been managed using the cultivation practices and preventative and curative treatments using pesticides with a Field EIQ of $\leq$ 25, shall apply pesticide treatments using products with and Field EIQ of 25 or less. Applications of pesticides with a Field EIQ> 25 are only recommended under extreme conditions as confirmed by the Town of Southampton

Department of Land Management. Primarily the treatment approach for these areas is by renovation and restoration (re-seed or sod) of damaged turf as needed.

When the aforementioned conditions occur, the Town of Southampton Department of Land Management shall be immediately notified in writing (e-mail is acceptable) with acknowledgement that a pesticide application with a product having a Field EIQ of >25 is necessary. The specific pesticide, application rate, amount of area to be treated and the pest scouting report and/or pest diagnostic report will be included in the notification.

When damage is caused by rapidly spreading diseases (such as Pythium) and timing of the application is critical for effective treatment or as stated on the pesticide label, the superintendent shall have the decision making authority to implement the treatment within four (4) hours of the notice to the Town if weather conditions are still favorable for the disease development and damage.

For less critical conditions including weed and insect damage and infestations, the superintendent shall not apply treatments with pesticides having a Field EIQ of >25 until a confirmation and approval from the Town of Southampton Department of Land Management is received, usually within 7 days.

Causes of Turf Loss:

Include but may not be limited to the following:
Resistance of the pest to low Field EIQ value pesticides available for control.
New pathogen not known at time of ITHMP development (ex. southern pine beetle).

*Emergency Protocols: Treatment and Application of Pesticides (non-organic and FEIQ > 25)*

1. Limit the applications to the areas of high maintenance turf only.
2. The emergency application of pesticides with a Field EIQ of >25 should be limited to no more than 4 times per year for a given green, tee, fairway or primary/secondary rough.
3. Where practically possible, the emergency application of pesticides with a Field EIQ of >25 should be made only within areas experiencing the pest attack (i.e. spot treatment).
4. The emergency application of pesticides with a Field EIQ of >25 that include propiconazole, prodiamine, and/or future pesticides that are possible, probable or likely carcinogens should be used as a last resort.
5. Select pesticides labeled for treatment in priority of the lowest Field EIQ number:

*Calculate the Field EIQ using the following method*:

*(Pesticide EIQ) x Percent of Active Ingredient (Ai%) x Application Rate of Product per Unit of Area= Field Environmental Index Quotient*

*(Pesticide EIQ) x (Ai%) x (Fluid ounces or pounds x 1000 SF) = Field EIQ*

6. Treat the live turf area(s) with the label rate of the recommended pesticide and when recommended, reduce the cumulative application of the active ingredients in the product by mixing lower rates with products shown to have a combined synergistic effect.
7. Monitor the treatments on a daily basis to assess controls and efficacies. Record the results.
8. Where there are multiple areas of damage treat each area and independently monitor the results to evaluate effectiveness under various micro climates (shade, applied water, soil types, etc.).
9. Dead turf must be removed and exposed soils prepared for reseeding or sod to minimize erosion and improve/restore turf density as soon as practically possible.
10. The record keeping shall include the: date, weather conditions, irrigation applications, pesticide name/brand, active ingredient, FEIQ, quantity used, area treated, target organism, results of treatment and scouting report and/or diagnostic pest report. The report shall be submitted quarterly to the Town of Southampton Department of Land Management.
11. A summation of all FEIQ for pesticides above a Field EIQ of 25 and below 25 shall be maintained for record keeping and reported annually to the Town of Southampton Department of Land Management.

## Table 9. Weeds & Herbicide Control *

| Broadleaf Weeds | Poa annua | Chickweed | Henbit | Goosegrass |
|---|---|---|---|---|
| Fiesta/hand weed | Waipuna | Fiesta/hand weed | Fiesta/hand weed | Corn gluten/hand weed |
| Sethoxydim | Sethoxydim | | | Sethoxydim |
| | | Carfentrazone-ethyl | Carfentrazone-ethyl | |
| Carfentrazone-ethyl | Mesotrione | Bispyribac-sodium | Bispyribac-sodium | Fenoxaprop |
| Fluazifop-p-butyl | Fluazifop p-butyl | Dicamba | Dicamba | Fluazifop p-butyl |
| Bispyribac-sodium | Prodiamine | 2,4-D | 2,4-D | Prodiamine |
| Dicamba | Bispyribac-sodium | Bensulide‡ | Bensulide‡ | Bispyribac-sodium |
| 2,4-D | 2,4-D | | | |
| Bensulide‡ | Ethofumesate | | | Bensulide‡ |
| | Bensulide | | | |

| Crabgrass | Nutsedge/Kyllinga | Sedge Species | Barnyard Grass |
|---|---|---|---|
| Corn gluten | Garlic oil, Pepper Spray & Fiesta | Fiesta | Corn gluten |
| Sethoxydim | Sethoxydim | Sethoxydim | Sethoxydim |
| Fenoxaprop | Halosulfuron-methyl | Halosulfuron-methyl | Fenoxaprop |
| Fluazifop p-butyl | Fluazifop p-butyl | Fluazifop p-butyl | Fluazifop p-butyl |
| Prodiamine | Prodiamine | Prodiamine | Prodiamine |
| Bispyribac-sodium | Bispyribac-sodium | Bispyribac-sodium | Bispyribac-sodium |
| Bensulide‡ | Bensulide‡ | Bensulide‡ | Bensulide |

*The pesticides that will be used to treat the pests listed are in ascending order of potential risk (i.e., lower risk pesticides at the top of the columns will be used first). See *Emergency Protocols*

‡

ETS recommends that these pesticides be used primarily on the lined greens, and occasionally on the tees when the need is significant, and that there be no applications made to fairways or roughs. Note: chickweed and henbit are broadleaf weeds.

Source: ETS

## Table 10. Insect Pests and Insecticide Control*

| Cutworms | Annual bluegrass weevil | White grubs |
|---|---|---|
| ---- | ---- | Beneficial Nematode/Milky Spore |
| Deltamethrin | Deltamethrin | Deltamethrin |
| Bifenthrin | Bifenthrin | Bifenthrin |
| Spinosad | Spinosad | Spinosad |
| Imidacloprid | Imidacloprid | Imidacloprid |
| Lambda-cyhalothrin | Lambda-cyhalothrin | |
| Chlorpyrifos‡ | Chlorpyrifos‡ | |

*The pesticides that will be used to treat the pests listed are in ascending order (i.e., lower risk pesticides at the top of the columns will be used first). See *Emergency Protocols*

‡ The assessment recommends that these pesticides be used primarily on the lined greens, and occasionally on the tees when the need is significant, and that there be no applications made to fairways or roughs.

Source: ETS

## Table 11. Cultural Practices & Treatment Guide for Disease Control

| **Diseases** | **Host Turfgrass** | **Area of Occurrence (G, T, F, R)**† | **Examples of Cultural Practices** | **Chemical Treatments* (When severe turf loss is eminent- Selection based on lowest FEIQ value)** | **Preventative Organic Control (IPM Approach)** |
|---|---|---|---|---|---|
| Algae | All turfgrass | G, T, F, R | Reduce shade, avoid excessive watering, improve soil drainage, fertilize and irrigate to maintain vigor | Polyoxin, Mefenoxam, Metconazole, Fluazinam, Penthiopyrad, | Civitas<br>Mineral oil |
| Anthracnose | Annual Bluegrass | G, T | Maintain adequate nitrogen and a balanced fertility level, irrigate to prevent wilting, core aerate and overseed in the fall | Polyoxin, Mefenoxam, Metconazole, Fluazinam, Penthiopyrad, Azoxystrobin, Propiconazole, | Spotless TX<br>Psuedomonas aureofaciens<br>Endorse<br>Polyoxin D Zinc Salt<br>Companion<br>Bacillus subtilis<br>Ecoguard<br>Bacillus licheniformis |
| Brown Patch | Annual bluegrass, creeping bentgrass, tall fescue, fine leaf fescue | G, T, F, R | Reduce nitrogen, increase air circulation | Polyoxin, Mefenoxam, Metconazole, Trifloxystrobin, Fluazinam, Penthiopyrad, Azoxystrobin, Flutolanil | Spotless TX<br>Psuedomonas aureofaciens<br>Endorse<br>Polyoxin D Zinc Salt<br>Companion<br>Bacillus subtilis<br>Ecoguard<br>Bacillus licheniformis |

| **Diseases** | **Host Turfgrass** | **Area of Occurrence (G, T, F, R)†** | **Examples of Cultural Practices** | **Chemical Treatments* (When severe turf loss is eminent- Selection based on lowest FEIQ value)** | **Preventative Organic Control (IPM Approach)** |
|---|---|---|---|---|---|
| Dollar Spot | Creeping bentgrass, annual bluegrass, bluegrasses, perennial ryegrass, fine fescue, colonial bentgrass, Kentucky bluegrass, | G, T, F, R | Maintain accurate levels of nitrogen and nutrients, remove dew & guttation | Polyoxin, Mefenoxam, Metconazole, Boscalid, Fluazinam, Penthiopyrad, Myclobutanil, Propiconazole, Triadimefon, | Spotless TX Psuedomonas aureofaciens Endorse Polyoxin D Zinc Salt Companion Bacillus subtilis Ecoguard Bacillus licheniformis |
| Erwin a spp<br>Foliar Anthracnose | Annual bluegrass, creeping bent grass Kentucky bluegrass, fine fescue, rye grass | G, T, F | Reduce watering, increase nitrogen | Trifloxystrobin, Pyraclostrobin, Azoxystrobin, Myclobutanil, Propiconazole, & Triadimefon | Endorse Polyoxin D Zinc Salt Companion Bacillus subtilis Ecoguard Bacillus licheniformis Spotless TX Psuedomonas aureofaciens |
| Fairy Ring | All turfgrass | G, T, F, R | Remove infested sod and soil, replace with clean soil and seed/sod. Improve water penetration with aerification and wetting agents. | Polyoxin, Mefenoxam, Metconazole, Fluazinam, Penthiopyrad, Azoxystrobin, Flutolanil | Endorse Polyoxin D Zinc Salt Companion Bacillus subtilis Ecoguard Bacillus licheniformis Spotless TX Psuedomonas aureofaciens |

| **Diseases** | **Host Turfgrass** | **Area of Occurrence (G, T, F, R)†** | **Examples of Cultural Practices** | **Chemical Treatments* (When severe turf loss is eminent- Selection based on lowest FEIQ value)** | **Preventative Organic Control (IPM Approach)** |
|---|---|---|---|---|---|
| Gray Leaf Spot | Perennial ryegrass | R | Reduce nitrogen. Daytime watering | Polyoxin, Mefenoxam, Metconazole, Trifloxystrobin, Fluazinam, Penthiopyrad, Pyraclostrobin, Azoxystrobin, Myclobutanil, Propiconazole, Triadimefon, | Endorse Polyoxin D Zinc Salt Companion Bacillus subtilis Ecoguard Bacillus licheniformis Spotless TX Psuedomonas aureofaciens |
| Leaf Spot | Kentucky bluegrass, perennial ryegrass, fine leaf fescue, creeping bentgrass | G, T, F, R | Remove clippings, raise mowing heights, provide adequate nutrients | Polyoxin, Mefenoxam, Metconazole, Fluazinam, Penthiopyrad, | Endorse Polyoxin D Zinc Salt Companion Bacillus subtilis Ecoguard Bacillus licheniformis Spotless TX Psuedomonas aureofaciens |
| Melting Out | Kentucky bluegrass | R | Remove clippings, raise mowing heights, provide adequate nutrients | Polyoxin, Mefenoxam, Metconazole, Fluazinam, Penthiopyrad, | Endorse Polyoxin D Zinc Salt Companion Bacillus subtilis Ecoguard Bacillus licheniformis Spotless TX Psuedomonas aureofaciens |

| **Diseases** | **Host Turfgrass** | **Area of Occurrence (G, T, F, R)†** | **Examples of Cultural Practices** | **Chemical Treatments* (When severe turf loss is eminent- Selection based on lowest FEIQ value)** | **Preventative Organic Control (IPM Approach)** |
|---|---|---|---|---|---|
| Pink Snow Mold | Annual bluegrass, creeping bentgrass, fine leaf fescue, perennial ryegrass, Kentucky bluegrass | G, T, F, R | Avoid late fall nitrogen applications, rake leaves and short cut, control drifting snow; may occur without snow cover. | Polyoxin, Mefenoxam, Metconazole, Trifloxystrobin, Fluazinam, Penthiopyrad, Pyraclostrobin, Azoxystrobin, Myclobutanil, Propiconazole, Triadimefon, Thiram | Endorse Polyoxin D Zinc Salt Companion Bacillus subtilis Ecoguard Bacillus licheniformis Spotless TX Psuedomonas aureofaciens |
| Necrotic Ring | Kentucky bluegrass, annual bluegrass | R | Provide adequate nitrogen and nutrients, provide light-daily irrigation | Polyoxin, Mefenoxam, Metconazole, Fluazinam, Penthiopyrad, Myclobutanil, Propiconazole, | Endorse Polyoxin D Zinc Salt Companion Bacillus subtilis Ecoguard Bacillus licheniformis Spotless TX Psuedomonas aureofaciens |
| Pink Patch | Fine leaf fescue, perennial ryegrass, colonial bentgrass, creeping bentgrass, annual bluegrass, tall fescue | G, T, F, R | Provide adequate levels of nitrogen and nutrients. | Polyoxin, Mefenoxam, Metconazole, Fluazinam, Penthiopyrad, Myclobutanil, Propiconazole, Triadimefon | Endorse Polyoxin D Zinc Salt Companion Bacillus subtilis Ecoguard Bacillus licheniformis Spotless TX Psuedomonas aureofaciens |

| **Diseases** | **Host Turfgrass** | **Area of Occurrence (G, T, F, R)†** | **Examples of Cultural Practices** | **Chemical Treatments* (When severe turf loss is eminent- Selection based on lowest FEIQ value)** | **Preventative Organic Control (IPM Approach)** |
|---|---|---|---|---|---|
| Powdery Mildew | Kentucky bluegrass, fine leaf fescues | F, R | Reduce shade, increase air circulation | Polyoxin, Mefenoxam, Metconazole, Trifloxystrobin, Fluazinam, Penthiopyrad, Pyraclostrobin, Azoxystrobin, Myclobutanil, Propiconazole, Triadimefon | Civitas<br>Mineral oil<br>Spotless TX<br>Psuedomonas aureofaciens |
| Pythium Blight | Annual bluegrass, fine leaf fescue, perennial ryegrass | F, R | Improve soil drainage, increase air circulation, maintain nutrients to improve vigor | Polyoxin, Mefenoxam, Metconazole, Fluazinam, Penthiopyrad, Propamocarb, Foestyl-Al | Phosphite<br>Spotless TX<br>Psuedomonas aureofaciens |
| Red leaf Spot | Creeping bentgrass | G | Maintain nutrient levels to improve vigor | Polyoxin, Mefenoxam, Metconazole, Fluazinam, Penthiopyrad, | Endorse<br>Polyoxin D Zinc Salt<br>Companion<br>Bacillus subtilis<br>Ecoguard<br>Bacillus licheniformis<br>Spotless TX<br>Psuedomonas aureofaciens |

| **Diseases** | **Host Turfgrass** | **Area of Occurrence (G, T, F, R)†** | **Examples of Cultural Practices** | **Chemical Treatments* (When severe turf loss is eminent- Selection based on lowest FEIQ value)** | **Preventative Organic Control (IPM Approach)** |
|---|---|---|---|---|---|
| Red Thread | Fine leaf fescue, perennial ryegrass, Kentucky bluegrass, creeping bentgrass, annual bluegrass | G, T, F, R | Remove clippings, Maintain nutrient levels to improve vigor. | Polyoxin, Mefenoxam, Metconazole, Fluazinam, Penthiopyrad, Myclobutanil, Propiconazole, Triadimefon, | Endorse<br>Polyoxin D Zinc Salt<br>Companion<br>Bacillus subtilis<br>Ecoguard<br>Bacillus licheniformis<br>Spotless TX<br>Psuedomonas aureofaciens |
| Rust | Kentucky bluegrass, perennial ryegrass | F, R | Provide adequate nutrient levels. Mow frequently | Polyoxin, Mefenoxam, Metconazole, Trifloxystrobin, Fluazinam, Penthiopyrad, Pyraclostrobin, Azoxystrobin, Myclobutanil, Propiconazole, Triadimefon, | Civitas<br>Mineral oil |
| Slime Molds | All turfgrass | G, T, F, R | Remove mechanically by mowing or raking | No pesticides used | Civitas<br>Mineral oil<br>Spotless TX<br>Psuedomonas aureofaciens |
| Stripe Smut | Kentucky bluegrass, creeping bentgrass | G, R | Reduce nitrogen, irrigate to prevent dormancy | Polyoxin, Mefenoxam, Metconazole, Fluazinam, Penthiopyrad, Myclobutanil, Propiconazole, Triadimefon | Civitas<br>Mineral oil<br>Spotless TX<br>Psuedomonas aureofaciens |

| **Diseases** | **Host Turfgrass** | **Area of Occurrence (G, T, F, R)†** | **Examples of Cultural Practices** | **Chemical Treatments* (When severe turf loss is eminent- Selection based on lowest FEIQ value)** | **Preventative Organic Control (IPM Approach)** |
|---|---|---|---|---|---|
| Summer Patch | Kentucky bluegrass, annual bluegrass | R | Apply light, frequent watering during dry periods to reduce heat stress, do not water heavily or deeply, provide adequate nutrient levels | Polyoxin, Mefenoxam, Metconazole, Fluazinam, Penthiopyrad, Pyraclostrobin, Azoxystrobin, Myclobutanil, Propiconazole, Triadimefon | Endorse Polyoxin D Zinc Salt Companion Bacillus subtilis Ecoguard Bacillus licheniformis Spotless TX Psuedomonas aureofaciens |
| Take All patch | Creeping bentgrass, colonial bentgrass | G, T, F | Avoid drought stress | Polyoxin, Mefenoxam, Metconazole, Fluazinam, Penthiopyrad, Myclobutanil, Propiconazole | Endorse Polyoxin D Zinc Salt Companion Bacillus subtilis Ecoguard Bacillus licheniformis Spotless TX Psuedomonas aureofaciens |
| Typhula Blight | Creeping bentgrass, annual bluegrass, fine leaf fescue, perennial ryegrass | G, T, F, R | Avoid early fall nitrogen applications, rake leaves, mow short, control snow drifting | Polyoxin, Mefenoxam, Metconazole, Trifloxystrobin, Fluazinam, Penthiopyrad, Pyraclostrobin, Propiconazole, | Endorse Polyoxin D Zinc Salt Companion Bacillus subtilis Ecoguard Bacillus licheniformis Spotless TX Psuedomonas aureofaciens |

| **Diseases** | **Host Turfgrass** | **Area of Occurrence (G, T, F, R)**[†] | **Examples of Cultural Practices** | **Chemical Treatments* (When severe turf loss is eminent- Selection based on lowest FEIQ value)** | **Preventative Organic Control (IPM Approach)** |
|---|---|---|---|---|---|
| Xanthomonas spp<br><br>Bacterial wilt | Creeping bentgrass, annual bluegrass, Kentucky bluegrass, perennial ryegrass | G,T,F, R | Raise Mowing heights, re-establish with resistant species- major host is Toronto creeping bentgrass | Oxytetracycline | Oxytetracycline |
| Yellow Tuft | Annual bluegrass, Kentucky bluegrass, creeping bentgrass | G, R | Avoid standing water | Polyoxin, Mefenoxam**,** Metconazole, Fluazinam, Penthiopyrad | Endorse<br>Polyoxin D Zinc Salt<br>Companion<br>Bacillus subtilis<br>Ecoguard<br>Bacillus licheniformis<br>Spotless TX<br>Psuedomonas aureofaciens |

[§] adapted from Vargas 2005

[†] G, T, F, R = greens, tees, fairways, roughs

* Chemical treatments will be used as a last resort. When used to treat a disease(s), the lower risk pesticides will be used first as listed (See Table 13 Flutolanil should only be applied to lined greens, or occasionally to tees, as needed.

## Table 11-A Recommendations for Restricting Pesticide Use Based on a Higher Level Toxicologic Analysis

| Pesticides Flagged for Oncogenic Characteristics | Comments on Toxicology | Detected in Sebonack's or The Bridge's Ground Water? [PRZMGW results mean conc. ppb in brackets] | Field EIQ > 25? Yes or No | Field EIQ >50? Yes or No | Recommendation |
|---|---|---|---|---|---|
| Triadimefon + metabolite triadimenol | The most sensitive No Observed Adverse Effects Level (NOAEL) in the mouse carcinogenicity study was 13.5 mg/kg-day, and the NOAEL in the subchronic neurotoxicity study in rats was 3.4 mg/kg-day (Griffin et al., 2006). Therefore basing the drinking water HAL on the latter effect is more protective of the cancer effect. (Group C) | Triadimefon [3.2E-6] not detected, but the triadimenol metabolite [7.9E-3] was detected. | Yes (62) | Yes | Use on turf at the project should not be prohibited, but use on home lawns should be minimized. See *Emergency Protocols* |
| Propiconazole | "Propiconazole is not genotoxic and this fact, together with special mechanistic studies, indicate that propiconazole is a threshold carcinogen . . . At doses below the RfD, liver toxicity is not expected; therefore tumors are also not expected" (US EPA 2014). Therefore basing the drinking water HAL on the 0.1 mg/kg-d RfD will be protective for the cancer effect. (Group C) | Propiconazole detected [1.99E-6] | Yes (34.8) | No | Use on tees and greens should not be prohibited. Not recommended for the lawn care program. The FEIQ score is "low". See *Emergency Protocols* |
| Iprodione | "Likely" human carcinogen (Taylor, 2012). Linear low dose extrapolation yields a *de minimus* HAL of 0.8 ppb, vs. an HAL of 350 ppb (US EPA, 2013) based on a hormonal effect (Taylor, 2012). | Iprodione detected [3.72E-3] | Yes (66.0) | Yes | Based on Dr. Petrovic's comments, **prohibit use**. |

| Pesticides Flagged for Oncogenic Characteristics | Comments on Toxicology | Detected in Sebonack's or The Bridge's Ground Water? [PRZMGW results mean conc. ppb in brackets] | Field EIQ > 25? Yes or No | Field EIQ >50? Yes or No | Recommendation |
|---|---|---|---|---|---|
| Prodiamine | "The EPA Peer Review Committee classified prodiamine as a Group C carcinogen based on a weight of evidence consideration. They concluded that a Reference Dose (RfD) approach was indicated as being appropriate for quantification of human risk. Their recommendation was based on the absence of genotoxicity, the nature of the response (benign thyroid follicular cell tumors) and the lack of a clear neoplastic response at sites other than the thyroid" (Lindsay, 1992). Therefore an HAL based on the chronic reference dose is more protective of the cancer effect. | Not detected [0.0] | No (11.5) | No | Use on turf at the project should not be prohibited. The FEIQ score is "very low", and cancer is not a risk to people exposed to levels much higher than might occur in the environment. See *Emergency Protocols* |
| Chlorothalonil | "EPA has determined that the mechanism of carcinogenicity is non-linear (i.e., not a non-threshold effect) and that the point of departure used in calculating the cPAD is protective of the cancer effects" (Federal Register, 2008). This conclusion appears to form the basis for the fact that the US EPA has issued tolerances for chlorothalonil use (residues) on more than 40 crops (40 CFR §180.275). Also, the FEIQ score is very high, mostly due to chlorothalonil's toxicity to aquatic organisms (Tables 10 and 13 of our report), but no aquatic organisms will be exposed. | Chlorothalonil detected [0.0] | Yes (308.7) | Yes | **B**ased on Dr. Petrovic's concerns **prohibit use.** |
| Etridiazole | It is a category B2 carcinogen ("probable"), with linear low dose extrapolation (US EPA 2000). Its carcinogenic potency factor is also relatively high, yielding a low HAL. "Moderate" FEIQ. | No [1.81E-12] | Yes (95.3) | Yes | Based on Dr. Petrovic's concerns, **prohibit use**. |

| Pesticides Flagged for Oncogenic Characteristics | Comments on Toxicology | Detected in Sebonack's or The Bridge's Ground Water? [PRZMGW results mean conc. ppb in brackets] | Field EIQ > 25? Yes or No | Field EIQ >50? Yes or No | Recommendation |
|---|---|---|---|---|---|
| | "Low" FEIQ. Group C ("possible" carcinogen), but the cRfD protects for cancer, which followed a nonlinear response (US EPA, 1997) | Pendimethalin† not modeled w/PRZM GW | Yes (265.5) | Yes | No lawn use. See *Emergency Protocols* |
| | Not a carcinogen (Group E), and "low" FEIQ score, but detections very long after use, albeit at low levels, warrant caution. | Myclobutanil [1.76E-6] | Yes (31.7) | No | Recommend use on tees and greens only. See *Emergency Protocols* |
| | Flutolanil is in carcinogenicity category Group E, "no evidence of carcinogenic potential," and its HAL is very high (low toxicity), but its FEIQ score is very high. | Flutolanil* [1.39E-4] | Yes (399.6) | Yes | Allow use on golf course, prohibit use in lawn care. See *Emergency Protocols* |
| | "Low" FEIQ score (close to "very low"). | Paclobutrazol [4.58E-2] | Yes (26.4) | No | Allow use on all turf. See *Emergency Protocols* |
| | "Low" FEIQ score. High HAL (low toxicity). | Ethofumesate* [9.9E-6] | Yes (38.7) | No | Allow use on all turf. See *Emergency Protocols* |
| | "Very low" FEIQ score. Not carcinogenic (Group E). | Imidacloprid [2.285E-3] | No (11) | No | Allow use on all turf, but do not apply within two weeks of blossoming of adjacent flowers. See *Emergency Protocols* |
| | "Very low" FEIQ score, but high PRZSM-GW result. | Quinclorac* [53.5] | No (16) | No | *Not for use in Suffolk County* |

*It was not used on the golf courses; it may have originated from purchased sod after application by a sod farm.

† listed for lawn care not golf course use

## Irrigation

Irrigation water supply for the golf course will be from an onsite wells. The well design will be adequate to provide irrigation water for the course and common areas. The estimated maximum output for the golf course irrigation system can be achieved with a variable frequency drive (VFD) electric pump and control system. A water storage pond is designed to include an impermeable liner to store irrigation water pumped from the well, provide capacity for stormwater detention. Stormwater generated runoff will be captured by a collection system and directed to the manmade pond; mixed with the irrigation water and recycled on to the golf course. The pond edge will be planted with freshwater wetland plants. The wetland plantings will

absorb nutrients into the plant leaf tissue as a method to reduce nutrient concentration and provide wetland habitat.

A manifold system on the pump station will allow the operator to pump water directly from the irrigation well to the golf course. During periods of low rainfall and low water elevation in the storage pond, the by-pass manifold will reduce energy required to initially pump groundwater into the pond and then pump water from the pond to the course. During periods of low precipitation, the pond will receive water from the well to maintain its minimum design water elevation.

The irrigation system will be designed toward water conservation and energy efficiency. Current golf course irrigation systems use moisture meters (both mobile hand held and permanent meters installed throughout the course) to measure soil moisture in shallow and deeper soil levels (2-3-inches to 6-9-inches). The permanent meters send a signal through a wireless router to a computer which activates the irrigation controls, when hand held meters are not in use. Handheld meters provide site specific, reliable information aided by the professional's on site visual inspection of the conditions. The newest controls activate only those irrigation heads in the areas that are drying down faster; then end irrigation once an adequate moister level in the soil has been detected by the meter's sensors.

The irrigation system design will include auto-cad style mapping, whereby the superintendent can visually inspect the operations on a computer screen and manually control the irrigation as may be required (based on the hand held moisture meter monitoring). Today's systems simply require the operator to use a cell phone or i-pad to turn on or off the system, adjust an individual or a series of heads or syringe the green(s) in accordance with his direction (for example after applying topdressing).

The golf industry is worldwide and has recognized its obligation to conserve water resources. The golf course irrigation industry leaders (Toro Company and RainBird) have developed sophisticated golf course irrigation systems in response to controlling limited available water. Each company provides additional consultation during design, which will be utilized as the golf course becomes more refined in its development. Manufactures of turf irrigation systems have designed components to manage the irrigation needs which maximize the "water window" (the allowable time to water a golf course due to dry down and player activity; about 6 hours). New irrigation controls permit the golf course to receive water quickly and reduce the overall time for irrigation, while maximizing the pumping capacity of the system. The estimated use of applied water (water actually pumped form the irrigation well) for an 18-hole golf course is between 18-24 MG per year. Using typical standards for evaporation/transpiration (E/T) rates on Long island, it is estimated approximately 50% of the applied water is recharged (with the balance lost through evaporation and plant uptake). Turf areas that comprise the bunker surrounds will be irrigated by subsurface "drip" irrigation to minimize water entering the sand bunker

## Nutrients

During the past two decades the Town of Southampton has approved three major 18-hole golf courses; Atlantic Golf Club, Bridgehampton; Golf at the Bridge (The Bridge) Bridgehampton and Sebonack Golf Club, Southampton. The Town planning and approval processes required those project sponsors to prepare environmental impact statements (EIS) that resulted in mitigation methods to minimize and or avoid potential for significant adverse impacts.

During the past several decades the golf turf industry has come under intensifying scrutiny for its role of impacts to natural resources. The increased golf course development projects worldwide which occurred from 1990-2005 generated questions regarding land use, habitat loss, surface and groundwater quality and quantity impacts, economic and social issues, traffic concerns, pesticide fate and other ecological impacts. In some areas of the United States, such as high population areas in Suffolk County, New York that have strong advocacy groups formed for environmental protection, these questions continue to linger and have recently refocused on fertility and turf management programs at existing and proposed golf courses. The Suffolk County Legislature adopted a change to the Suffolk County Code known as the Fertilizer Law, Chapter 459 (Appendix 16). The law places restrictions on the use, dates, amounts and types of fertilizer mixes applied within Suffolk County.

For the protection of human health and welfare and protection to natural resources it is critical that turf managers employ practices to avoid or minimize environmental impacts to soils, groundwater, surface waters and wetlands. This section of the analysis includes literature search and review, explores and summarizes the validity of predictable and potential environmental impacts from nitrogen leaching to groundwater, and pollution from runoff generated by golf courses; provides information toward improved understanding and approaches to turfgrass nutritional programs.

There is a need to identify what role a golf course plays in nitrogen loading to groundwater. Researchers from SUNY (SOMAS), Stony Brook, NY, introduced research on nitrogen impacts to the maritime ecology. The research generated in comments to the New York State and Federal mandates regarding the acceptable allowable recharged nitrogen concentrations in groundwater water (10 mg/L) and whether the nitrogen MCL is sufficient to protect the marine environment. The university research suggests that N loading to groundwater at or above 10 mg/L (as leachate) is the major source of N inflow to the local Long Island bays. The cause and effect reflected in the research is based on the hydrology of Long Island's unconfined aquifer, which permits precipitation to first recharge vertically (conveying surface contaminants along with it) downward and after entering groundwater, flow in a down gradient-horizontal direction to the bays. In general terms, Long Island's freshwater surface waters, freshwater groundwater and maritime bay waters behave as single water resource and basically share an "inter-connected hydrology."

In January 2014, the Office of the Suffolk County Executive, released the *Executive Summary Update, January 2014 Suffolk County Comprehensive Water Resources Management Plan.* The plan states, "Nitrogen is public water enemy #1, as nitrate contaminant from unsewered and fertilizer use pose a threat to both drinking water supplies and coastal marine habitat and resources."

The 1992 *Long Island Comprehensive Special Groundwater Protection Area Plan* (Koppelman, Kunz, Tanenbaum & Davies) included a section to address golf course as a land use within the groundwater protection areas as *Appendix G: Golf Course Management and Nitrates in Groundwate*r, as originally authored by Petrovic. In the assessment, compared with other land uses evaluated in New York State, "the portion of golf courses having the highest potential for nitrate leaching represents an insignificant threat to the environment as a whole." (Appendix 10).

The analysis of impact potential of nitrogen leaching and runoff affirms previous university research projects that have addressed nitrogen leaching and runoff generated by fertilizer applications on turfgrass. Many of these historical research projects were conducted with input from the USGA. During the late 1990s golf course superintendents from Long Island's Suffolk County volunteered their resources to the USEPA, SCDHS, NYSDEC and local environmental groups to develop a nutritional program applicable to Long Island golf courses located within the Peconic Estuary watershed. The program, called the "East End Nitrogen Reduction Program for Golf Courses" has specifically targeted a reduction of nitrogen limited to 2.0 mg/L, is still active and administered by Cornell Cooperative Extension.

In February 2014, the New York State Best Management Practices for Golf Course was released by Cornell, Ithaca, NY (Appendix 1). The proposed Hills project has incorporated the BMP into the golf course design and turf management program. With authorization from the authors of the NYSBMP, the criteria is utilized throughout this assessment with the expectation that the course would be designed, constructed and operated within the framework of the BMP.

One objective of this impact assessment is to provide a clearer understanding of how significant golf course generated nitrogen loads and current turf management contribute to large scale environmental degradation of ground and surface waters. A second objective is to provide improved management strategies for nutritional requirements and control of disease and pest populations in order to minimize adverse environmental impacts. A third objective is to clarify methods used to evaluate environmental impacts and/or adverse conditions generated by golf course turf management. The goal is to offer an objective understanding of best management practices recognized as modern management guidelines, used by golf course turf managers and provide information about these practices.

The assessment also identifies the nutritional requirements of golf course turf, water management, fertilizer selection and timing of applications, plant tissue sample and analyses, clipping measurements, soil samples and soil chemistries. Key areas currently under study by the turf industry are: how to clarify the definition of "Healthy Turf," and how one measures optimal turf.

Unlike crop sciences, that use crop yield (for example: the number of bushels of a corn generated per acre) to measure results of nutritional needs or other plant management practices; turf science has no clear or universal "yard stick" to use as a single standard. Typically researchers use turf color, density, plant physiological assessment; or perhaps root mass, or green speed, or player satisfaction, perhaps disease and stress tolerance or simply whether the turf is

dead or alive and any combination of these qualitative and quantitative means. The turf industry is working to determine what turf quality and health metrics it will universally accept and apply and how these are specifically measured. It is perhaps difficult to demonstrate to the general public, golfers, environmental groups, and legislators what professional turf managers and turfgrass researchers utilize to measure "successful turf" and what is needed in the form of inputs to meet that goal.

Currently turf managers and turf scientists are defining quality turf as "Healthy Turf." The following definition was developed by the "Plant Health Academy" a cooperative effort among the Environmental Institute for Golf, university researchers (UNC, Clemson, Virginia Tech,) Bayer Crop Sciences, and a highly qualified group of nationally selected superintendents;

Healthy Turf is: "Optimal plant performance where environmental conditions are balanced with management inputs."

Hence if the plant or turf is performing at its optimal level within dynamic environmental conditions, it is in balance; and if it is not, then managing inputs to influence and counter-balance the environmental conditions is necessary to retain optimal plant performance.

## Groundwater Description

Long Island, New York is located along the east coast of the United States. The Island extends approximately 120 miles from New York City to Montauk Point and is generally bounded by the Atlantic Ocean and estuaries along its south coastline and the Long Island Sound and various bays along its north coastline. Long Island has several nationally protected estuaries including the Jamaica Bay Estuary, South Shore Estuary, Long Island Sound and Peconic Estuary. The Island's geology formed 21,000 years ago during the ice age as the result of glacier movements that created the Harbor Hill Moraine along the north shore and the Ronkonkoma Moraine which borders along the south shore. The Island has four (4) counties, (Kings, Queens, Nassau and Suffolk) and is completely surrounded by salt water. The area's population of is completely dependent on groundwater for freshwater needs. The source of the freshwater is a groundwater aquifer that is a wedge shape of unconsolidated sands, gravels, silts and clay overlain by glacial deposits of equal geological characteristics. There are three primary aquifers that make up the Island's hydrogeology, the Upper Glacial aquifer at the top of the wedge; the Magothy aquifer in the middle; and the Lloyd aquifer located below the Magothy and above the underlying bedrock. The Magothy is the primary source of drinking water for Long Island, with the Upper Glacial aquifer having been compromised by industrial and agricultural pollutants and the Lloyd aquifer generally unused for water supply due to its vertical depth and regulations to protect withdrawal.

There are two confining units: the Pleistocene Gardiners Clay which restricts flow between the Upper Glacial and the Magothy; and the Raritan confining unit which restricts flow between the Lloyd and Magothy aquifers. Precipitation enters the groundwater system via the highly porous sandy soils and gravels at Long Island's surface. Groundwater has two hydraulic gradients that cause water to flow in both the vertical and horizontal directions. This

characteristic is important for understanding how recharge can convey surface pollutants from the Upper Glacial aquifer vertically into the deeper Magothy aquifer (drinking water source). The horizontal movement of groundwater is driven by the higher elevation of groundwater (creating greater head) moving generally and dominated by southerly and northerly directions toward the Atlantic Ocean and Long Island Sound. The horizontal flow is driven by groundwater mounding; where one can think of a "hill of water" flowing outwardly from the center of the peak in all directions towards the base. The recharged water is split into different directions as it flows away from the peak; where the groundwater flows in opposite horizontal directions is known as the groundwater divide. The vertical flow is relatively fast near the surface of the aquifer, approximately 300 feet per year. Age of the water is calculated by its travel time through the Magothy aquifer; with water nearer the surface estimated to be about 10 years old, near the center 100 years old and at the base of the Magothy aquifer the water is about 500 years old (USGS). This indicates that much of the drinking water on Long Island is drawn from a source with high water quality because this "older water" was from precipitation that fell on the Island long before it was developed.

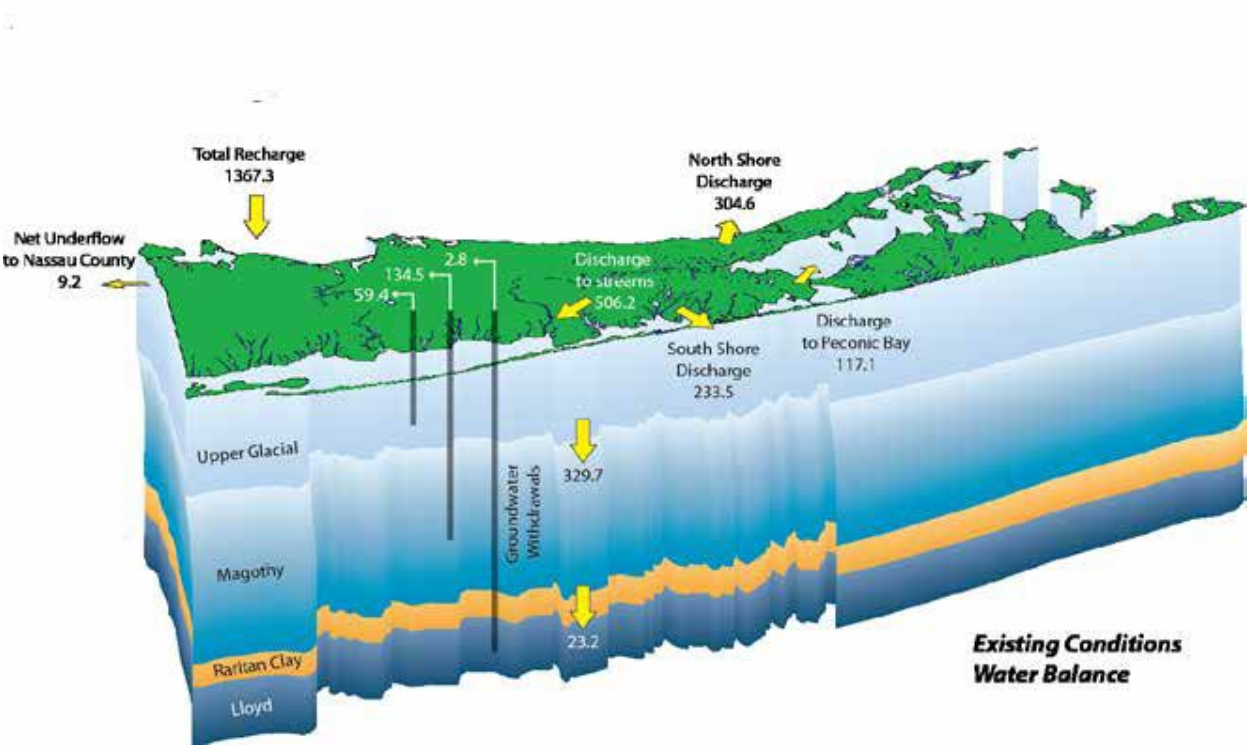



**Figure 4.**

***Suffolk County's Aquifer System & Water Balance***

*(Source: Executive Summary Update, January 2014 Suffolk County Comprehensive Water Resources Management Plan)*

Long Island receives an average of 44-inches of precipitation per year and approximately 50% of this returned to the atmosphere as evapotranspiration (USDA). The water balance from Long Island's averaged precipitation is equivalent to 1600 MGD, ("Proceedings of the Conference on Water Quality on Long Island" Jan. 26, 1993) with the following accounting summary:

780 MGD lost via evapotranspiration
820 MGD enters hydrologic cycle: 480 MGD enters the groundwater and 340 MGD is stream runoff.
The 480 MGD volume is eventually returned to the ocean.

The aquifer system can be thought of as a bubble of freshwater floating on or surrounded by saltwater. The freshwater has a lower density than the salt water so it is "floating" on the saltwater that surrounds the Island. The groundwater quality is generally pure with total dissolved solids at 50 ppm and pH ranging from 4.4 to 6.1.

Within the site, the depth to groundwater varies from several feet below ground surface to approximately 100 feet at the higher elevations of the property. The groundwater general horizontal flow direction is southerly and southeasterly.

## General Nitrogen Source Contaminant Factors

One major contaminant source is sanitary wastewater generated by the more than 7.68 million people that reside on Long Island. The western counties of Kings (Brooklyn), Queens and Nassau have municipal sewerage facilities that collect and treat residential and commercial wastewater. Suffolk County has about 1.5 million residents (US Census Bureau 2012 data) many of whom use septic systems (cesspools) which rely on a septic tank for solids collection with wastewater discharged to leaching pools designed to filter (with sand and biological activity) the wastewater as it recharges through the soils to the groundwater. Sanitary discharges are considered a prime source for nitrogen concentrations in groundwater from the 350,000 cesspools within Suffolk County.

Suffolk County is also New York State's largest generator of agricultural revenues producing more than $ 242.9 million (NYS Comptroller). The county has approximately 34,000 acres in farmland and is the top producing county in New York for sales in nursery, greenhouse, floriculture and sod products; the third largest state producer of grapes, peaches and strawberries and the largest producer for tomatoes, cauliflower and pumpkins. There is concern that agricultural land use practices are contributing to Long Island's groundwater pollution including elevated concentration of nitrogen from fertilizers. The County reported that 32,432.19 tons of fertilizer sold in Suffolk with 20.1 percent sold for agricultural use and 79.9 percent sold as residential. The County did not specifically identify exactly how golf course fertilizer sales were categorized. Site specific concerns include the surface runoff from farmland along Lewis Road, which collects along the roadway and is discharged to the two Town of Southampton recharge basins. This runoff has potential to convey agricultural generated pollutants to groundwater.

## Golf Course and Turfgrass Nitrogen Source Contaminant Factors

A SRI International survey of New York State's golf industry reported 818 golf courses that generated a total economic benefit of $5.3 billion and supported 56,600 employees with incomes of $1.6 billion. Suffolk County reports 73 golf courses; 35 private clubs and 38 public/municipal courses (Portmess & Petrovic 2011). Suffolk County is home to some of America's finest and oldest golf courses and has hosted premium golf tournaments including men's and women's national championships. Long Island's dominance of well-draining sandy soils provides desirable conditions for golf course construction and provides a pathway for leachable contaminants to enter groundwater via precipitation recharge.

The native sands and gravels are used for sand-soil-peat blends to build greens, tees and fairways that meet USGA recommendations. Many of Long Island's greens use native gravels for drainage layer construction with no intermediate layer needed. However the local sandy and gravely soils (Carver, Plymouth and Riverhead Series) are often rated as having low fertility and high permeability (USDA Soil Survey, Suffolk County, 1975) producing conditions for the potential to leach contaminants to groundwater.

## Table 12. The Essential Turfgrass Nutrients.[13]

| Nutrient | Symbol | Available form(s)* | Sufficiency range** |
|---|---|---|---|
| *Bold type indicates the form more commonly available to turfgrasses.<br><br>**Sufficiency ranges are expressed as percentages or parts per million (ppm) on a dry weight basis. Values were obtained from publications by J. B. Jones, 1980, *Turf Analysis,* Golf Course Management, 48:1, 29–32; H. Marschner, 1995, *Mineral Nutrition of Higher Plants,* Academic Press, New York; and E. Epstein, 1972, *Mineral Nutrition of Plants: Principles and Perspectives,* John Wiley, New York. Ranges in some cases are based on general observations and are not necessarily applicable to all turfgrasses or every growing condition or management situation. | | | |
| ***Macronutrients*** | | | |
| Carbon | C | $CO_2$ | 44% |
| Hydrogen | H | $H_20$ | 6% |
| Oxygen | O | $O_2$, $H_20$ | 44% |
| Nitrogen | N | $\mathbf{N0}_3^-$, $NH_4^+$ | 2.75-4.2% |
| Phosphorus | P | $H_2\mathbf{P0}_4^-$, $HPO_4^{2-}$ | 0.3-0.55% |
| Potassium | K | $K^+$ | 1.0-2.5% |
| Calcium | Ca | $Ca^{2+}$ | 0.5-1.25% |
| Magnesium | Mg | $Mg^{2+}$ | 0.2-0.6% |
| Sulfur | S | $SO_4^{2-}$ | 0.2-0.45% |
| ***Micronutrients*** | | | |
| Iron | Fe | $\mathbf{Fe}^{2+}$, $Fe^{3+}$ | 30-100 ppm |
| Manganese | Mn | $Mn^{2+}$ | 20-150 ppm |
| Zinc | Zn | $Zn^{2+}$, $ZnOH^+$ | 20-55 ppm |
| Boron | B | $B(OH)_3$ | 10-60 ppm |
| Copper | Cu | $Cu^+$, $\mathbf{Cu}^{2+}$ | 5-20 ppm |
| Molybdenum | Mo | $MoO_4$+ | 0.15-0.5 ppm |
| Chlorine | Cl | $Cl^-$ | not known |

[13] This publication is available from the Publications Distribution Center, The Pennsylvania State University, 112 Agricultural Administration Building, University Park, PA 16802. For information telephone 814- 865-6713.

Turfgrass and ornamental plants require nitrogen for physiological functions that produce proteins as enzymes, nucleic acids, amino acids, and chlorophyll. Table 4 provides general recommendations for total nutrient levels of turfgrasses.

For turf and ornamental plant cultivation, nutrients and soil amendments are commonly added to soil media to supplement nutrient and soil requirements needed for enhanced plant health. Managing soil pH is important for maximizing efficient uptake of organic and applied nitrogen. Root zone pH can be managed by understanding chemical forms of nitrogen to avoid toxic build-up of ammonium and control pH at the root zone (Mattson, Leatherwood & Peters). Turf roots take up available nitrogen commonly found as nitrate, ammonium and urea from the surrounding soil media; and the form of nitrogen applied will directly impact root zone pH level.

The ionic charges assigned to these nitrogen compounds are: $NH_4^+$Ammonium (positive ionic charge); $NO_3^-$ Nitrate (negative ionic charge); and $(NH_2)2CO$) Urea (neutral ionic charge). Depending on which form of N the plant root takes up, the plant root releases an oppositely charged molecule to maintain a pH balance between the root and the root zone soil media. As forms of positively charged cations of N in the form of ammonium are absorbed, the root releases positively charged hydrogen ions ($H^+$) which reduces the soil's pH. As N is taken up in the form of nitrate, which is negatively charged, hydroxyl molecules ($OH^-$) are released from the root tip to the root zone soil and pH increases. Different forms of N added to the soil can be converted by natural processes and produce another form of N. For example urea can be converted to ammonium and ammonium converted to nitrate by soil bacteria. Urea is converted to ammonium very quickly (<48 hours) and after two days the ammonium taken up by the root tip will result in releasing hydrogen molecules and decreasing root zone soil pH.

Mattson, Leatherwood and Peters demonstrated the effect of nitrogen form on growing medium pH by growing rose plants hydroponically in nutrient solutions containing different percentages of ammonium. After five days, the treatments of 8 percent and 16 percent ammonium solutions taken up by the roots initially dropped the pH one to two units, as bacteria converted the ammonium to nitrate. As nitrate became available in these treatments the pH increased over time as only nitrate was available. In the treatment using 31 percent ammonium solution, after the two to three unit drop in pH, the pH remained fairly constant for five days both forms of N as nitrate and ammonium were available. Forms of N as urea and ammonium are commonly grouped together as "ammoniacal nitrogen." Although soil pH can be adjusted with addition of limestone the experiment illustrates how the form of applied N impacts soil pH.

Nitrification occurs once ammonium is added to warm, moist soils and the bacteria in the soil convert ammonium to nitrate. In sandy soils, the most important nitrogen change in the environment is the nitrification process (Wolkowski, Kelling & Bundy).

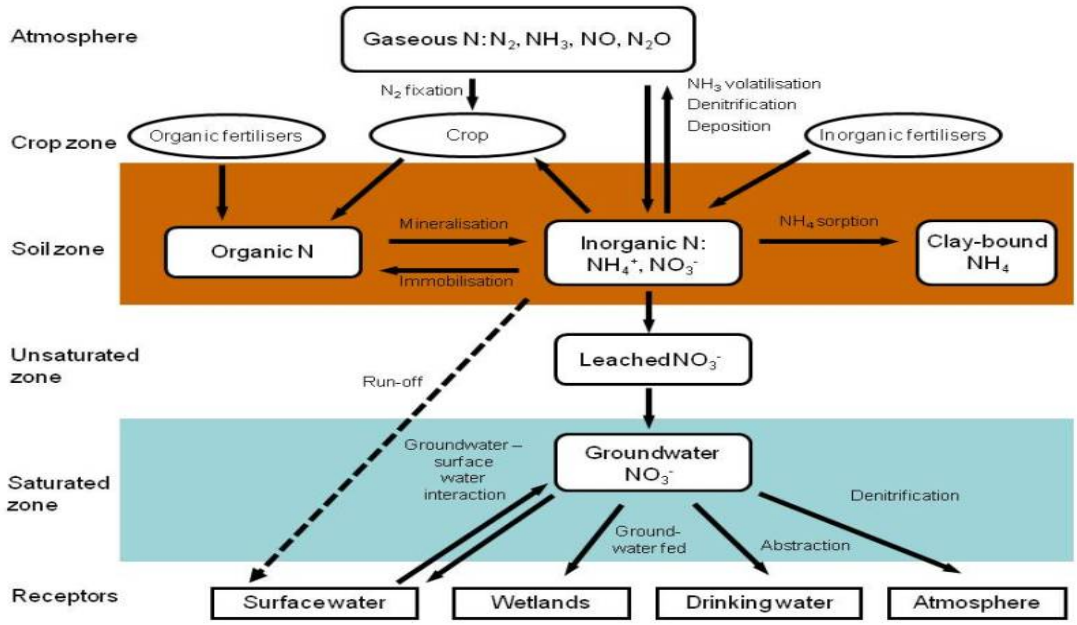



**Figure 5. The Nitrogen Cycle**

***(Source: google search)***

Nitrate ($NO_3^-$) leaches more readily in sandy soil than finer-textured soils because sandy soils have a lower water holding capacity and typically sandy soil characteristics are chemically inert (there are fewer chemical bonds formed between sandy soil particles and nitrogen ions as compared with soils that contain silts and clays). Nitrate can leach rapidly through channels formed in sandy soils by insects, burrowing animals, and deep roots. Organic matter in sandy soils is usually lower than fine-textured soil. The organic matter is a source of nitrogen. Golf course management controls thatch (organic matter) levels on greens, tees and fairways. These management processes include core aeration, deep verti-cutting and straight sand top dressing programs.

Golf course turf management has come under a high level of environmental scrutiny and is often categorized in the same context as agriculture and sod farm management. However there are significant differences in how crops are managed and how a playing surface for golf is managed, even within the same geographic region. Dr. Bruce Clark, a noted turf pathologist at Rutgers, the State University of New Jersey, reminds us that turf management science is still a relatively new and evolving science; with many historical evaluations based on agricultural crop sciences. Although there may be very broad similarities of nutrient programs among crop and turf land uses there needs to be more refined discussion on golf course turf management and environmental impacts aimed to separate and distinguish playing turfs from crops, including sod.

Modern golf course turf management and its potential impact to local environmental degradation can best be understood by education. To help educate municipal land planners, the

USGA published, "Reviewing Golf Course Proposals, Materials for Local Officials," prepared by Cook College, Rutgers. The publication offers information and additional resources for municipalities to use for golf course environmental impact assessments, practical options for site use, land use regulations, community impacts, preservation areas, mapping of ecological conditions, construction issues, water resources, IPM, maintenance facilities, and post construction monitoring. Today, the golf industry's direction is toward "sustainability."

At the GCSAA 2014 Industry Conference, Orlando Florida, sustainability was defined having three interrelated components; people, planet, and profits. Each of these components depends on the other two for sustainability to be successfully realized.

The significance of N loading to ground and surface waters from golf course managed turfgrasses may be misunderstood by the general public, regulatory/municipal administrators and even researchers that have been exposed to poorly prepared studies. Kenna and Snow provide an excellent summary of this problem. Golf courses became the subjects of environmental concerns during the late 1970's and early 1980's when droughts occurred in California. During those decades, golf courses became highly regulated with respect to water use. As new course construction boomed in the late 1980's through the 1990's course development projects came under attack due to potential impacts on natural habitats, pesticide use, and nitrogen loading. Unsubstantiated claims were made by anti-development groups about harmful impacts generated from golf courses simply to fight off real estate development projects.

By 1989, the USGA implemented an environmental impact assessment program to evaluate golf course development and management by conducting university studies focused on fertilizer and pesticide impacts on ground and surface water. Nitrogen leaching was investigated by seven universities primarily by using bucket lysimeters to evaluate the potential for downward movement by water of nitrogen through the turfgrass-soil system. The studies reported that very little nitrogen leaching occurred when nitrogen was properly applied, soil types were considered, and water management for supplemental irrigation and rainfall were properly planned for (Kenna & Snow). Sandy soils were more prone to leaching than loam soils; during year one of establishing turf and resulted in nitrogen leaching potential ranging from 11 percent of applied N for pure sand root zone mixes to one percent or less for root zones containing greater percentages of silt and clay. Simply by utilizing a USGA recommended root zone mix for greens construction, the N leaching potential was reduced to about three percent compared to a pure sand green construction where leaching potential was approximately 7.6 percent of an annual application rate of 12 pounds of N per 1000 sf. Pure sand greens resulted in N loading that exceeded the Federal MCL of 10 ppm; in no cases did the USGA recommended green construction with sand- peat root zone mix did the concentration of N leachate exceed 10 ppm. As newly established turf matured through years two and three, less nitrogen leached and light applications of slow release nitrogen sources applied frequently provided excellent control to avoid leaching potential.

Branham who conducted the research for the USGA reported that over a two and one half year period, in undisturbed loam-soil, N leaching was less than one percent through a depth of four feet. The nitrogen was recovered in grass clippings (38 percent to 35 percent), thatch 17

percent to 13 percent) and soil (25 percent to 13 percent); and Branham suggested the remaining was lost through de-nitrification and volatilization (40 percent to 18 percent).

The USGA examined the impact of nitrogen loading by experiments conducted in Pennsylvania on fairway plots. The plots were described as having slopes of 9 percent to 13 percent, good quality loam soil, and turfs comprised of either creeping bentgrass or perennial ryegrass maintained at ½-inch height, with annual applications rates of N of 4 lbs. per 1000 sf. Other studies were performed to evaluate N loading and runoff impacts in Georgia, and the effects of buffer strips in Oklahoma. The results of the studies showed that dense turf cover reduces the potential for runoff losses of nitrogen, with greater runoff losses expected on highly compacted soils; and on soils with very high moisture content. Buffer strips reduced nitrogen runoff when soil moisture was low or moderate, but were not effective when soil moisture was high. Nitrogen runoff potential was reduced significantly when a slow release product (sulfur coated urea) was used compared to a more water soluble product (urea). Several factors determine the leaching potential of a fertilizer applied to turf (Petrovic, A.). These include: the rate of application, the source of the N and how soluble or readily available it is, the season the application is made, irrigation/rainfall events and the soil types. Turfgrass management can control the rate of application, timing of application and selection of the source of nitrogen. Thus according to Petrovic, nitrate leaching potential can be maintained near zero, or at an acceptable level with proper turfgrass management.

The risk of runoff laden nitrogen and conveyance to surface waters was found to be much greater than nitrogen leaching to groundwater. The study conducted at Oklahoma State University designed a management program to reduce pesticide and nutrient runoff from Bermudagrass turf maintained under fairway conditions (Baird, J. Basta, R., et al.). The study compared buffer treatments of various sizes to evaluate effectiveness in reducing runoff under simulated rainfall events. All buffer treatments reduced chemical runoff compared to treatments applied to areas with no buffer. Vegetated buffer strips can be used to effectively control both runoff containing sediments and nitrogen; and can be as simple as grassed swales adjacent to fairways and greens that capture and slow the velocity of “first flush” rainfall generated runoff (Corbitt).

Environmental damage can occur when excessive losses of turf nutrients (nitrogen and phosphorous) are released into surface waters. Aquatic problems include increased algal growth, hypoxia and eutrophication. Algal blooms can be triggered by total nitrogen and phosphorous concentrations in the range of 1.0 ppm and 25 ppb (Baird). New York State and Suffolk County regulations have removed phosphorous in standard fertilizer mix applications unless the application is performed to establish new turf on bare soils and/ or soil sample analyses performed by a qualified laboratory determine phosphorous is needed. All fertilizer applications are banned between October 31 and April 1 (regardless of other factors such as soil temperatures, turf tissue analyses or soil chemical analyses) (Suffolk County Legislators, 2010).

Human health is also effected by high concentrations of nitrogen; the primary pathway for the toxin’s entry being ingestion. Toxicology, the study of poisons, teaches us, “all things are toxic, depending on the dose” (Casarett & Doul). The amount of nitrogen consumed is relevant to the mass weight of the subject; and infants are at particular risk because of their low body

mass. Feeding liquid diets to infants (usually less than 3-4 months old) with formulas mixed from water containing high concentrations of N subject the infant to risks of a condition whereby the oxygen carrying capacity in the blood is reduced by the presence of nitrates; known as methemoglobinemia ("blue baby" syndrome). To protect human health from consuming nitrogen contaminated water, the USEPA limits the MCL of N to 10 mg/L in drinking water. The lowest recorded concentration of nitrogen in water that posed reported health problems was 20 mg/L (Petrovic).

The CDC records show the first infant fatality reported in the U.S. was caused by well water contaminated with nitrogen in 1945. Over the next 25 years, 2000 cases of methmogloinemia were reported worldwide with a 10 percent mortality rate. Sporadic cases were reported during the 1980s, 1990s and 2000s. Petrovic reports virtually no cases in the U.S. in recent years; with a 1982 occurrence involving a well containing a concentration of 121 mg/L of nitrate and a six week old infant; who recovered once the child's formula mix no longer used the well's contaminated water.

## East End Nitrogen Reduction Program for Golf Courses

During the late 1990s, in direct response to concern for Long Island's water quality, the USGA, USEPA, SCDHS and local golf course superintendent developed the "East End Nitrogen Reduction Program for Golf Courses" which is administered by Cornell Cooperative Extension. The program includes reduction of potential nitrogen loading to groundwater from golf courses nutrient programs to a maximum of 2.0 mg/L.

The voluntary reduction in nitrogen load (2.0 mg/L) at golf courses within the Peconic Estuary watershed represents less than half the nitrogen loading from residential development (USEPA). Local golf courses continue to come under environmental scrutiny and superintendents respond by participating to voluntarily reduce turf chemical inputs. The local golf industry was recognized for their past efforts for participating in the Nitrogen Reduction Challenge as summarized by the following USEPA news release:

> **"**NEW YORK -- More than 88 percent of the golf courses on the east end of Long Island have accepted a challenge from the U.S. Environmental Protection Agency (EPA) and its government and private partners to protect the health of the Peconic Estuary and other local waters by reducing their use of fertilizers. This is the first time that a group of golf courses in one geographic area of the country have voluntarily agreed to better manage their fertilizer use to limit the amount of nitrogen that enters ground water, ultimately winding up in rivers, streams and the estuary. Thirty of the thirty-four East End public and private golf courses are participating in the program.
>
> 'This is the first time that a large segment of the golf industry in one area has voluntarily come together to reduce fertilizer use and the nitrogen it produces to protect the future of our estuaries,' said EPA Regional Administrator Jane M. Kenny. "The protection and restoration of coastal waters requires everyone to do his or her part, and the golf courses of eastern Long Island are certainly setting a laudable example.'

> Through the Challenge, the USGA and Cornell provide technical assistance to participating public and private golf courses, enabling each course to better manage its fertilizer use.[14]"

One of the primary concerns for turf managers is the response from golfers and course owners when nutrient programs and turf management practices are voluntarily changed in response to outside environmental pressures or controlled by legislative mandates. Another concern turf managers have is what the long term outcome is with respect to overall turf quality, diseases, and stress.

Typical university field studies are excellent indicators; however actual applications on the golf course can yield varying degrees of success and failures. One long range study performed on the golf course was conducted by Dr. Frank Rossi, Cornell University. Rossi conducted a long term field evaluation of turf management practices, turf quality and environmental impact by using reduced chemical applications at Bethpage State Park. The reduced chemical management of the putting surfaces was conducted over a five year period and included a golfer survey to evaluate satisfaction with ball speed roll and visual quality. Although the project involved various treatments to evaluate the effects of low input levels on turf and sustainability, the golfer survey indicated the putting surfaces provided acceptable visual quality and ball roll. This suggested that for the golfer, visual and playability may have a wide range of acceptance. Furthermore, healthier turf is expected when mowing heights are raised, fertilizer applications increased and mowing frequencies decreased from seven days per week to five (Rossi, F. & Grant, J.).

Snyder and Cisar evaluated nitrogen leaching by monitoring the vadose zone on warm season grasses grown on USGA constructed greens. Although the study did not expressly address cool season grasses, it remains relevant to understanding nitrogen leaching potential. The researchers found appreciable levels of nitrogen leached (20 ppm to 200 ppm) from greens constructed on sand soils during the early stage of grow-in, but decreased with increased turf density. Fairways evaluated in the study which cover larger areas of a course compared to greens, were found to leach less nitrogen and showed no increase of nitrate in groundwater during the seven month study. In part the study identified turf density was essential to reductions in nitrogen leaching potential.

Cation exchange capacity (CEC) is influenced by the soil texture, type of clay present, and percentage of organic matter and to some extent the soil pH. With predominately high sand content in constructed greens there is increased potential for low CEC, a concern for turf managers. Increasing CEC (with topdressing containing peat; leaving clippings and managing thatch) will increase soil moisture holding potential and can reduce nitrogen leaching potential (Frank & Horgan). Dr. Kevin Frank (Michigan State University) and Dr. Brian Horgan (University of Minnesota)[15] reported mature turf should be fertilized at reduced rates to minimize leaching potential. During a ten year on-going study at MSU after approximately four years after grow-in, high rates of N applications (5 pounds N per 1000 SF) produced high nitrate-

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14 USEPA website news announcement.

[15] "Cool-Season Turfgrass Nutrition, Fertilizers and Programing" 2014 GCSAA Conference, Orlando, FL.

nitrogen leachate levels at concentration of 20 ppm to 40 ppm; while low rates of nitrogen applications (2 pounds of N per 1000 SF) resulted in leachates with concentration at or below 5 ppm. Fertilization programs need to be adjusted based on specific golf course turf and environmental conditions, season of application, regulatory requirements, water needs, disease pressure and general plant health.

One important aspect of nitrogen leachate prediction is accounting for dissolved organic nitrogen (DON); which is a source of total nitrogen loading that is often misunderstood as a significant source in older turf stands. A planned fertilization program that minimizes potential for excessive nitrogen applications is discussed in the following section.

## Turf Management to Avoid or Minimize Potential N-Loading

In a 2011 summary report, Petrovic offered turf management practices to minimize or avoid potential water quality damage from nitrate leaching and run off. The recommendations follow monitoring programs at golf courses in Suffolk County and literature reviews that summarized and debunked previous assumptions regarding turf fertilization and nitrogen fate. Petrovic has clarified the golf course turf and nitrogen-water quality issue. He found that on average about 25 percent to 35 percent of fertilizer nitrogen applied is expected to be lost to the atmosphere by de-nitrification and volatilization, especially when urea is used. Fertilizer nitrogen stored in thatch and soils was approximately 36 percent to 47 percent of the amounts applied. The high sand content of areas on the golf course is generally limited to greens which are normally 2 to 4 acres of turf within the 60 to 100 acres of turf on an 18-hole golf course. Comparatively, with nearly 1000 golf courses in New York State, there would be nearly 2000 acres of greens, out of a total of 30 million acres in the state; or 0.00007 percent of the land area.

Cropland in New York accounted for 20 percent and residential lawns 2.3 percent of land area. Petrovic illustrated that suggesting golf courses hold the highest potential for nitrate leaching to groundwater was grossly misunderstood and that research showed the threat to the environment as a whole was insignificant. When research did show nitrate leaching potential from turfgrass, the use of best management practices could be employed as mitigation measures. Leaching potential increased in circumstances where excessive nitrogen rates were used; more frequently when highly water soluble formulations of urea, ammonium nitrate, ammonium sulfate, and potassium nitrate are used; when fertilizer applications were made during turfgrass dormant periods; and where excessive irrigation increased potential for leaching nitrate through the soil. Petrovic explains the worst case scenario is substantial amounts of water passing through the soil when formulations of soluble nitrogen are in the soil.

Turf managers consider additional approaches to refine their specific turf nutritional needs that yield high turf quality with minimal environmental risk. Solely relying on turf color, or “traditional” fertilization dates offer less reliable diagnostic and science based assessments of nutritional needs. When asked what the most common mistake turf managers make in fertilization programs, Horgan and Frank replied immediately with, “Overwatering.”

The dynamics of nitrogen uptake by turfgrass is driven by water and mass flow; nitrogen laden water is absorbed by the root hairs and trans-located by the vascular system. Nitrogen applied by foliar methods is absorbed by the plant at the stomata with residual amounts that enter the soil available for root absorption. After fertilizer applications excessive irrigation rates and natural rainfall events significantly increase risks of nitrogen leaching and runoff potential. Soil type, temperature and root density are important to factors governing nitrogen leaching rates (Frank & Horgan). Selection of fertilizer physical characteristics, release mechanisms, and carrier types should be considered to minimize leaching and runoff potential. Physical aspects include prill size and blends, carrier types are quick release, slow release or a combination of each and release mechanisms include: microbial, osmosis, hydrolysis and physical breakdown.

Turf managers are challenged with providing optimum turf conditions at the lowest cost. Decision for selecting a quick release versus a slow release fertilizer is sometimes cost driven with different leaching and runoff potential outcomes, and benefits as summarized in Table 13.

## Table 13. Comparison of Nitrogen Carriers (Frank & Horgan)

| Factor | Quick Release | Slow Release |
|---|---|---|
| Cost | Less Expensive/Lb. N | More Costly/lb. N |
| Initial Plant Response | Rapid | Slow |
| Burn/Salt Index | High to Moderate | Slow |
| Duration of Response | Short to Moderate | Moderate to Long |
| Leaching Potential | High to Low | Low |
| Efficiency | Generally good | Good over time |

## Table 14. Tissue Sufficiency Range for Nitrogen in Cool Season Grasses (Frank & Horgan)

| Species | Tissue Sufficiency Range (Nitrogen expressed as percent) | Typical Annual N Needs (Lbs. N/1000 SF) |
|---|---|---|
| Creeping Bentgrass | 4.50 - 6.00 | 2.5-3.5 |
| Perennial Ryegrass | 3.34-5.10 | 3.0-5.0 |
| Kentucky Bluegrass | 4.0-4.5 (est.) | 2.0-5.0 |
| Fine Fescue | 1.5-2.5 (est.) | 1.5-3.0 |
| Annual Bluegrass | 4.0-4.5 (est.) | 3.5-4.5 |
| | | |
| Typical Greens/Tees | 4.0-5.0 (est.) | 2.0-6.0 |
| Typical Fairways | 4.0-4.5 (est.) | 2.0-4.5 |
| Typical Roughs | 0.0-2.0 (est.) | 0.0-2.5 |

*Estimated tissue sufficiency – no data reported*

Table 14 shows typical nitrogen sufficiency ranges for cool season turfs. These guidelines are important to recognize when planning fertilization programs but cannot be considered independent of the following factors:

Optimum Temperature Ranges

- For shoot development: (60-75 F: air temperatures)
- For root development: (50-60 F: 4-inch-soil temperatures)

Seasonal Growth Activity

- Dormant stage: No application is necessary
- Early spring: Generates good color, competitive advantage over weeds, and good density (but may produce rapid growth and deplete carbohydrate reserves needed for summer stress).
- Late spring: Generates intermediate responses, improves stress prevention before summer.
- Summer: Provide light applications of nitrogen (0.5 lbs. N/1000 SF) for color; providing disease pressure is low (for example gray leaf spot pressure and its impact on rye grass).
- Fall and late fall: DiPaola and Beard describe late fall as, "around the last fall mowing." When growth has essentially stopped and there is no clipping production. Roots are active and photosynthesis continues; producing carbohydrates but little growth. Risks with late fall fertilizer programs include promoting snow molds and wrong selection of fertilizer carrier types (N carriers that are dependent on soil microbes for nitrogen release would be a poor choice for late fall programs and potentially increase pollution potential).

Turf managers recognize that nitrogen release mechanisms influence the applicability of fertilizer choices as it pertains to the release mechanisms and environmental factors:

- Microbial action mechanisms are driven by soil microbes, which are themselves affected by soil temperatures, moisture levels and oxygen levels and would be a poor choice for late fall applications in the northeast.

- Osmosis release mechanisms are driven by nutrient (ion) concentration levels and naturally move from a higher area of concentration to a lower area.

- Hydrolysis releasing mechanisms allow water to break down compounds and release nitrogen into the soil, obviously influenced by water, particularly unpredicted rain storm events.

- Turf mangers also consider the salt index when selecting fertilizers that use hydrolysis as the basic release mechanism. Most quick release nitrogen carriers are water soluble and can cause nitrate to leach to the soil. Salt release can cause plant injury (burn) and discoloration and over time require flushing past the root zone and upper soil profile.

- Physical breakdown mechanisms depend upon breakage of the coatings to release nitrogen. Physical breakdowns occur when the particles are mowed, walked on, dragged with a brush mat and releases are often rapid. Table 7 provides a listing of nitrogen release mechanisms of common fertilizers and the respective salt index associated with water soluble mechanisms of release.

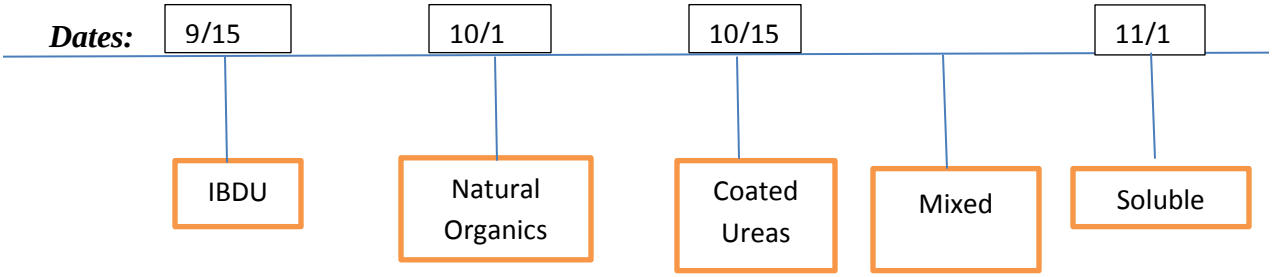
## Table 15. Fertilizer Types and Nitrogen Mechanism Considerations

| **Quick Release N Carriers (salt types)** | ***Release Mechanism*** | **Salt Index** |
|---|---|---|
| Ammonium nitrate | water soluble | 105 |
| Ammonium sulfate | water soluble | 69 |
| Potassium nitrate | water soluble | 74 |
| Monoammonium phosphate (MAP) | water soluble | 30 |
| Diammonium phospahte (DAP) | water soluble | 34 |
| Calcium nitrate | water soluble | 53 |
| Urea | water soluble | 75 |
| **Quick/Slow Release Carriers (Methylene Urea)** | Microbial/water soluble if blended | 75 |
| **Slow Release N Carriers** | | |
| Synthetic organic N carriers- methylene urea based | Microbial/water soluble | 24 |
| Natural Organic (animal waste, sewage sludge) | Microbial | 2 |
| Isobutyraldehyde (IBDU) | Low solubility/hydrolysis | 5 |
| Polymer and Sulfur Coated Urea | Temperature driven due to low solubility ; low microbial action | |

According to Frank and Horgan the following recommendations are considered for late fall applications:

- Soluble N sources should be applied about the time turf growth ceases.
- Sulfur coated ureas should be applied 10 to14 days before turf growth ceases.
- Natural Organics should be applied 3 to 4 weeks before turf growth ceases.
- IBDU: Should be applied 4 to 6 weeks before turf growth ceases.
- Mixed Soluble and slow release: Should be applied 4 to 10 days prior to turf growth ceasing depending on the percent of slow release and type of carrier.

***Frank & Horgan: Typical Cool Season Turf Late Fall Timing Strategies***




Turf managers use spoon-feeding methods on sandy soils with low nutrient retention capabilities. Spoon feeding applies low rates N at frequent intervals. (Carrow, et tal). Vargas emphasizes how proper turf nutritional programs are essential to fungicide efficacy. It is common knowledge that turfgrasses already stressed due to poor nutritional programs take longer or fail to recover from foliar diseases such as dollar spot, rust and leaf spot. Increased potential for snow mold can be exacerbated by excess nitrogen applications in the late fall. According to Vargas there is an abundance of data that supports nitrogen ability to reduce disease. A summary of nitrogen and disease impacts from Vargas is shown in Table 16.

## Table 16. Effects of Nitrogen Application on Turfgrass Disease

| ***Severity of Diseases Increases*** | ***Severity of Disease Decreases*** |
|---|---|
| *Pythium* blight | Dollar spot |
| Brown Patch | Rust |
| Gray leaf spot | Red thread |
| Stripe smut | Pink patch |
| *Microdochium* patch | Anthracnose |
| *Typhula* blight | Necrotic ring spot |
| | Summer patch |
| | Melting-out |
| | Leaf spot |
| | Take-all patch |

The correct balance of available N is necessary to maintain optimum turf physiological performance, fungicide efficacy, and when properly applied will maintain the turf's physiological equilibrium. This balance provides turf with only the nitrogen needed for health

requirements, offering less residual nitrogen forms that negatively impact the environment through leaching and runoff. Measuring turf nutritional needs only by subjective visual analyses (color, density, and growth) is often inconsistent and varies due to time of day, moisture levels and each observer's interpretation. Vargas recommends (as a rule of thumb) 0.5 lbs. N /1000SF per growing month in order to receive the maximum benefit of fungicide applications.

Establishing the overall nutrient balance is essential to optimal plant health. The Bridge has monitored groundwater for the past nine years to determine the course's nutrient and pesticide concentration impact to local groundwater. The long term average goal for nitrate in groundwater is limited to 2.0 mg/L. To achieve these goals the total nitrogen fertilizer application rate is limited to 3000 pounds per year or the equivalent of 0.9 lbs. N/1000 SF of the Bridge entire parcel area. To date, at the Bridge, there have been no reported significant impacts to the groundwater quality or negative impacts to the golf course.

The impact of nitrogen on turf disease control and the efficacy of an applied fungicide will only be realized when the turf manager has properly identified the pathogen. For the Hills' project, the turf manager will use a qualified turf pathology laboratory to correctly diagnose the turf disease, select fungicides based on the NYSBMP model and NYS reduced risk pesticide list (as first methods of treatment as applicable to the specific pathogen) and determine if nitrogen will help or worsen the condition. The turf manager will determine what environmental condition(s) exist that increased disease risk and implement cultural practices to reduce the persistence of pathogen incidence. Improvements to soil health will be evaluated to determine if the disease risk can be minimized by soil amendment and microbial activities.

Table 17 represents typical microbial levels recommended for two mixes of turfs, bluegrass/rye and bentgrass/fescues. The microbial levels are part of the soil food web; and inoculation of soils with microbes and soil amendments with compost are higher priorities than applications of synthetic inputs. The Hills' ITHM program requires soil sample analyses for these organism populations on a seasonal basis. The applicants will analyze the soil for microbial levels prior to the final design of the project, to determine the necessary levels with respect to the selected turf species. Microbial levels will continue to be monitored throughout the operational stages of the golf course as part of the ITHM program.

## The Hills at Southampton Monthly Nitrogen Nutrient Projection:

An estimate of maximum applied nitrogen was determined by calculating the amount of nitrogen applied through the groundwater supply of irrigation water (I) plus the amount of supplemental nitrogen applied as fertilizer (S). The annual maximum amount of nitrogen applied from groundwater is 0.74 pounds and is based on groundwater nitrogen concentration of 15 mg/L. Monthly irrigation is estimated from the percentage of annual irrigation applied each month. The maximum allowable amount of monthly applied nitrogen (irrigation and supplemental) was set at 0.248 pounds per month based on an annual limit of 2.5 pounds of nitrogen per 1000 SF of managed turf per year excluding roughs.

| | | | | | |
|---|---|---|---|---|---|
| April: | 0.74# N x 5% = | 0.037# N(I) | + | 0.211# N(S) = | 0.248 pounds |
| May: | 0.74# N x 15% = | 0.111# N(I) | + | 0.137# N(S) = | 0.248 pounds |
| June: | 0.74# N x 15% = | 0.111# N(I) | + | 0.137# N(S) = | 0.248 pounds |

| | | | | | |
|---|---|---|---|---|---|
| July: | 0.74# N x 20% = | 0.148# N(I) | + | 0.100# N(S) = | 0.248 pounds |
| August: | 0.74# N x 20% = | 0.148# N(I) | + | 0.100# N(S) = | 0.248 pounds |
| September: | 0.74 # N x 20% = | 0.148# N(I) | + | 0.100# N(S) = | 0.248 pounds |
| October: | 0.74 # N x 5% = | 0.037# N(I) | + | 0.211# N(S) = | 0.248 pounds |
| **Total:** | **100% =** | **0.74#N(I)** | **+** | **1.736# N(S) =** | **2.476 #N/1000 SF/year** |

## Table 17. Suggested Microbial Levels for Turf Grass Mixes

| **Spring** | **Bluegrass/Ryegrass** | **Bentgrass/Fescue** |
|---|---|---|
| Active bacteria | 15 to 25 | 15 to 25 |
| Total bacteria | 100 to 300 | 100 to 300 |
| Active fungi | 10 to 20 | 15 to 25 |
| Total fungi | 50 to175 | 100 to 300 |
| Flagellates | 10000 + | 10000 + |
| Amoebae | 10000 + | 10000 + |
| Ciliates | 50 to 100 | 50 to 100 |
| Nematodes | 20 to 30 no root feeders | 20 to 30 no root feeders |
| % Mycorrhizal Colonization | 40 to 80 | 40 to 80 |
| **Summer** | | |
| Active bacteria | 10 to 25 | 10 to 25 |
| Total bacteria | 150 to 300 | 150 to 300 |
| Active fungi | 5 to 20 | 10 to 25 |
| Total fungi | 100 to 200 | 150 to 300 |
| Flagellates | 10000 + | 10000 + |
| Amoebae | 10000 + | 10000 + |
| Ciliates | 50 to 100 | 50 to 100 |
| Nematodes | 20 to 30 no root feeders | 20 to 30 no root feeders |
| % Mycorrhizal Colonization | 40 to 80 | 40 to 80 |
| **Fall** | | |
| Active bacteria | 1 to 5 | 1 to 5 |
| Total bacteria | 75 to 100 | 175 to 300 |
| Active fungi | 1 to 5 | 1 to 5 |
| Total fungi | 50 to 75 | 175 to 300 |
| Flagellates | 5000 + | 5000 + |
| Amoebae | 5000 + | 5000 + |
| Ciliates | 50 to 100 | 50 to 100 |
| Nematodes | 10 to 20 no root feeders | 10 to 20 no root feeders |
| % Mycorrhizal Colonization | 40 to 80 | 40 to 80 |
| | | |
| ***Note: units are ug/gram of soil*** ***Source: Appendix G DEIS Bayberry Project (Sebonack Golf Club)*** | | |

Nitrogen applications for Hills golf course will be foliar and applied by the turf sprayer and via the on-site fertigation system (which applied liquid fertilizers through the irrigation system).

- **Turf Tissue Sampling**

Turf tissue sample testing is growing in popularity to asses turf nutrient balance. Table 6 provides recommended levels of nitrogen tissue levels for various cool season turf. There are two methods that can be used to monitor nutrient level and relate the condition to the response from fertilizer; diagnose nutrient deficiencies (micro and macro nutrients) to (1) determine underlying turf problems and (2) to provide verification of visual observations (Murphy). The preferred tissue test method is the total analysis of the elemental content of plant tissue and sap. The method is quantitative and precise. The second method is a rapid test of the soluble nutrients in the plant sap.

For the Hill's ITHMP, tissue samples will be collected at least monthly during the growing season from areas of good and poor turf; and avoid collection of weeds, debris and other foreign matter. The laboratories will be contacted in advance of sample collection and shipment to clarify all sample preservation requirements and diagnostic processes. There are final decisions about the use of turf tissue analyses. These include frequency of sample collection (weekly, seasonal); composite sample collection or discreet sample collection; and accuracy with respect to the dynamic conditions of turf's physiological activity and environmental influences (traffic wear, mower damage).

Unlike crops where critical nutrient level standards can be set based on yield; turf does not equate to a "yield based standard" and critical nutrient levels are instead based on density, color, and other turf qualitative parameters as well as its growth (Murphy). Murphy found there is a "significant limitation to the use of tissue analysis for nitrogen status monitoring because the "interpretation of results suffers from limited quantitative nitrogen response data" (as compared to maximum yield goals for crops). Optimum yield is used for turf rather than maximum yields as is used for crops. Murphy suggested and evaluated the relationship of dollar spot disease severity on *Penncross* creeping bentgrass in a randomized complete block design experiment with five replications; analyzing nitrogen content in clipping samples (to evaluate various treatments of N application) to define a parameter for optimum levels of tissue nitrogen content. Murphy also found that the clipping yield (as a measurement of creeping bentgrass growth) increased in a linear fashion with increasing tissue content of N. A content in clippings of 4.5 percent N will provide bentgrass recovery from dollar spot; and suppression of dollar spot will require clipping nitrogen content of approximately 5 percent but will increase growth rates and could reduce carbohydrate reserves and limit root development (Murphy). These percentages of optimum nitrogen levels are impacted by periods within the growing season and should be considered in terms dynamic; not static conditions. Murphy brings attention to the obvious need for the turf industry to establish a "universal standard" to define optimal turf conditions, which may not be possible with respect to the dynamic state.

The applicability of tissue sample analyses to determine nutrient decision making was examined by Gelernter and Stowell. They suggest that misleading nutrient deficiencies may be reported in tissue test results; but the lack of nutrients may be caused by secondary soil related issues including: soil compaction, waterlogging, black layer, high salt levels, and anaerobic

conditions. Their research discovered that nutrients were in the soil, and simply unavailable for root uptake because of limitations caused by the soil physical properties. The researchers found tissue samples collected during different periods of growth during the day or collected in areas of shade or no shade will show different tissue analytical results for nutrient levels. Using a regression coefficient calculation of the results, a comparison of 197 golf course green soil and tissue analyses was used to correlate 20 different nutrient parameters; with no statistically measureable correlation found except for a weak correlation between copper and nitrogen values. The researchers discouraged using tissue sample analyses alone to decide turf nutrient level requirements. The Hill's will utilize multiple diagnostic tools (soil and tissue chemistry, microbial levels, soil moisture holding capacity, etc.) for turf management decision making.

- **Soil Sampling**

Cultural practices are critical to turf nutrient balance to optimize turf health. Shearman and Rieke acknowledge there is no soil test for predicting nitrogen nutritional needs for turf. There are several reasons for this problem. Soil analytical results can show adequate nitrogen concentration in the soils, yet the nitrogen is unavailable for turf root uptake. Causes include lack of oxygen in the soil which blocks aerobic bacteria activity; poor drainage and saturated soils (causing low $O_2$ levels), and temporal quantities of N that exceed plant uptake needs (due to soil temperatures, seasonal growth, compaction, sunlight/shade exposure timeframes, and salt). Nitrogen and calcium supplemental sources that include sulfur as a base chemical can under anaerobic conditions, lead to formation of black layers in the soil profile. Many of these conditions can be corrected through cultural means including: soil aerification, improved sunlight exposure, soil amendments, and proper irrigation. Soil analyses will include physical characteristics to evaluate soil properties and evaluate what conditions exist or can be altered to provide the most efficient environment for root zone nutrient uptake. The Hills' turf manager will be cognizant of which fertilizer release mechanisms (Table 4) are involved, what form the nitrogen is in, if the salt index is a concern, and what background soil conditions influence availability of nutrients and the efficiency of root uptake.

- **Clipping Weight & Clipping Management**

Clipping weight measurement is a useful tool to evaluate shoot growth and can be used to fine tune nutrient programs. Depending on the turf species desired in the stand and time of season, monitoring growth through clipping weight can aid in understanding when to aid the cultivar population in gaining a competitive advantage over less desirable turfgrass. Turf managers desiring higher populations of bentgrass over *Poa annua* must not only correctly time nutrient supplemental applications to promote bentgrass and "starve" *Poa* but also use clipping weights to aid in monitoring of progress of plant population shifts. Clippings management is also critical because clippings are a source of nitrogen, with 35 to 38 percent of the applied nitrogen found in clipping tissue. Clipping weights are a more effective nitrogen management tool when used in conjunction with turf tissue analysis. Clipping weights will be measured weekly for monitoring growth rates of greens and tees and every other week for fairways during the period of May 1- October 1. Daily clippings collected in mower baskets from tees and greens will be used as a mulch/topdressing for broadcast applications to the practice range and roughs.

The Hills turf managers will typically return clippings to fairways and roughs and must account for the nitrogen loads from this source within the annual nutrient budget and ground-

surface water monitoring program. Two recommendations of the "East End Nitrogen Reduction Program for Golf Courses" are turf equipment wash-down pads with wastewater collection and treatment facilities; and removal of grass clippings placed on bare soils as bulk storage (i.e. compost piles) to minimize sources for nitrogen loadings due to runoff and recharge. Clippings generated from the site and not needed for supplemental nutrients will be collected and disposed of off- site. Clippings and equipment wash down solids can be consolidated and temporarily stored on impermeable storage areas (either on concrete, in metal containers or on impermeable liner barriers, and covered until collected. This will avoid potential impacts to groundwater generated by grass clippings. Clippings from the non-golf areas will be returned with dethatching performed on an as needed basis, with debris removal to an approvable off site location.

- **Dissolved Organic Nitrogen (DON)**

Pare, et al preformed an experiment with $^{15}N$ isotope to trace applied nitrogen to various turfgrasses and collected water that passed through lysimeters to evaluate leaching potential. The researchers' conclusions are quoted below in their entirety, because of the significance of their findings regarding the measurement of dissolved organic nitrogen and its contribution to the total nitrogen mass balance equation of accountability:

> "In this lysimeter experiment, the amounts of $NO_3$ lost through leaching were inversely related to plant N uptake. The application of $_{15}N$-labeled fertilizer demonstrated that one-third to one-half of the $NO_3^-$ leached was derived from N accumulated in soil **before** the $_{15}N$ application, presumably from re-mineralized organic N. Therefore, the mineralization of soil organic N should be accounted for when determining the fertilizer requirements for golf greens to reduce the risk of N leaching. Dissolved organic N was a significant component of the total N leached from golf-green profiles, and was assumed to be derived primarily from background soil and rhizospheric N. Measuring DON in leachates allowed for a nearly complete recovery of the applied fertilizer $_{15}N$ in most planted lysimeters. We conclude that part of the N losses traditionally attributed to gaseous N emissions (volatilization and denitrification) in golf greens would be due to the leaching of dissolved organic N."

The aforementioned quote emphasizes a common error with theoretical calculations used by some reviewing agencies during golf course impact with respect to nitrogen leaching potential. DON must be considered when predictive methods are used to evaluate potential leaching from additional nitrogen applications and it is particularly important when older turf stands are involved (Frank & Horgan). The actual fate of nitrogen is influenced by a number of factors, including soil pH, moisture, organic matter, temperature, aeration, N carrier, clippings, and soil texture and structure. The Pare research was conducted in a greenhouse in Canada, and one must cautiously apply these conclusions to Long Island outdoor locations.

Field experiments conducted at the University of Illinois showed that 52 percent of the N applied as fertilizer found its way into the thatch and soil organic matter, 30 percent was removed in the clippings, 8 percent volatilized, 6 percent was in the plants, and *none leached*. The only way to accurately determine the fate of nitrogen on a turf in Long Island is to measure it (Turgeon 2014).

- **Soil Moisture**

Irrigation and rainfall cannot be overlooked when evaluating nitrogen leaching and runoff potential. Water is not only the resource that becomes contaminated by excessive nitrogen but also the driving media that moves nitrogen compounds from the soil to water. Course topography and soil characteristics play important roles, but water is the primary attribute in nitrogen concentration levels, leaching and runoff potential. Moisture meters (www.specmeters.com) measure the moisture level in upper 4-inches of the soil and have become widely accepted by the industry. The meters can be either hand held or permanently installed. The installed meters are commonly integrated with the irrigation system's central controller; and allow irrigation only in areas directed by the moisture meter settings. Handheld meters hold a slight advantage because they are site specific and applied by professional staff that also inspect the overall conditions of the turf. The use of moisture meters will have a profound impact on controlling nitrogen loading generated by applications of excessive irrigation water which has direct impacts to runoff and groundwater recharge. As Frank and Horgan have expressed, the greatest and most common mistake turf mangers make with their cool season turf nutrient program is "overwatering."

Excessive irrigation can increase runoff potential and easily drive nitrate molecules from sandy soils to groundwater. One of the more sensitive conditions that increase potential nitrogen loading to ground and surface water is the golf course grow-in period. The grow-in is also a time where irrigation and proper soil moisture levels are critical. Grow-in starter fertilizers commonly include phosphorous, which is a primary environmental concern. Turf managers sometimes exclude or minimize the amount of phosphorus during the grow-in period to reduce the competitiveness of annual bluegrass (*Poa annua*) against creeping bent grass (*Agrostis stolonifera*); however on low organic sandy soils, (i.e. USGA greens) the developing turf seedlings require nitrogen and phosphorus once the roots develop. As water is needed for germination, the balance among seedling nutritional needs, consistent soil moisture levels, and available supplemental nutrients applied at rates that minimize environmental impact can be controlled by the turf manager.

The Hills will install moisture meters connected to the irrigation central control system to provide the turf manager a most important tool during the grow-in. The Hills professionals will use hand held moisture meters for site specific, more frequent soil moisture metering during periods of abiotic stress (drought, heat, wear, and shading). Moisture meters reduce risks of overwatering; can increase the success of seed germination; can be adjusted for providing advantageous conditions for selected turf species; minimize release of nitrogen and phosphorous to the environment. Early establishment of turf and increased density during the grow-in period significantly reduce environmental impact potential of nutrient loading to ground and surface water.

The use of a fertigation system during grow-in greatly aid the manger in establishing turf. After the grow-in period, the Hills will continue the use of the fertigation system as the primary tool for nutrient applications, both on the golf course and within the residential/non-golf turf areas. A dual system will be adapted to each of these areas, and each will be under the direct

supervision of the professionally trained, qualified golf course turf management staff._The fertigation system optimizes nutrient inputs which are injected into the irrigation water during applications. This method provides the correct amounts of specific nutrients during applications to the landscape. Fertigation systems can provide a method for applying inputs designed for improving healthy soils, and plant physiological defense systems. The Hill's turf managers and planners have considered the course topography to evaluate grow-in methods such as the use of hydro-seeding and sodding. Before the final design stage, the Hill's will carefully plan how best to quickly develop high density turf and healthy root development.

**Figure 5.** ***Integrated Turf Health Management Triangle*** *(OSU Extension, Management of Turf Diseases, L-187, Mar. 2011)*

- **Cultivar Selection**

Cultivar selection is of superior importance. Trewarth's climatic classification for Long Island, NY is Dcfb; temperate continental, with no dry season, and cool summers; allowing good conditions for cool season grasses of the Pooidea subfamily of grasses. More common turfgrasses used in the Long Island region include fescues, bluegrasses, ryegrasses, and bentgrasses. The Hill's turf managers have a relatively broad range of turf varieties from which to select. Selection of cultivars will be completed later in the design phases of the project, and as stated will consider soil and growing conditions specific to the Hill's site location. Table 18 shows a representative comparison of turf species and general annual amounts of nitrogen required.

- **<u>Soils and Soil Amendments</u>**

The soil for the greens will be comprised of greens mix which conforms to the USGA recommendations. The soil mix will be performed only off site and monitored under strict quality control standards. On site sands cannot be used for the greens mix because of the potential for cross-contamination by soils of different physical properties, weed seed, a lack of control of the soil mixing machine and contamination from site construction debris. The greens

drainage and root zone mixes will be mixed off site and placed within the green as each green is constructed. The greens root zone mix and drain layer soil property specifications are explained in Appendix 3. Quality control will include sampling of the mix and testing by a qualified soils laboratory. Typical samples are collected from soil mix stockpiles at 500 yard increments, with several preserved samples retained indefinitely. The specifics of the root zone and drainage layer QA/QC program will be specified in the golf course construction documents.

Tee mix soils will closely mimic the greens root zone mix. There is a possibility to use some screened on-site native soils for tee construction. However the risks of producing a soil of less than adequate quality remains. The recommendation is to prepare the tee mix soil off site and from an approved source, with samples collected for quality control. The specifics of the root zone and drainage layer QA/QC program will be specified in the golf course construction documents.

Fairway soils will be blended from on-site native sands and the thin layer of organics. During clearing, grubbing and rough shaping (grading), the upper soil horizon will be stockpiled. These materials will be screened to remove tree roots, brush, large stones and other debris. Some of the organic debris may be useful for processing on site and incorporated into the roughs and fairway areas as an organic amendment. The prescribed bentgrass and fescues favor slightly lower soil pH, sandy soils, good drainage, and will germinate in soils with naturally low organic content. Difficult as these conditions can prove for crop production, management of fine turf can be very well controlled in this environment. The initial amendment to fairway and rough native soils may require organic leaf matter compost be blended in to retain soil moisture and provide organic matter as a food stock for soil micro-organisms. Once the population of soil microbes becomes established the organisms and thatch generated from grass clippings, will provide a sustainable soil mix.

Amended soils will require sampling and analyses for physical properties, (particle size distribution, bulk density, organic matter content, porosity and saturated hydraulic conductivity) to evaluate how the soil properties influence the fate of applied water, chemical inputs, nutrient uptake, and their fate with respect to groundwater. At a minimum of once per year, post grow-in, the Hills will collect soil samples for these analyses and cross reference the results with the ground and surface water monitoring programs.

This information will be used to evaluate the impacts(s) that post construction soils may or may not have on ground and surface water quality, and what mechanisms (cultivation, soil amendments, changes in turf management) may be implemented to minimize or avoid potential negative impact and/or document how post construction soils have affected the phyto-remediation design technology and predicted improvement in overall water quality, as compared to the pre-construction existing conditions.

It is not advisable for land clearing/organic debris to be buried within the playing areas of the course. As the debris decomposes it can cause settling and uneven surface conditions, or encourage fungus problems that interfere with fine turf management. There is opportunity to process and till some of the debris into the roughs, practice area of naturalized/restored areas. Excess land clearing debris will be removed from the site and processed at an approved facility.

Residential areas and non-golf areas are expected to tolerate greater quantities of organic compost. Organic leaf compost will be used to amend the nutrient weak sandy soils within these areas. The selection of all compost materials will be in accordance with the recommendations referenced in Appendix 4. "Using Compost to Improve Turf Performance," (Landschoot).

### Table 18. Nitrogen Requirements for Cool Season Grasses (Frank & Horgan)

| **Species** | **Typical Annual N Needs (Lbs. N/1000 SF)** |
|---|---|
| *Creeping Bentgrass* | 2.5-3.5 |
| *Perennial Ryegrass* | 3.0-5.0 |
| *Kentucky Bluegrass* | 2.0-5.0 |
| *Fine Fescue* | 1.5-3.0 |
| *Annual Bluegrass* | 4.0-6.0 |

*Estimated tissue sufficiency – no data reported*

### Table 19. Establishment Vigor of Popular Cool-Season Turfs (Turgeon)

**FAST RATE OF ESTABLISHMENT & VIGOR**

*Perennial rye grass*
*Tall fescue*
*Fine fescue*
*Creeping bentgrass*
*Colonial bentgrass*
*Kentucky bluegrass*
*Rough bluegrass*

**SLOW RATE OF ESTABLISHMENT & VIGOR**

Table 19 represents the rate and vigor of turfgrass establishment and illustrates how turf selection during the grow-in period can impact nitrogen applications and for potential leaching and runoff. Runoff will be directed to "naturalized" areas and constructed stormwater wetlands where the sediments and nutrients conveyed by rainfall can be absorbed by the otherwise unfertilized, minimally managed areas.

## Integrated Turf Health Management Program & Protocols

The ITHMPs are based Integrated Turf Health Triangle (Figure 5) developed Ohio State University. OSU recommends the following management practices to improve success of ITHMP.

## Diagnosing Turfgrass Problems

Proper diagnosis is a critical step in the management of plant diseases. Without a solid diagnosis, it is impossible to suggest or develop an adequate management strategy. The more the superintendent knows, the better equipped the turf manager will be to take corrective action. For turfgrass disease diagnosis, the more one knows about the host, environmental, and biotic factors that favor disease development (the disease triangle), the greater likelihood of making a correct diagnosis. Confirmation of disease diagnostics will be conducted at recognized turf diagnostic laboratories. The following 6-step approach will be used for diagnosing turfgrass problems at the Hills.

**Define the problem**

The staff will gather as much information as possible about the situation such as grass species, cultivar or variety, age of the stand, recent fertilizer or pesticide applications made, cultural practices implemented, weather trends, irrigation practices, use of growth regulators, history of problems, etc. It is essential to correctly identify the plant affected and to be familiar with its healthy state and characteristics. Staff will take seasonal effects into account.

**Examine the entire turfgrass plant community**

The applicant's approach will be to observe the entire plant community. For example, if there is a potentially diseased fairway, staff will look at other golf courses in the area to assess what may be happening, and contact other golf course superintendents within close proximity of the Hills to inquire about similar conditions. At the Hills, staff will inspect other fairways to see how widespread the damage is and examine the entire fairway; noting light conditions, wind direction, slope of the land, air movement, soil conditions, etc. Once completed, staff will focus on the affected plant(s) or area. By examination of the leaves, stems, crowns and roots, staff will make observations to avoid quick decisions or a wrong diagnosis.

**Patterns: Diseases don't occur in straight lines**

It is important to look for patterns. Is only a single plant affected? Is the problem restricted to a certain area or a single species? Are the symptoms randomly distributed or are there distinct patterns or clear lines of demarcation between healthy and affected plants? Is the damage occurring in a pattern consistent with recently performed maintenance practices? Random patterns often are indicative of diseases or insect pests whereas uniform damage such as streaks or lines or damage over a large area is indicative of an abiotic (chemical, physical, or mechanical) culprit.

**Timing of events: How did the problem develop?**

Did it appear suddenly or over time? Has the damage spread or stayed in the same location? Does the damage coincide with changes in the weather? Progressive development and spread of a problem over time is commonly associated with a pest or pathogen. Acute damage is typically caused by abiotic factors: environmental stress, mechanical damage (caused by mowers, topdressing, abrasive sand, etc.) or chemical injury.

**Look for evidence of a pathogen or pest activity**
The Hills' superintendent will look for key diagnostic signs or symptoms that are indicative of pathogens or insect pests. For instance, the presence of large numbers of fruiting bodies or mycelium might lead one to suspect a fungal infection. If after gathering sufficient background information, staff finds no evidence of a chemical misapplication and/or staff has eliminated the possibility of pathogens and insect pests, the superintendent will retrace his steps and focus his diagnosis on abiotic factors. This is where diagnosis may require the services of a plant pest or disease diagnostic laboratory to narrow the probable causes. Photographs or digital images to aid the diagnostician will be taken with any samples of turf collected for lab analysis.

**Seek professional help**
The Hills will utilize agronomists from USGA; disease experts from U-Mass, Amherst, Penn State, and Rutgers.

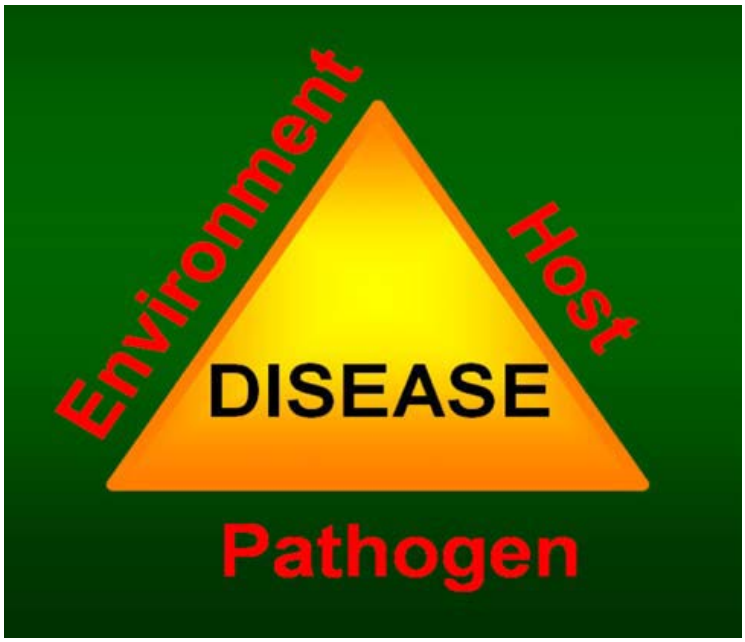



**Figure 6. Disease Triangle**

**Plant pathologists have developed a simple model called "The Disease Triangle" to illustrate this concept. Practices which influence the temperature, moisture and fertility status of the turfgrass have the greatest impact on disease development. (Source, Management of Turfgrass Diseases, Mar. 2011 OSU Extension Bulletin L-187)**

As pressures mount to reduce inorganic fertilizer and pesticide inputs on turfgrass, interest has increased regarding the development and use of integrated pest management (IPM) programs that either forego or limit the use of pesticides. Although voluntary in some situations, fungicide use is prohibited or strictly regulated in other situations such as in the case of home lawn or residential turfgrass disease management. The first line of defense to preventing or minimizing disease is through the selection and/or use of disease resistant turfgrass species/cultivars and the use of certified seed.

Information regarding disease resistant turfgrass will be obtained by contacting local seed distributors, extension specialists and via the National Turfgrass Evaluation Program (NTEP; http://www.ntep.org). The use of genetically resistant turfgrass shall be considered when establishing or renovating turfgrass areas or in situations where over-seeding is used, such as the range.

The second line of defense against turfgrass diseases is the use of cultural management practices that favor turfgrass health over pathogen activity. Cultural practices related to seedbed preparation prior to establishment are critical for seedling and root diseases such as Pythium damping-off and the patch diseases. Sand-based root zone mix considerations for putting greens and athletic fields are equally critical. Under certain situations, it may be possible, although difficult, to modify poor quality soil conditions under existing turfgrass swards through the use of core aerification and organic matter topdressing programs. Disease management in established turfgrass swards is often achieved by modifying cultural management practices such as mowing, watering, fertilization, tree pruning, top-dressing and core aeration. As mentioned previously, intensely managed golf course turfgrass is often more predisposed to environmental and biotic stresses and so it is crucial that agronomic practices be timed to optimize health. By providing growing conditions that favor plant growth over pathogen development or activity, it is possible to minimize or avoid disease.

Plant pathologists have developed a simple model called “The Disease Triangle” to illustrate this concept (Figure 6). Practices which influence the temperature, moisture and fertility status of the turfgrass have the greatest impact on disease development.

Fungicide applications are often essential where there is a demand for high quality turfgrass during environmental periods that favor pathogen growth. In general, fungicides are most effective when applied prior to the onset of disease symptoms (referred to as preventive applications). Fungicides applied after the onset of disease symptoms are typically made to slow or stop pathogen activity and to protect asymptomatic or healthy turfgrass. These type of applications are referred to as being curative. Keep in mind the pathogen is not killed with curative applications.

Other considerations for effective use of fungicides include: (a) selection of product; (b) use of proper water volume (i.e., minimum of 2 gallons per 1,000 $ft^2$); and (c) sprayer nozzle selection (for liquid applications), and spreader calibrations for granular applications.

The NYSDEC requires certified applicators read and follow label recommendations when applying fungicides as with any pesticide.

Several recent advances in the use of biological control strategies to manage turfgrass diseases have been reported, such as the application of material rich in organic matter and the use of antagonistic microorganisms. Relatively few products are commercially available that provide consistent and predictable reductions in disease.

Lastly, high-value turfgrass systems, such as golf course putting greens are intensively managed (i.e., daily mowing, irrigation, core aerification, topdressing applications.). Although frequent manipulation allows for timely intervention of problems, it can also lead to increased wear and the predisposition of turfgrass to environmental and biotic stresses.

The following lists of some of the many complex factors provided by OSU that are considered by golf course superintendents as they strive to manage healthy golf course turfgrass.

## The ITHM Complexity Factors Considered When Managing Golf Course Turfs

### *Human Relations*

- Client Relations
- Crew Size and Organization
- Human Error Language/ Ethnicity Dynamics
- Experience Level of Employees
- Expectations & Opinions
- Amount of Play/Use

### *Budget*

- Staff
- Equipment
- Management options
- Revenue Generation

### *Cost*

- Recovery Equipment
- Irrigation system Characteristics
- Mowers
- Sprayers and Spreaders
- Injection Equipment

### *Environment*

- Weather
- Shade
- Thatch
- Air Movement
- Water Dynamics
- Temperature
- Soil or Root zone Mix Characteristics
- pH
- Soil Compaction

### *Agronomics*

- Fertility (dates for fertilizer applications are limited to between April 1 and October 31)
- Mowing heights and frequencies
- Air Movement
- Irrigation
- Thatch
- Core Cultivation
- Heat Stress
- Drainage
- Shade/Sunlight
- Trees & Flowers

### *Playability*

- Aesthetics
- Compaction & Wear
- Topdressing
- Hard Surface Maintenance
- Traffic
- Syringing
- Turfgrass Selection (genotypes)
- Water Quality
- Repair
- Mulching
- Soil Type
- Age of Turf Stand/Facility Turfs

### *Pathogens & Pests*

- Diseases
- Insects
- Grassy and Broadleaf Weeds
- Wildlife Management

### *Regulatory Concerns*

- Product Availability & Selection
- Rates & Means of Delivery
- Environmental Stewardship

For standard IPM/BMP/ITHM practices, the Hills will conduct daily course monitoring and surveys to monitor pest and disease issues.

IPM requires establishing thresholds for when pests need to be tolerated and when damage exceeds this threshold. The above photograph is of grub damage in a “naturalized native grass area” where no abatement measures were needed.

## Equipment and Products for ITHM Relevant to Turf Management and Turf Chemical Reduction

In addition to the standard mowing equipment (fairway, greens and rough mowers) the ITHM will require specific turf equipment to maintain the course. The following equipment will be used in conjunction with best management practices:

- Greens aerator with various tines
- Fairway aerator with various diameter and depth tines
- Fairway soil reliever (solid tines and solid knives)
- De-thatching units for fairways and greens
- Powered turf boom sprayer with GIS system, computer and spray nozzle boom curtain
- Irrigation control systems and Fertigation System
- Soil biological, physical and chemical sample collection equipment
- Plant tissue sample collection equipment
- Lysimeters
- Water sample collection kits
- Disease diagnostic kits

Turf products will include materials that contain bio-stimulants:

- Cytokinins
- Auxins
- Sea kelp extracts
- Amino-acids
- Fungicides
- Bio-pack mixtures (microbial stimulates, microbes and soil enhancements)
- Dolomitic Lime
- Plant Growth Regulators
- Certified seed mixes

These materials stimulate plant growth and can be found in products such as: Sea-Cal; Growth Products Bio-packs, Companion and Restore, Civitas and Primo Maxx.

## Integrated Pest Management Plan: Hills at Southampton

Integrated Pest Management Plans (IPM) set forth site specific goals and thresholds for pests that threaten the health of turfgrass and ornamental plantings. The Hills' ITHMP provides the management techniques to establish and maintain healthy dense turf. The IPM provides thresholds for insects, weeds and disease presence and tolerable levels of damage that once exceeded result in the expected loss of turf. The golf course and non-golf areas are continuously inspected by turf professionals to monitor insect, weed and disease activity in advance of conditions that can progress to the IPM thresholds. Decisions to implement controls as determined by the golf course superintendent are based on a hierarchy of decisions and

alternatives to manage the pest(s) below the threshold levels. Appendix 14 provides tables for the IPM program.

Healthy, dense turf is the foundation of turf management goals set to reduce inputs, especially pesticides. There are several components to the Hills IPM strategies:

**Grow-in**

During the time period necessary to the establish golf course turf (grow-in period) turf areas are more susceptible to damage by biotic and abiotic factors, and recovery is much slower than older, mature turfs of like varieties. Furthermore there may be a correlation between the older turf's genetic responses to site specific conditions (light penetration, internal defense mechanisms to frequent pathogen attacks, population dynamics within the turf stand, etc.) that resulted in adaptations not found within a younger turf stand.

Therefore during grow-in the response to pest thresholds needs to be more flexible to provide conditions to permit the desired turf to survive and mature. It may not be feasible to predict the length of time required for plants to adapt, however a two-year growing season should provide an adequate turf root system and moderately good density.

Different areas of the golf course will exhibit various development stages during the grow-in period caused by planting dates, shade, topography , planting methods (seed or sod), and golf course construction staging. One major issue may be weed control because native soils and compost amendments may not be weed free. The on-site native soils disturbed during construction will bring dormant seeds to the surface where germination is more likely.

Initially, insect damage is predicted to be less of a concern because no host turfs are currently available. After the grow-in period this condition will change, with and expected arrival of more common pests: grubs, cut worms, sod worms, chinch bugs, and annual bluegrass weevil. A major concern within the preserved woodlands adjoining the course is the southern pine beetle and potential for significant and continued loss of pitch pine. NYSDEC has identified areas of Hampton Bays already severely damaged by southern pine beetle. The Hills turf and ornamental plant managers will work with the NYSDEC to identify and manage the pest within the Hills property, including the pitch pine forests proposed as undisturbed areas. The State's current approach to this pest's management is to cut down infected trees during the winter, limb or chip the fallen tree and permit cold temperature to control the southern pine beetle population. The Hills will participate with the NYSDEC in whatever responsibilities, the State determines is the most beneficial.

Appendix 14 includes the IPM informational tables. *IPM Table 1: Pest Weed Thresholds, IPM Table 2: Pest Insect Thresholds and IPM Table 3: Pest Disease Thresholds.* These tables provide pest thresholds that are typical for Long Island east end golf courses that implement formal ITHMPs. *IPM Table 3: Pest Disease Thresholds* provides the response time (expressed in hours) that the golf course superintendent is required to analyze the turf problem and implement a cultural and mechanical method of treatment. These response times also set a deadline for the golf course superintendent to determine when an appropriate pesticide treatment is needed for control. *IPM Table 4 Insect Activity for Suffolk Count*y provides common dates of

insect pest pressure, offers insect morphological prediction, and monitoring/trapping date guidance. Pesticide treatments will be limited to the list of EIQ modeled pre- screened pesticides provided in Tables 9, 10, and 11, with exception of pesticides listed with the USEPA as known carcinogens.

IPM monitoring may be modified based on pest life cycles and environmental conditions typically used in pest prediction and management (phenology, weather, season, models and sample analysis). Preventative methods to control meeting the pest thresholds are a recommended component of IPM protocols. The ability to control pest populations reduces the need to implement curative controls,

Priority of preventative and curative treatment pesticides will be:

1. Biologicals (Bacillus,sp., Pseudomonas sp., predatory nematodes, milky spore, corn gluten, etc.) largely preventative
2. Category III pesticides.
3. Category II and Restrictive Use Category II pesticides, limited to fairways, tees and greens only if catastrophic loss of turf is eminent.
4. Category I pesticides for use as treatments to greens if catastrophic loss of turf is eminent.

**Post Grow-in**

Post grow-in IPM program monitoring, pest tolerance thresholds and treatment response times will remain the same as during the grow-in. The monitoring may be modified as dependent on pest life cycles and environmental conditions typically used in pest prediction and management (phenology, weather, season, models and sample analysis).

The priority of pesticide treatments will begin as:

1. Biologicals (Bacillus,sp., Pseudomonas sp., predatory nematodes, milky spore, corn gluten, etc.) largely preventative
2. Category III pesticides.
3. Category II and Restrictive Use Category II pesticides, limited to fairways, tees and greens only if catastrophic loss of turf is eminent. (pursuant to the *"Emergency Protocols").*
4. Category I pesticides for use as treatments to greens if catastrophic loss of turf is eminent *pursuant to the "Emergency Protocols").*

The selection of NYSDEC/Suffolk County usable pesticides will be further limited by excluding the following pesticides that were detected in groundwater and pond water samples collected at the Bridge and or Sebonack golf courses. Unless extreme conditions are experienced pursuant to the *Emergency Protocols* with approval by the Town of Southampton Department of Land Management, the use of these pesticides will be excluded from use on areas of tees, roughs and fairways:

| | | | |
|---|---|---|---|
| Paclobutrazol | Sulfentrazone | Pentachlorophenol | Propiconazole-b* |
| Triadimenol | Fenarimol | Chloroantraniprole | PCNB |

| | | |
|---|---|---|
| Myclobutanil | Triadimefon* | Boscalid |

Furthermore pesticides that have been classified as possible, probable, or likely carcinogenic to humans now or as classified in the future shall be avoided. Only under extreme conditions will use of these products be applied pursuant to the *Emergency Protocols* and approval by the Town of Southampton Department of Land Management. This list currently includes the following pesticides registered for use on golf courses located in Suffolk County:

| | |
|---|---|
| Tridiamefon* | Fungicide |
| Propiconazole* | Broad spectrum fungicide (DMI) |
| Prodiamine | Pre-emergent broadleaf control |
| Etridiazole | Fungicide |

*eliminated based on detection in ground and surface waters at 0.2-7.5 ppb

When available preventative control methods or treatments fail to provide results the golf course superintendent may consider the use of these products. Table 11-A provides comments and recommendations by ETS regarding the use. Consideration will follow the IPM response times and coordination with a designee of the Town of Southampton. The superintendent will record information regarding the application including but not limited to the product name, active ingredient, quantities, dates, specific location, reasons supporting the decision for use and shall monitor the post application results.

When the superintendent determines treatments are necessary the following reduced risk pesticides and low risk pesticides will be available. The following pest control methods will be used to control weed pest thresholds, until the treatments fail to adequately control pest tolerance:

| **Pre-emergent:** | **Brand Names:** |
|---|---|
| Corn Gluten | Generic brands |
| | |
| **Post-emergent:** | |
| Cinnamon and cinnamon oil | Weed Zap |
| Citric acid | Burnot II |
| Citric acid, malic acid and clove oil | Phydura |
| Cloves and garlic oil | Matran EC |
| Eugenol | EcoSmart Weed & Grass Killer |
| Sodium chloride | Adios |
| 2- Phenethyl propionate | 2-Phenethyl propionate |
| Citrus Oil (d-limonene) | Avenger |
| Iron HEDTA | Fiesta (selective broadleaf control) |
| Pelargonic acid | Scythe |
| Potassium salts of fatty acids | Safer Brand Fast Acting Weed & Grass Killer |

One concern with reduced risk herbicides and EPA exempt products is their inability to provide a selective control with exception of (Iron HEDTA). Each product requires the applicator to treat a specific plant or area to avoid phyto-toxicity on non-target plants.

Other products that are consistent with low input golf course management that have been successful and will also be used at the Hills are:

*Civitas plus Harmonizer* which has been shown to reduce incidence of dollar spot and anthracnose
*EcoGuard*: a biological general use broad spectrum fungicide
*Rhapsody*: a biological broad spectrum fungicide
*Title Phyte*: a phosphite product used to control Pythium
*Spotless TX*: a biological broad spectrum fungicide
*Sustane, Nature safe* and urea are formulations of organic, supplemental nitrogen
Wetting agents: reduce leaf wetness and improve water dispersion through the root zone.
Beneficial Nematodes and milky spore are used to combat grubs.
Hand weeding: labor intensive at $2800/acre compared to a pre-emergent (corn gluten) at $50-70/acre
Weed control: corn gluten, fire management methods, hand weeding, mowing, water management, *Waipuna* (heated water and soap like foam) Fiesta (high iron content) for spot treatment of broadleaf weeds
Over seeding: building a dense turf stand can out compete weeds for available space.

**Residential Areas**

IPM programs within the common areas and residential lots provide for management using very low inputs with professional management by the golf course superintendent and course staff compared to the typical residential landscaper. The use of a Home Owner's Association permits management of turf and ornamentals within residential home sites, common areas and undeveloped lands under pre-established guidelines and covenants. These non-golf areas will follow the recommendations described in Appendix 15- "Lawn Care Without Pesticides" (Rossi) and "Perfect Earth Project Toxin-Free Lawn and Landscape Manual" (2015).

The residential and common areas will be monitored by the golf staff, and weekly inspections conducted to evaluate turf and ornamental plant conditions. The home site landscape plans will include lawn areas comprised of endophytic tall fescues, Kentucky bluegrass/tall fescue mixes, planting beds with a mixture of native plants and cultivated ornamentals, and preservation of existing mature, healthy trees.

The IPM program, pest tolerance thresholds and treatment response times within non-golf areas will remain the same as the golf course. The monitoring will be weekly depending on the pest life cycle and environmental conditions typically used in pest prediction and management (phenology, weather, season, models and sample analysis).

Residential and common areas will receive treatments in the following priority:

1. Biologicals
2. Category III pesticides

The non-golf low traffic areas will be established using endophytic tall and creeping fescues and maintained at an average height of 3-inches. Areas of high traffic and wear will be comprised of a mixture of Kentucky bluegrass, endophytic tall and creeping fescues and maintained at 3-inches.

The residential and common ground areas will use of pesticides that are USEPA Exempt (25 (b) FIFRA) weed control products for use at NYS school grounds and day care centers include:[16]

| **Pre-emergent:** | **Brand Names:** |
|---|---|
| Corn Gluten | Generic brands |

| **Post-emergent:** | |
|---|---|
| Cinnamon and cinnamon oil | Weed Zap |
| Citric acid | Burnot II |
| Citric acid, malic acid and clove oil | Phydura |
| Cloves and garlic oil | Matran EC |
| Eugenol | EcoSmart Weed & Grass Killer |
| Sodium chloride | Adios |
| 2- Phenethyl propionate | 2-Phenethyl propionate |

When the superintendent determines the residential and common areas require an "emergency treatment" the following reduced risk herbicides will be available:

| **Product:** | **Brand Name:** |
|---|---|
| Citrus Oil (d-limonene) | Avenger |
| Iron HEDTA | Fiesta (selective broadleaf control) |
| Pelargonic acid | Scythe |
| Potassium salts of fatty acids | Safer Brand Fast Acting Weed & Grass Killer |

One concern with reduced risk herbicides and EPA exempt products is their inability to provide a selective control with exception of (Iron HEDTA). Each product requires the applicator to treat a specific plant or area to avoid phyto-toxicity on non-target plants.

**Nutrient Planning**

The Hills golf course will be a regulated activity pursuant to the Suffolk County "Fertilizer Law" (Appendix 16) and specifically the following sections of the law pertaining to applications of fertilizer:

***Local Law NO. 41 -2007, Suffolk County, New York***
***A Local Law to Reduce Nitrogen Pollution by Reducing Use of Fertilizer in Suffolk County***

[2] Rossi, F. Grant, J. 2015-16 Cornell Pest Management Guidelines for Commercial Turfgrass, Cornell University, Ithaca, NY.

**Section 3. Prohibitions.**

A.) Fertilizer shall not be applied to County owned real property, except as authorized under Section 8 of this law.

B.) Fertilizer shall not be applied to any turf on any non-County owned real property any non-County owned real property by any person between November 1 and April 1 of every year, except as authorized by Section 8 of this law.

**Section 8. Exemptions.**

B.) Section 3(A) of this law shall not apply to:

i.) Golf courses, provided, however, that only the minimum amount of slow-release and organic fertilizer shall be used that is needed to sustain healthy turf on golf courses, and that fertilizer application rates shall be limited to 3 lbs. of nitrogen/1000 sq. ft. per year, over the golf course as a whole, consistent with the Organic Maintenance Plan adopted via Suffolk County Resolution No. 608-1998.

The Hills golf course will receive nitrogen from its irrigation water, which is calculated to contain 15 ppm of N. Based on an estimated use of 20 MG per year of irrigation applied to the playing areas of the golf course, the annual quantity of N derived from irrigation applied to the 78 acres of golf course managed turf area is 2,502 pounds, equivalent to 0.74 pounds of nitrogen per 1000 square feet of turf area (expressed as 0.74 # N/1000 SF).

In geographic areas where there is concern for nitrogen leaching and nitrogen laden runoff contamination to ground and surface water resources such as Suffolk and Nassau Counties in New York and Cape Cod and Martha's Vineyard, Massachusetts, regulations limit the annual nitrogen applications on turf to 3 #N/1000 SF.

At the Hills golf course this limit would be reduced to 2.26 #N/1000 SF because of the annual amount of applied irrigation water.

The annual maximum limits of applied nitrogen and sources are:

| Turf | Irrigation # N/1000 SF | Supplemental # N/1000 SF | Total # N (max.) per Year/1000 SF |
|---|---|---|---|
| Greens | 0.74 | 1.76 | 2.5 |
| Tees | 0.74 | 1.76 | 2.5 |
| Fairways | 0.74 | 1.76 | 2.5 |
| Roughs | 0.74 | 0.00 | 0.00 |
| Native Areas | 0.00 | 0.00 | 0.00 |

The supplemental nitrogen application rate will not exceed ≤ 0.4 #N/1000 SF of soluble nitrogen in any single application. The greens will receive more frequent applications at the low rates at ≤ 0.25 # N/1000 SF. Tees will also receive frequent applications at low rates because of divot repairs especially to the par 3 holes. Fairways will receive higher rates, less frequently. A typical yearly application of nitrogen (excluding irrigation waters) during the operating season can be described as:

Greens- 16 applications; Tees-10 applications; Fairways-4 applications; Rough applications are by dispersing clippings (from tees, greens and or fairways) into the roughs for disposal.

The fertilizer source will be from the product line of "Sustane." According to the manufacturer, Suståne is the most thoroughly researched organic fertilizer product available. Suståne products are backed by over 30 years of independent applied research on diverse crops and ecosystems. Suståne products are safe and effective to use, USDA Biobased Certified (low carbon footprint) and listed as Allowable for use in the production of Certified Organic Farming by the Organic Material Review Institute (OMRI).

Suståne is manufactured in the U.S.A. and is used locally, regionally and internationally. Exported to over 60 different countries, Suståne Natural Fertilizers are used by professional turf and landscape managers, farmers, growers and horticulturists worldwide. The products proposed for use at the Hills are included in Appendix 17. A more complete understanding of the products is available at the website: http://www.sustane.com.

Residential and non-golf common areas are expected to mimic golf course roughs fertilizer application frequency and rates. The total nitrogen fertilizer applied to the residential areas will not exceed 3.0 pounds of N/ 1000 SF per year. Liquid forms of fertilizers have become desirable for golf course turfs because applications of low rates are more accurately controlled through fertigation systems (Appendix 18) or by turf sprayer equipment. These types of application equipment can also deliver other plant nutrients, plant bio-stimulants and inputs (auxins, amino acids, cytokinins, iron, soil microbes, humic acid, wetting agents, etc.). Sources of nitrogen will be from urea, converted organics, using slow release and quick release liquid forms and slow release granular formulations as seasonal weather conditions dictate.

Long term use of the fertigation system will be practical and used for the turf management because the nitrogen supplied via the irrigation system (from the nitrogen enriched groundwater supply). Fertigation methods will also be used to adjust the fertigation mixing tanks to deliver a more precise amount (calibrations to deliver 0.01 pounds nitrogen per 1000 SF is common) of supplemental nutrients than can be expected from rotary or drop spreaders using granular forms of plant nutrients. Fertigation equipment will be used for nutrient programs during the golf course grow-in duration, establishment and during normal long term turf maintenance.

**Record Keeping**

Maintaining records is critical to the IPM program. Records provide documentation of problem pests, golf course problem areas, evaluations of treatments, dates of pest activity,

fertilizer and pesticide use records, rainfall, degree days, soil moisture levels, ET rates and irrigation. Today's golf course superintendent can utilize technology to manage turf related data.

Appendix 19 provides an example of the vast amount of record keeping and use of predictive models designed to pre-empt pest and disease problems. These versatile software programs are used with smart phone and tablet based hardware, using real time, in-field use by the professionals. Frequently the software provides pest scouting forms and is compatible with on-site weather station, irrigation software, and GPS/turf sprayer technology to allow for extremely accurate and site specific turf management. One software company is integrating the EIQ numbers into the software, to provide a hierarchy of pre-programmed pesticides for treatment of a particular pest based on the lowest EIQ number, the area of treatment and frequency of application, whereby a Total FEIQ can be used to select the best treatment with the lowest environmental impact. The software was demonstrated in 2016 and is expected to be on the market within the next year.

Appendix 19 includes a manual form of fertilizer record keeping that describes the entries that will be made to record the application of nutrients.

Scouting records provide daily reports on pest conditions. On line websites including Cornell's provide daily information on pest conditions and offers geographic locations where activity levels are expected to advance. Each turf manager develops custom record keeping formats based on the types of conditions associated with the course location, host turf types, and micro climates within the course.

In summary, Cornell University has recently published the 2015-2016 Cornell Guide for Commercial Pest Management which is an excellent guidance document for managing New York turf grasses. The Hills turf management team will follow the document's guidelines in addition to their professional and academic training to develop refinements to the IPM and ITHMP, once the facility is operational.

## Ground and Surface Water Monitoring Protocols (G&SWMP)

The Hills will provide the technical expertise and funding to develop Ground and Surface Water Monitoring Protocols (G&SWMP). The G&SWMP will be a voluntary program used to demonstrate how the Hills' inputs and turf management practices influence the local water quality. The monitoring program also serves as a management tool to evaluate the efficacy of the turf management practices.

The Hills and the Town of Southampton will establish reasonable threshold limits for selected compounds and of pesticides and nutrients that are applied. These limits will act as "triggers" and generate a response by the Hills management team (resampling and/or turf management responses) to address exceedances. The program will be used to evaluate the actual post construction impact of applied pesticides and nutrients.

Southampton has requested similar post construction quarterly water quality monitoring at golf courses, specifically at Sebonack Golf Club and Golf at The Bridge. The Hills and the Bridge have approximately the same areas of managed turf. The total allowable fertilized/input managed area of the Bridge is 80.38 acres and the proposed Hills golf course managed turf area is 78 acres; and the Bridge serves as a reasonable model for the expected water quality impacts from the Hills. Historical water quality monitoring results collected at the Sebonack Golf Club provide a reasonable prediction of groundwater impacts associated with golf courses constructed with lined greens. Results from these project sources showed no significant impact on ground or surface water quality has resulted from the ongoing golf course management programs.

The G&SWMP must consider existing conditions and future local ground and surface water quality impact potential generated through up-gradient land use, agricultural runoff, area wide sanitary discharges and stormwater controls positioned along Lewis Road. The background water quality data will require careful evaluation to establish the parameters for the monitoring program and the thresholds for the concentration of compounds (triggers) and potential sources.

The anticipated G&SWMP will involve installation of groundwater monitoring wells (couplets), suction lysimeters, sampling points at Weesuck Creek, and possibly coordination with other involved agencies (SCDHS, NYSDEC).

The G&SWMP will include recordkeeping of the depth to water, groundwater directional flow, dates and quantities of applied inputs, rainfall and temperature information (recorded by the onsite weather station), and irrigation rates.

## Summary Comments

Long Island's geology is dominated by glacial till comprised of gravel and sandy soils; and its public drinking water supply is from the sole source aquifer with a federal standard of MCL for nitrogen (N) of 10 ppm designed to protect human health and the environment. Although a MCL of $\leq$ 6.0 ppm may be desirable to protect aquatic resources, unsewered sanitary systems, especially residential systems installed in close proximity to the shoreline are the primary source of N. N leaching and runoff from golf courses has been shown to be minimal based on water quality monitoring, professional turf management practices, existing regulations and implementation of ITHM and BMP protocols. The Hills golf course is expected to yield a maximum nitrogen discharge of $\leq$ 2.0 ppm, well below the 10 ppm standard set for public health protection.

The research papers and literature reviewed for the Hills proposed golf course integrated turf health management plan identified approximately 40 years of university and industry experiments and data assessment to determine the significance of inputs from golf courses and potential impacts to ground and surface waters.

As early as the middle 1980s the USGA and researchers concluded that established turf grass stands, when properly managed by turf professionals posed low potential for environmental damage from inputs. The use of historical and current management tools available to turf

managers, minimizes potential for leaching and runoff to the ground and surface waters, even in soils dominated by sand.

The turf management strategies include the following: monitoring turf nutritional requirements through soil and tissue testing as measures to assess nutrient status, monitoring clipping yield to assess turfgrass growth and density, controlling thatch and mat accumulation to maximize soil moisture levels and soil gas exchange, periodic sampling and monitoring water quality at ponds, streams, and other water bodies to determine if runoff is occurring, soil sampling for physical and chemical characteristics, including CEC, implementing moisture metering for improved irrigation controls, and using NVDI instruments to record conditions as impartial and consistent method of measurement.

This management plan explains how professional turf management programs minimize environmental degradation of ground and surface waters. Without reductions in turf quality, university research concludes that golf courses can reduce inputs including nitrogen loads ($\leq$ 2.0 mg/L, well below the Federal and New York State drinking water standard of 10 mg/L).

Best management strategies for nutritional requirements minimize potential adverse environmental impact. These techniques have been outlined above and in the NYSBMP for Golf Courses. Methods of evaluating environmental impacts and adverse conditions must be consistent and objective. There are many sources of nitrogen, with sanitary discharge and disposal methods used on Long Island a major contributor; well in excess of nitrogen generated from turf.

The Hills golf course designs and turf management will conform to the NYSBMP initiative. The Phase Two, scheduled completion date in late 2015, provides an excellent opportunity for the Hills to implement the record keeping and assessment tools during course construction, grow-in and long term maintenance beginning in 2016 (the anticipated date of golf course construction). The Hills will, on an on-going basis, complete the Phase Two assessment tool and upon request, provide the Phase Two information to the Town of Southampton. The approach provides additional monitoring and record keeping of turf management practices and confirms compliance with the NYSBMP.

DON must be considered when measuring total nitrogen. Properly planned and constructed, the Hills' golf course will act as a "green space" providing a potential sink for existing nutrient laden urban and agricultural runoff. Visual observations and review of the drainage designs indicate localized stormwater generated from the agricultural lands flows to the low point of Lewis Road and into the Town of Southampton's recharge basins. If this stormwater quality is compromised and recharged to groundwater, it may be significantly impacting the water quality at Weesuck Creek. Land uses up-gradient of the proposed Hill's project must be carefully evaluated to assess what impacts these have on surface and groundwater quality.

There is a growing trend in golf turf management to utilize Precision Turf Management (PTM). PTN uses global positioning satellite mapping (GPS) of golf course micro-environments (3,000-5,000 SF units) for improved and select use of turf management practices (pH adjustment, irrigation, pesticide and nutrient applications). According to the February 2014 issue of Golf

Course Industry magazine, the use of this technology is expected to grow. The technology can significantly reduce the use of resources applied as inputs which will be placed only in specific areas of need and these areas continuously monitored. The growing acceptance of this technology already in practice on large scale agricultural properties, may in the long run be a critical factor in reducing the potential for nitrogen leaching and runoff concerns. The Hills in in the process of assessing this technology and its applicability with respect to the anticipated construction and operation of its golf course.

Concerns for "drift" described as the dispersion of applied products beyond the intended area of application can be minimized and avoidable by equipment selection and calibration. Powered turf boom sprayers with air induction spray nozzles include boom curtains. The spray nozzles for turf applications are located 20-inches from the ground surface. The turf boom sprayer is specifically designed for product application in a downward direction (on to the turf). Spray rates (gallons per minute) and ground speeds (amount of the product applied per area, i.e. fluid ounces of the product per 1000 square feet of turf area) is governed by an onboard computerized sprayer pressure and vehicle ground speed regulating system. The computer is preprogramed by the certified applicator with the required spray rate. As the vehicle's ground speed changes (such as with topography) the rate of spray is changed by adjusting the pressure and therefore the flow. This system provides an automated calibration to occur in real time, so that the correct amount of product is consistently applied to the turf regardless of the boom sprayer's vehicle speed. Certified applicators are required to inspect spray equipment and calibrate the sprayers before applications. With the turf sprayer control system is a GIS system. The system is designed to specifically operate the equipment and apply inputs only within the predetermined GIS mapped areas. The GIS map is created for the areas only where the inputs are intended (i.e. each green, fairway and tee) and automatically activates only the sprayer nozzle(s) (typically located 14 to 20-inches apart horizontally) programmed for the mapped area. The over spray or under spray during product application is for practical terms eliminated or in the worst case reduced to 14 to 20-inches. For additional control of inputs boom sprayers are equipped with a boom curtain. The curtain covers the boom from the above the spray nozzle to approximately 2 inches above the turf canopy. This attachment reduces impact from changing wind directions, wind speeds and vehicle direction operations on the spray applications, thus directing the spray downward on to the turf.

The Lead Agency Final Scope required the applicant "evaluate and report on the potential for the pesticides used to maintain the golf course to become air-borne, causing the spread of pollutants to sites outside of the project."

The USEPA reviews and registers pesticides for use in the United States. NYSDEC reduces this federal list through a State registration procedure, and further limits pesticide products and application rates within Nassau and Suffolk Counties. For the Hills ITHMP, the pesticides approved by New York for use on golf courses in Nassau and Suffolk were screened using the USEPA Pesticide Root Zone Model (PRIZM). The results from the PRIZM screening tool and recommended low risk pesticides were further evaluated using the Field Environmental Index Quotient (FEIQ), and toxicological assessments of human and ecological impact potential. The application of a limited number of pesticides must follow ITHMP emergency protocols including Town of Southampton notification, pest and disease identification, selection of

product(s), limited number of applications, specific areas of treatment, record keeping, reporting and review.

The Hills turf management program utilizes professionally trained turf managers, qualified superintendents and state of the art equipment.

In the United States, the legal use of pesticides is controlled by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), enacted in 1947. The most significant amendment to FIFRA was the Federal Environmental Pesticide Control Act (FEPCA) of 1972. One significant part of the amendment required the USEPA to register all pesticides as well as each use of that pesticide and approve the product label. In summary the USEPA reviews all pesticides brought to market and either rejects or registers the pesticide for use. The pesticide label is required to provide product information as mandated by federal law. This labeling requirement is generally interpreted as, "the pesticide label is the law." Each pesticide label includes:

- Product Name
- Active Ingredients (by percent)
- Inactive Ingredients (by percent)
- Signal Words (Caution, Warning, Danger)
- First Aid
- Precautionary Statements (hazards to humans, animals, aquatic environments, etc.)
- Personnel Personal Equipment (PPE)
- User Safety Requirements
- Engineering Controls
- User Safety Recommendations
- Environmental Hazards
- Directions for Use (Agricultural and Non-Agricultural)
- Aerial Drift Advisory Information
- Integrated Pest Management Statements
- Target Organism Resistance Management
- Mixing, Loading and Application Instructions
- Application Rates and Application Sites and Timing
- List of Target Organisms Controlled
- Maximum Allowable Quantity of Active Ingredient Allowed per Application per Year.
- Storage and Disposal

There are three classifications for pesticides that are used to categorize toxicity and provide warning statements used to advise the applicator. The product's safe handling by the applicator is detailed on each pesticide label. The label is required to provide "signal words" that advise applicators of potential concerns.

- Class I "Caution" mildly toxic
- Class II "Warning" moderately toxic
- Class III "Danger/Poison" (skull and cross bones) highly toxic

All registered pesticide labels state, "Keep-Out of Reach of Children."

Personal Protective Equipment (PPE) generally required for each classification:

Class I: Wear work clothes including long pants, long sleeve shirt, socks, and shoes.
Class II: Wear coveralls over your work clothes or wear chemical resistant overalls.
Class III: Wear chemical resistant overalls, chemical resistant boots and gloves.

If the chemical is an eye irritant applicators wear eye protection.

The applicator makes the final decision on what PPE is necessary based on the statements provided on the product label. Every pesticide label is reviewed for its specific personal safety requirements based on its specific toxicity rating. For golf courses, the majority of pesticide applications are fungicides, which generally are listed as Class I and II; with less frequent applications of herbicides and insecticides listed as Class I and II. Soil fumigants such as *Basamid* (Dazomet) are Class III. Soil fumigants are commonly used for pre-plant controls of soil nematodes, fungi and weed seed germination. The Hills golf course will not need the use of soil fumigants for the construction or operational phases of the golf course.

The USEPA is also responsible for the administering the national program that assures a desired level of technical competence associated with private and commercial pesticide applicators. In New York State, the lead agency designated for pesticide registration, pesticide use, applicator certification and enforcement of state and federal regulations is the NYSDEC, Division of Materials Management Bureau of Pesticides Management. Commercial pesticide applications can only be performed by a NYS Certified Commercial Pesticide Applicator. General eligibility requirements for certification are:

- Qualify as a Commercial Technician- Minimum age of 17; Completion of 30-hour NYSDEC approved training program.
- Pass Core Exam – 90 minutes 50 questions- closed book
- Pass Technical Exam- 90 minutes 50 questions-open book
- Provide Proof of One-year experience with pesticide applications performed under supervision of a NYS Certified Commercial Applicator
- Complete 12 hours of category specific certification training credits from pesticide courses approved by the NYSDEC
- Pay NYS Certification fees

NYSDEC regulates pesticide applications pursuant to 6NYCRR Part 325 Rules and Regulations Relating to the Application of Pesticides. Part 325.16 describes twelve categories of commercial pesticide applications. Generally turf professionals are certified in the category 3A: Ornamentals and Turf. On-site staff involved in the application of pesticides shall at a minimum be NYS Certified Commercial Pesticide Applicators- Category 3A.

The NYSDEC also registers pesticides for use in the state, such that all USEPA registered pesticides are not legally permitted for use in New York unless the product is also registered by the state. The NYSDEC further restricts pesticide use within specific counties, with Nassau and

Suffolk Counties having the most restrictions on pesticides available for use and limitations of annual cumulative application quantities for specific pesticides.

Pesticides are available in several different formulations. These include aerosols, granules, ready-to use (RTU), emulsified concentrates (EC), wettable powders (WP), soluble powders (SP), flowables and fumigants. Controlling drift is important for the commercial applicator. The pesticide's formulation together with selection of pesticide application equipment can be effective in reducing the potential for drift. For example a pesticide as an aerosol formulation would have a greater potential for aerial drift than that same pesticide in a large particle granule formulation. With regard to equipment, an accurately calibrated drop spreader would apply a pesticide in a more precise location than a broadcast spreader; yet each would have less potential for aerial drift than the same pesticide applied from a helicopter.

To be effective, the pesticide must be applied precisely on the target at the correct rate, volume and pressure. Particle drift can be influenced by particle size, nozzle design and orientation, pressure, temperature, humidity, evaporation, height of release, air velocity and movement, and each must be considered.

To avoid aerial drift, and mitigate the potential for the spread of pollutants to sites outside of the project area, the applicator shall be required to follow the pesticide label. Typical label instructions are:

- Use the largest particle and droplet size
- Use the lowest practical pressure
- Select nozzles that produce large numbers of large particles
- Apply as close as practical to the target
- Use a drift control additive (aka "stickers")
- Not apply when wind, temperature or humidity are unfavorable
- Choose non-volatile pesticide formulations
- Increase flow rates of the application
- Establish buffer zones to avoid ecologically sensitive areas and waterways
- Use new technologies including: drift reduction nozzles, spray shields-boom curtains, air-assist spray and GPS area control equipment.

There are three primary methods of applying pesticides to turfgrass and ornamental plantings:

1. Low pressure (30-60 psi) boom sprayers, typically mounted on a small utility vehicle with multiple (11-21) nozzles located approximately 20 inches above the ground surface. This equipment is used for pesticide formulations that are mixed with water (emulsified concentrates, wettable powders, soluble powders, emulsifiable concentrates, and flowables).
2. Spreaders either rotary broadcast spreaders or drop spreaders either walked or towed by a tractor or utility vehicle. This equipment is used for dry particle pesticide applications (granules).

3. Hand held/back-pack sprayers are used for "spot spraying" generally defined as placing the hand held discharge nozzle directly on the target organism (typically a weed). Spot spraying applications are generally limited to areas of 900 square feet or less per application.

All pesticide application equipment must be calibrated by the applicator to determine the rate of the application and adjust the equipment for the correct discharge of the active ingredient whereby pesticides are not over or under applied.

Typically the majority of golf course pesticide applications utilize a low pressure boom sprayer. Depending on the product formulation and environmental conditions, rotary and broadcast spreaders are also used, and low pressure hand held sprayers utilized for spot spray weed control.

To minimize the potential for the pesticides used to maintain the golf course to become air-borne, and causing the spread of pollutants to sites outside of the project, the Hills NYS Certified Commercial Pesticide Applicators will in addition to product label instructions, utilize a powered turf boom sprayer, equipped with a spray nozzle boom wind-curtain (Appendix 22). The boom curtain encapsulates the boom (the boom is where the nozzles are mounted approximately 20-inches above the ground), isolates the spray from the weather conditions and directs the spray directly to the turf. The use of the curtain reduces the potential of drift to nearly zero. The sprayer uses a GPS system with on-board real time computerized application controls. The controls are designed to specifically apply inputs at pre-set rates, continuously adjusted for various ground speeds, within the GPS pre-programmed mapped areas (footprints of the greens, tees and fairways are programed into the sprayer's on-board computer and GPS). The equipment directs application of nozzle spray downward, only within the designated areas, with zero to minimal potential for overspray. In combination with the boom curtain, the GPS system is the most advanced sprayer technology available designed to minimize applicator error, conserve inputs and avoid impacts to non-target areas and organisms.

The use of hand held sprayers for spot spraying and low pressure boom sprayers equipped with GPS and spray shield-boom curtains, together with experienced certified applicators and pesticide label instructions, particle drift is expected to be avoided or be limited to areas within the immediate Hills property boundaries. Label instructions require applicators to follow specific set-back distances from environmentally sensitive areas, water resources and non-target plants. This requirement will be implemented through on board computer programing of the sprayer and the GPS mapping systems. This technology automatically shuts off the sprayer or sprayer nozzles within programmed geographic areas to avoid non- target releases.

There were 28 pesticides that would be appropriate for use on the golf course with no or minimal restrictions beyond the risk-assessed and heavily regulated product labeling. There were significant restrictions recommended on another 11 golf course pesticides, and a recommendation that eight pesticides that are legally registered for golf course use in Suffolk County not be used at this site. For the lawn care program, 16 pesticides were identified for use without additional restrictions beyond the regulated labeling, and one with a timing restriction. It was recommend that eight registered pesticides not be used on home lawns at this site. In

addition, three pesticides will not be used and two pesticides will have limited use, based on Dr. Marty Petrovic's concerns. ***It is important to note that only a small fraction of this total is expected to be used in any single year.***

The Hills turf management facilities will be equipped with PPE, OSHA required MSDS and employee hazard communication programs, emergency response and spill cleanup kits, trained personnel, wash down and wastewater recycling equipment.

Turf and soil samples will be routinely collected and analyzed by qualified laboratories to determine nutrient levels, plant physiological conditions, evaluate physical properties of soils and identify turf pathogens. This part of the Integrated Pest Management (IPM) and ITHMP provide alternative controls to pesticide applications necessary to address turf health.

Turfgrass when compared to other cultivated plants (vegetable crops, nursery stock) creates a "carpet-like" canopy and dense root system. Turf provides more significant area for input collection and uptake than most row-crop plantings. Row-crop plantings allow for a greater area of un-vegetated soil exposure, where applied inputs by-pass the plant leaves and roots and if mobile, move through the soil profile to groundwater or hold potential for dispersion via sediment laden runoff. Acre for acre turfgrass offers more vegetative cover than most all agricultural and nursery products.

The ITHM program together with the G&SWMP will provide an integrated system for turf management. The lined greens and stormwater collection/treatment for the development systems will offer additional environmental protection.

The NTEP uses a system of rating turfgrass performance trials and is based on visual observations, rating each parameter (color, density, etc.) on a scale of 1 to 9 with 9 being the highest qualitative number. The NTEP rating is used by trained professionals that understand its use and their abilities to arrive at consistent and useful turfgrass ratings. There is no need to significantly change or eliminate the NTEP rating system largely because its use is limited to the NTEP. What must be considered is a tool for the broader use that can evaluate turf health; and provide a consistent standard that is acceptable to a wide range of stakeholders.

To accurately perform ITHM, historical turf information (chronic insect populations, persistence of plant disease, cultural practices including dates for aeration and materials used for topdressing etc.) will be developed by the Hills' turf manager and will be evaluated over time. Soil sample (collected from tees greens and fairways) analytical results, plant tissue analysis and cultivar types are all necessary for long term ITHM development.

All major varieties of turf grasses are not the same and within the particular major types available for use at the Hills site (Kentucky bluegrass, fescue, bentgrass, annual bluegrass and rye grass). There are hundreds of genetic variations of these grasses. These genetic variations have a profound effect on how each cultivar reacts to specific turf management practices. What may be good for one type of cultivar (i.e. high rates of fertilization) may not produce the best results for another cultivar of the same turf type. This can provide growth advantages to one type of plant compared to another. However while that type may do well with increased fertilizers (and the other be not as responsive) it may not perform well under high heat stress, or

rebound after insect attack. The surrounding ecology and environmental conditions (soils, available sunlight, and topography) will be indicators for selection of turfgrass selections to avoid the "wrong" plant that will require large inputs of water and turf chemical applications to maintain it.

The concentration of soil based nutrients required for healthy turf and turf growth varies depending upon the turf species, specific cultivars, and the specific nutrient. Ideally turf grass will be sustained with supplemental macro nutrients, micro nutrients and water such that their carbohydrate production levels, utilization and production of plant enzymes, respiration and biochemical reactions during photosynthesis remain in physiological equilibrium. Basically, healthy turf depends upon plant physiology, and plant physiological reactions can be very specific among different plant species, cultivars within the species and their tolerance to biotic and abiotic stresses.

The critical concentration for each nutrient is defined as the concentration level in the plant tissue at which the plant achieves 90% of its maximum growth. The successful ITHM is therefore based on the science of the turf grass, plant genetic characteristics, and soil and tissue analyses for each cultivar used within the golf course (tees, greens, fairways and roughs).

Although many "organic" products are available for turf management, our turf management team depends upon science to evaluate the most suitable materials and cultural practices for yielding the best results, while minimizing environmental impact. This does not exclude "organic" based products, however some "organic" products such as weed control herbicides made from pepper juice are non-selective and kill the weed as well as the grass.

The applicants have direct access to the recognized turf management experts from Cornell University, Pennsylvania State University (PSU), University of Massachusetts (UMASS) Amherst, Center of Agriculture Plant Diagnostic Lab for providing analysis, identification and ecologically sound management strategies for diseases, insects, weeds and nematodes found in turf and ornamentals.

ITHM will begin with an independent and objective soils analysis likely conducted by Brookside Laboratories, Inc., New Knoxville, OH considered among the finest agricultural testing labs in the country and recognized for their science based linkage of existing soil chemistries with turf plant health. Brookside will be sent soil samples from areas of the site proposed for fairways, tees and greens and conduct an analysis and audit of soil conditions.

Once the background soil analyses are determined, the applicants will assess the results with respect to turf selection. The NTEP reports will be used in conjunction with university field trials (Rutgers, Penn State, U Mass and URI) to evaluate the selection of turfgrasses most adapted to the local environment.

NTEP is designed to develop and coordinate uniform evaluation trials of turfgrass varieties and promising selections in the United States and Canada. Test results can be used by national companies and plant breeders to determine the broad picture of the adaptation of a cultivar. Results can also be used to determine if a cultivar is well adapted to a local area or level of turf maintenance.

While the IPM approach often includes use of cultural practices to improve the hardiness and sustainability of the plants, the emphasis is still on pest management. For the Hill's golf course a healthy plant system will be developed that generally resists invasion by weeds, is more resistant to disease attack, is better able to withstand insect attack, and can better recover from extreme weather conditions (i.e., drought, heat, and cold). The current thinking is embodied in the idea of Plant Health Care (PHC), or in our case ITHM.

For the progressive IPM it is imperative to establish and maintain what level of damage or organism population size is acceptable before actions are implemented. IPM is still a necessary component of turf management and the Hills will continue to utilize IPM in accordance with management practices required by NYSDEC Pesticide Certification requirements for turf and ornamentals, the NYSBMP and the ITHMP.

The G&SWMP will provide long term post construction water quality information that can be used to adjust onsite management of turf and ornamental plantings. Fuel and chemical storage and handling equipment will meet the minimum standards required for approval of installation and storage pursuant to SCDHS and NYSDEC regulations.

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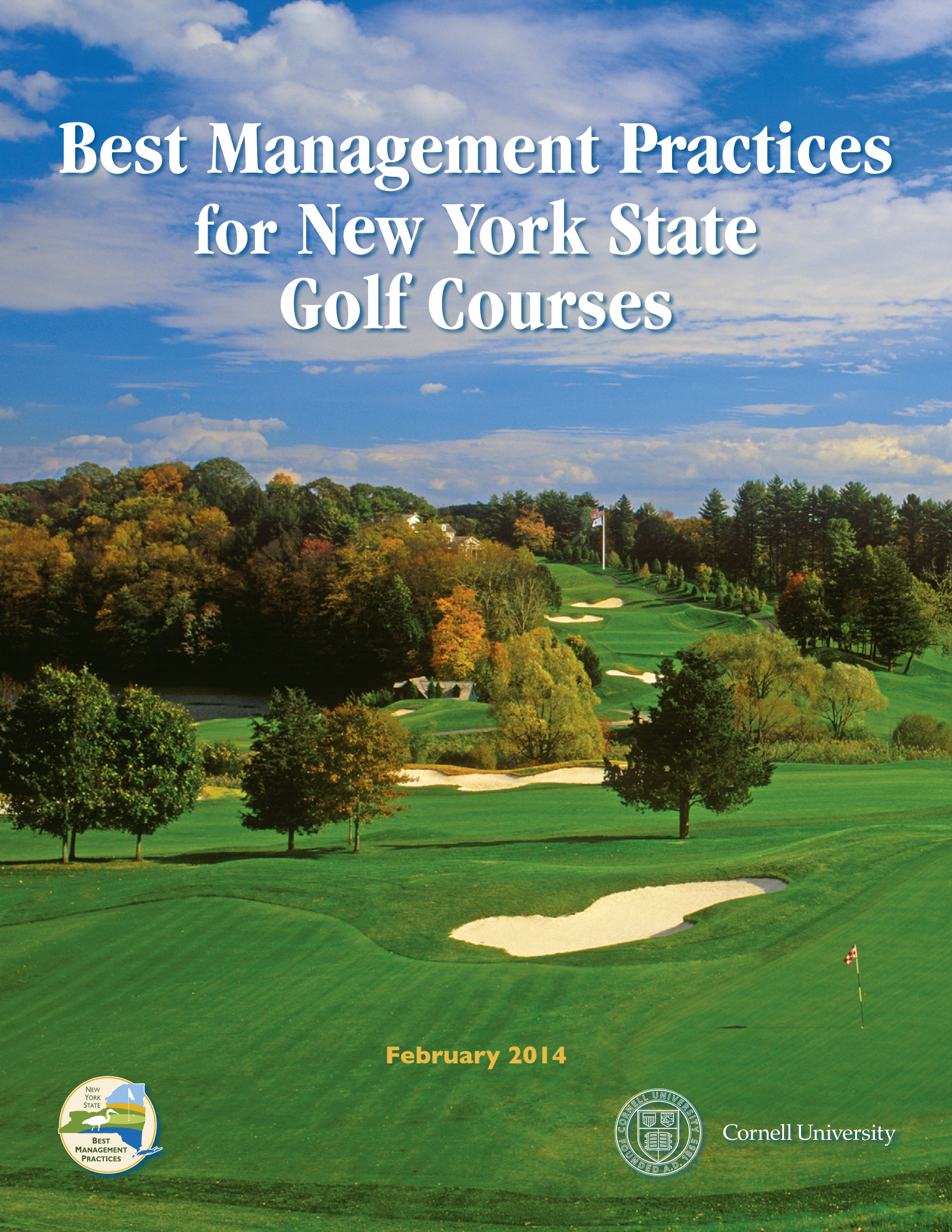
# Appendix 1
# New York State Best Management Plan for Golf Courses

# Best Management Practices for New York State Golf Courses



February 2014

New York State Best Management Practices

Cornell University

# Best Management Practices for New York State Golf Courses

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Cover photo: GlenArbor Golf Club, Bedford Hills, NY.

# FOREWORD

The game of golf provides boundless recreational opportunities and health benefits to millions of golfers worldwide. As both a golfer and a golf course designer, I believe that golf courses should exist in harmony with the natural setting. Therefore, respecting the environment is at the core of everything I do.

When I am involved in a golf course project, such as the construction of GlenArbor Golf Club in Bedford Hills, I require that everyone involved share this respect. At my company, we have particularly focused on one of earth's most precious resources – water. Protecting water quality and conserving water are not only a fundamental responsibility for our industry, but also translates into real cost savings for golf course operations. For these reasons, I am proud to endorse the *Best Management Practices for New York State Golf Courses*. The New York State golf course superintendents associations, researchers at Cornell, and the state and national organizations that have provided additional support should be commended for this effort and making this information so readily accessible to anyone who cares about conserving our natural resources.

- *Gary Player, January 2014*

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Adirondack Golf Course Superintendents Association
Central New York Golf Course Superintendents Association
Finger Lakes Association of Golf Course Superintendents
Golf Course Superintendents Association of America
Environmental Institute for Golf
Hudson Valley Golf Course Superintendents Association
Long Island Golf Course Superintendents Association
Metropolitan Golf Association
Metropolitan Golf Course Superintendents Association
Metropolitan PGA
New York State Turfgrass Association
Northeastern Golf Course Superintendents Association
Turfgrass Environmental Stewardship Fund
Western New York Golf Course Superintendents Association

Last, this project was reviewed in the draft and draft final stages by members of the partner organizations, members of the golf industry, as well as the New York State Department of Environmental Conservation. We thank the reviewers for the time and effort spent to improve the final products of these efforts.

## Acronyms

| | |
|---|---|
| A | acre |
| AAPFCO | Association of American Plant Food Control Officials |
| ABW | annual bluegrass weevils |
| AI | active ingredient |
| BMP | best management practice |
| BOD | biological oxygen demand |
| BPD | backflow prevention devices |
| CA | calcium |
| $CaCO_3$ | calcium carbonate |
| CEC | cation exchange capacity |
| CNMP | Comprehensive Nutrient Management Plan |
| $CO_3$ | carbonate |
| CU | coefficient of uniformity |
| CWA | Clean Water Act |
| DAP | diammonium phosphate |
| DCD | dicyandiamide |
| DI | deep and infrequent irrigation |
| DU | distribution uniformity |
| DULQ | distribution uniformity of the lowest quartile |
| EC | electrical conductivity |
| ECe | salt tolerance of turfgrass species |
| ECL | Environmental Conservation Law |
| ECw | electrical conductivity of water |
| EIQ | Environmental Impact Quotient |
| EPA | Environmental Protection Agency |
| ET | evapotranspiration |
| FUEIQ | field use EIQ rating |
| g/L | grams per liter |
| GCSA | Golf Course Superintendents of America |
| GIS | geographic information system |
| GPS | global positioning system |
| GUS | groundwater ubiquity score |
| $HCO_3$ | bicarbonate |
| IBDU | isobutylidene diurea |
| IPM | integrated pest management |
| IRPeQ | pesticide risk indicator for Quebec |
| K | potassium |
| $K_2O$ | potassium oxide |
| Kc | crop coefficient |
| Koc | soil adsorption |
| lbs/A | pounds per acre |

| | |
|---|---|
| LF | light and frequent irrigation |
| LR | leaching requirement |
| MAP | monoammonium phosphate |
| MCL | maximum contaminant levels |
| Mg | magnesium |
| mg/L | milligrams per liter |
| MOA | Memorandum of Agreement |
| mPa | millipascal |
| MSDS | Material Safety Data Sheets |
| MU | methylene urea |
| N | nitrogen |
| Na | sodium |
| NBPT | n-butylthiophosphoric triamide |
| NCDC | National Climate Data Center |
| NFPA | National Fire Protection Association |
| $NH_4$ | ammonium |
| $NH_3$ | ammonia |
| $NO_{2-}$ | nitrite |
| $NO_{3-}$ | nitrate |
| NRCC | Northeast Regional Climate Center |
| NYSDEC | New York State Department of Environmental Conservation |
| NYS | New York State |
| NYSDOH | NYS Department of Health |
| NYSDOT | NYS Department of Transportation |
| OEHD | Occupational and Environmental Health Department |
| P | phosphorus |
| $P_2O_5$ | phosphate |
| PAWC | plant-available water capacity |
| Pb | lead |
| PET | potential evapotranspiration |
| PIMS | Product Ingredient Manufacturer System |
| PMEP | Pesticide Management Education Program |
| PPD | Pesticide Properties Database |
| PPE | personal protective equipment |
| ppm | parts per million |
| PSEP | Pesticide Safety Education Program |
| RCRA | Resource Conservation Recovery Act |
| RSC | residual sodium carbonate |
| S | sulfur |
| SAR | sodium adsorption ratio |
| SC | scheduling coefficient |
| SDS | Safety Data Sheet |
| SDWA | Safe Drinking Water Act |

| | |
|---|---|
| SEQR | State Environmental Quality Review |
| SPDES | State Pollutant Discharge Elimination System |
| SSP | single superphosphate |
| SWPPP | Stormwater Pollution Prevention Plan |
| TDS | total dissolved salts |
| TMDL | Total Maximum Daily Load |
| TN | total nitrogen |
| TP | total phosphorus |
| TSS | total suspended solids |
| UAN | urea-ammonium nitrate |
| UF | urea-formaldehyde |
| USDA | United States Department of Agriculture |
| USGS | United States Geological Survey |
| VOC | volatile organic compound |
| WIN | water insoluble nitrogen |
| WIN PST | Windows Pesticides Screening Tool |
| WSN | water soluble nitrogen |
| Zn | zinc |

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# 1 INTRODUCTION

Golf courses and their supporting industries benefit New York State residents directly and indirectly:

- **Environmental benefits.** Golf courses provide open space, and their well-managed turfgrass protect water and other natural resources.

- **Economic benefits.** The golf industry contributes more than $3 billion and 50,000 jobs annually to the state's economy. Golf fundraisers also contribute approximately $100 million annually to charities across the state, funding countless diverse and worthy causes.

- **Recreational and health benefits**. Golf courses provide excellent recreational and health benefits for golfers of all ages. A Swedish study found golfers who walk when playing live five years longer than non–golfers.

As the stewards of golf courses in NY, superintendents are dedicated to protecting New York's natural resources and embrace the responsibility to maintain these facilities in harmony with the natural environment. The golf industry has led the effort in establishing Best Management Practices (BMPs) for golf courses in New York State. These BMPs will help those in the golf industry work in concert with policymakers and regulators in a shared commitment to water quality protection.

Authors from Cornell University have integrated the latest research on BMPs specifically for New York's climate and environment; however, neighboring New Jersey and Connecticut will benefit as well. The research-based, voluntary BMP guidelines are designed to protect and preserve New York's water resources that enhance open space using current advances in golf turf management.

This effort to provide extensive guidance for environmental stewardship is being conducted in the best traditions of golf, as defined by golf's inherent values: honesty, integrity, and fair play (including upholding the rules when no one is watching). These are core values of golf turf professionals and serve as the basis for this innovative environmental effort.

## What are BMPs?

BMPs are methods or techniques found to be the most effective and practical means of achieving an objective, such as preventing water pollution or reducing pesticide usage. Many BMPs reduce stormwater volume, peak flow, and nonpoint source pollution through evapotranspiration, infiltration, detention, filtering, as well as biological and chemical actions. This new guidance provides information for using BMPs to prevent or minimize the effects of golf course management on surface and groundwater to insure and enhance public health and environmental quality. Pollution prevention is easier, less expensive, and more effective than

addressing problems "downstream". Essentially, BMPs are a sustainable approach to providing environmental, economic and social benefits to golf and society.

## Why are BMPs important to the golf industry?

Golf courses rely on a healthy environment that includes water and wildlife. It is of paramount importance to enhance and protect water quality. A significant body of research exists that indicates successful implementation of BMPs virtually eliminates the golf course risk to water quality. In fact, several studies have shown that implementing BMPs enhances water quality on its journey on and through the golf course property.

Additional incentives for golf courses in New York State to implement BMPs include the following:

- potential for more efficiently allocating resources by identifying management zones
- cost savings associated with applying less fertilizer and pesticide
- improved community relations
- recognition by club members and the community at large as environmental stewards

Through a cooperative approach between the golf industry and friends and neighbors outside the industry, practices have been developed that benefit all parties.

## When should you be aware of BMPs?

BMPs provide a science-based approach to protecting water quality from potential risks. Whether managing an existing course, renovating an existing course or constructing a new course, BMPs can be designed, installed and implemented. For example, golf course renovation and design projects can incorporate landscape BMPs such as vegetated swales, properly sited maintenance and storage facilities and efficiently designed irrigation systems. Specifically, during a renovation or grow-in period, BMPs protect water quality while the site is most vulnerable to soil erosion. For existing courses, the day-to-day management decisions on when, how much and how to apply nutrients provides many additional opportunities to apply BMPs that preserves and protects water quality.

## How to align golf course management with BMPs

Successful implementation of BMPs begins with understanding a few basic environmental and water quality concepts associated with land management and water (Chapters 2 and 3). Using these concepts, a thorough site-specific understanding of vulnerable areas can focus BMP implementation in every stage of golf course design, construction, renovation, and maintenance (Chapter 4).

BMPs for irrigation (Chapter 5) and nutrient management (Chapter 6) and the role of turf density (Chapter 7), integrated pest management (IPM) and pesticide management (Chapters 8 and 9) will prevent runoff, leaching, and drift. Golf course managers must understand how

much water is needed and when to apply it; how to select fertilizers and pesticides; and when, how, and where these compounds should and should not be applied. In addition, IPM principles provide alternatives to applying pesticides, as well as justification for using pesticides when necessary. Finally, maintenance facilities should also be properly managed in order to prevent point source release of chemicals that can reach ground or surface waters (Chapter 10).

# 2 ENVIRONMENTAL CONCEPTS

Understanding the following environmental concepts provide the basis for understanding the role of BMPs in water quality protection:

- concepts related to climate and microclimates
- concepts related to water, such as the hydrologic cycle and watersheds
- concepts related to soils, such as soil texture and soil moisture
- concepts related to geology, such as karst topography

Water, soils, and geology all play a role in environmental fate and transport mechanisms (such as runoff and leaching) that can contribute to water quality impacts. BMPs act on these fate and transport mechanisms to prevent water quality contamination.

## 2.1 Climate

Projections of a changing climate suggest that rainfall events will become less frequent, but more intense. As a result, a greater volume of the precipitation is expected to run off instead of infiltrating into the soil and replenishing groundwater. Consequently, the need for supplemental irrigation may increase, and superintendents will need to take greater care in the applying fertilizer and pesticides to reduce the risk of runoff. Structural BMPs are also valuable in managing increased runoff. For more information on available climate data for New York, see the Northeast Regional Climate Center (http://www.nrcc.cornell.edu/).

Golf courses are diverse landscapes with a variety of microclimates that require site-specific management to maintain uniform playing conditions. Microclimates are created by landforms as well as by vegetation and water bodies. In each case, the golf course superintendent must adapt management programs that address nutrient and pest management needs while understanding the effect these microclimates might have on the fate of applied materials.

## 2.2 Hydrologic Cycle

The hydrologic cycle is the cyclic movement of water in its various phases through the atmosphere, to the Earth, over and through the land, to the ocean, and back to the atmosphere (Figure 2-1). The sun is the powerhouse for the hydrologic cycle, providing the energy for phase changes of water (evaporation and condensation) and for the storage and release of latent heat. Because water is an efficient solvent, all water-soluble elements follow this cycle at least partially. Thus, the hydrologic cycle is the integrating process for the fluxes of water, energy, and the chemical elements throughout the environment.

Water enters the hydrologic system as precipitation, primarily in the form of rainfall or snowfall. It is then delivered to surface waters from runoff or infiltrates into the subsurface. Water can leave the system via stream flow or runoff, evaporation from open bodies of water, or evapotranspiration (evaporation from soil surfaces and transpiration from the soil by plants).

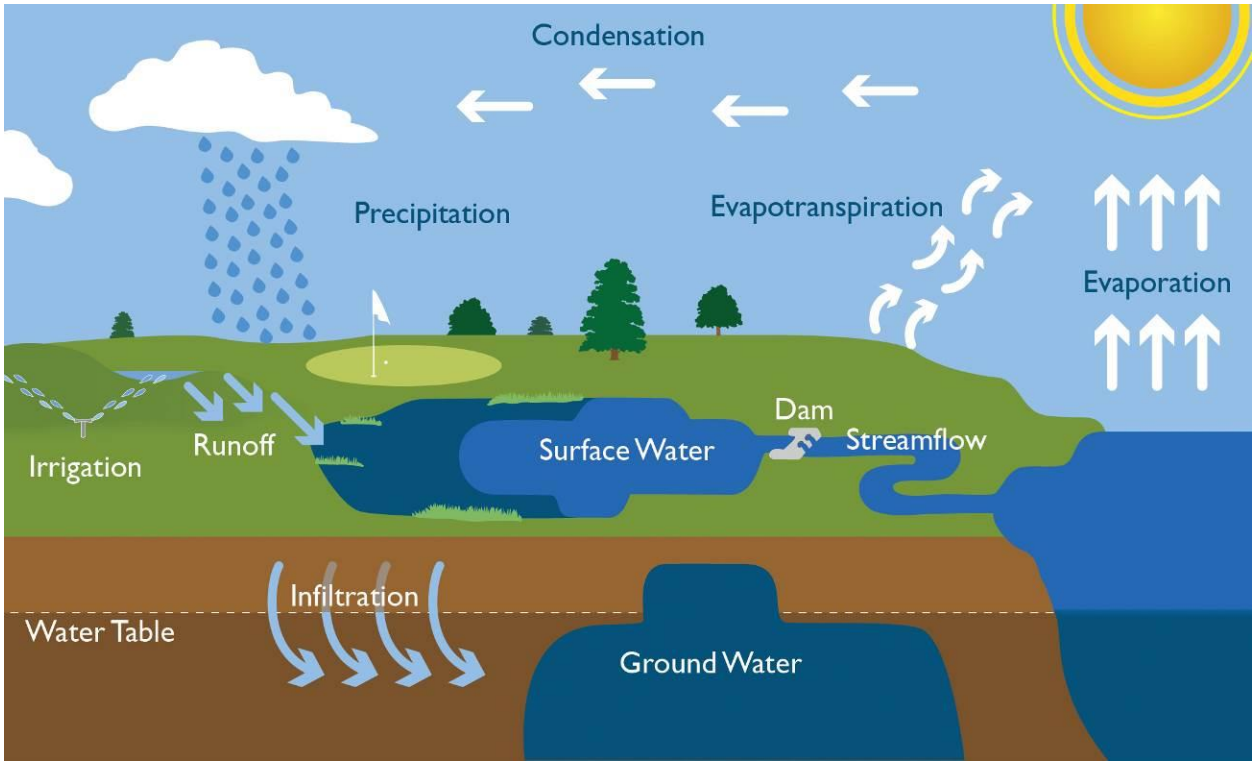



**Figure 2-1. The hydrologic cycle.**

### 2.2.1 Groundwater Recharge

Water moves through the surface of the earth, eventually through the soil horizons to natural storage areas below the ground. Depending on subsurface rock formations and overall permeability, the filling of these storage areas or "recharge" can collect water from a few hundred square feet to a few square miles. Groundwater often provides the source of water for perennial stream flow at base flow conditions when there is no precipitation. It is critical to understand the basics of groundwater recharge, both in size and scope, to mitigate potential contamination.

### 2.2.2 Infiltration and Runoff

The amount of water that infiltrates into the ground from the total run off depends on a number of variables, including the intensity of precipitation or irrigation, soil infiltration capacity, site characteristics, antecedent soil moisture, and season. Water that infiltrates into the soil either is stored within the soil profile or percolates downward toward groundwater, depending on the soil moisture conditions and soil structure. This soil water is then available for evapotranspiration. If the moisture-holding capacity of the soil is exceeded, the excess water percolates downward through the soil profile to groundwater. If the soils are at saturation, any additional precipitation does not infiltrate into the soil and becomes surface runoff instead. It is in this runoff that more soluble compounds applied to turf have the greatest potential to move off site.

Site characteristics including land use, land cover, soils, and topography also influence the amount of infiltration versus amount of runoff. Turf, forests, fields, and other vegetated areas slow down the flow of runoff, filter out sediments, and trap pollutants or break them down biologically. Conversely, hard impermeable surfaces such as buildings, roads, parking areas, and exposed bedrock prevent water from infiltrating into the ground. These hard impermeable surfaces, as well as bare soils, offer little resistance to reduce the velocity of runoff. Similarly, compacted soils and saturated soils retard the infiltration of water and therefore promote runoff. Lastly, steep slopes can increase the rate and amount of runoff.

The amount of runoff versus infiltration at any location also varies seasonally. During the winter, soils in New York are likely to be frozen and impermeable to water. Snowmelt, rain, and low evapotranspiration rates in the spring generate wet soil conditions and downward movement of water to groundwater. The potential for runoff is high because the near-saturated or partially frozen soils have low water infiltration capacities. During the summer, high rates of evaporation and plant water uptake may reduce soil water storage, leaving none to percolate downward. Summer rains only partially recharge the soil profile, and the soil's moisture holding capacity is typically not exceeded. Except for high-intensity thunderstorms, runoff and erosion potentials are generally low during the summer. In the late fall, evapotranspiration rates decrease, and groundwater recharge occurs when the moisture-holding capacity of the soil is exceeded. Runoff and erosion potentials also increase during this period. However, in New York, runoff from turf most often occurs from wet soils and not from high rainfall intensity.

## 2.3 Watersheds

A watershed is generally defined as an area of land that drains into a body of water, such as a river, lake, estuary, reservoir, sea, or ocean. Thus, all golf courses are in some watershed. A watershed includes the network of rivers, streams, and lakes that convey the water, as well as the land surfaces from which water runs off. Watershed boundaries follow the highest ridgeline around the stream channels and meet at the bottom or lowest point of the land where water flows out of the watershed. The boundary between watersheds is defined as the topographic dividing line from which water flows in two different directions.

Identifying and defining watersheds depends on the scale at which the landscape is examined. A watershed may be small and represent a single tributary within a larger system (such as a subwatershed), or be large and cover thousands of miles and cross numerous state boundaries, such as the Chesapeake Bay watershed. New York State is divided into 17 watersheds (Figure 2-2).

**Figure 2-2. Watersheds in New York State.**

At a larger scale, the U.S. Geological Survey (USGS) has divided and subdivided the United States into units classified into four levels: regions, subregions, accounting units, and cataloging units. A fifth field of classification (watershed) and sixth field (sub-watershed) are currently under development by USGS. The hydrologic units are arranged or nested within each other, from the smallest (cataloging units) to the largest (regions). Note that watersheds cut across typical regulatory boundaries such as counties and states, which can complicate regulation.

The first level of classification divides the United States into 21 major regions. Regions contain either the drainage area of a major river, such as the Missouri region, or the combined drainage areas of a series of rivers, such as the Texas-Gulf region, which includes a number of rivers draining into the Gulf of Mexico. New York State is situated within the boundaries of three regions: Ohio, Mid-Atlantic, and Great Lakes.

For more information on watersheds, see:

- NY Department of Environmental Conservation (NYSDEC ) web site on New York watersheds (http://www.DEC.ny.gov/lands/60135.html)
- USGS watershed classification (http://water.usgs.gov/GIS/huc.html)

**USGS Hydrologic Units Example**

Cataloging Unit: French River

Accounting Unit: Allegheny

Subregion: Allegheny River Basin

Region: Ohio

- U.S. Environmental Protection Agency (EPA) Surf Your Watershed (http://cfpub.epa.gov/surf/locate/index.cfm)

## 2.4 Water Conservation

The increasing concentration of the US populations in urban and suburban areas is leading to concentrated demand for water resources. This urbanization has begun to challenge the supply of affordable and plentiful fresh (potable) water for irrigation in New York State. Water suppliers in most of the northeastern US must double the supply capacity to meet demand in the summer, resulting in high infrastructure costs. Therefore, economic, social, environmental, and political pressures dictate that water is used efficiently and conserved on New York's golf courses.

Golf course superintendents can maintain a landscape optimal for play, while conserving water, through effective course design and management. For example, reducing managed turf areas reduces water needs, maximizes rooting in areas that are irrigated, and improves the use of the water applied. In addition, a well designed, properly maintained, and wisely used irrigation system ensures the uniform application of water and minimizes runoff. Many of the BMPs discussed in this manual result in more efficient water usage, such as improving the efficiency of irrigation systems. In addition, superintendents can reduce irrigation requirements by a number of means, such as minimizing maintained areas, maximizing rooting potential, reducing water lost through evapotranspiration, and improving soil water storage where possible on sandy sites.

For general information on water conservation on golf courses, see:

- "Water Conservation on Golf Courses" United States Golf Association (USGA), http://www.usga.org/Content.aspx?id=25918
- "Water Conservation" Golf Course Superintendents Association of America (GCSAA), http://www.gcsaa.org/_common/templates/GcsaaTwoColumnLayout.aspx?id=1783&LangType=1033

For specific water conservation measures for golf courses, see:

- Fertilizing for Water Conservation (Cornell research), published in *Golf Course Management*, http://www2.gcsaa.org/gcm/2000/dec00/pdfs/12fert.pdf

## 2.5 Soils

Soil is the growing medium for turf on golf courses. Golf course superintendents must understand the behavior and function of water in the soil, as it assists with determining the potential off-site movement of fertilizers and pesticides.

Water can infiltrate into the soil and then can be held in pores or adhere to soil particles. The infiltration and water holding capacity of a soil involves different forms of energy. Three forces determine the water storage capacity of soil:

- gravitational potential, which draws water down and through the soil profile.
- matrix potential, which is defined by the adsorption of water to the soil particle surfaces. Smaller soil particles, like clay or silt, as well as organic matter, have a greater total surface area than a coarser material such as sand.
- osmotic potential, which is the attraction of water to solutes. The plant root system uses osmotic potential to draw water from the soil across the root membrane.

Downward movement of water through large soil pores or when soil is fully saturated is driven by gravity, hence the term gravitational water (Figure 2-3). When the soil is saturated, some of this water will become groundwater recharge or can enter drainage tiles, if present. The amount of water that remains after gravity has exerted its influence is referred to as the "field capacity" of the soil.

The water content of the soil determines whether plants thrive or wilt. Evapotranspiration from the turf surface draws water from the soil. If this process continues unabated and no irrigation or rainfall occurs, the soil will dry to a point known as the wilting point. The difference between soil moisture content at field capacity and the point at which plants wilt due to lack of moisture is referred to as "plant available water". Often little plant-available water is present in the soil when it reaches the wilting point, which is the point at which the soil holds the water with greater energy force than the plant can exert to extract it.

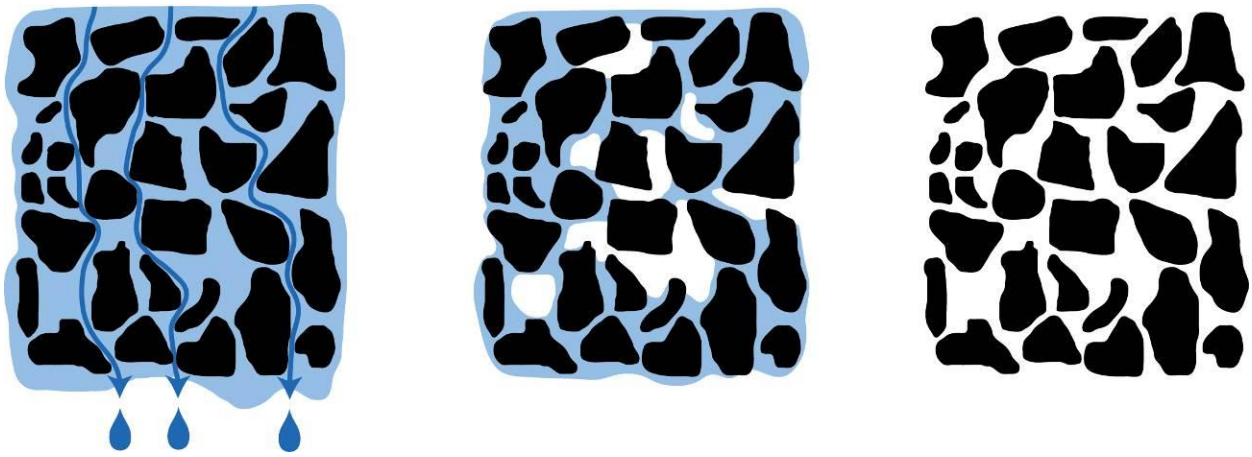


**Figure 2-3. Soil water field conditions: saturation (left); field capacity (middle), and wilting point (right).**

The amount of plant-available water depends upon the soil structure, texture, and organic matter. The classification of soil structure and textural analysis is shown in the soil texture triangle. (Figure 2-4). Lab analysis can determine the percent distribution of sand, silt, and clay. The amount of plant-available water held by different soils is presented in Figure 2-5. Commercially available moisture meters are able to read soil moisture percentage.

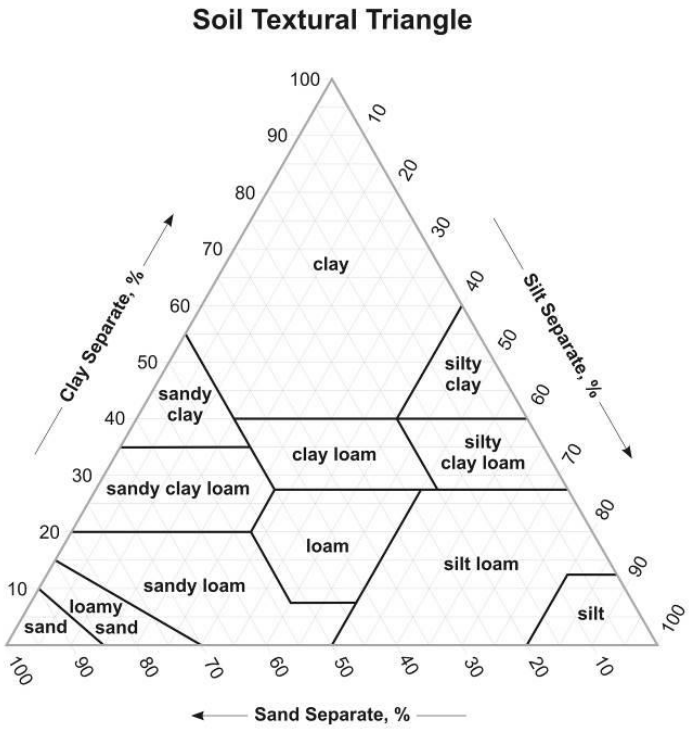



**Figure 2-4. Soil textural triangle depicting soil particle distribution for different soils. Soil size definitions are as follows: Clay <0.002mm, Silt = 0.002-0.05 mm, Sand = 0.05 -2.0 mm. Source: USDA.**

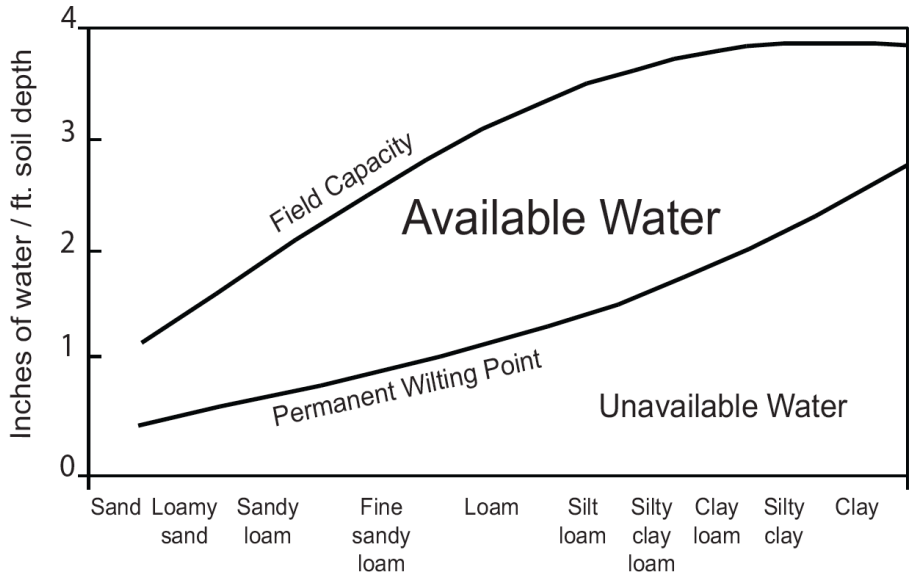



**Figure 2-5. Available water by soil type. Source: Ohio Agronomy Guide, 14th edition, Bulletin 472-05.**

Adding amendments to sand can dramatically increase the plant-available water capacity (PAWC), as shown in Table 2-1. While peat only slightly increases the PAWC of a 12-inch sand

root zone, adding calcine diatomite and a natural zeolite can double or even triple the PAWC of sand.

**Table 2-1. Plant-available water holding capacity for sand and sand with amendments**

| Material | Plant available water holding capacity (% by volume) |
|---|---|
| Sand | 4 |
| Sand/Calcine clay (90:10) | 6 |
| Sand/Calcine diatomite (90:10) | 8 |
| Sand/Natural zeolite (90:10) | 11 |
| Sand/peat (80:20) | 5 |

For more information on soils in New York, see: http://websoilsurvey.nrcs.usda.gov.

## 2.6 Geology

Golf courses can cover large expanses of land that may vary in geological properties. Understanding these geological properties is critical because these properties can pose risks for ground or surface water contamination.

### 2.6.1 Surficial Geology

Surficial geology is the study of landforms and the unconsolidated sediments that lie beneath these landforms. The type of surficial geology, along with the type of subsoil and depth to groundwater, can influence the surface water and groundwater interactions that allow contaminants to move from one medium to the other. Soils with hard pans or finer textured horizons in the subsoil may have a greater ability to adsorb contaminants as they leach through the surface horizons. The greatest potential for groundwater contamination occurs where sandy soil overlies porous materials (such as limestone or coarse gravel) with a shallow water table.

For New York State maps of surficial geology, see http://www.nysm.nysed.gov/gis/#surf.

### 2.6.2 Karst Geology

Karst geology (also called karst topography) is a type of surficial geology associated with carbonate bedrock (limestone, dolomite, or marble) and characterized by sinkholes, depressions in the land surface, caves, and underground drainage systems (Figure 2-6).

In New York State, continental glaciation and local stratigraphic and structural conditions have produced karst features, which may affect the quality and quantity of groundwater in the state. Karst features are created over time by rainwater, which dissolves the carbonate bedrock as it drains into fractures, creating channels and openings in bedrock. These channels and openings to the ground surface provide a direct connection between surface water and groundwater; these enhanced connections are known as “focused” or ‘direct’ recharge. Direct recharge quickly replenishes the water supply; however, it also leaves the aquifer particularly vulnerable

to contamination, especially where the topsoil layer is thin and does not filter out potential contaminants.

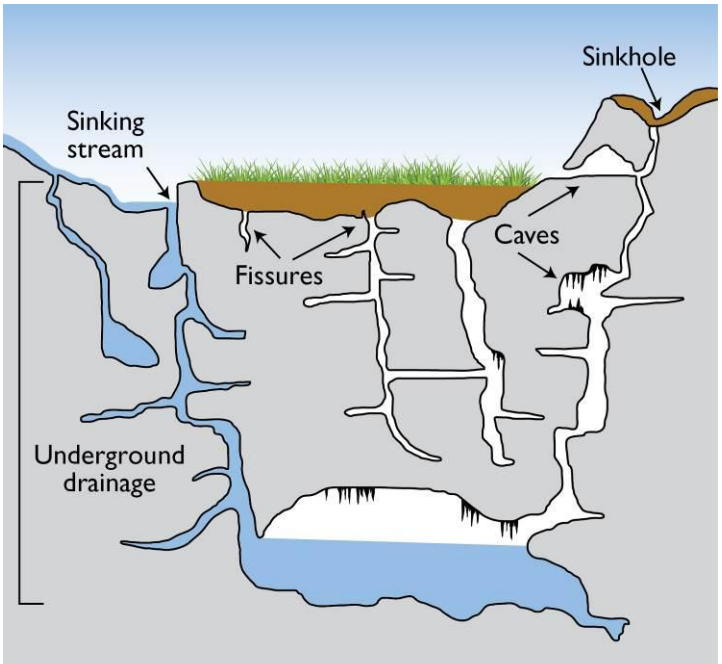



**Figure 2-6. Karst geology is characterized by such features as sinkholes, fissures, and caves.**

Available bedrock geology maps of NYS identify carbonate bedrock areas that indicate the potential presence of karst features. However, higher resolution maps of the boundaries as well as karst features in these bedrock units would be better suited for site-specific management, but may not be available from other sources.

For more information on karst geology, see:

- Bedrock geology map of NYS: http://www.agiweb.org/environment/karstmap.pdf
- "Living with Karst", American Geological Institute: http://www.agiweb.org/environment/publications/karst.pdf
- Fickies, R.H. and Fallis, E., 1996, Rock Type Map of New York State: New York State Geological Survey, Open file Report 1g1222, scale 1:1,000,000.

## 2.7 Environmental Fate and Transport Mechanisms

Understanding contaminant fate and transport mechanisms will help superintendents to minimize the risk of off-site movement of nutrients and chemical pesticides applied to golf courses. First, research indicates that using BMPs minimizes the chances for movement of potential water quality contaminants into ground or surface water. When BMPs are not properly implemented, however, water quality is at greater risk. These risks are primarily the result of runoff and leaching, which are themselves environmental fate and transport mechanisms:

- Runoff is the movement of water across the turf and soil surface, typically following a storm event or heavy irrigation.
- Leaching is the downward movement of water through the soil and potentially into groundwater.

Additional fate and transport mechanisms for nutrients and pesticides include drift and spills. Drift occurs when pesticides become airborne as dry particles, liquid spray droplets, or vapor. Spills are the unintended releases of chemicals, such as fertilizers, pesticides, hazardous materials, or petroleum products released during transportation, storage, and routine maintenance and facility operations. These releases can be a point source of contamination.

### 2.7.1 Runoff

Surface runoff is a water flow along the surface of the ground that occurs when the soil is saturated, compacted, high in clay particles, or has lost soil structure (large pores). When runoff flows along the ground, it can pick up contaminants (including but not limited to pesticides, fertilizers, and petroleum) that then become discharge or nonpoint source pollution. The potential for runoff is greater on steep slopes. Research on golf courses has shown that in areas with minimal slopes, runoff on fairways is less than 5% of rainfall (Easton et al. 2005).

### 2.7.2 Leaching

Leaching refers to the loss of water-soluble plant nutrients or chemicals from the soil as water moves through the soil profile and into the vadose zone (saturated zone). Solute leaching becomes an environmental concern if it contributes these contaminants to groundwater or to surface waters where contaminated groundwater replenishes surface water bodies. Several variables influence the probability and rate of leaching, such as soil type and structure, vegetation, chemical properties, rate of precipitation, and depth to groundwater. When deciding on the rate and timing of fertilizer and pesticide application, it is critical to assess soil moisture status and potential for high infiltration in order to minimize potential losses. In addition, soil texture is a major influence on nutrient and pesticide leaching. For example, three to four times more nitrates have been shown to leach from a bentgrass sand fairway turf than from a sandy loam or silt loam soil (Petrovic 2004).

For more information on leaching see:

- "Loss of Nitrogen and Pesticides from Turf Via Leaching and Runoff", http://www.usga.org/course_care/articles/environment/pesticides/Loss-of-Nitrogen-and-Pesticides-from-Turf-via-Leaching-and-Runoff/
- Appendix B, Groundwater Quality of Eastern Long Island, NY Golf Courses

### 2.7.3 Drift and Volatilization

Pesticides can move from the sites where they are applied into the surrounding environment through drift and volatilization. EPA defines pesticide spray or dust drift as "the physical

movement of pesticide droplets or particles through the air at the time of pesticide application or soon thereafter from the target site to any non- or off-target site."

Volatilization occurs when pesticide surface residues change from a solid or liquid to a gas or vapor after a pesticide application. Once airborne, volatile pesticides can come into contact with applicators or move long distances off site. Not all pesticides are volatile, and the higher the vapor pressure of a given chemical, the higher its volatility will be. Appendix C lists all the pesticides registered for use in New York State with the corresponding vapor pressures. Generally, any pesticide with a vapor pressure greater than 1 millipascal (mPa) is deemed to be volatile. For more information on drift and volatilization, see:

- EPA Pesticide Issues: pesticide volatilization
  http://www.epa.gov/pesticides/about/intheworks/volatilization.htm
- Croplife Foundation, "Minimizing Pesticide Spray Drift"
  http://croplifefoundation.files.wordpress.com/2012/05/spray_drift.pdf
- Cornell University Pesticide Application, Turf Spraying web page:
  http://web.entomology.cornell.edu/landers/pestapp/turf.htm

### 2.7.4 Sedimentation

A primary benefit of turfgrass or any perennial vegetation is the reduction in sediment and particulate movement, or reduced soil erosion. Precipitation and irrigation can carry soil particles (sediment) in runoff and deposit them into surface waters. Too much sediment can cloud the water, reducing the amount of sunlight that reaches aquatic plants and harming aquatic species. In addition, sediments can carry fertilizers, pesticides, and other chemicals that are attached to the soil particles into the water bodies, causing algal blooms and depleted oxygen. Sedimentation is controlled through BMPs that control the volume and flow rate of runoff water, keeping adequate turf density, and reducing soil transport.

### 2.7.5 Point Sources

The legal definition of "point source" is provided in 6 NYCRR Part 050-1.2(65) as follows:

> The term "point source" means any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, or landfill leachate collection system from which pollutants are or may be discharged. This term does not include agricultural storm water discharges and return flows from irrigated agriculture.

On golf courses, point sources of pollution can originate from:

- storage and maintenance facilities
- the unintended release of chemicals, such as pesticides, fertilizers, or fuel, during transportation, storage, or handling

- drainage discharge outlets (for example, the end of a drainage pipe)

Containment measures can easily prevent chemicals from becoming point sources of pollution during storage and handling. To prevent discharges from contaminating surface waters, the discharges must be diverted away from surface water and onto turf areas or other appropriate areas instead.

# 3 WATER QUALITY MANAGEMENT

Golf course BMPs are designed to minimize the transport of potential water quality contaminants (such as nitrogen and phosphorus) from the golf course into surface waters and groundwater. A decade of public and privately funded research concerning the fate of fertilizers and pesticides applied to turf has concluded that golf courses using BMPs pose little to no risk of contributing to water pollution. Specifically, several studies investigated the movement of nutrients and pesticides through the perennial turfgrass system and found that maintaining a dense, vigorous turf, identifying environmentally sensitive areas, and recognizing potential risks of certain soils and climatic conditions are essential to protecting water quality.

Regulatory compliance is the first step in aligning golf course management with BMPs. New York has some of the nation's strictest state regulations on pesticides and fertilizers. Golf course superintendents must be aware not only of regulations on the purchase, storage, handling, and application of fertilizers and pesticides, but also of the potential water quality contaminants, sources, and impacts associated with these compounds. The next step in successful BMP implementation is to recognize the many management decisions that involve potential contamination of surface waters and groundwater and address course management practices in a systematic fashion. Once course management becomes aligned with regulations and water quality protection BMPs, additional value can be gained by using water quality monitoring as a final step to assess the actual water quality entering and leaving the course.

## 3.1 Regulatory Framework

Maintaining water quality is a high public priority, to ensure a safe and abundant public drinking water supply as well as to protect fish and wildlife resources that use State waters and wetlands as part of their habitat. A number of federal and state regulations that apply to both drinking water and surface water quality for the protection of aquatic life are relevant to golf course operations, depending upon the proximity to drinking water sources, and surface waters, and depth to groundwater. These include regulations related to stormwater; wetlands; pesticides and pesticide usage; fertilizers; hazardous materials; and water withdrawal.

Maintenance facilities are likely to be subject to a number of local requirements, which may vary by county or town. Local building inspectors should be consulted during planning for new facilities to outline the permitting process and local requirements. Also, consider meeting with a representative from a NYSDEC regional office and the local fire marshal. The NYSDEC requests a State Environmental Quality Review (SEQR) for new construction, which is administered by local governments. NYSDEC comments on SEQR as well as other interested and involved agencies.

### 3.1.1 Drinking Water

The Safe Drinking Water Act (SDWA), passed in 1974, is the main federal law that ensures the quality of Americans' drinking water. Under the SDWA, EPA sets standards for drinking water quality and oversees the states, localities, and water suppliers who implement those standards.

SDWA authorizes EPA to set national health-based standards for drinking water, known as the National Drinking Water Regulations, to protect against both naturally occurring and manufactured contaminants. These regulations specify maximum contaminant levels (MCLs) for contaminants, which include nitrates, nitrites, and some pesticide constituents. EPA, individual states, and water systems are compelled to work together to ensure that these standards are met. The New York State Department of Health (NYSDOH) established standards for drinking water quality that are more stringent than EPA standards and must be complied with in the state.

For more information, see:

- Surface Drinking Water Act: http://water.epa.gov/lawsregs/rulesregs/sdwa/index.cfm
- National Drinking Water Regulations: http://water.epa.gov/drink/contaminants/index.cfm
- Drinking water contaminants MCLs: http://water.epa.gov/drink/contaminants/index.cfm#List
- NYSDOH drinking water protection program: http://www.health.ny.gov/environmental/water/drinking/

### 3.1.2 Stormwater

Stormwater is water that originates in some form of precipitation, as either rainfall or snowmelt. Because this water travels along or through the earth's surface, it can collect and carry potential contaminants that could compromise surface waters or groundwater. Therefore, regulations exist that govern the quality of water discharged from runoff sources. NYSDEC has established limits for some chemicals in stormwater, including nitrites, nitrates, and pesticides. NYSDEC has also established a limit for phosphorus levels in stormwater of 0.1 mg per liter.

Individual or general permits for stormwater discharges may be required for activities associated with stormwater discharges, including construction activities. Construction activities disturbing one or more acres of soil must be authorized under the General Permit for Stormwater Discharges from Construction Activities. Permittees are required to develop a Stormwater Pollution Prevention Plan (SWPPP) to prevent discharges of construction-related pollutants to surface waters. The New York State Stormwater Management Design Manual was reissued in 2010 for more information.

The concentration of activities in and around maintenance facilities may increase the levels of chemical residues susceptible to runoff from heavy precipitation. Stormwater collection areas may need to be established to capture runoff in accordance with NYSDEC specifications.

For more information see:

- NYSDEC's "Stormwater" page: www.dec.ny.gov/chemical/8468.html
- NY Stormwater Design Manual: http://www.dec.ny.gov/chemical/29072.html

### 3.1.3 Surface Water

The goal of all surface water quality protection programs is to ensure that all waters of the State meet water quality standards. The Federal Clean Water Act required states to classify all of the waters of the State according to their best uses and to adopt water quality standards in order to protect those best uses. NYSDEC uses the best uses and standards so established to regulate surface waters, land use associated with tidal and freshwater wetlands, and dams. Specifically, NYSDEC is charged with identifying impaired surface water bodies (i.e., waters not meeting water quality standards), recommending mitigation, and establishing guidelines for enhanced protection through a variety of regulatory programs.

For surface waters in New York not meeting the established State water quality standards, NYSDEC establishes total maximum daily loads (TMDLs) for the pollutant of concern causing the impairment (such as nitrogen, phosphorus, or sediments). NYSDEC has completed TMDLs for many water bodies in New York State, including Long Island Sound, Lake Champlain, waters of the Croton River watershed, and a number of lake watersheds. EPA may also require localities to develop Comprehensive Nutrient Management Plans (CNMPs) for activities in those impaired watersheds. Currently, CNMPs are focused on agricultural land use specifically related to the New York City Watershed Memorandum of Agreement (MOA). Note that state, federal, and local water quality regulations can change—remain informed on local, regional, and national policies and regulations.

For more information, see:

- NYSDEC Division of Water Regulations: http://www.NYSDEC.ny.gov/regs/2485.html
- NYSDEC TMDLs: http://www.NYSDEC.ny.gov/chemical/23835.html
- EPA's National Assessment Database: http://www.epa.gov/waters/305b/

### 3.1.4 Groundwater

NYSDEC regulates groundwater, including setting groundwater quality and effluent standards. For more information, see NYSDEC Division of Water Regulations: http://www.dec.ny.gov/regs/2485.html.

### 3.1.5 Freshwater Wetlands

Article 24 of New York Environmental Conservation Law requires permits to conduct activities within a wetland and an adjacent area bordering the wetland. Physical disturbance, as well as application of chemicals (pesticides, herbicides, fungicides, even fertilizer), requires an Article 24 permit if the action is done in a state-regulated wetland or within the regulated adjacent area (typically 100 feet from wetland boundary).

### 3.1.6 Fertilizers

A growing number of states have enacted regulations that restrict fertilizer sale and application. For example, Minnesota and Wisconsin enacted specific legislation that restricts the application of phosphorus containing fertilizer unless a soil test indicates need. Additionally, Minnesota

requires education and certification of applicators to ensure that applicators understand environmental aspects of fertilizer application.

In New York, the Dishwater Detergent and Nutrient Runoff Law became effective in January 2012. This law prohibits the use of phosphorus-containing fertilizers with a phosphate ($P_2O_5$) content greater than 0.67%, unless:

- soil tests show a phosphorus deficiency
- the fertilizer is being used to establish new seeded or sodded turf
- the fertilizer being used is an organic compost
- the fertilizer is derived from litter

The law prohibits application of fertilizer onto impervious surfaces. Fertilizer should not be applied within 20 feet of any surface water, modified to 10 feet if the buffer has vegetative cover. An exception to the buffer requirement exists if the spreader guard, deflector shield or drop spreader is at least three feet from surface water. Finally, the law prohibits the application of fertilizers on lawns and non-agricultural turf between December 1 and April 1.

In addition to state regulations, turf managers should review their county and town ordinances to determine if stricter restrictions apply to phosphorus fertilizer use and application. For example, a few counties have extended the phosphorus-containing fertilizer restriction from November 1 or November 15 to April 1. Currently, local laws enacted to reduce phosphorus include ones adopted in Westchester, Nassau, Suffolk and Chautauqua counties and the Village of Greenwood Lake.

In addition to restrictions on the use of phosphorus-containing fertilizers, CNMPs for those NY counties required to submit plans for impaired waters may restrict the use of nitrogenous fertilizers. Turf managers should consult with the local County Cooperative Extension Office, SWCD Office, or County Water Authority to learn if any restrictions apply.

For more information, see:

- NYSDEC Dishwasher Detergent and Nutrient Runoff Law web page: http://www.dec.ny.gov/chemical/67239.html
- Minnesota legislation: https://www.revisor.mn.gov/statutes/?id=18C
- Westchester County local regulation: http://www.westchestergov.com/pdfs/ENVFACIL_2008LawnFertilizerLaw.pdf
- Nassau County local regulation: http://www.nassaucountyny.gov/agencies/legis/documents/locallaw11-2009.pdf
- Suffolk County local regulation: http://legis.suffolkcountyny.gov/resos2007/i2117-07.htm
- Chautauqua County local regulation: http://www.planningchautauqua.com/?q=watershed/Phosphorus_Law.htm

### 3.1.7 Pesticide Use Regulations

The New York State Environmental Conservation Law (ECL), Article 33, Part 325, establishes statutory authority to the New York State Department of Environmental Conservation to regulate pesticides and pesticide use. These regulations are covered in detail in Chapter 9, Section 9.1. of this document.

### 3.1.8 Aquatic Pesticide Applications

The application of any pesticide to water, such as an aquatic herbicide used to control vegetation in golf course ponds, or mosquito or other insect control applied to water, must be covered under a SPDES General Pesticide Permit. For more information, see: http://www.dec.ny.gov/chemical/70489.html.

### 3.1.9 Maintenance Facilities

Every golf course has a central area for the maintenance and storage of equipment and supplies. These areas can potentially become point sources of pollution because of unintended releases of chemicals such as pesticides, fertilizers, or fuel during storage or handling of these materials. Maintenance and storage facilities are high priority areas to address in protecting water quality. Containment measures in these areas can easily prevent chemicals from becoming point sources of pollution. More information on regulatory considerations related to maintenance facilities and potential hazardous materials is provided in Section 10.1 of this document.

## 3.2 Potential Water Quality Contaminants

Fertilizers and pesticides maximize productivity and performance in a variety of agricultural and horticultural settings, including golf turf management. In addition to regulations on applying these compounds, their storage and handling is also regulated. Although application practices can affect water quality, the environment is typically at the greatest risk from spills of larger volumes of the concentrated chemicals used to mix fertilizers and pesticides for application. Regardless of how the chemicals are released into the environment, superintendents should understand the fate of these inputs as well as other potential sources of contamination in order to prevent or to mitigate any potential effects on water quality.

### 3.2.1 Fertilizers

Of the many nutrients applied to golf turf, the primary contaminants of concern in fertilizers are nitrogen and phosphorus. These nutrients can leach into groundwater or be carried in runoff into surface waters after applications. New York's Environmental Conservation Law (ECL) narrative standards state that no nitrogen and phosphorus are allowed in runoff that contribute to algal growth, weeds, or the impairment of the water.

### 3.2.2 Pesticides

Pesticides may be toxic to aquatic and terrestrial systems. The varying chemical properties of pesticides—for example, their solubility, toxicity, and chemical breakdown rate—determine the

potential impact to water quality. Pesticide safety and management is covered in Chapter 9 of this document.

### 3.2.3 Sediments

EPA defines suspended and bedded sediments as follows:

> "…particulate organic and inorganic matter that suspend in or are carried by the water, and/or accumulate in a loose, unconsolidated form on the bottom of natural water bodies. This includes the frequently used terms of clean sediment, suspended sediment, total suspended solids, bedload, turbidity, or in common terms, dirt, soils, or eroded materials."

Increases in sediment loading can compromise the ecological integrity of aquatic environments, affecting water quality physically, chemically and biologically. In addition, sediments often carry organic matter, nutrients, chemicals (such as pesticides), and other wastes. For example, phosphorus is immobile in most soils and concentrates in the top few inches of the soil, where it is very susceptible to erosion and thus likely to be present in sediment.

### 3.2.4 Hazardous Materials

Other potentially hazardous materials, such as fuels and paints that are used in everyday operation and maintenance, can contaminate water quality if accidentally released, especially in large quantities. BMPs followed for maintenance operations can prevent contamination from accidental releases.

### 3.2.5 Waterfowl

The deposits of fecal matter by resident and migrating waterfowl (Canada Geese, mute swans, and others) may contribute to water quality impairment through nutrient enrichment. The overall impact of bird feces on water quality, however, depends on numerous factors, such as the size, depth, and natural chemistry of the water body; avian populations and behavior; and the rate at which other nutrient sources enter the water body (Unckless and Makarewicz 2007). On golf courses, shallow ponds with significant populations of waterfowl are most likely to be affected. In these cases, annual phosphorus loading by waterfowl can be calculated using the days per year that each species spent on any lake or reservoir.

## 3.3 Potential Water Quality Impacts

If water quality contaminants reach surface waters or groundwater, the potential water quality impacts can include the following:

- drinking water impairment, if nitrogen as either nitrate ($NO_3$) or nitrite ($NO_2$) is present at levels above health-based risk values in drinking water
- nutrient enrichment of surface waters
- sedimentation due to eroding soils

- toxicity to aquatic life

### 3.3.1 Drinking Water Impairment

The presence of nitrogen as either nitrate ($NO_3$) or nitrite ($NO_2$) at levels above health-based risk values in drinking water may adversely affect health. MCLs established by EPA are 10 mg/L for nitrate and 1 mg/L for nitrite. Phosphorus contamination of drinking water has not been directly linked to human health problems, although increased levels may affect water taste and odor and, in some cases, enhance the growth of toxic algae. MCLs have been established for some pesticides or pesticide constituents in drinking water, such as glyphosphate.

Although drinking water impairment from golf course management activities is possible, research indicates that this is uncommon. Seventeen studies (36 golf courses) were reviewed by Cohen et al. (1999) and were incorporated into a detailed data review. A total of 16,587 data points from pesticide, metabolite, solvent, and $NO_3$ analyses of surface water and ground water were reviewed. Approximately 90 organics were analyzed in the surface water database and approximately 115 organics in the ground water database. The results of the analysis indicated that widespread and repeated water quality impacts by golf courses were not observed at the golf course study sites. None of the authors of the individual studies concluded that toxicologically significant impacts were observed, although health advisory levels, MCLs, or maximum allowable concentrations were occasionally exceeded.

### 3.3.2 Nutrient Enrichment

Nutrient enrichment of surface waters is widespread across the state of New York in large part because of the prevalence of sources of phosphorus and nitrogen, including the following:

- municipal wastewater treatment plant discharges
- urban runoff from impervious surfaces such as parking lots, rooftops and roads
- agricultural activities
- flow from inadequate onsite septic systems
- home lawn and other fertilization practices
- atmospheric deposition

Nutrient enrichment can lead to eutrophication, the process by which a body of water acquires a high concentration of nutrients, which promotes excessive growth of algae (called algal blooms). As the algae die and decompose, oxidation of the organic matter and respiration by the decomposing organisms can deplete dissolved oxygen in the water, in turn causing the death of aquatic organisms such as fish and invertebrates.

Although both phosphorus and nitrogen must be managed to prevent eutrophication, nitrogen is the higher priority for marine environments, while phosphorus is more important in fresh waters. In Long Island Sound, nitrogen fuels the growth of excessive amounts of planktonic algae. In the Sound, the eutrophication process results in hypoxia (very low levels of dissolved

oxygen in the water column) each summer, especially in the western half of Long Island Sound. In marine systems, the eutrophication process can also alter the habitat for submerged aquatic vegetation and marine life, reducing the size and diversity of the ecosystem and fisheries. Some algal blooms, often referred to as red or brown tides, can also be toxic to crustaceans, fish, and humans. In freshwaters, phosphorus fuels the growth of excessive amounts of algae that also results in reduced amounts of dissolved oxygen available to freshwater aquatic organisms. Phosphorus levels of 0.035 to 0.10 mg/L have been linked with increased levels of algal growth in rivers, lakes, and estuaries.

In addition to excessive algae growth, nutrient enrichment can contribute to the excessive growth of vascular aquatic plants. Excessive aquatic plant growth can alter the aquatic plant community, deplete oxygen, impact fish communities, restrict recreational use, and cause odors during die off.

For more information, see:

- NYSDEC "Nutrient Loadings and Eutrophication" fact sheet: http:// www.dec.ny.gov /docs/water_pdf/top10nutloading.pdf
- NYSDEC "Aquatic Weeds and Invasive Species" fact sheet: www.dec.ny.gov /docs/water_pdf/top10invasives.pdf
- EPA Nutrient Pollution web page: http://epa.gov/nutrientpollution/

### 3.3.3 Sedimentation

Sedimentation is the process whereby water that is carrying sediments from eroding soil slows long enough to allow soil particles to settle out. The smaller the particle, the longer it stays in suspension. Larger, heavier particles such as gravel and sand settle out sooner than smaller, lighter particles such as clay (which may stay in suspension for long periods and cause water turbidity). The effects of sedimentation are generally site specific and depend on a number of variables including sediment grain size and type, and hydrological conditions; water quality impacts can include increased turbidity, impairment of aquatic habitats, and filling in of water bodies. In addition, sediments can also affect water quality if they contain other contaminants such as organic matter, nutrients, pesticides, or other chemicals. Sedimentation is only likely to occur on golf courses during construction and major renovations when soils are disturbed.

### 3.3.4 Toxicity to Aquatic Life

Pesticides applied to golf courses can be harmful to fish and wildlife. Herbicides used to control weeds can be transported to ponds and streams where they can be harmful to aquatic vegetation and algae. Insecticides, including some of the products used for adult mosquito control, also tend to be toxic to fish and aquatic life, and if transported off treated areas by runoff, fish and invertebrates in adjacent waters can be harmed. Fortunately, turf tends to hold water and retard runoff, greatly reducing the pesticide load transported to adjacent water bodies, particularly compared to pesticide treatments on bare ground or agricultural fields. To ensure the protection of aquatic life and compliance with pesticide regulations as described in Section 9.1 of this document, close attention should be paid to all of the instructions listed on the

pesticide label. Carefully following label instructions is the best way to insure that a pesticide application will not be harmful to fish and wildlife.

## 3.4 Water Quality Monitoring

Aligning management programs with established, research-based BMPs is the first step to ensuring water quality protection. Water quality monitoring can confirm the effectiveness of a BMP-based program. Golf course superintendents wanting to develop and implement a water quality monitoring program to document the water quality conditions should first review available baseline water quality data. Baseline data can be assessed to determine the likely origin of contaminants, measure the extent of sedimentation and nutrient inputs, and estimate the potential impacts to surface water and groundwater. Following implementation of BMPs, routine monitoring can be used to measure water quality improvements and identify any areas where corrective actions should be taken.

Water quality monitoring can also demonstrate the presence of water quality issues inherent in water as it enters a golf course property. For example, in Suffolk County extensive laboratory testing for contaminants has shown that groundwater entering the golf course already has extremely high nitrate levels (near or greater than the regulatory limit; see Appendix B) The county also collects surface water samples and shares the test reports with superintendents.

### 3.4.1 Sources of Existing Information

Several sources of existing surface and groundwater monitoring data may be available, including:

- Soil and Water Conservation Districts – Comprehensive water quality management programs; may be willing to test surface water and assist in installation of groundwater monitoring wells. SWCD listings for NYS are available at: http://www.nys-soilandwater.org/contacts/county_offices.html
- NYSDEC - Conducts a groundwater monitoring program in coordination with USGS. http:// http:// www.dec.ny.gov /docs/water_pdf/top10nutloading.pdf/lands/36117.html
- USGS - Reports results of groundwater monitoring and compares to EPA and NYSDOH standards. The USGS has completed testing and published reports for most of the major watersheds in the state. http://ny.water.usgs.gov/projects/305b/.
- County Water Authorities - Maintain and test community water wells and may have additional test data from other points within the watershed.

### 3.4.2 Developing a Water Quality Monitoring Program

Developing a water quality monitoring program can include both groundwater monitoring and surface water monitoring. The data from this periodic monitoring can be used to identify issues that may need corrective actions. In addition, water quality monitoring of irrigation sources (particularly water supply wells and storage lakes) provides valuable agronomic information

that can inform nutrient and liming programs. A water quality monitoring plan should identify appropriate sampling locations, frequency, and monitoring parameters.

Groundwater monitoring from wells located at the hydrologic entrance and exit from the course may be the best way to evaluate a golf course's impact on water quality. If groundwater monitoring data from these locations are not available from existing sources, monitoring wells can be installed by private companies. Installing groundwater monitoring wells can be relatively expensive, but the expense may be justified in certain cases where the origin of contamination needs to be determined through comparison of water quality entering and exiting the property. To identify the appropriate site for monitoring wells, groundwater flow is required. In some areas of New York, groundwater flow maps have been developed, but may not be available at a fine enough scale for an individual golf course. Experienced environmental engineering firms or USGS can assist in determining suitable monitoring well locations. Testing protocols can be simplified to test only those parameters that are directly influenced by course management, including organic and inorganic levels of nitrogen and phosphorus and a pesticide screen for certain pesticides used on the course. NYSDEC pesticide reports provide the necessary documentation for pesticides used. The USGS also offers contract services to advise on sampling and testing of water samples. SWCD offices can also provide guidance on groundwater testing programs.

Surface water monitoring can include the laboratory testing of a number of different physical and chemical parameters to assess water quality. In addition, the sampling of macrobenthic invertebrates can be used as a relative assessment tool for stream health. Sampling of surface waters can be conducted by golf course staff or volunteer monitoring groups (Figure 3-1).

**Figure 3-1. Golf course staff can easily sample surface water. Source: Ken Benoit**

A number of references for detailed information on planning a water quality monitoring program on golf courses can be used to plan a site-specific water monitoring program:

- *Environmental Stewardship Guidelines* (Oregon GCSA, 2009) includes a highly detailed chapter on water quality monitoring specific to golf turf. http://www.ogcsa.org/Pages/environmental/ogcsa-guidelines.html
- *Environmental Best Management Practices for Virginia's Golf Courses* (Virginia GCSA, 2012) includes a detailed chapter on water quality monitoring and an example water quality monitoring report appendix. http://www.vgcsa.org/view.asp?id=373&page=68702
- *A Guide to Environmental Stewardship on the Golf Course* (Audubon International, 2002)

***BMP Statements***

- Assess current surface and groundwater quality.
- Conduct water quality assessment using accepted standards.
- Use an accredited laboratory for water quality assessment.

# 4 SITE ANALYSIS AND WATER QUALITY PROTECTION

Site analysis is the first and most important step in aligning golf course management with research-based BMPs designed to protect water quality and ecosystem integrity. A site analysis describes site maintenance areas, chemical storage and handling practices, equipment cleaning, and other priority areas on the golf course associated with topography and environmental sensitivity. Following this thorough assessment the feasibility of land use, structural, and management BMPs should be considered to ensure reasonable water quality protection.

The BMPs discussed in this chapter can be incorporated into design for a new course or course renovation. For an existing golf course, the golf course superintendent can undertake a site analysis to identify specific areas of interest to focus the implementation of BMPs. For a new golf course development or a renovation project, the state of New York requires that a licensed golf course designer guide the site analysis process to ensure compliance with relevant regulations. Designers and others involved in golf course development are encouraged to work closely with local community groups and regulatory bodies during planning and siting and throughout the development process. For every site, local environmental issues and conditions must be addressed.

The first step in a site analysis is to develop a better understanding of how a golf course fits into the landscape. The site assessment begins with identifying high priority areas and the current potential for water quality impacts. Note that the high priority areas are more often located where equipment is cleaned and fertilizer and pesticides are stored and handled because these areas have the potential for large volume releases.

## 4.1 Identifying Priority Areas

Understanding the golf course landscape is the first step in assessing potential water quality issues. Areas to identify first are the environmentally sensitive areas such as wetlands, surface water bodies and shorelines, steep slopes to surface water, and areas with shallow depth to ground water or that are located in a critical groundwater recharge zone (especially true for Long Island, due to its sandy soils). In addition, identify relevant geological characteristics such as karst topography, which leaves groundwater vulnerable to contamination.

On golf courses, point sources of pollution should be identified as priority areas for water quality protection. Specifically, these point sources can originate from storage and maintenance facilities and as the unintended release of chemicals, such as pesticides, fertilizers, or fuel, during transportation, storage, handling or cleaning of mowers and pesticide application equipment. Containment measures can easily prevent chemicals from becoming point sources of pollution, as described in Chapter 10.

The goal of the site assessment process is to identify priority areas, beginning with determining the following:

- the golf course's position relative to its position in the watershed

- drainage basins
- environmentally and ecologically sensitive areas
- management zone boundaries

**Watershed drainage basins.** Drainage basins on the property should be identified on both topographic maps and routing plans. Identifying drainage basins also helps to determine the approximate area of greens, tees, fairways, and roughs in each drainage basin.

**Environmentally sensitive areas.** Environmentally sensitive areas are those areas with natural resources susceptible to changes that can alter ecosystem structure or function (such as wetlands), or areas that might be home to an endangered, threatened, rare species, or species of special concern. Information on the presence of endangered species can be obtained from New York's Natural Heritage Program (see http://www.dec.ny.gov/animals/31181.html).

One of the objectives of BMPs is to provide the necessary protection for these environmentally sensitive areas by design and operation of the golf course and maintenance facilities. Superintendents can protect these areas through BMPs, careful selection of pesticides and fertilizers, restrictions on the use of certain materials in sensitive areas (for instance, "no spray" zones), and proper construction. These practices minimize the potential for point and nonpoint source pollutant input to sensitive areas within the management zones at the course.

**Management zones.** In order to manage a golf course in an environmentally sensitive and responsible manner, establish management zones throughout the course. Management zones are defined as areas that have distinct management practices based on the area's position in the watershed and the drainage basin analysis conducted for the watershed. Management zones work hand-in-hand with BMPs and IPM. Management zones include the following:

*Management Zone A:* These zones may or may not be part of the playable area AND are considered to be of the highest risk for water quality issues. Therefore, any management of these areas should be focused on minimizing any chemical use, preventing direct discharge into water bodies, and maximizing resident time for water moving along the surface in this zone.

*Management Zone B*: These zones are part of the playable area and therefore require an increased level of maintenance, but pose significantly less risk than in Zone A. Additionally, when wind speed is greater than 10 mph, a shroud should be used on spray equipment to avoid drift. Therefore, management of these areas should allow for additional chemical use while still minimizing the potential for movement into surface or groundwater.

Management zones should be clearly marked on course maps and the maintenance crew should be familiar with these areas. The use of GPS/GIS systems for precision mapping of these zones and identifying boundary locations can assist the crew in following the management zone guidelines.

## 4.2 The Broader Golf Course Landscape

Adjacent ecosystems form complex and diverse mosaics on the landscape. Forests, wetlands, bottomland hardwoods, agricultural fields, streams, rivers, and lakes, combine to form biologically diverse and ecologically complex watersheds.

When designing and managing golf courses as ecosystems, do not override or alter natural processes, but rather work to maintain naturally occurring processes. For example, chemical cycling is constantly occurring and it is a key to ecosystem stability. Losses of essential elements are controlled by complex feedback loops involving plants, animals, soil microorganisms, decaying litter, and soils. Natural ecosystems function because of their complexity, which builds stability in these systems.

Chemicals can have an important part impact on the ecosystem. Ecosystems use energy to assimilate chemicals into new biological structures, decompose dead materials, and recycle mineral nutrients. Introduction of chemicals such as pesticides into the system need not upset the natural balance. However, golf courses must be careful not to override the natural cycling processes or to introduce toxic materials where they can harm organisms or ecologically sensitive areas. The best approach is to avoid or minimize problems by using BMPs. These practices may include the sensible use of pesticides, emphasizing localized applications that act quickly and effectively without any appreciable impact on the natural system.

## 4.3 Water Quality Protection Systems

Using BMPs and management zones, turfgrass management can coexist in harmony with nature. The quantity and quality of water generated within the property boundaries can be protected by appropriate watershed controls and management practices. Because water is the primary movement mechanism for contaminants, protection of water resources also provides protection for sensitive areas and species. Surface water is the focus of watershed protection because recent research on the environmental impact of nutrients and pesticides applied to golf courses has indicated that for the majority of the acreage under turf management, surface runoff is a much greater concern than leaching. While leaching of certain materials does occur at low levels and under specific environmental and climatic conditions, more materials are transported in surface runoff than through leaching (Baris, R.D. et al. 2010). However, certain areas of New York have a history of groundwater contamination problems.

Preventive measures must be in place to keep potential contaminants from entering surface waters. The building blocks of water quality protection include preventive measures (source prevention) or nonstructural practices that minimize or prevent the generation of runoff and the contamination of runoff by pollutants. Structural controls that are part of the design and engineering of the course are capital improvements designed to remove, filter, detain, or reroute potential contaminants carried in surface water. The most effective way to manage surface water is by using a comprehensive systems approach that includes integration of preventive practices and structural controls (Eaker 1994).

This comprehensive systems approach, which should be used throughout the golf course property, should stress optimum site planning and the use of natural drainage systems. Livingston and McCarron (1991) suggest that a stormwater management system might be considered as a "Best Management Practices (BMP) Train" in which the individual BMPs are considered the cars. In most cases, the more BMPs incorporated into the system, the better the performance of the treatment train. The first cars might include BMPs to minimize generation of runoff (for example, irrigation management) and pollutants (such as IPM) and the final car could include a retention pond.

### 4.3.1 Preventive Strategies

At any golf course, preventive strategies should include combinations of land use controls and source prevention practices. An integrated water quality protection system is based on a tiered concept as follows:

- prevention - prevent problems from occurring
- control - have safeguards in place to control any problems
- detection - consider a monitoring program to detect changes in environmental quality

Preventive measures are categorized as either land use BMPs or source prevention BMPs. Land use BMPs are engineered and incorporated into the course during golf course design and construction. Land use BMPs protect natural resources through primarily mechanical methods, as described in the remainder of this chapter. Source prevention BMPs are implemented during golf course operation to prevent or preclude the possibility of movement of sediment, nutrients, or pesticides from the property or from toxic materials being introduced into ecologically sensitive areas. Source prevention BMPs include the use of management zones as described in Section 4.1 and IPM strategies, as described in the later chapters.

Land use BMPs are incorporated during design for construction activities that affect drainage, surface water, sedimentation and erosion control, and ecologically sensitive areas. Examples of land use control BMPs include

- settling and filtering processes for removing sediment and pollutants that are bound to sediment particles associated with surface runoff
- subsurface drainage, infiltration, and use of land absorption areas (vegetated filter strips) to detain water, allow it to be filtered prior to groundwater recharge
- grassed waterways or outlets
- critical area planting to stabilize highly erodible areas

Other land use BMPs are structural, such as quality basins, infiltration basins, and catch basins that detain water to reduce runoff quantity and nutrient and pesticide discharge.

#### *4.3.1.1 Vegetative Practices*

*Vegetative Filtration*. Common examples of vegetative filters that can be used throughout the golf course are conservation areas or buffers, land absorption areas (vegetated filter strips) and swales (diversions, berms). Vegetative filters act as natural biofilters to reduce storm water flow and pollutant load, and turf areas are effective filters.

Turf uses the natural processes of infiltration, filtration, and biological uptake to reduce flows and pollutant loadings. Vegetated filter strips remove sediment and attached chemicals, organic material, trace metals, and nutrients (nitrogen and phosphorus). Sediment removal rates are generally greater than 70% and nutrient removal is typically greater than 50%.

Maintenance of vegetative filters requires management to achieve dense, hearty vegetation. Where changes in vegetative cover must be made, these changes are normally established in low maintenance ground covers. This practice may include the use of native or naturalized plants, including low maintenance turfgrasses. When turf is used as the filtration medium, cultural activities should focus on producing healthy turf with a minimum of maintenance activities.

Turf should be allowed to grow to the highest end of the optimum range for more effective filtration. Fertilizers and pesticides are usually not applied in these areas except sparingly (sometimes during establishment to reduce erosion and runoff problems much faster) or after a risk assessment has determined that application of certain materials will have no impact in adjacent areas. Establishing these buffers reduces erosion and sediment loss decreases. Buffers also protect surface waters by attenuating pollutants in surface runoff.

Soil surface runoff may also be moderated, reducing the impact on receiving water bodies and streams. The greatest benefit is the protection of adjacent ecologically sensitive areas—potential pollutants are simply not introduced, or are introduced on a limited basis compared to more highly maintained turf areas. Figure 4-1 shows several examples of vegetated buffers.

*Conservation Areas or Buffers*. These are areas where it is critical to establish and maintain perennial vegetative cover to protect resources. 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. Therefore, retaining vegetated buffers along watercourses is one of the most effective practices used to protect water quality and should be designed to handle the anticipated runoff. If the area is a state or locally designated wetland, a buffer may be required and the width of the buffer specified by the regulating authority.

*Critical Area Planting*. Planting vegetation on highly erodible or critically eroding areas also protects water quality. The greatest amount of soil erosion and sediment delivery to surface waters occurs when large areas are graded during the construction phase, which requires phased construction to minimize the amount of bare land. Quickly establishing vegetation

reduces the movement of materials in runoff, as plants take nutrients in the soil and reduce the amount that can be washed into surface waters or leach into groundwater, as well as trap particulates.

Sodding is an important consideration in these areas since it provides instant ground cover and rooting can occur rapidly for permanent establishment. In certain instances, strip sodding rather than solid sodding can be used if the slopes are not too steep and the strips are wide enough to adequately handle the sediment carried in the runoff. However, sod production systems that use inputs can potentially contribute to water quality issues after installation; pesticides have been found in groundwater monitoring wells on very sandy sites following sodding.

*Grassed Swales or Berms or Diversions*. Channels constructed across a slope with a supporting ridge on the lower side are another effective control. These channels stabilize a runoff area and reduce sheet and rill erosion by reducing the length of slope. These measures also eliminate vertical channeling and large gullies, which reduces the amount of sediment and related pollutants delivered to the surface waters.

Berms direct water into specific areas to allow vertical filtration rather than allowing surface runoff. Vegetated swales are used to permit filtering and infiltration of storm water. The grasses for these swales should be water tolerant and erosion resistant (rapid germination and establishment to form dense sod). These types of swales are used on gentle slopes where slower velocities enhance the filtering and infiltration processes.

Swales are also effective in routing water to maximize contact time of water and vegetation. An example in which swales are helpful is the routing of water from the underdrains of greens. Filtration can be greatly increased by carefully choosing the route of water from the underdrain. If space is limited, drainage water could be directed to flow along a path that maximizes the distance of contact with vegetation, rather than choosing the shortest route to the lowest elevation. The effectiveness of swales in reducing flows and pollutants is similar to that of filter strips.

*Vegetated Filter Strips*. Filter strips are manmade or naturally occurring flat areas established at the perimeter of disturbed or impervious areas to intercept runoff as sheet flow and remove particulate matter and contaminants. Either grassed or wooded areas can function as filter strips.

*Grassed Waterways.* These natural or constructed channels are shaped, graded, and planted to ensure the stable flow of runoff. This practice reduces erosion in a concentrated flow area, such as in a gully or in ephemeral gullies, and reduces sediment and substances delivered to receiving waters. Vegetation may also filter some of the sediment delivered to the waterway; however, filtration is a secondary function of a grassed waterway.

Any chemicals applied to the waterway in treating the adjacent areas may wash directly into the surface waters when runoff occurs shortly after spraying. If standing water is present, applications of fertilizer or pesticides should also be avoided.

*Turfgrass used as a Vegetative Filter*. One of the most effective BMPs for protection of surface water is use of turf as a vegetative filter in swales and filter strips. Turfgrass areas are extremely effective in reducing soil losses compared to other cropping systems. In a comparison of soil loss from conventional agriculture with soil loss from turf, measured soil loss from tobacco production (4210 lbs/acre) was 842 times higher than from turf areas (5 lbs/acre), even with a slope of 16% on a silt loam soil.

Where polluted runoff from agricultural areas has occurred, establishment of turf buffer strips of only 15 feet have been shown to improve water quality. Studies at Oklahoma State University have shown that turfgrass buffers of 16 ft effectively reduce concentrations of chemicals in runoff. Other studies noted that in cases where water quality has declined due to agricultural practices that lead to loss of nutrients and erosion, grass buffer strips placed between treated fields and surface waters significantly reduce the problem (Cole et al 1997). This result is related to the architecture of the turf canopy, the fibrous turf root system, and the development of a vast macropore soil structural system that encourages infiltration rather than runoff.

**Figure 4-1. Grasses filter strips discharging into water filtration basins. *Source*: Robert Alonzi.**

Turf density, leaf texture, rooting strength, and canopy height physically restrain soil erosion and sediment loss by dissipating impact energy from rain and irrigation water droplets. These turf features also provide resistance to surface movement of water over turf. Additionally, turfgrasses have an extensive fibrous root system, with 80% of the root mass found in the upper 4 inches of the soil profile. The combination of turf canopy and root mass has a strong soil stabilizing effect.

#### *4.3.1.2 Structural BMPs*

Structural BMPs include water quality basins, infiltration basins, and catch basins to regulate or impound runoff. These structures detain and filter water through plant material prior to discharge and can reduce runoff quantity as well as nutrient and pesticide discharge. See Appendix D for renderings of structural BMPs.

*Subsurface Drainage.* Subsurface drainage directs drainage water and can reduce runoff and leaching. Subsurface drainage is also installed to control a water table or to interrupt subsurface seepage or flow. Where possible, directing this drainage into vegetative areas for biological filtration or infiltration basins helps to control the potential loss of nutrients and pesticides from the golf course, rather than directly draining it into surface water.

*Water Quality Basins.* These basins are designed to capture the "first flush" runoff and provide water quality treatment primarily through physical settling of sediment-based pollutants. These basins can be constructed by excavation or embankment (or both) to create a ponding area sufficient to handle the required water quality volumes. Planting wetland species in the bottoms

of these basins achieves additional quality control through biological filtering and uptake. The discharge system for basins can include a gravel underdrain layer with a small diameter perforated drainage pipe to slow dissipation of runoff over an extended period. Gravel underdrains without an outlet can also provide a measure of infiltration and groundwater recharge where appropriate. Finally, higher intensity storms can be routed through water quality basins for proper flood control and flow attenuation.

*Wet Ponds*. These ponds are earthen embankments or a combination ridge and channel generally constructed across the slope and minor watercourses to form a sediment trap and water retention basin. Wet ponds are one of the most effective structural BMPs for protecting water quality. Wet ponds at the golf course use a permanent water surface to achieve a high removal rate for sediment, nutrients, and metals. Aquatic plants and biochemical processes within the ponds enhance the removal of nutrients, metals and other pollutants. Secondary benefits include recreation, aesthetics, and wildlife habitat.

Pollutant removal efficiencies of wet ponds vary based on the pollutant of concern and the size of the permanent pool. The highest removal efficiencies are achieved in larger ponds at the golf course, where the ratio of basin volume to the volume of runoff from the average storm is greatest. Wet ponds are also effective in reducing peak discharges, downstream flooding, and stream bank erosion at the golf course.

This feature traps and removes sediment and sediment-attached substances from runoff. Trap control efficiencies for sediment and total phosphorus transported by runoff may exceed 90% in silt loam soils. Dissolved substances, such as nitrates, may be removed from discharge to downstream areas because of the increased infiltration. Where geologic conditions permit, the practice leads to increased loadings of dissolved substances toward groundwater. Water temperatures of surface runoff, released through underground outlets, may increase slightly because of longer exposure to warming surfaces during its impoundment.

*Infiltration Controls*. Infiltration controls are a general category of structural BMPs that maintain or enhance the ability of water to percolate through the soil profile. Infiltration generally improves water quality by allowing natural physical, chemical, and biological processes to remove pollutants. Pollutant removal in an artificial media or natural soil profile occurs through filtration, absorption, and oxidation by soil microorganisms.

*Catch Basins*. Catch basins are used primarily as a pretreatment device for the removal of coarse grit, sand, and debris. This pretreatment extends the life and performance of the other BMPs. From the catch basins, runoff is conveyed to the other water quality BMPs.

*Wetland and Riparian Zone Protection.* Wetlands and riparian areas are often continuums along rivers, streams, and coastal waters and are particularly sensitive to landscape changes and fragmentation. These areas play a critical role in attenuating nonpoint source pollution by intercepting runoff, subsurface flow, and certain groundwater flows and then removing, transforming, and storing pollutants (such as sediment, nitrogen, phosphorus, and certain

heavy metals). In addition, they provide aquatic habitat, stream shading, flood attenuation, shoreline stabilization, and groundwater recharge. Wetlands and riparian areas are often highly regulated by the state and local regulatory authorities.

*Constructed Wetlands.* Constructed aquatic ecosystems features poorly drained soils and rooted emergent hydrophytes, which simulate the role of natural wetlands in water purification. These structures efficiently remove certain pollutants (nitrogen, phosphorus, metals, sediment, and other suspended solids) and can treat wastewater, such as discharges from equipment wash pads. Once these areas are constructed, however, they are considered wetlands and regulated as such.

### 4.3.2 Effectiveness of BMPs

The effectiveness of pollutant removal by land use BMPs is a function of the following:

- physical, chemical, and biological processes
- the fraction of runoff treated by the BMP
- the nature of the pollutant being removed

Thus, an effective BMP train is one that treats 100% of runoff by physical, chemical, and biological processes. Table 4-1 shows relative removal efficiencies of infiltration basins, vegetated filter strips, grass swales, wet ponds, and storm water wetlands for five variables (total suspended solids, total phosphorus, total nitrogen, pesticides, and chemical oxygen demand). By including as many removal mechanisms as possible, the probability of success for removal of a particular pollutant is increased. These factors should be considered as follows:

1. BMPs that use settling and filtering processes are relatively effective at removing sediment and pollutants that are bound to sediment particles.
2. 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.
3. Turf density, leaf texture, and canopy height are physical factors that 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.
4. Ponds and infiltration BMPs can achieve 60 to 100% removal efficiencies for sediment.
5. Infiltration BMPs are capable of similar removal efficiencies for sediment, but are subject to clogging if sediment inputs are excessive.
6. Wet ponds and extended-detention ponds with shallow marshes have a moderate to high capability for removing both soluble and particulate pollutants because they use settling and biological uptake and degradation of pesticides.

**Table 4-1. Stormwater pollutant removal efficiencies, urban BMP designs (Sources: Schueler 1987 and NYSDEC, 1993)**

| BMP/Design | TSS* | TP | TN | Zn | Pb | BOD |
|---|---|---|---|---|---|---|
| **Extended Detention Pond** | | | | | | |
| "First flush" runoff volume produced by 1.0 inch storm, detained for 24 hours | 75% | 50% | 35% | 55% | 55% | 40% |
| Runoff volume produced by 1.0 inch storm detained for 24 hours or more with shallow marsh added in bottom stages | 80% | 70% | 55% | 75% | 75% | 50% |
| **Wet Pond** | | | | | | |
| Permanent pool equal to 0.5 inch of runoff per watershed acre | 55% | 35% | 25% | 25% | 45% | 25% |
| Permanent pool equal to 2.5 times the volume of runoff from the mean storm (0.5 inch) | 75% | 55% | 40% | 40% | 70% | 40% |
| **Water Quality Basin** | | | | | | |
| Infiltration basin which exfiltrates "first flush" of 0.5 inch runoff/ impervious acre | 70% | 50% | 50% | 50% | 50% | 70% |
| **Filter Strip** | | | | | | |
| 25 to 50 foot turf strip | 40% | 20% | 20% | 40% | 40% | 20% |
| 100 foot wooded strip | 90% | 50% | 50% | 90% | 90% | 70% |
| 25 to 50 foot wooded strip | 80% | 40% | 40% | 80% | 80% | 60% |
| **Grassed Swale** | | | | | | |
| High slopes with check dams | 20% | 20% | 20% | 10% | 10% | 20% |
| Low gradient | 30% | 30% | 30% | 20% | 20% | 30% |
| *TSS= Total Suspended Solids; TP=Total Phosphorus; TN= Total Nitrogen; Zn=Zinc; Pb=Lead; BOD=Biological Oxygen Demand | | | | | | |

### 4.3.3 Maintenance of Structural BMPs

Periodic long-term inspection and maintenance of the structural BMPs are essential to ensure that they function as designed. The superintendent and maintenance crews should be responsible for the inspection and maintenance of the BMPs for the golf course. Best practices for maintenance of these structures are described below.

#### *4.3.3.1 Water Quality Basins*

*Inspections:* Ponds should be inspected on a regular basis to ensure that the structure operates as designed. When possible, inspections should be conducted during wet weather to determine if the pond is meeting the targeted detention times and include checking:

- any evidence of subsidence, erosion, cracking or tree growth on the embankment
- condition of the emergency spillway
- accumulation of sediment around the riser
- adequacy of upstream/downstream channel erosion control measure
- erosion of the pond's bed and banks
- modifications to the pond or its contributing watershed that may influence pond performance

Inspections should be carried out with as-built pond plans in hand (Schueler 1987). Repairs should be made when the need for them is observed.

*Mowing.* The upper stage, side slopes, embankment, and emergency spillway of an extended detention dry pond must be mowed at least twice a year to discourage woody growth and control weeds. The use of water-tolerant, hardy, and slow-growing native or introduced grasses is recommended.

*Debris and Litter Removal.* Debris and litter should be removed during regular mowing operations.

*Erosion Control.* The pond side-slopes, emergency spillway and embankment may periodically suffer from slumping and erosion and require regarding and re-vegetation. However, slumping and erosion should not occur often if the soils are properly compacted during construction.

*Sediment Removal.* If properly designed, significant quantities of sediment can accumulate in the detention pond. This sediment should be removed periodically in order to preserve the available stormwater management capacity and to prevent the outlet or filter medium from becoming clogged. In addition, accumulated sediment may become unsightly. While more frequent sediment removal may be needed around outlet control structures, the lower stage of a detention pond should be cleaned manually typically every 5 to 10 years.

#### *4.3.3.2 Grassed Swales*

Swale maintenance keeps the grass cover dense and vigorous through periodic mowing, occasional spot re-seeding, and weed control. Watering may also be necessary during a

drought, particularly in the first few months after establishment. In addition, excessive sediment buildup behind check dams should be removed as necessary.

#### *4.3.3.3 Vegetative Filter Strips*

The maintenance required for a filter strip depends on whether or not natural vegetative succession is allowed to proceed. Maintenance tasks and costs are both sharply reduced for "natural" filter strips. However, corrective maintenance is still needed around the edge of the strip to prevent concentrated flows from forming.

Shorter filter strips must be managed as a lawn or short grass meadow and therefore should be mowed at least two or three times a year to suppress weeds and interrupt natural succession. Periodic spot repairs, watering, and fertilization may be required to maintain a dense, vigorous growth. Accumulated sediments deposited near the top of the strip 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 vehicle traffic, encroachment, gully erosion, density of vegetation, and evidence of concentrated flows through or around the strip. Extra watering, fertilization, and re-seeding is also usually needed in the first few months and years to make sure the strip becomes adequately established (Schueler, 1987).

#### *4.3.3.4 Catch Basins*

Catch basins should be cleaned out at least twice a year. Inlet structures usually are cleaned out with a vacuum pump. The resulting slurry of water, sediment, and other contaminants can be transported to a treatment plant or approved landfill for disposal. An alternative disposal method involves carefully siphoning out each chamber without creating a slurry and allowing it to infiltrate over a nearby grass area. The remaining grit and sediment can be removed and trucked to a landfill for final disposal. Maintenance records and clean-out schedules should be kept as part of the maintenance process.

#### *4.3.3.5 Dry Wells*

Dry wells rapidly take excess surface water and transport it to the subsoil that recharges groundwater. In areas where groundwater contamination is a problem, such as sandy areas of Long Island, the use of dry wells should be discouraged. Dry wells bypass the biofiltering capacity of the surface turf ecosystem and thus can inadvertently allow nutrients and pesticides to potentially contaminate groundwater. If they are used, the dry wells should be covered when fertilizers and pesticides are applied to prevent direct contamination of the dry wells. Applications of fertilizers and pesticide should also be avoided during wet periods when the dry wells are collecting water to prevent groundwater contamination.

*Preventive Maintenance*. Maintenance of infiltration facilities ensures their continued effectiveness. Preventive maintenance practices identify areas of erosion in the contributory

drainage and stabilize those areas. For example, if suspended solids are not identified and removed, void areas in the stone reservoir of an infiltration trench may become clogged.

*Inspections.* Logs should be maintained for each BMP structure, recording the rate of de-watering after large storms and the depth of sediment buildup in the well for each observation. Once the performance characteristics of the structure have been verified, the monitoring schedule can be reduced to an annual basis unless the performance data indicate that a more frequent schedule is required.

***BMP Statements***

- Properly assess maintenance sites and golf course for priority areas related to water quality protection.
- Determine most effective structural or vegetative BMP strategy, if needed.
- Assess effectiveness of implemented BMP strategy.

# 5 IRRIGATION

Water is a fundamental element for physiological processes in turf such as photosynthesis, transpiration, and cooling, as well as for the diffusion and transport of nutrients. Golf turf quality and performance depend on an adequate supply of water through either precipitation or supplemental irrigation. Too little water induces drought stress and weakens the plant, while too much causes anaerobic conditions that stunt plant growth and promote disease. Excessive water can also lead to runoff or leaching of nutrients and pesticides into groundwater and surface water.

Precise water management is arguably the single most important turf practice for maintaining high quality golf turf. When the amount of water lost from the turf system by evapotranspiration (ET) exceeds amount supplied by rainfall, the turf must be irrigated. Courses should maximize water use efficiency through proper irrigation, as this conserves water and decreases the likelihood of water quality impacts from runoff or leaching. Deliberate use includes using an efficient irrigation system and ensuring the system's proper function, using only the amount of irrigation water needed to maintain healthy turf in playing areas, and incorporating cultural practices that increase the water holding capacity of soil.

## 5.1 Irrigation Water Supply

### 5.1.1 Irrigation Water Sources

Irrigation water can come from several sources:

- surface water from ponds, lakes, or stormwater detention ponds
- groundwater from wells
- recycled water sources
- any combined supplemental sources from rainwater and stormwater collection

Regardless of the source, irrigation water must be dependable, reliable, and of sufficient quantity and quality to accommodate turf grow-in needs and ongoing maintenance.

In the northeast, irrigating with recycled water may become more common as the cost of water increases and availability of fresh water decreases, especially in large metropolitan areas. Recycled water is defined as any water that has been treated after human use and is suitable for limited reuse, including irrigation; this water is also referred to by other names such as reclaimed water, wastewater, and effluent water. Using recycled water may also be part of a nutrient reduction strategy to meet TMDLs in impaired watersheds.

For more information on the use of recycled water on golf courses, see:

- Appendix E, G*uidelines for Using Recycled Wastewater for Golf Course Irrigation in the Northeast*
- Environmental Institute for Golf, "Using recycled water on golf courses" http://www.stma.org/sites/stma/files/pdfs/gcsaa_recyledwater_leaflet-1.pdf

### 5.1.2 Irrigation Water Quality

Water quality used for irrigation turf on golf courses must be suitable for plant growth and pose no threat to public health. Nonpotable water irrigation sources (such as recycled water or storage and detention ponds) should be tested regularly to ensure that the quality is within acceptable limits to protect soil quality and turfgrass performance. In addition, wells along the shore that supply potable water might need to be tested for salt water intrusion. Summarized below is a brief description of water quality parameters of greatest interest for irrigation water (nutrients and salinity issues); additional parameters such as pH and micronutrients may be valuable for detailed evaluations of water quality.

For more information on irrigation water quality, see:

- "Understanding Water Quality and Guidelines to Management" http://gsr.lib.msu.edu/2000s/2000/000914.pdf
- "Irrigation Water Quality Guidelines for Turfgrass Sites" at http://plantscience.psu.edu/research/centers/turf/extension/factsheets/water-quality

#### *5.1.2.1 Nutrients*

Irrigation water may contain macronutrients, including phosphorus and nitrogen, as well as other nutrients that should be accounted for in nutrient management programs to avoid over fertilization. Irrigation water, especially reclaimed, recycled, or effluent water, should be tested frequently. Excess nutrients may accumulate to levels that are toxic to plants, potentially influencing aquatic plant growth in rivers, lakes, and estuaries and contribute to a variety of soil- related problems. For example, irrigation water high in sodium and low in calcium and magnesium applied frequently to clay soils can break down soil structure, cause precipitation of organic matter, and reduce permeability. Table 5-1 presents the potential for problems at various nutrient levels in irrigation water. Conversion factors and an example for calculating pounds nutrient per acre-foot of irrigation water are provided in Appendix F.

#### *5.1.2.2 Salinity*

Recycled waters usually contain higher amounts of dissolved salts than other irrigation water sources within a specific geographic region (Harivandi 2007). Water quality analyses may report salinity using a number of parameters (Appendix E). Dissolved salts in recycled water tend to reduce the number of cation exchange sites, reducing the nutrient holding capacity of the soil. Deflocculation causes the breakdown of clayey soils and reduces the porosity of the soil. Accumulations of salt in the soil are also phytotoxic.

**Table 5-1. Summary of Irrigation Water Quality Guidelines. Source: Duncan, R. R., Carrow, R. N., & Huck, M. T. (2009).**

| Water Parameter | Units | Desired Range | Usual Range | Average Domestic | Average Reclaimed |
|---|---|---|---|---|---|
| **General Water Characteristics** | | | | | |
| pH | 1-14 | 6.5-8.4 | 6.0-8.5 | 7.7 | 7.1 |
| Hardness | mg/L | <150 | --- | --- | --- |
| Alkalinity | mg/L | <150 | --- | --- | --- |
| Bicarbonates ($HC0_3$) | mg/L | <120 | <610 | 174 | 194 |
| Carbonates ($C0_3$) | mg/L | <15 | <3 | 3.0 | 0 |
| **Total Salinity** | | | | | |
| ECw | dS/m | 0.40-1.20 | <3.0 | 0.8 | 1.1 |
| TDS | mg/L | 256-832 | <2000 | 617 | 729 |
| **Sodium Permeability Hazard** | | | | | |
| SARw | meq/L | <6.0 | <15 | 1.9 | 3.1 |
| RSC | meq/L | <1.25 | --- | -2.3 | -1.88 |
| ECw | dS/m | >0.40 | --- | --- | --- |
| **Specific Ion Impact on Root Injury of Foliar Uptake Injury** | | | | | |
| Na | mg/L | <70 | --- | --- | --- |
| Cl | mg/L | <70 | --- | --- | --- |
| B | mg/L | <0.50 | <2.0 | 0.17 | 0.44 |
| **Specific Ion Impact on Direct Foliar Injury** | | | | | |
| Na | mg/L | <70 | --- | --- | --- |
| Cl | mg/L | <100 | --- | --- | --- |
| $HC0_3$ | mg/L | <90 | --- | --- | --- |
| **Selected Nutrients/Elements** | | | | | |
| N | mg/L | <10 | <2.2 | --- | --- |
| P | mg/L | <0.1 | <0.66 | --- | --- |
| K | mg/L | <20 | <2.0 | 4.0 | 26 |
| Ca | mg/L | <100 | <400 | 67 | 64 |
| Mg | mg/L | <40 | <60 | 24 | 23 |
| $SO_4$ | mg/L | <90 | <960 | 171 | 196 |
| Fe | mg/L | <1.00 | --- | 0.16 | 0.20 |
| Mn | mg/L | <0.20 | --- | 0.01 | 0.03 |
| Cu | mg/L | <0.20 | --- | 0.04 | 0.03 |
| Zn | mg/L | <1.0 | --- | .012 | 0.08 |
| Na | mg/L | <120 | <920 | 70 | 114 |
| Cl | mg/L | <70 | <1062 | 82 | 130 |

Considerations for irrigation water with higher concentrations of salts (total dissolved salts (TDS) > 500) include irrigation duration and frequency, drainage, and turfgrass species selection. Generally, if the amount of water applied to soil (irrigation and precipitation), exceeds ET, salt movement is downward through the soil profile. Conversely, salts move upward in soils if ET exceeds the amount of water in precipitation or irrigation applied to soil. In the latter case, salt drawn to the soil surface gradually accumulates to levels that are toxic to plants (electrical conductivity (EC) > 3 ds/m). This basic process combined with the type of grass grown determines how severe the problem can potentially become and whether it will ultimately affect the playing quality of the turf. Perennial ryegrass and tall fescue are relatively tolerant to salinity compared to annual bluegrass, bentgrass, and Kentucky bluegrass (Table 5-2).

Precipitation levels in New York State are generally great enough to naturally flush soils, thereby controlling salinity levels in soils. If precipitation is not enough to flush soils, leaching fractions can be used to calculate the amount of water needed to flush the soil of salts. The formula for calculating the leaching requirement (LR) is as follows:

$$\text{LR} = \frac{EC_w}{5(EC_e) - EC_w}$$

where:

$EC_w$ = Electrical Conductivity of Water
$EC_e$ = Salt Tolerance of Turfgrass Species

**Table 5-2. Relative salt tolerance of turf species in NYS. Source: Harivandi 2011.**

| Sensitive (<3 dS/m) | Moderately Sensitive (3-6 dS/m) | Moderately Tolerant (6-10 dS/m) | Tolerant (>10 dS/m) |
|---|---|---|---|
| Annual Bluegrass | Annual Ryegrass | Perennial Ryegrass | None in NYS |
| Colonial Bentgrass | Creeping Bentgrass | Tall Fescue | |
| Hard Fescue | Slender Creeping, Red, and Chewings Fescues | | |
| Kentucky Bluegrass | | | |

The sodium (Na) concentration and the quantity of other salts in the irrigation water can affect the permeability (the ability of water to infiltrate into the soil and move through the profile) in clay soil. When irrigation water has Na levels > 200 mg $L^{-1}$ , Na may build up over time and affect permeability. Calcium, which is important to soil structure stability, is displaced by sodium, which in turn causes the soil structure to break down, and results in reduced water and oxygen infiltration and percolation. This problem can become a more serious problem on fine-texture clayey soils than sand-based systems (see Table E in Appendix E).

Residual sodium carbonate (RSC) values are used to assess the sodium permeability hazard. RSC is a measure of the influence of bicarbonates and carbonates as compared to the calcium and magnesium concentration. The total salt content of the water (EC) and the sodium adsorption ratio (SAR) must be considered together when determining irrigation water restrictions due to the sodium permeability hazard (Table 5-3). RSC levels below 1.25 meq/L are safe to use for irrigation.

**Table 5-3. Irrigation water restrictions related to soil water infiltration. Source Harivandi 2011.**

| SAR | None | Slight to Moderate | Severe |
|---|---|---|---|
| | EC (mmhos/cm) | | |
| 0-3 | >0.7 | 0.7-0.2 | <0.2 |
| 3-6 | >1.2 | 1.2-0.3 | <0.3 |
| 6-12 | >1.9 | 1.9-0.5 | <0.5 |
| 12-20 | >2.9 | 2.9-1.3 | <1.3 |
| 20-40 | >5.0 | 5.0-2.9 | <2.9 |

### 5.1.3 Irrigation Water Requirements

Seasonal and bulk water requirement analysis can be conducted to determine water requirements. The seasonal bulk water requirement analysis verifies the suitability of a water source and irrigation system to supply irrigation water under normal conditions. The maximum seasonal bulk water requirement analysis is a worst-case scenario estimate to simulate extended drought conditions, calculated by not allowing for effective rainfall. The National Climate Data Center (NCDC) provides historical climate data as far back as 1895 as well as statistics on precipitation across ten regions in New York. The NCDC uses Palmer Indices, which summarize data for precipitation, evapotranspiration, and runoff, which can be used to calculate the average number of weeks in a statistical year with a water deficit, the average values of the deficits, and the peak evapotranspiration losses assuming no precipitation. For more information, see:

- NCDC data: http://www.ncdc.noaa.gov/
- Calculating water requirements: Chapter 3, "Environmental Best Management Practices for Virginia's Golf Courses" at http://www.vgcsa.org/BMPs.

### 5.1.4 Water Withdrawal

NYSDEC requires water withdrawal reporting for any system capable of withdrawing more than 100,000 gallons groundwater or surface water per day. In accordance with the recently enacted water quality standard for flow, any withdrawal must also ensure that the existing best use of the waterbody from which the water is taken, such as protection of aquatic life, is not impaired.

For more information on water withdrawal reporting and regulations in New York, see: http://www.dec.ny.gov/lands/55509.html.

## 5.2 Irrigation System Design and Performance

### 5.2.1 Design

Irrigation systems should be designed to be efficient, distribute water uniformly, conserve and protect water resources, meet state and local code, and meet site requirements. Site specific characteristics and incorporation of water conservation practices and technologies should be evaluated in the design. The Irrigation Association lists 25 design-oriented BMPs. Figure 5-1 includes several examples of irrigation site-specific designs to conserve water.

**Figure 5-1. Irrigation site-specific designs and technologies help to conserve water. *Source*: Frank Rossi.**

#### *5.2.1.1 Site Considerations*

The design and operation of an irrigation system must be tailored to conditions on the course. Planning should account for different soil types, areas of irrigation, and turf species. Soil conditions dictate how much water is needed to complete deep and infrequent cycles to replenish water in the root zone. The areas of irrigation may also vary in their water requirements depending on site characteristics such as aspect to the sun, hill slopes, and degree of shade. For example, wind-exposed areas have greater transpiration losses than sheltered areas and therefore greater water requirements.

#### *5.2.1.2 Infrastructure*

Infrastructure design considerations include sprinkler and piping placement, sprinkler coverage and spacing, and communication options and serviceability. An irrigation system must be designed to match peak demand. The capacity to deliver more water in a short interval of time can be increased up to, but not exceeding, the infiltration rates of the soils. Any increase beyond the infiltration rate results in runoff.

The type of system used for irrigation influences the efficiency and effectiveness of water usage. Single head systems irrigate the areas closest to the head more than areas farther out. The difference in distribution uniformity presents a serious problem, as achieving planned water replacement on the outer reaches of the head results in excess water being applied in the middle and increases the risk of runoff. Double-row systems offer an improved efficiency over single-row coverage, although manual watering or other types of supplemental watering may be needed outside the fairway area and into the extended rough. Multi-row sprinkler systems provide the best method to control and conserve water, with the ability to respond to specific moisture requirements of a given fairway area. In addition, newer designs are available with multiple nozzle configurations, back and front, that provide the flexibility to more precisely size the system and improve distribution uniformity.

Advanced irrigation control systems are recommended when possible because they provide precision irrigation control. These systems provide specific schedules for each green, tee, and fairway and allow course managers to make adjustments for differences in microclimates and root zones. Weather stations can be integrated to calculate and automatically program water replacement schedules. Additional features may include rain stop safety switches that either shut down the system in the event of rain or adjust schedules based on the amount of precipitation. Advanced systems can connect soil moisture meters, temperatures gauges, and salinity probes installed on the course.

### 5.2.2 Performance

Properly working systems are necessary for efficient irrigation. Irrigation audits can be conducted to assess the system function, ensuring that the irrigation system works reliably and cost effectively. The Irrigation Association has published irrigation audit guidelines (http://www.irrigation.org/Resources/Audit_Guidelines.aspx). The following are common measures of system performance used in irrigation audits:

**Figure 5-2. Regular irrigation system maintenance helps to conserve water. *Source:* Frank Rossi.**

*Coefficient of Uniformity (CU)*. CU measures system performance by how widely a system varies in distribution. A CU of 100% means that a system is uniform. A CU of 84% or better is considered acceptable for high value products.

Because the CU is calculated with the absolute value of the deviations, the score does not indicate whether the system is over- or under-watering. In addition, the score does not indicate what section of the area tested is not performing.

*Distribution Uniformity of the Lowest Quartile (DULQ)***.** The most commonly used calculation to determine uniformity of a sprinkler layout, DULQ is the ratio of the average measurements in the lowest 25% of samples to the overall average of all samples expressed as a percentage. For example, a DULQ of 60% means that the lowest 25% of the samples measured only received 60% of the average water applied. Some resources suggest that a DULQ of 65% or less is poor, 75% is good, and 85% or more is excellent.

*Scheduling Coefficient (SC)*: measures the average water applied to the driest, most critical areas of an area under test and compares to the average. An SC of 100% implies the distribution is uniform. An SC of 120 % indicates that the average was 120% more water applied than the driest area. The SC is often used to adjust run times to ensure that the driest areas receive the required scheduled water replacement. The disadvantage of this method is that all other areas receive 20% too much water, increasing the risk of runoff and leaching.

**Figure 5-3. Regular irrigation system auditing ensures uniform application.** ***Source:*** **Frank Rossi.**

## 5.3 Irrigation Management Decisions

Irrigation should be scheduled when soils reach 50% of the plant available water point and the amount of water should replenish the root zone to field capacity. The infiltration rate, effective root zone depth, and estimated ET demand determine irrigation frequency and soak cycle needs. Turfgrass species also affects irrigation frequency, since some turfgrasses more effectively resist drought than others.

### 5.3.1 Infiltration Rate

Infiltration rates depend on soil texture. Sandy soils have higher porosity and greater infiltration rates than silty or clayey soils. The matrix potential of the finer particle soils increases the time to wet the soil. Figure 5-2 shows the time and area wetted for two different soils: a 15 minute irrigation cycle on a sandy loam penetrates and wets to a depth of 12 inches and a 40 minute cycle wets nearly 36 inches of sandy loam, while clay loam soil requires hours of irrigation to wet the same profile.

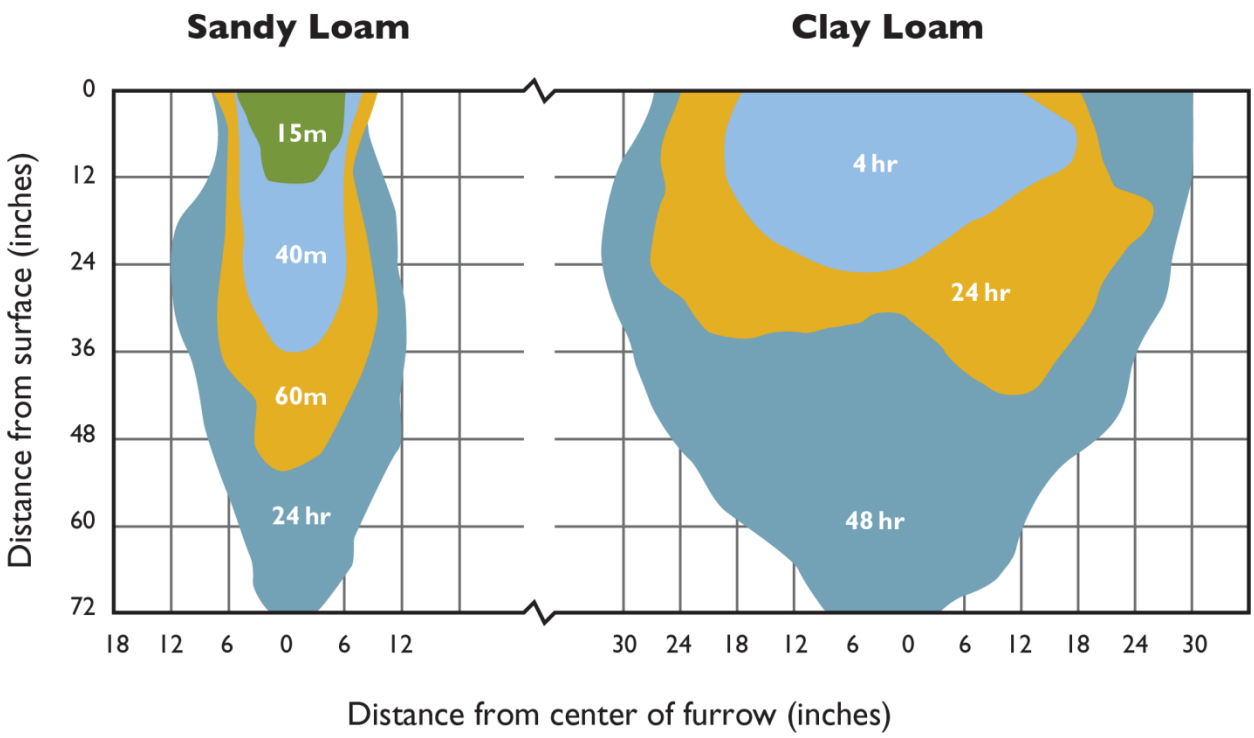



**Figure 5-4. Infiltration of two different soil types measured in time and area wetted.**

Soils develop unique characteristics called preferential flows that, in some cases, influence or accelerate flow through the profile downward towards groundwater. Examples of preferential flow are as follows:

- Macropores created by larger size particulate, gravel, or wormholes, create channels of preferential flow that direct water downward (Figure 5-3).

- Uneven mixes of soil types can result in veins of sandier soil that are more conductive than finer particle soils.
- Organic matter, organic residues, and subsurface layers of mixed densities may restrict and direct flow in unique patterns or fingers.
- Finger flow in sand, which acts like a large channel, allows water to rapidly flow through the profile along with any soluble compounds (fertilizer and pesticides).
- Hydrophobic soils repel water and thus the water must find another pathway, flowing (by runoff) towards areas that are wettable or into cracks in the soil.

Preferential flow and restrictions can lead to non-uniform moisture distribution in the root zone. Some areas of turf may be drier and other areas may be wetter, even saturated. Superintendents can develop better and uniform soil conditions by managing the soil compaction and organic matter content or thatch, such as by frequent aerification and top-dressing to provide better root-zone profiles. The use of water dispersants may be required to help water move through hydroscopic soil conditions associated with localized dry spot. Wetting agents, and in some cases organic amendments, may be needed to increase water holding capacity of some soils, particularly sandy soils.

**Figure 5-5. Preferential flow in soils.** ***Source:*** **Cornell, Soil & Water Lab.**

### 5.3.2 Root Zone Depth

The depth of the root zone (the depth to which 90% of the root system penetrates) must be determined onsite with a soil probe or spade. The soil type and root zone depth together are used to estimate the soil water-holding reservoir available to the root system.

### 5.3.3 ET Demand

ET describes the water lost through soil evaporation and plant transpiration and is influenced by the climate conditions on any given day. Hot, windy days with low relative humidity have higher rates of ET than cooler calm days with low relative humidity. At the wilting point, ET has depleted the available water and the plant begins to show stress. Irrigation scheduling needs to periodically refill the soil reservoir to avoid wilting and can be scheduled by calculating the potential evapotranspiration (PET).

### *5.3.3.1 Calculating PET*

The Northeast Regional Climate Center (NRCC) provides estimates of PET based on climate data from every regional airport in New York State. An ET rate of 0.20 is considered high. Conversely, an ET rate of 0.05 is considered moderate. Calculating PET requires a crop coefficient ($K_c$), which varies by plant species, the leaf area characteristics, and density of the canopy. The $K_c$ typically used for turfgrass management is 0.80. PET estimates should be factored by the crop coefficient to calculate the water replacement to be scheduled.

$$PET \times K_c = \text{Adjusted PET for Turf}$$

$$\text{Precipitation - Adjusted PET for Turf} = \text{Water Deficit}$$

In 2012, New York State experienced three successive seasons that challenged turf managers with very hot and dry periods. Using NRCC data, the 2012 PET deficit for each week is shown for Syracuse Hancock Airport in Figure 5-3. During the 2012 season, ET exceeded precipitation for 17 weeks, exposing turf to drought stress. The total deficit was 10.18 inches of water. Replacing 80% of the PET deficit would have used 11.9 million gallons of water to irrigate 54 acres, the average number of irrigated acres on an 18-hole golf course in the Northeast (Throssell et al 2009).

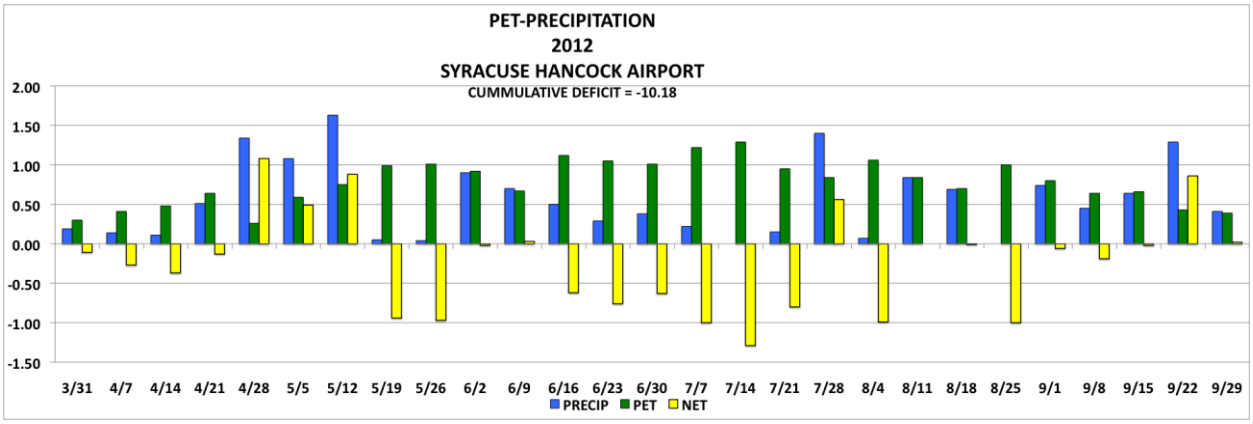



**Figure 5-6. Cumulative weekly evapotranspiration deficit (Precipitation –PET) for Syracuse Hancock Airport, New York.**

The NRCC provides historical data and ET forecasts at http://www.nrcc.cornell.edu/grass/.

### *5.3.3.2 Using PET*

Information from onsite weather stations or PET data from the NECC can be used at a golf course scale or at a smaller scale to adjust for microclimates and conditions. Meaningful ET occurs from April through October in most cases in NY, so rainfall and ET is useful for this period. A few well-monitored golf courses in NY have demonstrated the importance of factoring in the soil water holding capacity to calculate the amount of irrigation. As shown in Figure 2-6 in Chapter 2, the soil texture determines water supply and frequency of irrigation. For example, a typical 12 inch USGA sand root-zone green will have only about 0.75 inch of

plant available water stored. Any daily rain events greater than 0.75 inch need to be reduced to 0.75 inch in the PET calculation (rainfall-ET). Also, to avoid drought stress in turf, irrigation should be at 50% of the PAW, or in the case of the sand green, about 0.20 inch of PET. On very dry days, this value could mean irrigating daily or every couple of days, depending on the weather. At the smaller scale, irrigation should be adjusted in areas with lower PET, such as shady areas. If an on-site weather station is not an option, at the least a rain gauge should be used to collect rainfall due to localized summer storms.

### 5.3.4 Monitoring Soil Moisture

The NRCS provides a guideline for estimating the soil moisture content of soil by touch (http://nmp.tamu.edu/content/tools/estimatingsoilmoisture.pdf). The turf industry, however, offers tools to more precisely measure soil moisture content. Several handheld and portable instruments can be used to spot check areas (Figure 5-7).

**Figure 5-7. Root zone moisture, temperature, and salinity meter (left) and portable moisture meter (right). *Source*: John J. Genovesi, Maidstone Club**

Programs are also available to map moisture content using global positioning system (GPS) positioning. Maps can be compared between different times of day, different seasons, and different management routines to compare soil moisture conditions. Irrigation system suppliers now offer in ground moisture meters to provide continuous data input to their controllers to adjust irrigation rates based on soil moisture.

### 5.3.5 Deep and Infrequent Versus Light and Frequent Irrigation

Several studies have compared deep and infrequent irrigation (DI) to light and frequent (LF) schedules. DI was applied at signs of wilting and the soil was wetted to a depth of 9.5 inches. LF treatments watered daily to replace the ET lost and generally wetted the top 1.5-3.0 inches of soil. Both treatments were syringed as required to cool turf on hot days. The turf treated using DI had increased root and leaf carbohydrates, larger and deeper root masses, reduced thatch, and better overall quality throughout the season ((Fu, J., and Dernoeden, P. H. 2008; Fu, J., and Dernoeden, P. H. 2009a; Fu, J., and Dernoeden, P. H. 2009b). This particular study only considered physiological factors and did not assess the risks of leaching. Soils should not be

wetted much below the root zone because this practice increases the risks of pushing nutrient and pesticide residues closer to groundwater.

Other studies have demonstrated that turf pre-conditioned with deficit irrigation for a period of 7 to 14 days withstands periods of drought and has a quicker recovery. Pre-conditioning improves stomatal conductance, transpiration rates, and photosynthetic capacity in subsequent periods of stress. However, letting soils dry completely has a negative effect on plants. Creeping bentgrass, Perennial ryegrass, and tall fescue can be pre-conditioned replacing 60-80% of the water deficit. Kentucky bluegrass has much higher sensitivity to drought stress and should only be watered at 100% of deficit. Cool season turfgrass should not be watered below 40% of deficit. Even though Kentucky bluegrass has the greatest sensitivity to deficits, it has the highest resiliency to recover.

***BMP Statements***

- Design and maintain irrigation systems to uniformly apply water to the intended area of management.
- Determine accurate supplemental water needs based on appropriate climate and soil data.
- Assess system efficiency through regular audits of application rate and uniformity.

# 6 NUTRIENT MANAGEMENT

Although nutrients are present in the soil as well as in all forms of turfgrass and other plant material waste, turfgrass management requires the use of fertilizer to meet turf nutrient needs. Understanding the role of plant and soil nutrients as well as applied nutrients is essential to minimizing off-site movement of these compounds that could contaminate surface and groundwater. Because of this potential for off-site contamination, New York State and some local agencies regulate aspects of the use of fertilizers, as discussed in Chapter 3.

## 6.1 Nutrient Use in Plants

All plants require nutrients to sustain growth and development. Certain essential nutrients are classified as either macro- or micronutrients, based on the amount needed by plants rather than their importance for plant growth. Macronutrients include nitrogen, phosphorus, potassium, calcium, sulfur, and magnesium. Micronutrients include iron, zinc, copper, chlorine, nickel, molybdenum, boron, and manganese (a known issue on higher pH sands in NY).

Micronutrients are required in significantly lower amounts than macronutrients; however, a deficiency or excess of these micronutrients can have a profound influence on plant growth.

Proper nutrient management usually includes the following steps:

1. Determine plant needs (such as light levels, traffic levels, irrigated or not, and expected visual quality).
2. Assess the soil reservoir for availability (soil testing).
3. Determine nutrient needs and select the proper source of nutrient fertilizer (most are combination products).
4. Decide the rate, timing, and frequency of application.

## 6.2 Soil Testing

Soil testing is the beginning of precise nutrient management programs for all nutrients other nitrogen as it can be used to determine nutrient levels, make fertilizer recommendations, and in some cases diagnose the cause of poor performing turf. Assessing the existing reservoir of available nutrients in the soil can minimize the need for supplemental applications of fertilizer, which saves money while protecting the environment. Soil nutrient analysis aids in determining if nutrient deficiencies exist, as many soils have various levels of nutrient holding capacity, often referred to as cation exchange capacity (CEC). For example, sand-based systems, which have only a limited amount of stored minerals, may demand more mineral additions. Determining supplemental nitrogen needs are typically not based on soil tests as the method of extracting N and the subsequent calibration with plant growth have not been established.

Soil tests are required by the NYS Dishwasher Detergent and Fertilizer Law to confirm a need for phosphorus fertilization prior to its application. Research at Cornell University, however, concluded that no correlation exists between soil test phosphorus levels and runoff until

phosphorus levels are 50 fold greater than the sufficiency level. A survey of soil test submissions to the Cornell University Nutrient Analysis Lab found that less than 3% of all submitted samples over a 5 year period had phosphorus values at these levels.

### 6.2.1 Soil Sampling

General guidelines for soil sampling are as follows:

- Sample when soils are biologically active. Fall sampling is most common and allows time to review results and apply lime and nutrients in advance of spring growth and to develop a season-long plan.
- Do not sample within the two months following heavy fertilizing or liming; sampling around frequent, light applications (spoon feeding) is acceptable.
- Test soils at the same time of year to allow for comparison of results from year to year.
- Because soils exhibit significant spatial variability, take a number of samples, combine, and then subsample. As a rule, a minimum of ten sample locations should be sampled per acre.
- Sample areas with different soils and drainage separately, for instance, sample sand-based greens and tees separately from fairways and roughs.
- Take the sample from the root zone (typically 4-6 inches deep) typically by removing the grass mat from the top of the sample.

### 6.2.2 Laboratory Analysis

Soil test methods vary in a number of respects:

- the type of chemical extractant used to measure the nutrient that can be released or dissolved into solution
- the ratio of soil to solution
- laboratory methods

Some methods are more suitable for one type of soil than another; therefore different labs use different tests. For example, soil labs at universities in the northeast use the Morgan or Modified Morgan test, which is appropriate for the acidic soils found in this region. Other test methods, such as the Bray-1, the Olsen, and the Mehlich-3 tests, use very different extracting solutions, different soil to solution ratios, and processes and are more appropriate for other types of soils. The Olsen test is specifically designed for calcareous soils (soils that contain calcium carbonate). The Mehlich-3 provides reliable results across a wider spectrum of soil pH. Results vary depending on the test method and even when using the same method, can vary widely from one lab to another due to variations in lab procedures. Consistently use the same laboratory to perform soil test in order to compare results over time.

On sand-based areas of golf courses with low CEC (<6 cmol/kg), soil testing has limited utility. Test results in these areas are often low due to the soil's low nutrient holding capacity. On such sites, test only for pH, CEC, soluble salts, organic matter, phosphorus (to adhere to regulatory requirements); if the pH is above 7.5, also test for calcium and magnesium.

### 6.2.3 Interpreting Test Results

Soil nutrient analysis provides information on the levels of macronutrients (phosphorus, potassium, calcium, and magnesium) and typical micronutrients (iron, zinc, copper, and boron) present in the soil, as well as the soil pH. In addition to standard pH and nutrient information, additional soil test data, such as CEC, soil organic matter content, and total soluble salts, can be requested and may prove valuable in the management of putting green soils in particular. Soil test results may include N levels, however because nitrogen constantly fluctuates between plant available and unavailable forms, it is unclear whether this information is useful.

Laboratories report results for nutrients as either parts per million (ppm), pounds per acre (lbs/A), or as a predictive index (lbs/A can be converted to ppm by dividing the lbs/A reported by two and ppm can be converted to lbs/A by multiplying by two). Most laboratories report a rating indicating the relative status for each nutrient, such as Very Low, Low, Medium, High, or Very High. Test results provide recommended nutrient (including nitrogen) and lime application levels and frequency of application. Soil test results form the basis for nutrient management planning for selection of nutrient sources, rates of application, and appropriate timing to meet site specific needs for greens, tees, fairways, and roughs.

### 6.2.4 Supplemental Plant Tissue Analysis

Plant tissue analysis is a useful diagnostic tool when samples are collected over a season in which levels can be correlated with environmental, biological, and fertilizer events. Occasionally sampling provides little information regarding nutrient management when tissue levels are not properly correlated with fertilizer need. Therefore, tissue testing is not considered a reliable means of establishing a nutrient management program on its own. Used in conjunction with soil tests, analyzing plant tissues over time can be used to observe trends that can be correlated to environmental and management factors. Tissue testing may be best used on sand-based areas and when the majority of nutrients are going to be applied in fertigation (the application of nutrients through the irrigation system) or in small amounts (spoon feeding).

## 6.3 Nutrient Availability and pH

The pH of a soil influences the entire soil chemical environment and fundamentally determines nutrient availability, fertilizer response, and soil biology. In general, a neutral pH is considered adequate for most turfgrass needs; however, slightly more acidic pH can allow for increased levels of metal ions to become soluble and is often favored as a means of increasing the competitiveness of creeping bentgrass and fine fescue over annual bluegrass (Figure 6-1). Soil pH can be manipulated with a variety of fertilizer sources such as ammonia sources of nitrogen that have a slight acidifying effect as ammonium is processed by microbes. In addition, various types of liming materials such as calcium carbonate or dolomitic (higher Mg) lime supply nutrients can raise the soil the pH. Salts can also raise pH.

Efforts have been made to reduce soil pH with elemental sulfur to address calcareous soil issues with pH in excess of 7.3. Due to the high buffering capacity (the ability of soils where calcium or magnesium is a parent material to resist a pH change) of soils with pH greater than 7.3, the use of elemental sulfur results in little change. This result is especially true for limestone based soils in great lakes region of the state.

Soil pH profoundly influences phosphorus (P) availability and can influence movement on and through the soil profile. Soil available P or P fertilizer added is either fixed by adsorption to soil particles or retained without precipitating into secondary P minerals. The amount of fixation and retention depends on a wide array of factors, pH being one of the most significant. Precipitation increases as iron or aluminum precipitates at acid pH or as calcium precipitate at alkaline pH. The pH equilibrium between these precipitation extremes is between 6.0 and 7.0.

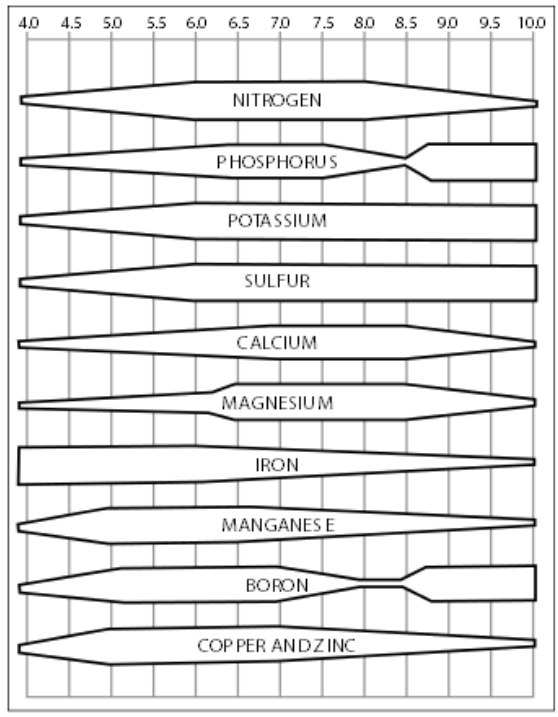



**Figure 6-1. Relative soil nutrient availability as influenced by pH. Source: Virginia Turfgrass.**

## 6.4 Critical Plant Nutrients

Golf course managers must ensure that all supplemental fertilizer is handled and applied to maximize plant response and minimize off-site movement. Nitrogen and phosphorus are the most important macronutrients to manage correctly because they are critical to both plant health and water quality.

### 6.4.1 Nitrogen

Nitrogen (N) is the most important managed nutrient for both plant growth and health. Insufficient N limits growth and plants' ability to withstand stress. For example, sufficient nitrogen is required for root growth; insufficient amounts may result in a weaker root system and lower reserves. Conversely, excessive N can lead to excessive shoot growth at the expense of root growth and result in a weaker plant structure. Providing sufficient quantities of nitrogen, consistently over time, maintains turf density, quality, and function.

The source, rate, and timing of nitrogen fertilization influence the turfgrass response. For example, soluble N sources provide quick green up but often do not sustain this response for more than a few weeks (depending on rate). These factors also have a significant influence on the fate of nitrogen applied into the environment (Figure 6-2).

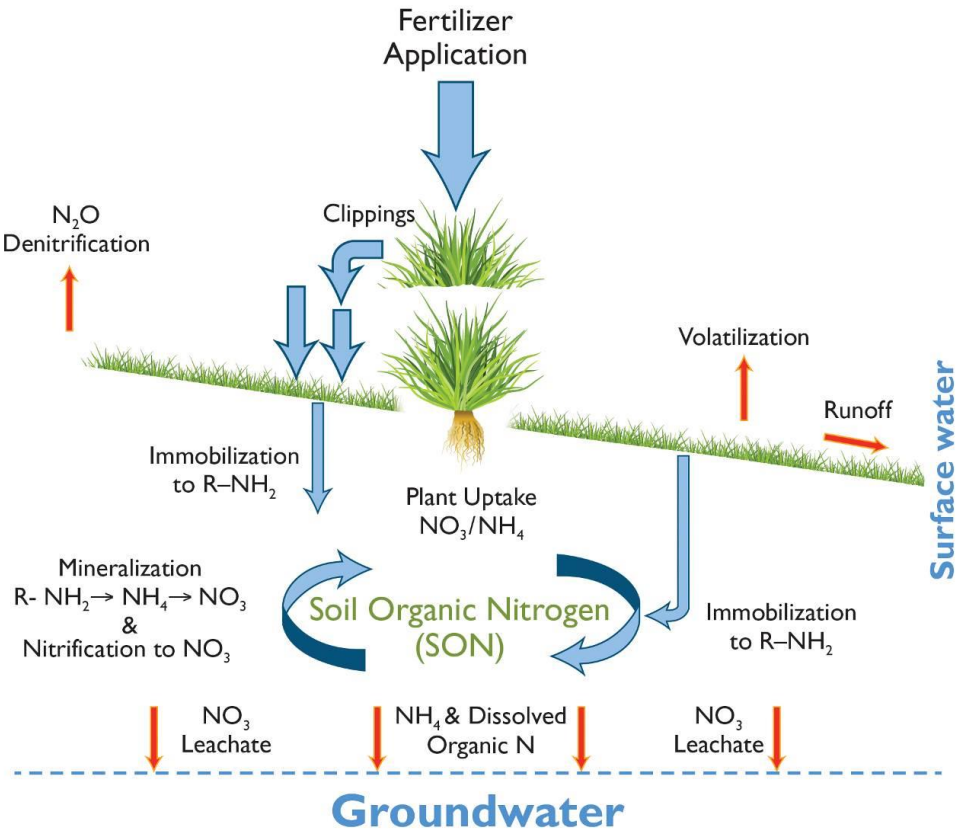



**Figure 6-2. Nitrogen cycle.**

## 6.4.2 Nitrogen Fertilizers

Many types of nitrogen fertilizers are available and vary by source, percentage of nutrient, and formulation. The fertilizer industry has standardized labeling to represent the "N" in the "N-P-K" label to represent the percent elemental N regardless of the form, while the P and K represent the percent of phosphate ($P_2O_5$) and potassium oxide ($K_2O$), respectively.

It is critical to understand the form of nitrogen supplied in a fertilizer and distinguish which forms have the lowest risk of contaminating groundwater, while still providing a consistent release of nitrogen over time. Additionally, it is critical to understand the environment that the nitrogen fertilizer is being released into to ensure minimal off-site movement.

### *6.4.2.1 Nitrogen Management Checklist*

Using the right product, at the right time, and at measured rates of application maximizes plant use of the fertilizer and minimizes the risk of nutrient leaching or runoff. However, determining these best practices requires an understanding of other important factors.

*Soil Issues*

- Soil Type: Well-drained soils with coarse textures and high percolation rates have lower water holding capacity, greater infiltration, and higher risks of leaching.
- Organic Matter: Soils with low amounts of organic matter have lower biological capacity to assimilate nitrogen and are more susceptible to leaching.

*Plant Issues*

- Growth Phase: Newly seeded areas pose higher risks of leaching and runoff than well-established stands of turfgrass. Once established, the increased density of root mass increases nitrogen uptake while reducing the risk of leaching. Turfgrass in early stages of growth (1 to 20 yrs or more, depending on the organic matter starting point) has increasingly greater capacity to store and release nitrogen, reducing fertilizer requirements. The lower the amount of organic matter present in turfgrass, the longer the period of storage will be. As the site matures and the amount of organic matter accumulates (20 to 50 yrs), it poses a higher risk of leaching than younger turf.

*Product Characteristics and Application*

- Product: The best strategy for use of water soluble fertilizers is light rates of 0.5 lbs n/1000 sq. ft in general; 0.4 lbs n/1000 sq. ft on sand; and no more than 0.7 lbs n/1000 sq. ft on other soils (assuming no heavy rain events) and more frequent applications. This practice more closely matches plant uptake and ensures minimal leaching past the turf root zone. Water insoluble or slow release products, including organics or stabilized products, used properly, have a lower risk of impairing water quality through leaching and runoff. Release rates of combined fertilizer sources and applications can increase or "stack" the amount of available nitrogen. The combined total nitrogen can possibly leach nitrogen even if individual products would not.
- Fertilizer Rate: Excessive applications of any nitrogen-based fertilizer product can create high soil nitrate levels (>1.0 ppm) susceptible to leaching.
- Timing: Application of any nutrient to saturated soil or prior to heavy rainfall can lead to significant off-site movement. Applications made too early in the spring or too late in the fall result in higher soil nitrate levels, posing a greater risk to groundwater quality. Similarly, applications should be reduced during summer decline when plant uptake decreases. Research has not shown an appreciable difference in turf quality using different schedules of application. Applications made every month compared with split schedules of spring and fall, spring only or fall only show reasonable consistency. Light-frequent applications may provide the most consistent quality and limit the susceptibility of losses to leaching and runoff. Low rates of N associated with light-frequent applications may require that applications be made using spray equipment to uniform coverage and response.

### *6.4.2.2 Nitrogen Fertilizer Use*

*Water Soluble Sources*

Water-soluble nitrogen (WSN), including inorganic N and synthetic organic urea, are released quickly into the soil, which can increase the risk of leaching at high rates. Inorganic sources include ammonium nitrate, ammonium sulfate, potassium nitrate, calcium nitrate, and mono-di-ammonium phosphate. Nitrate ($NO_{3-}N$) and ammonium ($NH_{4-}N$.) are the principle sources of inorganic nitrogen that plants absorb. Plants generally grow best with a combination of $NO_{3-}N$ and $NH_{4-}N$. $NH_4$ is best absorbed at a pH around 7.0 and less absorbed at more acidic pH. Conversely, $NO_{3-}N$ is best absorbed at an acidic pH.

Urea is a common and inexpensive water-soluble form of nitrogen. Urea can burn turf at high rates, but it has a lower burn potential than other inorganics. Losses due to volatilization may also be high when applied as a dry material on days that are hot (>80°F) and humid. Lightly watering in urea solutions (when possible) reduces the amount of volatilization.

*Slow Release Sources*

Urea is also available coated in sulfur or a polymer for slow release with less volatilization and leaching. In other variations, urea and urea-ammonium nitrate (UAN) are also available with urease inhibitors, n-butylthiophosphoric triamide (NBPT), and nitrification inhibitors, dicyandiamide (DCD). Inhibitors reduce volatility losses and slow the rate of nitrogen release. These coated and stabilized nitrogen fertilizers are effective at reducing the risks of contaminating groundwater and increase the utilization of nitrogen applied.

Other forms of urea include methyleneureas (MU), ureaformaldehyde (UF), triazone, and isobutylidene diurea (IBDU). The MU and UF fertilizers are available in short or long chain C-H or methyl links. Shorter chains have higher salt indexes, increase the burn potential, and release N quicker. The long chain formulations releases over a longer period with lower burn potentials. The products are grouped according to their "fraction". These distinctive fractions have characteristic water solubility and release rates.

The Association of American Plant Food Control Officials (AAPFCO) requires that ureaformaldehyde products be defined to contain at least 35% N-nitrogen, largely as insoluble but slowly available products with a water insoluble nitrogen (WIN) content of at least 60%. A ureaform produced with a 1.3:1 ratio of urea to formaldehyde contains 38% N of which 65-71% is WIN. A methylene urea product with a 1.9:1 ratio contains 39% N of which 36% is WIN. Products are often produced with a mixture of other water-soluble nitrogen sources and a percentage of WIN ureaformaldehyde. Course managers must understand the product being used, the percentage of water solubility, and the release rates in order to use these products effectively.

The UF and MU fertilizers require microbial activity to release their N. A urease enzyme hydrolizes the urea to $NH_4$ and bacteria nitrify the $NH_4$ to $NO_3$. Like the organic fertilizers, little

N is released unless the soil temperature is over 50° F. As the soil warms, and microbial activity increases, more N is released.

IBDU, typically 31% N, does not require microbes because it is slowly hydrolyzed by water. IBDU is available in two grades: a coarse grade that is 90% WIN and a fine grade (greens grade) that is 85% WIN. The finer grade releases quicker and is less likely to be collected during mowing. Acid soils also increase the N release rate.

*Liquid "Foliar" Sources*

Almost any source of nitrogen can be applied in a liquid form and, depending on how the much water is used when applying, the nutrient can be absorbed foliarly. Foliar products are available using combinations of urea and other inorganic nitrogen compounds. The product is typically sprayed to coat the leaf surface. Plant uptake is generally 10-70% of the fertilizer applied, which can be higher than the amount absorbed by the roots.

#### *6.4.2.3 Release Rates*

Research often evaluates different forms of fertilizers, rating each product according to turf quality, color, and clippings as a measure of growth. While these comparisons are important, knowing the portion of the fertilizer's nitrogen content that is "immediately available" and its release rate can help in selecting products and balancing rates with plant requirements. Controlling the amount of available nitrogen also reduces the risk of excess nitrates being leached from the soil.

Biologically active soils may react quickly to release the water insoluble portion of the fertilizer adding more nitrogen that is available to the plant or movement into ground water. A series of studies confirmed that, under active growing conditions, perennial ryegrass, Kentucky bluegrass, tall fescue, and creeping bentgrass assimilate nitrogen, as either nitrate or ammonium, within 48 hours of applications (Bowman et al 1989a). The results suggest that using prudent rates of application, the plant can quickly absorb and use the immediately available nitrogen that has been applied.

#### *6.4.2.4 Organics Versus Synthetics*

Several types of fertilizers have been measured for the losses associated with runoff and leaching of phosphorus, nitrate, and ammonium. Research has determined that once turf was established, natural organics lost 3-6% of the nitrogen applied as $NO_3$-N leachate compared to 8.6-11.1% lost for synthetic organics (Easton and Petrovic 2004). Little difference was found between sulfur-coated urea and the immediately available urea or ammonium phosphate fertilizer. Natural organics, notably dairy and swine composts, increased the percentage losses of phosphorus partially due to more P being applied at the same N amount of the synthetic fertilizer.

#### *6.4.2.5 Water Solubility*

Water solubility can potentially increase the risk of leaching. While ammonium cations ($NH_4^+$) can be held within the soils cation exchange sites, some soils, especially sandy soils, have too little cation exchange capacity to hold ammonium or other cations like potassium or calcium. Nitrates are freely solubilized and mobile in the soil solution. Slow release fertilizers can be used on sites with higher leaching risks to decrease the risks to groundwater. Slow release fertilizers can be applied at a rate of 2-3 lbs N per 1000 sq. ft. per year in split applications. Applications should not be made in late fall (November or later). Since much of the water recharging groundwater occurs during the late fall, winter and early spring, Late fall N applications can result in leaching for two reasons: ( 1) increased precipitation and groundwater recharge during the period from late fall to early spring and (2) reduced plant uptake of N during winter dormancy.

*Timing*

Leaching studies conclude that applying fertilizers during clear weather can prevent episodic losses of nitrates to groundwater. The use of quick release, water soluble, immediately available nitrogen sources is an acceptable practice when properly applied. Conversely, over-application or applications that are stacked due to short interval application schedules using some slow-release products can increase the risk of leaching. Precipitation events and excessive irrigation can also drive the nitrates deeper into the soil profile. Testing has shown that applications should be limited so that the water-soluble, immediately available, and released fraction of fertilizer additions does not exceed 0.5 lbs N per 1000 sq. ft., 0.4 on sand, and no more than 0.7 on other soils (assuming no heavy rains in the next several days).

### 6.4.3 Off-site Movement of Nitrogen Fertilizer

A variety of chemical and environmental factors influences the potential for off-site movement of nitrogen through leaching and runoff.

#### *6.4.3.1 Nitrogen Leaching*

All applied N eventually becomes the ammonium or nitrate form of N (or soluble organic N in some cases). Ammonium ($NH_4$) is rapidly converted in soils to nitrate ($NO_3$). Ammonium is also tightly held in the clay or organic profile of a soil, typically within the upper 0 to 2-inch layer. Studies typically report only trace amounts of $NH_4$ in leachate even under high fertilization and irrigation schedules (Bowman et al 1989b; Frank et al 2005).

Excluding the effects of runoff, nitrate ($NO_3$-N) presents leaching concerns for groundwater quality. Any fertilizer with solubility greater than 30 mg/L (or 30 ppm) can pose a risk for leaching and groundwater contamination. Leaching flow has been measured highest in winter and spring when plant water use is low and little N is taken up by the grass. However, "episodic" leaching events have been observed in the growing months when precipitation (or irrigation) is greater than the amount of water held in soils plus the amount used by plants.

#### *6.4.3.2 Nitrogen Runoff*

Runoff losses have been found to be five times greater on the lower slope than the upper slope in a study conducted on a 6-8% slope with sandy loam to loam soils (Easton and Petrovic 2005). The greater losses at the bottom of the slope were associated with higher clay accumulation, lower infiltration rates, wetter soils, and reduced lateral flow. The losses in the lower slopes are indirectly noted by higher saturation levels.

In general, runoff from turf during non-frozen soil conditions is due to saturation excess, not due to infiltration excess. Slope profiles in the topography of a site can lead to accumulated saturation zones that are prone to runoff. Such areas may also have shallow profiles with clay, bedrock, or other compacted soil layers (sometimes seen from construction activities) that creates or restricts lateral flow. The restrictions increase runoff losses in that area. The creation of shallow lateral flow channels tends to carry losses to other areas, including groundwater recharge.

For newly seeded sites, infiltration rates in turfgrass systems increase with age. Infiltration rates increase with increased shoot density through establishment. As infiltration rates increase, runoff decreases. Within a year after seeding, the infiltration rate can increase from 0.1 inch/hr to over 4 inches/hr. The frequency, duration, and intensity of irrigation or precipitation events can be overriding factors in ground saturation and runoff.

### 6.4.4 Phosphorus

Phosphorus is a critical nutrient for turfgrass growth and development, playing important roles in energy transformations in plant cells and root development. Therefore, P enhances turfgrass establishment and is the most important nutrient in 'starter fertilizers'. On soils low in P, most of the enhanced establishment is from the N. Phosphorus management is focused on maximizing plant response to supplemental phosphorus, when required as based on soil test results, while minimizing offsite movement.

In the soil, P is generally in complex with other elements and is an insoluble (plant unavailable) nutrient. Phosphorus is slowly made available to plants on an 'as needed' basis by chemical reactions in the soil that convert it to either of two anionic forms, dihydrogen phosphate ($H_2PO_4$)-or hydrogen phosphate ($HPO_4^{2-}$ ).

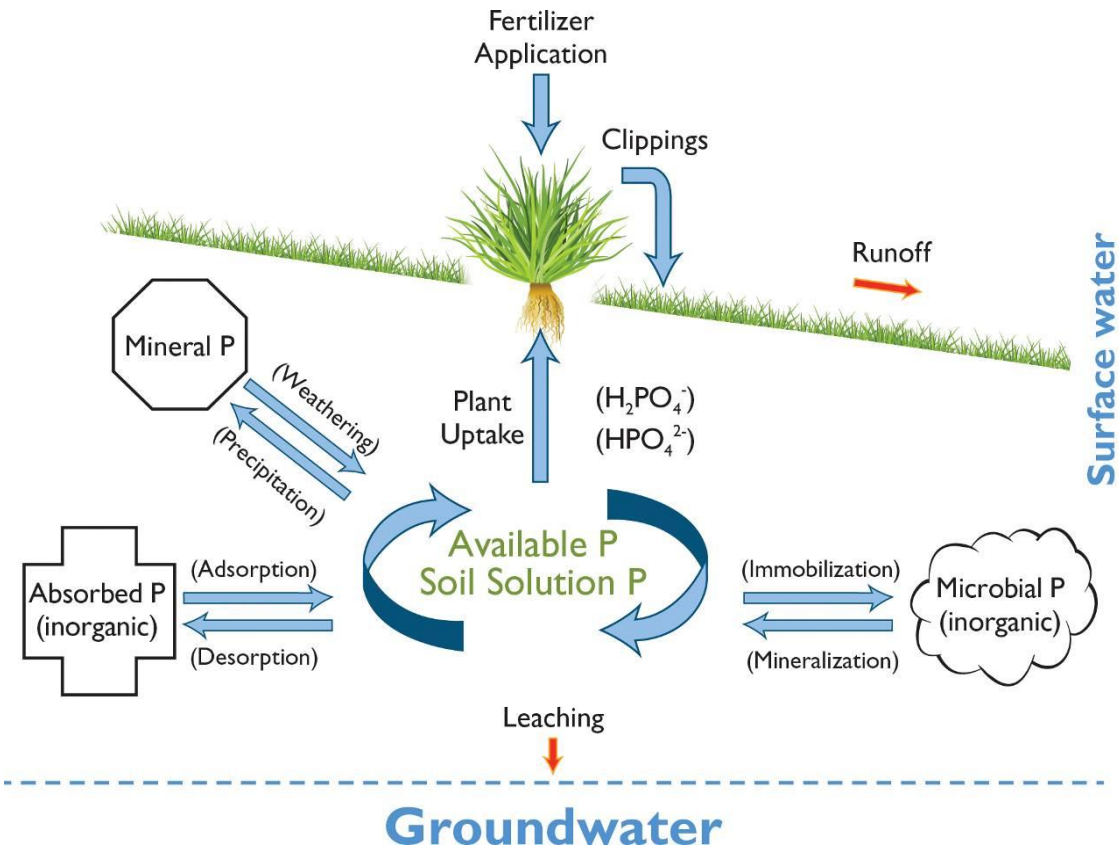



**Figure 6-3. Phosphorus cycle.**

A soil is considered to have a phosphorus deficiency if it is at or below the medium sufficiency level. Research has often found that turfgrass shows signs of distress at P levels of 5 to 11 ppm (Mehlich III), a range considered Low or Very Low. The medium sufficiency ratings for each test method are shown in Table 6-1.

**Table 6-1. Medium sufficiency levels by test method. Source: http://nmsp.cals.cornell.edu/software/Morganequiv7.xls**

| Test Method / Extractant | Medium Sufficiency | |
|---|---|---|
| | ppm | lbs/acre |
| Mehlich-3 | 26-54 | 52-108 |
| Bray P1 | 15-30 | 30-60 |
| Olsen | 12-28 | 24-56 |
| Morgan (for agronomic crops) | 10-20 | 20-40 |
| Modified Morgan/Cornell (for turf) | < 2 | 1-4 |

Testing labs provide recommendations for the amount of phosphorus fertilizer needed to correct the deficiency. Recommendations are made separately for fertilizing established turfgrass or for pre-plant fertilization to establish a new stand of turf with either seeded or sodded turfgrass (Table 6-2).

**Table 6-2. Phosphorus fertilizer recommendations for turfgrass (Petrovic 2012).**

| Established Turfgrass | Current Recommendations | | $P_2O_5$ Recommended lbs/acre |
|---|---|---|---|
| | Morgan lbs/acre | Mehlich-3 lbs/acre | |
| Low | < 1 | < 3 | 80 |
| Medium | ≥ 1 | ≥ 3 | 40 |
| High | > 4 | > 12 | 0 |
| Newly Seeded or Sodded Turfgrass | < 1 | < 3 | 140 |
| | ≥ 1 | ≥ 3 | 100 |
| | ≥ 4 | ≥ 12 | 60 |
| | ≥ 8 | ≥ 24 | 40 |

### 6.4.5 Phosphorus Fertilizers

Phosphorus fertilizers are processed from rock phosphate mined from apatite mineral deposits around the world. The processing increases the availability of reactive and water-soluble P content. Many products formulations are available. The P content of any fertilizer is listed in the N-P-K ratio on the label as the percent $P_2O_5$.

Water solubility is a measure of the fertilizer's ability to dissolve into the soil solution. Some of the water-insoluble fraction of the fertilizer P can be extracted by citric acid. The remaining P is citric insoluble and remains in the soil until soil processes mineralize the insoluble P. The water soluble fraction and the citric acid soluble fraction comprise the total plant available P. The formulas to convert these factors are based on the molecular weight:

$$\%P = \%\ P_2O_5 \times 0.43$$

$$\%\ P_2O_5 = \%P \times 2.29$$

Using a higher solubility fertilizer, while perhaps best for the plant, increases the risk of leaching or runoff contamination. Phosphorus fertilizers are listed in Table 6-3 with the corresponding fraction of Total Plant Available P (water soluble and citric soluble fractions).

**Table 6-3. Phosphate fertilizers (Tisdale, 1993; Turgeon, 1985)**

| Fertilizer | %N | % $P_2O_5$ | %P | % Total P Available | Cold Water Solubility (g/L) | Salt Index |
|---|---|---|---|---|---|---|
| Rock Phosphate | --- | 27-41 | 12-18 | 14-65 | --- | --- |
| Single Superphosphate | --- | 16-22 | 7-9.5 | 97-100 | 20 | 0.4 |
| Triple Superphosphate | --- | 44-52 | 17-23 | 97-100 | 40 | 0.2 |
| Monoammonium phosphate (MAP) | 11-13 | 48-55 | 21-24 | 100 | 230 | 2.7 |
| Diammonium phosphate (DAP) | 18-21 | 46-53 | 20-23 | 100 | 430 | 1.7 |
| Ammonium polyphosphate | 10-15 | 34-37 | 15-16 | 100 | --- | --- |
| Urea ammonium phosphate | 28 | 27 | 12 | 100 | --- | --- |
| Nitric phosphates | 14-28 | 14-28 | 6-10 | 80-100 | --- | --- |
| Potassium phosphates | --- | 41-51 | 17-22 | 100 | --- | --- |
| Sewer Sludge | 4 | 6 | 0 | 0 | --- | --- |

### *6.4.5.1 Phosphorus Management Checklist*

*Soil Issues*

- Phosphorus fixation increases with increasing clay content in the soil. The larger amount of surface area associated with clayey soils and the Al-Fe minerals in the lattice help adsorb more P than other soils. In calcareous soils, the adsoption is associated with calcium carbonate ($CaCO_3$).
- Larger fertilizer additions are required to maintain a level of plant available P in finer soils compared to that in coarser, sandy soils. The risk of leaching P is highest in sandy soils.
- The rate of biological activity, and therefore P mineralization, increases with increasing temperatures. Fertilizer applications should only be applied to active soils when soil temperatures are above 50°F.
- Liming acid soils increases the P solubility in acid soils, but over-liming can reduce P solubility. Sorption also occurs to calcium cations ($Ca^{2+}$) but only at pHs up to 6.5. At higher pH values, Ca-P precipitates form.
- Incorporating P into the soil when possible increases adsorption and reduces the amount of plant available P. Broadcasting P fertilizer on the surface leaves the fertilizer susceptible to runoff.

*Plant Issues*

- Returning clippings to the turf is a practical method of returning organic P back to the soil. Clippings may account for 0.10 to 0.35 lbs P per 1000 sq ft. If clippings are removed, the loss of P depletes available P for plant uptake.

*Other Sources Issues*

- Foliar applications at light rates may increase plant uptake. Unabsorbed foliar P, however, remains at risk for episodic losses due to runoff caused by heavy precipitation or excessive irrigation. A light irrigation after P fertilizer application has been shown to reduce P runoff.
- Phosphanate fungicides are chemically different from phosphanate fertilizers in that the fungicide provides a phosphite ion ($H_2PO_3^-$) having one less oxygen atom. Potassium phosphite, also labeled as mono and di-potassium salts of phosphorus acid, Aliette, and Chipco Signature are the most common examples of a phosphanate fungicides. No evidence suggests that the phosphite ion is used in the plants metabolism. Regardless, the amount of P supplied in any fungicide application is negligible.

### 6.4.5.2 Phosphorus Fertilizer Use

*Rock Phosphate*

Rock phosphate can be used as a P fertilizer on soils with a pH of 6 or less. It is not soluble in water. The mineralization of P is a slow process, typically over a period of years depending on soil properties. If used, it should be finely ground and incorporated into the soil. If a soil test indicates a severe deficiency, others sources may be best for the short term. However, rock phosphate could be used as a long term source.

*Single and Triple Superphosphates*

Single superphosphate (SSP) has 16 to 22% $P_2O_5$ (7 to 9.5%P). The fertilizer is 90% water soluble and is all plant available P. SSP also contains 12% sulfur (S).

Triple superphosphate has 44 to 52% $P_2O_5$ (17 to 23%P). The fertilizer has a very high water soluble fraction. It is only available in granular form.

*Ammonium Phosphates*

Studies suggest that there is increased plant uptake of the P in ammonium phosphate fertilizers due to the presence of ammonium ($NH_4^+$). Monoammonium phosphate (MAP) and diammonium phosphate (DAP) are water-soluble. MAP and DAP are granular products (Tisdale 1993).

Monoammonium, diammoniam, and ammonium polyphosphate are typically used for foliar P applications.

*Biosolids*

Another source of P comes from the use of biosolids as an organic fertilizer. Milorganite is a popular example containing 6% nitrogen and 4 % $P_2O_5$. Release of the N and P fractions is by microbial mineralization.

*Other P Sources*

Phosphorus may be an integral by-product of other soil amendments, natural organic fertilizers, and bio-stimulants. The most notable additions come from the use of composts as soil amendments or nitrogen sources and the use of recycled water.

- Manure & Composts: Fertilizers that are produced as by-products of the livestock or poultry industry can be classified as composts or manure. Phosphorus in these products exceeds the 0.67% limit stated in the Dishwater Detergent and Nutrient Runoff law, but have been exempted. Manure and composts are often used to improve soil structure or as sources of nitrogen fertilization. Applying dairy composts incorporated into the top 6 inches of soil at rates of 600 to 1,200 lbs per 1,000 sq ft introduces 5 to 10 lbs P per 1,000 sq ft. Dairy compost, at approximately the same rates, introduces 4 to 8 lbs P per 1,000 sq ft. The use of compost as a soil amendment has been shown to greatly increase the stratification of P in the upper soil profile and the risks of runoff contamination.
- Recycled Water: Recycled water used for irrigation has been reported to contain a range of 3 to 10 mg/L of inorganic $PO_4$-P and 10 to 15 mg/L of $NO_3$-N and $NH_4$-N each. The nutrients can be used for plant growth.

### 6.4.6 Off-site Movement of Phosphorus Fertilizer

Similar to nitrogen fertilization, a variety of chemical and environmental factors influence the potential for off-site movement of phosphorus. The primary means of off-site movement is by runoff due to phosphorus content at or near the soil surface. Improper handling of organic waste, notably clippings, can also be a significant source of phosphorus movement off-site, and thus clippings should not be placed in or near storm water treatment structures or wetlands. Finally, phosphorus leaching can occur, but only under very specific soil and chemical situations.

#### *6.4.6.1 Phosphorus Runoff*

Turfgrass, like other untilled systems, accumulates higher concentrations of soil P in the upper soil profile (0 to 2 inches) compared to lower depths. Frequent P fertilization, especially at higher rates, substantially increases the soil P levels in this upper profile. Consequently, P in fertilizer can be lost in runoff, as much as 20% of P fertilizer. Runoff can also wash away soil sediment and plant debris with mineral P and organic P. The runoff risks are very high during turfgrass establishment due to limited plant utilization and more runoff present than in established turf.

#### *6.4.6.2 Phosphorus Leaching*

In its rare anionic form, phosphorus can leach and is a concern for water quality issues. P leaching potential is best managed by applying P based on soil test results. When phosphorus is complexed with other elements in the soil, however, it has a low leaching potential unless it has been over applied for many seasons. Sandy soils, on the other hand, often have a low potential to fix (tie up) P and therefore are more likely to have a P leaching problem.

## 6.5 Fertilizer Applications

Proper application of fertilizers is possible only with accurately calibrated sprayers or spreaders. Incorrectly calibrated equipment can easily apply too little or too much fertilizer, resulting in damaged turf, excess cost, and contamination of the environment. Therefore, sprayers and spreaders should be calibrated at first use and after every fourth application. The time it takes to calibrate application equipment is returned many fold in improved results. An excellent resource for spreader care and calibration can be found on the Penn State Plant Science website (http://plantscience.psu.edu/research/centers/turf/extension/factsheets/calibrating-spreader). Spreaders should also be thoroughly cleaned after use due to the high salt content that corrodes metal parts. However, the wash water will likely contain N or P and should be disposed of properly (see Chapter 10).

### 6.5.1 Granular Fertilizer Application

Fertilizer is applied to turf in both granular and liquid forms. When applied in a granular form, it is distributed with a drop, rotary, or pendulum-type spreader. The drop, or gravity-type, spreader has a series of openings at the bottom of the hopper through which the fertilizer drops a few inches to the ground directly beneath. The rate of application can be changed by adjusting the size of the openings. Drop spreaders distribute fertilizer precisely and uniformly.

Drop spreaders are usually two feet wide, but wider models are available. Drop spreaders are normally preferred for the application of fine or very light particles such as ground limestone or granular pesticides that must stick to the foliage. Too much overlapping or misses between application swaths can result in streaking because of uneven nitrogen distribution.

Rotary spreaders are also called centrifugal, broadcast, or cyclone spreaders. Most have a plate, called an impeller, which is attached beneath the hopper and spins as the spreader wheels turn. When fertilizer drops through the adjustable openings at the bottom of the hopper, it falls onto the rotating impeller and is thrown away from the spreader in a semicircular pattern. Rotary spreaders broadcast granular materials over a wider area and faster than the drop type. The spreading width normally ranges from 6 feet for small spreaders to 60 feet for very large ones. Streaking is less likely with rotaries because the swaths are overlapped and the edge of the distribution pattern is not as sharp as that produced by a drop spreader. Rotary spreaders do not provide as accurate and uniform an application as drop spreaders, but the distribution can be satisfactory if the proper overlap is used. Spreading mixed materials of different sizes is a problem because larger, heavier granules are thrown farther than smaller, lighter particles and

ground limestone often drifts when applied with a rotary spreader. The speed at which the spreader is pushed or driven has a major impact on application rate.

Pendulum-type spreaders have a spout that moves from side to side. They are pulled by a tractor or turf vehicle, have a large hopper capacity, and can throw dry materials a great distance when the spout moves rapidly.

### 6.5.2 Liquid Fertilizer Application

Liquid fertilizer applications allow for lower rates and more precise applications than granular application. Liquid application is usually less expensive than granular applications, though the initial cost of the sprayer equipment is high compared to the cost of a spreader. If not expecting foliar uptake of nutrients, a minimum two gallon spray volume of the fertilizer-water mixture is applied per 1,000 $ft^2$ to ensure that fertilizer washes into the root zone.

Fertigation is the application of nutrients through the irrigation system. Minute amounts of fertilizer are regularly metered into the irrigation lines and distributed along with the irrigation water through the sprinkler heads. For fertigation, the irrigation system must be capable of distributing water uniformly. The advantages of fertigation include a more efficient plant use of nutrients, a steadier growth rate, and a savings on labor costs. Fertigation is not widely used yet on NYS golf courses, but could significantly improve nutrient application efficiency and water quality protection. So far, it has been most widely used during grow in to aid establishment, or for applying about half of the total yearly amount of N.

***BMP Statements***

- Recognize all organic waste generated on golf course contains nutrients that are potential contaminants.
- Determine accurate supplemental nutrient needs based on soil chemical and physical analysis. On sand based areas, consider foliar testing as a diagnostic tool.
- Supplement soil with appropriate rate and source of nutrients to maintain optimum availability and minimum off-site movement.
- Assess application efficiency through regular equipment calibration.

# 7 CULTURAL PRACTICES

Cultural practices support turfgrass density and therefore play an important role in preserving and protecting water quality. This chapter provides specific recommendations for ensuring that the turf is properly adapted and has adequate infiltration, yet sufficient water and chemical holding properties to minimize effects on water quality.

## 7.1 Turfgrass Selection

The increased availability of improved turfgrass species and varieties provides an excellent opportunity to select the most well adapted turf to site conditions (Figure 7-1 and 7-2). Well adapted species require reduced amounts of inputs of supplemental fertilizer and pesticides, and if selected for drought tolerance, requires less water to survive and maintain playability.

**Figure 7-1. It is critical to keep abreast of the latest developments in turfgrass breeding when selecting the best species and varieties. *Source*: Frank Rossi.**

**Figure 7-2. Attending field days offers great opportunities to interact with turfgrass scientists on the latest in turfgrass species and variety developments. *Source*: Frank Rossi.**

### 7.1.1 Climate

Highly specific and often less than ideal microclimate conditions challenge many superintendents. A common microclimate is a putting surface location with light deficits and restricted air movement. In these situations, limited options exist for proper turf selection, as these climates simply cannot sustain any turf without significant inputs. Typically, in northern climates, these adverse site conditions lead to increases in weedy species such as annual bluegrass.

### 7.1.2 Choosing the Right Grass

The perennial nature of golf turf implies that when you do establish or renovate a new turf area it is critical to choose a well-adapted species and variety. Of course putting surfaces are unique growing environments, but larger areas such as fairways could have grasses adapted to reduced nutrient levels, and traffic tolerance potentially reducing the nutrient loading. This is an important BMP for nutrient management. Additionally, natural areas that serve as Landscape BMP's also require careful attention to finding a well-adapted species. Certain grasses adapted to low inputs, reduced mowing, even submersion tolerance could be part of the selection criteria. Ultimately, it is vital to start out with a well-adapted species that will thrive, meet the functional and visual quality expectations, and be sustained using BMPs.

### 7.1.3 Annual Bluegrass Invasion

Over time, annual bluegrass becomes the dominant species in turf. This invasiveness is a result of the highly adaptive and prolific reproductive capacity of annual bluegrass that favors its competitive ability over other cool season turfgrass. Therefore, regular surface disruption when desirable turf is not actively growing selects for the invasive annual bluegrass.

Eventually, every course faces the choice to renovate or manage, invariably when there is catastrophic failure. Renovation eradicates and then manages to exclude annual bluegrass, hopefully with proper site modifications to allow perennial species to thrive. Conversely, others choose simply to manage the annual bluegrass type that has colonized the location. This is a “pay me now or pay me later” situation where management is less disruptive, but the inputs required to sustain adequate turf are costly.

Research shows that annual bluegrass requires significantly more inputs to provide acceptable quality golf turf, especially on putting greens, than more perennial species such as bentgrass or fescues.

**Figure 7-3. Annual bluegrass invasion into existing bentgrass putting green. Over time, the continued surface disruption and shift in maintenance will lead to increasing populations of this invasive species. *Source*: Frank Rossi.**

**Figure 7-4. Annual bluegrass is very susceptible to winter damage, especially from ice accumulation. Note the live bentgrass amongst the dead annual bluegrass. As the turf thins, the potential for off-site movement of inputs increases. *Source*: Frank Rossi.**

#### *7.1.3.1 Annual Bluegrass and Water Quality*

For water quality protection, the answer seems obvious that the less annual bluegrass being managed, the fewer inputs required, and the lower the risk to water quality. While this solution may not be as practical on putting surfaces, the putting surfaces comprise less than 10% of the managed turf. It is fairway, rough, and tee areas where annual bluegrass challenge water quality preservation with large tracts of land being treated to sustain a weedy species.

Why do courses not simply renovate to more perennial creeping bentgrass species? Because renovation is disruptive and preventing annual bluegrass re-invasion is difficult. The re-invasion often occurs because of managers' reluctance to alter site conditions, but also because restricted play in cold periods (when bentgrass is damaged) allows annual bluegrass to thrive. As a result, mixed stands of annual bluegrass with perennial grasses such as bentgrass, fescue, ryegrass, and Kentucky bluegrass must be managed. The recommended BMP is to favor the competitive ability of the perennial species in management practices in hopes that the annual bluegrass will adapt and tolerate the management. The better adapted the perennial turf is to the site and management, the better it competes with the annual bluegrass.

## 7.2 Turfgrass Establishment

At times, effective golf turf management requires renovating an existing stand or establishing new turf. Renovation can be ideal for including the genetically improved turfgrasses, which are well-suited to modern golf turf management. Also, the latest genetic material often requires significantly fewer inputs, further reducing the need for fertilizer, pesticides, and water.

Establishing new turfgrass areas or renovating existing stands can create significant risk to water quality. During establishment, soil is exposed prior to seeding or sodding to ensure effective contact for water transfer from the soil to the plants. Therefore, practices should be implemented that reduce establishment time to full turfgrass cover and protect the soil from being transported in rain events during establishment. These practices can include sodding heavily sloped areas or mulching new seedlings.

Minimizing the amount of fertilizer and chemicals used during the establishment phase is critical, as the establishing turf does not provide the needed uptake to prevent runoff and leaching. For example, a Cornell University study found that using fungicide-treated seed instead of a granular fungicide at establishment significantly reduces the risk of leaching.

Newly establishing areas, especially from seed with soil exposed, should be irrigated carefully. Light, frequent amounts of water to keep the seedbed moist will encourage germination and seedling development. Once the turf density reaches 60 to 70%, cover irrigation can be reduced to more normal levels, as turf will begin to root and extract water and nutrients from the soil.

**Figure 7-5. The use of sod can limit the species and varieties used, but significantly reduces the risks associated with new establishment. *Source*: Frank Rossi.**

## 7.3 Turfgrass Density and Runoff

Turfgrass runoff research consistently concludes that maintaining high shoot density turf is the most effective means of reducing runoff volume. The tortuous path travelled by rainfall or irrigation water increases as the number of shoots per unit area increases. In addition to the reduced runoff, the fibrous root system of turf has been shown to increase infiltration. The longer the water deposited on the turf surface is delayed from runoff, the more likely that proper infiltration will occur. The combination of reduced runoff volume and increased infiltration is a primary aspect of water quality protection, thus maintaining a dense turf is vital. In addition, denser turf also provides a better playing surface.

### 7.3.1 Mowing

A turf is defined as low growing vegetation maintained under regular mowing and traffic. Conversely, areas not regularly mowed are not considered turf. Mowing is a significant selection tool and one that, when done properly, has a profound influence on turf density.

#### *7.3.1.1 Mowing Height*

Mowing practices require decisions regarding type of mower, height, frequency, and clipping management. Individually and collectively these practices, when performed properly, maximize turf density.

Height of cut is often determined by the function of the site, with additional emphasis on visual quality. A close cut turf is often viewed as more aesthetically pleasing. However, lower heights of cut, especially at turf heights below 1.5 inches, require more maintenance to maintain turf density.

Mowing height significantly affects rooting depth because the lower the turf is mowed, the shorter the root system, and therefore the greater concentration of surface rooting. Additionally, the lower height of cut requires more frequent mowing as leaf extension accelerates when turf is cut lower and tissue must be removed more frequently.

Ultimately, every turfgrass species has an ideal mowing height range and a mowing range that the species can tolerate. Maintaining turf within the ideal range maximizes density. As long as mowing heights remain within the tolerance range, however, adequate density is possible when other maintenance factors such as water and nutrients are provided in the optimal range.

**Figure 7-6. Proper mowing adjustment, especially reel mowers, ensures maximum turf performance while minimizing stress that leads to reductions in turf density. *Source*: Frank Rossi.**

### *7.3.1.2 Mowing Frequency*

The turf growth rate and height of cut dictate mowing frequency. As mentioned previously, the lower the cut, the more frequently mowing is required. In general, increasing mowing frequency increases turf density.

Little evidence supports the accepted rule that no more than 30% of the leaf tissue should be removed in a single mow. Instead, significant evidence indicates that some turf species such as tall and fine fescue and perennial ryegrass can have between 50 and 75% of the tissue removed before any turf thinning occurs. Ultimately increasing mowing frequency positively effects turf density, but will increase the energy consumption of the maintenance program.

### *7.3.1.3 Mower Selection*

Mower selection is based on the expected height of cut. Mowing heights at or below 1.5 inches are typically best achieved with a reel-type mower. Reel mowers allow for rapid clipping of turfgrass tissue at practical operating speeds with minimal turf damage (when properly

adjusted). Mowing heights above 1.5 inches are best achieved with rotary impact mowers, also when blades are sharpened and properly balanced.

Any mistake in mower set up from blade sharpness to bedknife alignment can lead to increased stress from wounding and reduction in turf density. Therefore, the mower must be properly adjusted and set up to minimize leaf shredding and wounding for pathogens. Reel and rotary mower blades are shown in Figures 7-7 and 7-8.

**Figure 7-7. Reel mowers are ideal for golf turf mowed under 1" height of cut. *Source*: Frank Rossi.**

**Figure 7-8. Rotary mowers are best used for height of cuts above 1". Blades should be sharpened after every 10 hours of use. *Source*: Frank Rossi.**

### *7.3.1.4 Clipping Management*

Clipping management is the decision to let the clippings fall back to the turf canopy or remove them in a bucket or bag. From a water quality perspective, grass clipping are a nutrient rich resource and should be viewed as fertilizer and handled and applied with similar precaution. Accumulated clippings distributed over a relatively small area can significantly increase nitrate leaching. Some courses will remove clippings from fairways. Distributing these clippings to driving ranges, clubhouse lawns or simply stockpiled as organic waste. Excessive clippings aggregation has been shown to increase soil nitrate levels from less than 2.5 mg N kg-1 to a range of 15-30 mg N kg-1 across the 3-12 inch profile in areas that received four times the amount of normal clippings return. (Bigelow et al. 2005).

Removal of clippings should only be performed if the function of the site dictates removal (such as ball roll on a putting surface). If clippings are left on the site, they must not be allowed to discharge into adjacent water bodies or to clump on the surface and shade the turf (Figure 7-9and 7-10).

Several research experiments have investigated the effect of long-term clipping management on turf fertilization. In general, clipping removal mines the soil for nutrients and takes them to another location. Thus leaving the clippings on the site as the turf ages assists in sustaining the nutrient content of the soil and reduces the reliance on supplemental fertilizer.

In summary, a properly mowed turf maintains a high shoot density that limits surface water movement. A properly mowed turf sustains an adequate underground biomass to retain additional water and nutrients that infiltrate. Finally, when managing clippings consider them a nutritional resource and leave them on site if possible. Use care in removing or discharging in order to preserve water quality (for instance, do not put clippings in or near storm water treatment structures or wetlands).

**Figure 7-9. Clipping removal is only recommended on surfaces where they disrupt the function of the sites, such as putting surfaces. *Source*: Frank Rossi.**

**Figure 7-10. Clippings left on turf after mowing can lead to shading of the turf below and heat stress from microbial activity generated in the piles. *Source*: Frank Rossi.**

## 7.4 Organic Matter

Turf is a perennial plant system that increases biomass as a result of growth and management. Biomass accumulates at the surface from the development and deposition of plant parts such as leaves, stems, and roots. Aboveground plant parts such as leaves and stems are often removed and regrown as a result of frequent mowing. Underground plant parts such as stems (rhizomes) and roots cycle as living, dead, and decomposing organic matter.

The accumulation of organic matter in the top 3 to 6 inches of a turf system provides nutrient and water holding as well as cushioning and insulation. When organic matter accumulates at a rate greater than it degrades, however, it can restrict infiltration of water and gas exchange between the atmosphere and the soil air space in pores.

Excessive organic matter at the surface can become hydrophobic and increase runoff from the turf surface, which may also reduce the effectiveness of fertilizer and pesticides. Furthermore, excessive surface organic matter can promote surface rooting that interferes with the turf's use of water and mineral nutrients, which leads to increased potential for off-site movement of chemicals applied to turf. Figures 7-11 through 7-13 illustrate the problems resulting from the accumulation of surface organic matter.

**Figure 7-11. Excessive surface organic matter can lead to anaerobic conditions that encourage diseases such as black layer. *Source*: Frank Rossi.**

**Figure 7-12. Soil layering leads to impeded drainage, increasing surface moisture that can lead to runoff. *Source*: Frank Rossi.**

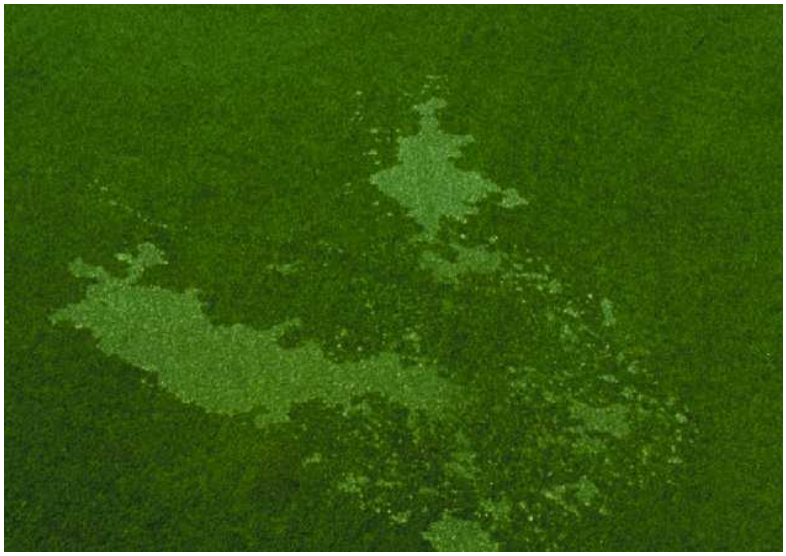


**Figure 7-13. Surface organic matter accumulation results in hydrophobic conditions that can lead to increased runoff. The use of wetting agents can mitigate such problems. *Source*: Frank Rossi.**

### 7.4.1 Factors That Increase Organic Matter

Many factors influence the accumulation of organic matter including turfgrass species, fertilization, and soil physical and chemical properties. Some turf species such as the fine leaf fescues produce significant amounts of highly lignified tissue that degrades slowly. Other species such as perennial ryegrass produce very little lignified tissue and therefore do not accumulate much surface organic matter. Grasses with high amounts of stem tissue, like rhizomes and stolons, often accumulate greater amounts of organic matter.

**Figure 7-14. Wet surfaces lead to reduction in golf turf performance, such as plugged balls. This also increases the risk of runoff when soil surface is persistently wet. *Source*: Frank Rossi.**

#### *7.4.1.1 Grass Type*

Creeping bentgrass and annual bluegrass are considered intermediate in their development of organic matter. They accumulate organic matter, but often that matter is not highly lignified tissue and, under warm moist soil conditions, it degrades. Still, these grasses accumulate

organic matter at the surface at a rate greater than microorganisms can degrade and thus the accumulation requires dilution or mechanical removal.

#### *7.4.1.2 Fertilization*

Increase in biomass is a normal aspect of plant growth. Supplemental fertilization for functional and aesthetic purposes produces more biomass and more organic matter when compared to an unfertilized turf. The rate of decomposition also increases with supplemental fertilization, up to a point. Therefore applying enough fertilizer to meet the visual and functional requirements of the turf, but not in excess of these requirements, is critical. Excess fertilization increases biomass production that leads to excess surface organic matter production, reduced infiltration, and increased runoff.

Organic matter is a food source for macro- and microorganisms. The soil food web requires an adequate amount of organic matter and microbial activity to function properly. Degradation of organic matter is maximized in a well-aerated, moist soil with temperatures greater than 65°F. For every ten degree Celsius increase in soil temperature, microbial activity increases tenfold; this principle is referred to as the "Q10".

#### *7.4.1.3 Soil Management*

Poorly drained soils with high bulk density and predominance of fine particles that restrict soil gas exchange reduce microbial activity. These dense, cool soils also restrict rooting to the surface, which further exacerbates the surface organic matter problem. Maintaining a permeable soil surface sustains adequate microbial activity, good deep root development, and proper infiltration. Taken together, these practices lead to a turf surface less likely to create runoff and more able to retain chemicals applied to turf top prevent leaching.

Understating soil physical properties and amending the soil to minimize the potential for compaction is the key to proper soil management. Soil modification is best performed at establishment. Additionally, hollow-tine cultivation by removing existing soil and organic matter and adding coarse textured material such as sand or compost can be effective over time. Hollow-tine cultivation that removes 0.5 inch soil cores to a 4 inch depth has been shown to influence less than 5% of the turf surface during normal operation. Equipment modifications can be made to increase that percentage to as much as 20%, however, this is a tedious and long-term process.

Additional forms of cultivation such as solid tine, needle tine, or water injection cultivation that make a hole but do not remove soil can also increase soil infiltration. The benefits of these practices are short-lived and consequently must be repeated routinely to maintain a permeable surface. Due to golf traffic, soils prone to compaction will continue to become compacted and limit infiltration without soil modification.

Figures 7-15 through 7-22 illustrate soil management techniques.

**Figure 7-15. Slice holes made from a putting surface spiking operation used to maximize infiltration and gas exchange. *Source*: Frank Rossi.**

**Figure 7-16. Core cultivation shown from a distance (top) and up close (bottom) is an ideal method for alleviating compaction, removing organic matter, and amending problem soils, which should increase infiltration and reduce the risk of runoff. *Source*: Frank Rossi.**

**Figure 7-17. Schematic representation of core hole over time. Note hole edges are different colors depicting change in bulk density around the core. Over time the core edges collapse as water and roots begin to infiltrate the core.**

**Figure 7-18. Deep slicing can aid with remediating large areas of soil in need of increased infiltration and gas exchange. *Source*: Frank Rossi.**

**Figure 7-19. Spiking attachments aid with increasing infiltration and can affect significant amounts of surface areas. *Source*: Frank Rossi.**

**Figure 7-20. Less invasive cultivation methods such as water injection significantly increases infiltration and gas exchange. *Source*: Frank Rossi.**

**Figure 7-21. Water injection cultivation is the 'gold standard' for increasing infiltration and improved gas exchange with minimal surface disruption. *Source*: Frank Rossi.**

**Figure 7-22. Hollow tine cultivation is an ideal method for amending soils. *Source*: Frank Rossi.**

### *7.4.1.4 Soil Modification With Topdressing*

Managing surface organic matter is best accomplished by prevention through proper fertilization and soil management. Many common golf turf grasses, however, under routine maintenance and adequate prevention still produce organic matter that requires some level of management. The most effective means of managing surface organic matter is through regular applications of sand or soil via topdressing. A light (0.1 to 0.2 inches) application of material applied and integrated into the surface of the turf dilutes the organic matter and creates a physical matrix that functions as a soil.

Topdressing is often performed in conjunction with some form of cultivation that either removes a core or makes a hole. The cultivation can not only provide minor removal of the surface material but also create space for topdressing to serve the purpose of dilution and creation of a pseudo-soil matrix.

Recent research suggests that under normal golf turf management, creeping bentgrass putting surfaces require between 18 and 22 cubic feet of sand per 1000 square feet per year to properly dilute surface organic matter. This application requires topdressing as frequently as every 5 days without any cultivation, to as many as 14 to 21 days with more routine cultivation. Ultimately, the goal of proper dilution is to ensure the adequate infiltration while preserving sufficient retention of the turf system to prevent leaching. Figures 7-23 through 7-26 illustrate soil modification with topdressing.

**Figure 7-23. Although large scale sand topdressing operations can be costly, they aid in reducing runoff from soils with organic matter accumulation and heavy compaction.** ***Source*****: Frank Rossi.**

**Figure 7-24. Sand topdressing helps provide high performance playing surfaces that also reduce the risk of runoff by increasing infiltration, reducing compaction, and diluting organic matter. *Source*: Frank Rossi.**

**Figure 7-25. Sand-based greens offer the best options for maximizing performance and minimizing water quality issues. *Source*: Frank Rossi.**

**Figure 7-26. Proper topdressing material selection and storage are vital for maintaining a permeable turf surface. *Source*: Frank Rossi.**

## 7.5 Summary

BMPs for golf course turf to preserve and protect water quality using cultural practices must be designed to sustain high turf shoot density. A dense turf reduces runoff and the negative effect of off-site movement of water and pollutants. This density maintenance must be a primary concern for golf courses.

A dense turf, however, accumulates surface organic matter that can restrict infiltration and lead to increased runoff. Maintaining the permeability of the turf surface is as important as maintaining turf density. Strategies for preventing excessive organic matter accumulation are important, but the management through dilution and cultivation of the soil is key. This practice can include modification to improve the root zone, balance adequate infiltration as means of reducing runoff, and adequate retention to prevent leaching.

***BMP Statements***

- Use and manage turfgrass species and varieties adapted to macro and micro climatic conditions of your location.
- Maintain turf with high shoot density to minimize runoff and maximize infiltration.
- Manage the surface accumulation of organic matter to maintain a permeable system that minimizes runoff and maximizes subsurface retention.

# 8 INTEGRATED PEST MANAGEMENT

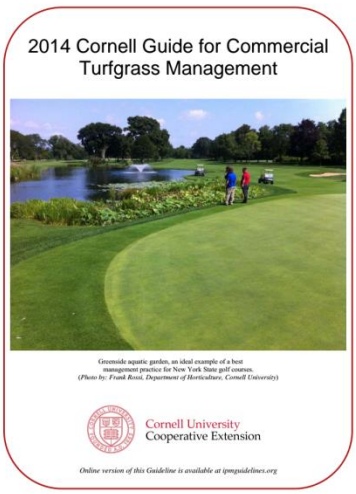
Integrated pest management (IPM) concepts were originally developed in the 1960s by entomologists who examined pest management, especially the use of pesticides, as it relates to both economic value and environmental impact in agriculture. Since then, the definition and practice of IPM has grown to include all types of pests (insects, weeds, pathogens and diseases, and vertebrates) and settings beyond agriculture such as parks, golf courses, homes, and office buildings (Bajwa and Kogan 2002; Hoffmann and Gangloff-Kaufmann 2004). The turf industry has embraced IPM and virtually all modern textbooks and courses on turfgrass management include IPM. IPM for turf can be defined as follows:

> IPM is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks and maintains turfgrass quality.

The concepts and principles of IPM should continually be reviewed and refocused with the goal of protecting water quality and soil on any property. Key tenets of IPM include pest prevention as a first line of defense and basing pest management decisions on:

- knowledge of pest biology and life cycle
- action thresholds—derived scientifically and through experience
- monitoring of pests
- monitoring of turfgrass health
- monitoring of weather conditions and forecasts

IPM is a useful framework for addressing course needs, while prioritizing initiatives and tasks. Using IPM requires careful attention to detail, which usually results in improved course quality, often using fewer inputs. By following the latest research, managers can have high quality playing surfaces with minimal impact on the environment. Research at Bethpage State Park has shown that IPM can result in 33 to 96% less environmental impact without reducing course quality, and does not cost more than conventional management (Rossi and Grant 2009). IPM is flexible and superintendents can usually balance course quality and environmental goals.




For more information:

- New York State's IPM Program: http://www.nysipm.cornell.edu/default.asp
- *Reducing Chemical Use on Golf Course Turf: Redefining IPM*: www.hort.cornell.edu/turf/pubs/manual.html
- *Cornell Guide for Commercial Turfgrass Management*: ipmguidelines.org/turfgrass/
- Bethpage State Park research: http://www.nysipm.cornell.edu/publications/long_term/files/long_term.pdf

## 8.1 Seven Steps of IPM

Although IPM permeates all aspects of course management and planning, it can be thought of in seven steps. The steps are sequential, but in practice all are ongoing and overlapping:

Step 1 – Planning
Step 2 – Identification and Monitoring
Step 3 – Course Management
Step 4 – Evaluation & Analysis
Step 5 – Intervention
Step 6 – Record Keeping
Step 7 - Communication

### 8.1.1 Planning

Many environmental stresses that result in higher pest incidence and severity can be avoided through careful course design and planning, however, most superintendents are faced with managing an existing course. Pest problems and inputs can still be minimized through course modifications and preventive cultural practices.

Knowledge of past pest occurrence, locations ( "hot spots"), and management practices are essential as past problems are likely to recur or continue without intervention. The winter months are a valuable time for reviewing pest issues from the previous season, by asking questions such as:

- Can environmental conditions be modified to reduce pest pressure? For example, can trees be removed around a putting green to increase airflow and reduce disease incidence and severity?
- Can traffic be routed to reduce stress? For example, can cart or walking paths be moved to diffuse walk-off areas on a putting green?
- Were monitoring procedures adequate to detect pests early? For example, should pitfall traps be installed to monitor for early season annual bluegrass weevil migration?
- Can pest-resistant grass cultivars be overseeded on any area of the course? For example, a cultivar such as Memorial, a dollar spot resistant cultivar of bentgrass, can be used to overseed putting greens.
- Are cultural practices adequate for minimizing pest problems? For example, would more frequent topdressing decrease anthracnose pressure?
- Have suppliers of new or hard to find products or equipment been identified in order to be prepared to react quickly to a pest outbreak? For example, where can entomopathogenic nematodes for grub control be obtained if needed and desired?

Part of planning is also being aware of new pests. Educational meetings, trade journals, blogs, listserves, and contact with other superintendents and local cooperative extension personnel are usually the best avenues for being alerted. Once a threat is identified, a superintendent should plan how to prevent, monitor, and manage the new pest.

### 8.1.2 Identification and Monitoring

Every course should have a plan for formal pest monitoring or "scouting" of all areas. For example, the frequency should be daily on putting greens, at least weekly on tees and fairways and bi-weekly on. Whenever possible, the pest pressure should be quantified with measurements such as:

- number of insects per unit area
- disease patch sizes
- percent area affected

**Figure 8-1. Pink and gray snow mold.**
***Source*: Jennifer Grant.**

Qualitative descriptors such as "high", "low", or "very bad" are subjective and difficult to calibrate and track change over time. Photographs also provide excellent documentation and can be used for identification and training.

Once detected, pests must be properly identified and documented, including mapping on an area map and recording the date of the outbreak. This information can be used to build a database for reference in future seasons. Superintendents and staff should continually hone and improve skills by attending training seminars and field days, obtaining reference materials, and providing peer-peer training on problems occurring on the course. Golf course personnel should also know where to send photos or samples when additional expertise is warranted for identification or confirmation.

**Figure 8-2. Soap flushes are a useful monitoring technique. The soap irritates many insects and causes them move out of the thatch and lower plant parts to the tips of grassblades for easier detection and counting. This technique is especially useful for monitor.**

**Figure 8-3. Soil cores removed with cup cutters can be searched quickly and easily for the presence of white grubs. The grubs can also be identified for species and life stage. *Source*: Curt Petzoldt.**

Recommended diagnostic laboratory locations include:

- Cornell Cooperative Extension County office (diagnostic labs available in limited locations), http://www.cce.cornell.edu/learnAbout/Pages/Local_Offices.aspx
- Cornell University Insect Diagnostic Laboratory, http://entomology.cornell.edu//extension/idl/index.cfm
- Cornell University Plant Disease Diagnostic Clinic, http://plantclinic.cornell.edu/
- Rutgers University Plant Diagnostic Laboratory, http://njaes.rutgers.edu/plantdiagnosticlab/default.asp

### 8.1.3 Course Management

Almost every aspect of golf course management affects the likelihood and severity of pest problems. Although practices required for playability sometimes supersede the optimal IPM choice, manipulating cultural practices should be a key part of an IPM approach. For example, low mowing heights used to obtain high ball roll distances on putting greens can be modified by mowing and rolling greens on alternate days to lessen turf stress while still providing the same ball roll. Similarly, frequent topdressing buries the crown, effectively giving the plant a higher height of cut, while still providing good ball roll. Ultimately stress-reducing practices such as these decrease the incidence of disease and reduce weeds, which in turn reduces reliance on chemical pesticides.

### 8.1.4 Evaluation and Analysis

IPM is a knowledge-intensive decision-making system, requiring evaluation of incoming information, such as:

- scouting results

- weather forecasts
- golf course calendar events
- previous pest history and course hot spots
- past pest management success (for example, timing and efficacy of cultural practices, biological controls, and pesticides)
- new information from university research and the experience of peers

By constantly integrating these sources of information, the superintendent can best decide if a pest threat exists, and when, whether, and how it can be avoided or controlled. For some pests, action thresholds will trigger an intervention reaction (Step 5) in season. For others, cultural management strategies may be intensified.

### 8.1.5 Intervention

Intervention is the action taken when pest levels reach the threshold known to cause unacceptable damage or turf loss. In some cases, these thresholds have been determined scientifically, while in other instances these thresholds are based on site-specific experience. To avoid unacceptable damage or loss, the IPM method relies on an integrated approach using multiple cultural, mechanical, and biological management methods. Using the IPM approach, chemical control is reserved as a last option used only when other methods are insufficient for maintaining acceptable turfgrass quality and playability.

When chemical control is warranted, evaluation and analysis (Step 4) often allows for early intervention, which may result in the use of lower toxicity treatments and spot treatment rather than whole area treatments. An IPM practitioner considers all approaches and selects the least disruptive, but effective, option.

### 8.1.6 Record Keeping

Documentation is key to connecting the elements of an IPM program and increasing its value. In order to be effective, IPM record keeping should exceed legal requirements (see Table 8-1, Figure 8-4).

**Table 8-1. IPM Record Keeping**

| Record-keeping Category | Record Details |
|---|---|
| Scouting Records | Pest occurrence, location and severity |
| | Improvements or increases in pest issues in response to management tactics |
| Cultural Management Logs | Frequency, timing, location |
| | Equipment settings, rates (e.g. amount of sand used for topdressing) |
| | Operator |
| Weather Conditions | Current |
| | Forecasted |

| Record-keeping Category | Record Details |
|---|---|
| Pesticide Application Records | All legal requirements such as date, location, product, area treated, and applicator |
| | Reason(s) for application |
| | Results |
| Water Requirements | Monitor soil moisture |

Ways to simplify documentation and integration of IPM methods with other aspects of course management include the following:

- Integrate scouting records with mandatory pesticide application records.
- Encourage all staff to report pest sightings and have a convenient method for tracking and sharing this information.
- Use electronic records rather than hand-written records.
- Encourage staff use of tablets and phones for sending data and photos to a central location.
- Use Cornell's TracGolf software program (http://www.nysipm.cornell.edu/trac/about/about_golf.asp)
- Emphasize scouting records and other IPM information as part of staff training, meetings, and daily communications.

**Figure 8-4. Photographs are useful for documenting pest occurrence and damage, and can be compared against past and future photos. *Source*: Jennifer Grant.**

### 8.1.7 Communication

Good communication within the maintenance team is an essential aspect of IPM. Regardless of who monitors pest issues, all staff should be aware of pest problems and management activities

and should be encouraged to report observed and potential problems. Furthermore, IPM training should be provided to as many staff as possible.

Communication to golfers, members, administrators, and neighbors is also important. Communicating with these stakeholders lessens the chance of surprises and conflicts and increases recognition of the superintendent and staff as trained professionals that care about protecting the environment. Explaining the IPM approach in personal communications, promotional literature, club newsletters, blogs, and websites helps to advance these goals.

## 8.2 Management Options

An IPM manager uses a mix of preventive and reactive strategies to manage pest problems. Course management decisions and cultural practices are ongoing, while reactive measures are decided and implemented in season. Selecting from a number of management options according to incoming information instead of the calendar is a hallmark of an IPM manager.

### 8.2.1 Diversification

Diversification of management options is key, using a variety of cultural, biological, physical, and possibly chemical strategies. The case against sole reliance on chemical approaches is obvious because it promotes resistance, and frequent use may subject applicators, golfers and the environment to unnecessary risks. Similarly, reliance on any other single-tactic approaches is also not recommended, because if it fails, damage or turf loss is likely which can also negatively affect water quality. IPM's diversification of tactics allows for multiple layers of protection, and therefore better insurance against pests.

### 8.2.2 Role of Cultural Management

Turfgrass is a perennial plant system in which cultural practices, especially irrigation, mowing, topdressing, aeration, and venting, greatly affect both short and long term plant health. Healthy plants and soil can better withstand pest pressure. Weak turf can be outcompeted by weeds that take advantage of bare ground or thin turf. Pathogens in particular can take advantage of weak, stressed, or otherwise unhealthy plants and cause disease. Unhealthy plants are also less able to fend off, compensate for, mask, or recover from insect damage. Below are examples of how an IPM approach can be used to for a specific weed, disease, and insect pest issue.

#### *8.2.2.1 Weed Example*

One of the most effective prevention strategies in weed management is to use the appropriate turf varieties for the specific site conditions and intended use on the golf course. For example, a recent development in some golf courses is the use of tall fescue/blue blends in the rough because heat and drought in the summers create challenges for turf management (Figure 8-6). Another

**Figure 8-5. *Poa annua*. *Source*: Jennifer Grant.**

**Figure 8-6. Tall fescue/bluegrass blend in a rough. Source: Bob Mugass, University of Minnesota.**

concept is to use weed suppressive fine fescues in the roughs, such as Intrigue II and Columbra II that produce allelochemical from their roots. These compounds inhibit the growth of weeds while maintaining a healthy stand of fine fescues. New turf varieties have been developed that provide improved drought tolerance, disease resistance, and have a greater ability to handle foot and cart traffic. In the near future, salt tolerance will be added to the growing list of improved turf varieties as restrictions on high quality water use become an increasing concern for golf courses. Using these improved turf varieties can effectively minimize weed infestation in greens and fairways with low turf density or bare areas.

Another effective prevention strategy is to use high quality turf seed that is free of weed seeds. Many suppliers provide a guarantee that states the percentage of weed-free content. The same strategy is useful in determining sod installations for the course as most suppliers guarantee a percentage cover of weed-free sod. The general rule is to purchase high quality seed that is greater than 99% weed free and sod that is 100% weed free, including annual bluegrass.

While prevention is a critical component in weed management, post-emergence control is a necessary part of routine turf management. Many chemical methods for post-emergence control provide rapid, inexpensive eradication of grass and broadleaf weeds. The nonchemical control options include use of thermal weeding technologies, such as propane weed torches, steam wands, and infrared heating devices. These thermal devices can remove patches of weeds or sections of turf for a renovation project. A study conducted at the Royal Quebec Golf Course showed control of *Poa annua* in bentgrass fairways treated with flame weeding using a tractor fitted with burners. The bentgrass was able to recuperate, while *P. annua* declined after one month (see GCSA Management article http://www2.gcsaa.org/gcm/1997/oct97/10poawar.html for more information). Thermal weeding can give stoloniferous or rhizomatous turfgrasses a competitive edge over weeds that grow as bunchgrasses.

**Figure 8-7. Hand weeding is sometimes the most effective and environmentally friendly method of weed management. This photo shows invasive species in the rough. *Source*: Jennifer Grant.**

Dollar spot, caused by the pathogen *Sclerotinia homoeocarpa*, is a common golf course disease in New York State (Figure 8-8). Besides using chemical controls, managers can plan to lessen disease incidence and severity with the following activities:

**Figure 8-8. Dollar spot. *Source*: Jennifer Grant.**

- Plant resistant cultivars of creeping bentgrass such as Memorial and Declaration.
- Minimize moisture stress and leaf wetness.
- Remove morning dew as early as possible.
- Roll putting greens three or more times per week.
- Apply biological organisms known to suppress dollar spot such as *Bacillus licheniformis*, *Bacillus subtilis*, and *Pseudomonas aureofaciens.*
- Use horticultural oils (Civitas), labeled for the intended use both for treated area and pest, instead of or in conjunction with traditional fungicides.

### *8.2.2.2 Insect Example*

Annual bluegrass weevils (ABW) are pests of golf courses in many parts of New York (Figure 8-9) . The only cultural practice known to successfully minimize their damage is to reduce the amount of annual bluegrass in infested areas. In mixed stands of annual bluegrass and creeping bentgrass, as is commonly found on putting greens, practices that favor bentgrass can be

promoted. In other areas, it may be acceptable to convert the grass to alternate species such as ryegrass or Kentucky bluegrass. It may also be possible to protect areas by creating a barrier strip of an alternate grass species that deters the spring migration of ABW adults traveling from their overwintering sites to playing surfaces.

**Figure 8-9. Annual bluegrass weevils. *Source*: Jennifer Grant.**

Vacuuming has been used to monitor ABW adults in turf, but may also work as a physical and mechanical control practice if done frequently, especially during the spring migration (Figure 8-10). Biological control methods have been largely unsuccessful in scientific research, but the use of entomopathogenic nematodes may still hold promise.

Beyond the techniques listed, IPM for ABW has relied mainly on careful monitoring of the insect as well as phenological indicators and degree days to target insecticide applications. Pitfall traps, soap flushes, and vacuum sampling detect when and where the adults are moving from their overwintering spots. An insecticide targeting adults is typically timed for the peak migration time. Subsequently, these sampling techniques, along with saline floats that monitor larval development, are used to time the application of an insecticide targeted at 3$^{rd}$ to 5$^{th}$ instar larvae.

**Figure 8-10. Vacuuming to determine annual bluegrass weevil adult presence, location, and movement. *Source*: Jennifer Grant.**

### 8.2.3 Use of Softer and Alternative Pesticides

IPM encourages the use of pesticides as a "last resort" when other methods of pest control prove to be inadequate. However, when pesticides are deemed necessary, an effective product least likely to harm human health or the environment should be selected. Other management options include using an alternative product, such as biological controls or reduced risk pesticides.

#### *8.2.3.1 Biological Controls*

Biological control uses other living organisms to suppress or eliminate pests. Several organisms are known to have some efficacy against turfgrass pests and have been marketed as pest control products. These biological controls may act to suppress pest populations alone or work synergistically with other natural, cultural, physical, or chemical management methods. Examples of biological controls that are commercially available in New York State are provided in Table 8-2.

**Table 8-2. Biological controls**

| Beneficial Bacteria | Action |
|---|---|
| *Bacillus licheniformis* | Labeled for dollar spot management |
| *Bacillus subtilis* | Labeled for management of brown patch, dollar spot, powdery mildew, rust and anthracnose |
| *Pseudomonas aureofaciens (strain TX-1)* | Labeled for management of anthracnose, dollar spot, pink snow mold and pythium |
| *Bacillus thuringiensis* | Labeled for management of caterpillars in turf. A strain that affects white grubs is known, but not currently commercially available. |
| *Paenibacillus popilliae* and *Paenibacillus lentimorbus* | Cause "milky spore disease" and are labeled for management of Japanese beetle grubs in turf. Other strains cause milky spores in other species of grubs, but are not commercially available. |
| **Entomopathogenic Nematodes** | **Action** |
| *Heterorhabditis bacteriophora* and *Steinernema glaseri* | Effective against white grubs |
| *Steinernema carpocapsae* | Effective against cutworms and possibly annual bluegrass weevils |

#### *8.2.3.2 Reduced Risk Pesticides*

The EPA defines conventional "Reduced Risk" pesticides as having one or more of the following advantages over existing products:

- low impact on human health
- low toxicity to non-target organisms (birds, fish, and plants)
- low potential for groundwater contamination
- lower use rates
- compatibility with IPM

A number of reduced risk pesticides can be used on turfgrass in NYS (Table 8-3). Biological pesticides, which also have many of these desirable characteristics, are classified separately by the EPA.

**Table 8-3. Reduced risk pesticides**

| Category | Reduced Risk Pesticide |
|---|---|
| Fungicides | Azoxystrobin |
| | Boscalid |
| | Fludioxonil |
| | Trifloxystrobin |
| Herbicides | Bispyribac-sodium |
| | Carfentrazone-ethyl |
| | Mesotrione |
| | Penoxsulam |
| Insecticides | Chlorantraniliprole |
| | Spinosad |

## 8.3 Pesticide Selection Criteria

When chemical control is needed, several important criteria can be used to select the right pesticide:

- must be registered for use in New York State
- must be properly transported, handled, and stored
- should be effective in treating the pest problem
- the frequency of pesticides usage considered with respect to the possibility of chemical resistance
- costs should be considered
- environmental risk and potential for water quality impacts must be evaluated

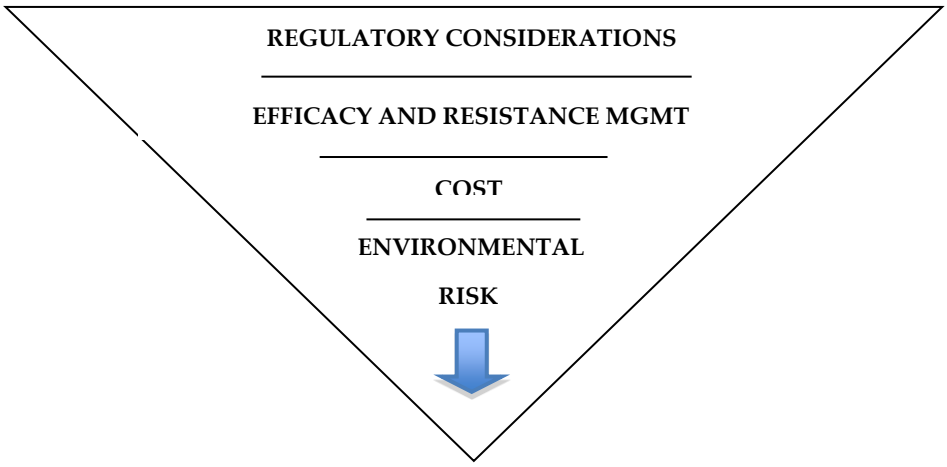



**Figure 8-11: Pesticide selection criteria.**

### 8.3.1 Efficacy and Resistance Management

Among the pesticides registered for use in New York, selection should be based on the effectiveness of the product to prevent or treat pest problems. Products that are more effective can often be used at lower rates and fewer applications. The *Cornell Guide for Commercial Turfgrass Management* published annually by Cornell University lists recommendations for the most effective treatments of pest problems. In addition to these guidelines, manufacturers and trade journals often present research reviewing different products tested. The University of Kentucky provides a special service to the industry by reviewing all research on fungicides and grading the effectiveness of fungicides annually.

If chemical control is required, rotating chemical classes of pesticides used is recommended to manage the potential of resistance to any specific mode of action. Avoiding resistance makes each chemical used more effective, reducing rates and frequencies of applications. Every pesticide label should identify its resistance class.

For more information, see:

- *Cornell Guide for Commercial Turfgrass Management*: ipmguidelines.org/turfgrass/
- University of KY fungicides report: www.ca.uky.edu/agc/pubs/ppa/ppa1/ppa1.pdf
- Fungicide Resistance Action Committee: www.frac.info
- Herbicide Resistance Action Committee: www.hracglobal.com/
- Insecticide Resistance Action Committee: www.irac-online.org/
- EPA Pesticide Resistance Labeling: www.epa.gov/PR_Notices/pr2001-5.pdf
- International Survey of Herbicide Resistance Weeds: www.weedscience.com/summary/home.aspx

### 8.3.2 Costs

Pesticides are marketed in a variety of forms and packaging. Product selection should not be based on the price per container, as application rates and intervals vary and more effective products with a lower environmental risk can cost less per day of treatment. The real costs of products can be compared using simple tools. Table 8-4 shows an example that compares very effective bio-based controls to conventional pesticides for the treatment of dollar spot.

**Table 8-4. Cost comparisons of alternative chemical control of dollar spot**

| Control | App Rate (oz or fl oz per 1000 ft²) | Cost per 1000 ft² | Acres Treated | Spray Interval | Cost per Day | FRAC Class | EIQ Quotient | Field Use EIQ |
|---|---|---|---|---|---|---|---|---|
| **Traditional Program** | | | | | | | | |
| Daconil | 4 | $1.94 | 3 | 14 | $18.09 | MS | 37.42 | 336 |
| Banner Maxx | 2 | 3.30 | 3 | 14 | $30.77 | 3 | 31.63 | 25 |
| **Program 4** | | | | | | | | |
| Emerald | 0.13 | $2.36 | 3 | 28 | $11.00 | 7 | 26.64 | 7 |
| Civitas | 16 | $3.59 | 3 | 28 | $16.77 | Bio-based | 0.00 | 0 |

### 8.3.3 Environmental Risks

The use of pesticides presents certain risks in terms of toxicity to human or other nontarget organisms including soil microbes, insects, birds, animals, and aquatic species. Pesticides can migrate off the target site through the environmental transport process of runoff, leaching, or drift. Understanding both the site and pesticide characteristics and their relationship is the basis for assessing a pesticide's site-specific vulnerability to environmental transport.

#### *8.3.3.1 Pesticide Toxicity*

Pesticides may pose varying degrees of risk to humans denoted by the EPA as acute toxicity levels for oral ingestion, dermal sensitivity, inhalation, and eye irritation. Signal words on labels characterize pesticide into four toxicity-based categories to invoke special attention when handling or applying the pesticide (Table 8-5).

**Table 8-5. Signal words by toxicity ratings**

| Toxicity | Signal Word |
|---|---|
| Category I | DANGER |
| Category II | WARNING |
| Category III | CAUTION |
| Category IV | None required |

Pesticide labels also stipulate proper personal protective equipment (PPE) to be worn when handling or applying pesticides. In addition, instructions on the label specify proper procedures in case of accidents or emergencies to prevent exposure. Not as much is known about chronic toxicity due to prolonged exposure to a pesticide as is known about acute toxicity. Some pesticides are known to accumulate over time, although the risks of such accumulation have not been fully identified.

The Pesticide Action Network has compiled a pesticide database that identifies pesticides with known or suspected toxicity. Appendix C provides human health and aquatic toxicity risk ratings for pesticides registered for use in New York State.

For more information:

- PAN Pesticide Database: http://www.pesticideinfo.org
- Pesticide Properties Database (PPDB), pesticide physicochemical, toxicological, ecotoxicological and other related data: http://agrochemicals.iupac.org

### *8.3.3.2 Pesticide Characteristics*

The fate of a pesticide applied to turf is determined by the soil characteristics, environmental conditions, and the chemical properties of the pesticide. These factors can be used to help recognize conditions and select pesticides that can help minimize the risk of ground and surface water contamination through leaching, runoff, or drift.

Information for pesticides approved for use in New York State are summarized in Appendix C and includes the following information: rate ranges, Field Use EIQ ranges, Chemical Class, Aquatic Toxicity, Solubility, Soil Adsorption (Koc), half life, GUS values, and WIN PST ratings for sand greens. The tables provide reference tools to select pesticides based on their environmental fate and toxicity. A summary of chemical and physical property threshold values indicating the potential for groundwater contamination is provided in Table 8-6.

**Table 8-6. Threshold values indicating potential for groundwater contamination by pesticides.**

| Chemical or Physical Property | Threshold Value |
|---|---|
| Water solubility | Greater than 30 ppm |
| Henry's Law Constant | Less than $lO^{-2}$ atm to $m^{-3}$ mol |
| Kd | less than 5, usually less than 1 or 2 |
| Koc | less than 300 to 500 |
| Hydrolysis half-life | more than 25 weeks |
| Photolysis half-life | more than 1 week |
| Field dissipation half-life | more than three weeks |

#### *8.3.3.3 Soil*

Soil texture is based on the proportion of sand, silt, and clay. Soils with larger particle sizes have higher aeration (macropore) porosity and greater risk of leaching. Soil surveys classify soil type and texture into four hydrologic groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation for a long period. The NRCS Soil Survey defines four hydrologic soil groups that vary with respect to leaching and runoff potential (Table 8-7).

**Table 8-7. Leaching and runoff potential by soil group**

**Runoff Potential** ↑

**Leaching Potential** ↓

| Soil Group | Description |
|---|---|
| A | Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission. |
| B | Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well-drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission. |
| C | Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission. |
| D | Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a clay pan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission. |

#### *.4 Pesticide Persistence*

Once applied, pesticides break down in the environment through a number of processes: exposure to light (photodegradation), chemical reactions in the soil, and the action of soil microbes or other organisms (biodegradation). Environmental conditions such as temperature, moisture, and pH also affect the rate of pesticide degradation. The rate of degradation is expressed in terms of half-life, which is the number of days required for half the concentration of a pesticide to breakdown. Persistent pesticides, those with a half-life greater than 21 days, pose a threat to water quality.

#### *8.3.3.5 Solubility*

Pesticide chemical properties include a measure of the chemicals cold water solubility, often expressed as grams per liter (g/L), milligrams per liter (mg/L), or parts per million (ppm). A pesticide with a solubility of less than 30 ppm (mg/L) is considered to have a low potential risk to ground and surface water contamination.

#### *8.3.3.6 Soil Adsorption (Koc)*

Once in the soil, pesticides vary in how tightly they are adsorbed to soil particles. Chemical mobility in soil is determined by the ratio of the pesticide's solid and aqueous phases, $K_D$, in the soil. In a solid phase, the pesticide can bind to soil particles and organic matter. In the aqueous phase, the pesticide dissolves in water. The $K_D$ factor varies by soil type. Soil scientists normalize the values, calculating a new coefficient, Koc that accounts for soil organic matter content. The higher the Koc value the greater the bond between the soil and the pesticide. Pesticides with a Koc less than 300-500 are considered a risk to ground water quality, as they tend to dissolve and move with water. The Koc is not well correlated in high clay soils. In these cases, $K_D$ is used to evaluate soil mobility.

#### *8.3.3.7 Groundwater Ubiquity Score*

The Groundwater Ubiquity Score (GUS) was developed to model persistence and soil adsorption factors to provide a method to determine the relative risk of leaching. The model was validated by comparing actual leaching data with predicted risks. Pesticides with GUS values greater than 2.8 have high risk of leaching. Pesticides with GUS values below 1.8 are considered to have a low risk of leaching. GUS values for pesticides approved for use in New York have been charted to identify the "leachers" from the "non-leachers" (Tables 8-7, 8-8, and 8-9). These GUS values assess risk based on the chemical properties and do not account for soil conditions. Soils with high infiltration rates or sites with excessive slope may be more prone to leaching and runoff. Nonetheless, GUS values provide a tool to help turf managers select chemicals with the lowest GUS value.

#### *8.3.3.8 Volatility*

Some pesticides volatilize readily. Volatility is influenced by environmental conditions, such as temperature, relative humidity, and air movement. High temperatures and low humidity increase evaporation rate. The level of a pesticide's volatility may be indicated on the label.

### 8.3.4 Pesticide Evaluation Tools

Models have been developed that combine multiple characteristics and give relative weighting or ranking of the potential risk of specific pesticides. These are briefly discussed below. For further information on pesticide evaluation tools, see:

- Cornell EIQ calculator: http://www.nysipm.cornell.edu/EIQCalc/input.php
- WIN-PST: http://go.usa.gov/Kok

- IRPeQ: http://www.mddep.gouv.qc.ca/pesticides/indicateur-en.htm

#### *8.3.4.1 Environmental Impact Quotient*

The Environmental Impact Quotient (EIQ) was developed to rate the risk of pesticides to human health and non-target organisms. The EIQ value is derived from mathematically weighting all the risk factors into a quotient. The EIQ is multiplied by the rate of application and percent active ingredient to calculate the Field Use EIQ Rating (FUEIQ):

$$\text{FUEIQ} = \text{EIQ} \times \text{Rate (lbs/acre)} \times \%\text{AI}$$

The FUEIQ provides a measure of the weighted risk or toxicity of a pesticide expressed as a value per acre. Multiplying the FUEIQ by the number of acres treated provides a risk/toxicity rating for the treated area. Summarizing all applications in this manner provides a summation of risks/toxicity for the entire property over a period. Cornell provides an online EIQ calculator to compare FUEIQ results (http://www.nysipm.cornell.edu/EIQCalc/input.php). A FUEIQ under 25 is desirable. Any value over 100 poses high risks to applicators and the environment. The *Cornell Guide for Commercial Turfgrass Management* lists the range of FUEIQs for the rate range on each pesticide registered for use in New York. The Cornell publication *Reducing Chemical Use on Golf Course Turf: Redefining IPM* describes the methodology to evaluate pesticide environmental toxicity using EIQ.

#### *8.3.4.2 Windows Pesticide Screening Tool*

Windows Pesticides Screening Tool (WIN-PST) is an environmental risk screening tool developed by USDA-NRCS for pesticides. This tool uses site-specific information to evaluate the potential of pesticides to move with water and eroded soil/organic matter and affect non-targeted organisms.

The risk of pesticide contamination of either surface water or groundwater is mostly affected by the properties of the pesticide, the properties of the soil, and the amount of rainfall after application. Unlike the EIQ and GUS, WIN- PST can be tailored to site-specific soil conditions and management practices. The method uses standard soil properties provided by the NRCS data base or can be adjusted to site-specific soil factors that affect the movement of pesticides, such the depth of the root zone and the organic matter content. The environmental risk can also be evaluated based on anticipated weather (rainfall).

The following example illustrates how WIN PST can be used for golf course conditions such as a sand green. For this example, the soil is sand at a typical greens depth of 12 inches and the average organic content for the 12 inch profile is 1%, by weight. The pesticides were applied to the turf foliage under two rainfall conditions: low potential for rainfall and a high potential for rainfall. Appendix G contains the WIN PST risk screening for pesticide leaching for most pesticides registered in NYS for use on golf courses. Under the low rainfall potential scenario, most of the pesticides evaluated had a low or very low risk (four had a high/extra high) to humans (long term exposure as a drinking water source) and only one pesticide has a high or

extra high risk to fish, even when applied to this very high leaching-groundwater contamination soil like sand. When applied under a high potential rainfall scenario, however, 15 pesticides had a high/extra high risk to humans, and 20 had high/extra high risk to fish.

Based on these result, one of the BMPs for this example is to only apply pesticides when the potential for rainfall is low. On sites where greens drainage is discharged near streams or near drinking water wells, extreme care needs to be taken if a pesticide application is needed during a period with a high potential for rain. Appendix G can be used to select pesticides that have a low risk even under these conditions.

#### *8.3.4.3 Pesticide Risk Indicator for Quebec*

Quebec's Ministry of Sustainable Development, Environment, Wildlife and Parks developed the Pesticide Risk Indicator for Quebec (IRPeQ), a diagnostic and decision-making tool designed for the optimal management of pesticides. This tool has both a health component and an environmental component.

***BMP Statements***

- Conduct a thorough assessment of pest pressure.
- Establish appropriate pest thresholds for managed turf areas.
- Identify and correct growing environments that exacerbate pest pressure.
- Implement sanitation, exclusion, and cultural practices to minimize pest pressure.
- Determine least toxic pest control programs including preventive approaches.
- Assess control program effectiveness using established monitoring practices.
- Recognize environmental fate of pesticides and select pesticides using a selection strategy that includes an evaluation of pesticide characteristics and potential for nontarget effects.

# 9 PESTICIDE STORAGE, HANDLING AND APPLICATION

Pesticides are an integral component of progressive IPM programs and are tools used to increase or maintain the economic value of properties being managed. The purchase, storage, handling, and use of pesticides are regulated by a number of state and federal agencies because of concerns these compounds pose for human health and the environment.

Recent survey information collected and published by the Environmental Institute for Golf's Environmental Profile Project indicates the level of safeguards currently enacted in the golf course management industry (Lyman et al. 2012). The survey indicated that 98% of average 18-hole golf facilities stored pesticides on the property, with no significant difference in the percentage of golf facilities storing pesticides based on the number of holes, facility type (private or public), or maintenance budget. The most common characteristics of pesticide storage areas include:

- locked or restricted access (94%)
- signs indicating pesticide storage (85%)
- emergency shower or eyewash station nearby (74%)
- impervious floor (68%)
- spill kits (67%)
- floors capable of containing liquid spills (63%)
- passive venting (58%)
- separate/dedicated building (54%)
- impervious shelving (51%)
- powered venting (50%)
- explosion-proof fixtures (30%)

The study also surveyed pesticide handling facilities. The most common characteristics of pesticide handling stations for average 18-hole golf facilities include:

- spill kit located near mix/load area (60%)
- anti-siphoning device on water line (56%)
- emergency water shut-off valve (45%)
- impervious floor (45%)
- recycling of pesticide containers (36%)
- tank-filling capacity greater than 50 gallons per minute (36%)
- floors capable of containing liquid spills (35%)
- overhead protection from weather (29%)
- pesticide rinsate collection (27%)
- stand-alone pesticide mixing tank (15%)

Golf course monitoring programs conducted in New York and several other states indicate little to no risk of water contamination of pesticides applied to golf turf (Appendix B). The application of pesticides is often made with low concentrations of active ingredients, often

between 1 to 5% solutions. Simple attention to proper application procedures, especially avoiding direct discharges into water bodies or near wellheads, should typically suffice.

The storage and handling of pesticides on golf courses presents the greatest risk to water quality contamination because of the potential for an unintended release of a large volume of pesticides. Therefore the greatest attention to BMPs should be directed at storage and handling. Properly selecting, storing, handling, and applying pesticides minimizes their potential to reach surface water or groundwater through runoff, leaching, or drift.

For more information on the general use and management of pesticides, see:

- Pesticide Safety Education Program (PSEP), Cornell University Pesticide Management Education Program (PMEP): psep.cce.cornell.edu
- Pesticide Product Ingredient Manufacturer System (PIMS): pims.psur.cornell.edu/
- Cornell University, College of Agriculture and Life Sciences, Occupational & Environmental Health Pesticide Program Overview: oeh.cals.cornell.edu/pestmain.html

## 9.1 Pesticide Use Regulations

The New York State Environmental Conservation Law (ECL), Article 33, Part 325, establishes statutory authority to the New York State Department of Environmental Conservation to regulate pesticides and pesticide use.

### 9.1.1 Business Registration

All businesses must register for permits to with the NYSDEC to commercially apply pesticides.

### 9.1.2 Certified Applicators and Technicians

The law requires commercial applicators and technicians applying pesticides to golf course turf to be certified in categories 3A (ornamentals, shade trees, and turf) or 3B (turf only). Commercial applicators must meet requirements in continuing education credits. Special supervisory restrictions apply to technicians and apprentices.

### 9.1.3 Labels

When chemical controls are to be used, only pesticides labeled for use in New York State are permitted. In addition to a listing by NYSDEC of registered pesticides, Cornell's pesticide Product Ingredient Manufacturer System (PIMS) lists all registered pesticides searchable by EPA registration number, common name, or active ingredient.

### 9.1.4 Pesticide Reporting Law

Applicators are required to file an annual report by February 1 each year summarizing their pesticide applications from the previous calendar year. These applicator reports are compiled each year in a summary report on sales and use around the state. The DEC is also monitoring

water quality reports to assess pesticide levels in high-risk watersheds, aquifers, and wells across the state.

### 9.1.5 Neighbor Notification

The ECL was amended to include the Neighbor Notification Law requiring a 48-hour notice to adjoining property owners prior to pesticide application. However, the requirement is only effective for counties that adopt the requirements into local ordinances; golf courses and sod farms are specifically exempted. Registered businesses should check with county officials or regional NYSDEC offices to see if specific local requirements apply.

### 9.1.6 Pesticide Storage

The pesticide label is the law and all pesticides should be stored according to instructions on their labels. In addition to the label, Part 326.11 of the New York Codes, Rules and Regulations (NYCRR)( http://www.dec.ny.gov/regs/4423.html) states "No person shall store any restricted pesticide or empty containers thereof in such a manner as may be injurious to human, plant or animal life or to property or which unreasonably interferes with the comfortable enjoyment of life and property throughout such areas of the State as shall be affected thereby." Pesticide storage areas should be designed and managed in a manner that prevents or minimizes the risk of injury, harm to the environment or any impact on the use or value of property. The following suggestions are offered for consideration:

- Storage facilities should be structurally separate from "residential, office and general work areas; livestock quarters, food, feed or seed storage and water supply sources". Storage should be in separate buildings and situated to be at least 50 ft away from residential or farm property. Fencing is currently not stipulated but could be considered as an added precaution.
- To the extent practical, pesticides should be stored more than 500 feet from wetlands and waterbodies.
- Storage areas should have a raised berm on all sides and an impervious surface for containment.
- Facilities should be equipped with "spill containment material" and fire extinguishers. Suggested spill containment material includes absorbent spill containment pads, sweeping compound, brushes or brooms, a dust pan, shovel and a disposal container or bag.
- Protective equipment should be available near but not within the storage area.
- The storage facility should be locked and properly posted with warnings.
- Annual updates should be provided to the local fire department and include a "Fire and Spill Response Plan". Additional precautions might include provisions of the National Fire Protection Association (NFPA) codes.
- Chemicals should be segregated by function (fungicide, insecticide, and herbicide) and hazard level. All flammable and "incompatible" materials should be stored separately.
- Mixing areas should be similarly bermed with impervious surfaces.
- Indoor mixing areas should be properly vented.

- Bulk containers, construed to be equal to or greater than 55 gallons, should be locked and drains should be used to collect any spills into a containment area. The spill containment system should have a capacity equal to or greater than 25% of the volume of pesticides stored.
- A water supply and wash station are required at or adjacent to the facility for emergencies.
- A suitable first aid kit for pesticide poisoning should be nearby.
- Forced air vent systems capable of exchanging the air volume 3 to 4 times per hour should be considered along with temperature control for keeping temperatures under 95°F and above freezing.
- Local fire departments should be made aware of the pesticides and fertilizers stored to prepare in event of a fire at the storage facility.

Very old or inadequate storage areas may or may not be out of compliance, but consider planning for improvements to implement these recommendations over time. For more information, see also NYSDEC guidelines for pesticide storage at http://www.dec.ny.gov/regs/4423.htm.

### 9.1.7 Pesticide Transport

Off-property transport of pesticides must comply with New York State Department of Transportation (NYSDOT) regulations. Regulations require that the driver be trained for hazardous material transport. Drivers are required to carry the pesticide label and SDS sheet, have sufficient knowledge to handle any spills, and communicate with emergency responders in case of spills. Pesticides transported off the property or stored in a sprayer tank must be labeled with basic pesticide information as required under the Environmental Conservation Law.

### 9.1.8 Mixing and Loading

Mixing, loading, and washing areas should be well ventilated and should take place in contained areas that are bermed, have impervious surfaces, and roofed to prevent rainfall spreading pesticide residue. Precautions should be in place to effectively respond to emergencies, such as the availability of proper PPE, spill response kits, and emergency wash stations.

NYSDEC regulations require the use of Backflow Prevention Devices (BPD) when public water is used with pesticide application equipment. Use caution and read the labels carefully to ensure that pesticides mixed together are compatible. Water used for mixing should be tested for pH to ensure that tank mixes do not expire prematurely due to alkaline hydrolysis.

The State of Michigan currently has some of the most comprehensive regulations addressing the construction of mixing and loading areas. This information is also part of the MI Environmental Stewardship Program that includes a useful module developed by Michigan State University

designed to help golf courses determine need, size and capacity of mixing loading areas (see www.mitesp.org/assets/Modules/05PestMixLoad2009.pdf).

### 9.1.9 Pesticide Waste and Rinse Water Disposal

Pesticide containers must be cleaned and disposed of or recycled properly. Procedures typically include triple rinsing nonflammable containers and either returning cleaned empty containers to the vendor or properly sealing and disposing of them in a sanitary landfill. Rinsate may be re-applied to turfgrass consistent with instructions on the label. Unused pesticides must be disposed of in accordance with state regulations, such as by returning to the supplier or disposing at an approved hazardous waste facility.

### 9.1.10 Aquatic Pesticide Applications

The application of any pesticide to water, such as an aquatic herbicide used to control vegetation in golf course ponds, or mosquito or other insect control applied to water, must be covered under a SPDES General Pesticide Permit.

For more information on pesticide usage, see:

- NY Pesticide Business Registration: www.dec.ny.gov/permits/209.html
- Pesticides Registered in NY: www.dec.ny.gov/chemical/27354.html
- NY State Pesticide PIMS: pims.psur.cornell.edu/
- NY Pesticide Reporting Law: www.dec.ny.gov/chemical/27506.html
- NYSDEC Pesticide Storage Guidelines: http://www.dec.ny.gov/regulations/8871.html
- NYSDEC Policies on Backflow Prevention Devices: www.dec.ny.gov/regulations/23471.html
- NYSDEC Waste Transporter Permit Program: www.dec.ny.gov/chemical/8483.html
- Regulated Hazardous Wastes in NY: http://www.dec.ny.gov/chemical/8486.html
- New York State Solid Waste Management http://www.dec.ny.gov/chemical/8498.html
- Michigan State University mixing and loading pad module, including checklists: www.mitesp.org/assets/Modules/05PestMixLoad2009.pdf
- SPDES General Pesticide Permits: http://www.dec.ny.gov/chemical/70489.html.
- Clean Sweep NY: www.cleansweepny.org

## 9.2 Pesticide Application Strategies

In addition to selecting an appropriate pesticide based on the strategies discussed in Chapter 8, a number of factors should be considered when applying pesticides to avoid water quality impacts (Table 9-1). For example, a number of site-specific considerations for the use of pesticides should be evaluated using the results from the site analysis to identify areas where the risks of pesticides reaching surface or groundwater are greater (such as steep slopes, shallow water tables, and areas with frequently wet soils). In addition, pesticides should be applied accurately and with care to avoid conditions that can increase the chances of runoff, leaching, or drift (Figure 9-1).

**Table 9-1. Factors contributing to greater risk for groundwater and surface water contamination. Source: USGA 1995**

| Chemical | Soil | Site | Management |
|---|---|---|---|
| High solubility | Porous soil (sand) | Shallow water table | Incomplete planning |
| Low soil adsorption | Low organic matter | Sloping land | Misapplication |
| Long half-life (persistent) | | Near surface water | Poor timing |
| Low volatility | | Frequently wet soils | Over-irrigation |

**Figure 9-1. Typical fairway pesticide application using foam and dye for accuracy. *Source*: Robert Alonzi.**

### 9.2.1 Preventing Runoff and Leaching

Pesticides can be transported into water by several means:

- surface runoff following precipitation events or irrigation
- leaching through the soil horizon to reach groundwater

- adsorbtion on eroded soil that reaches surface water
- flowing directly to groundwater through sinkholes and permeable rock

The use of vegetated buffers may be the single most important strategy mitigating the impact of runoff as these buffers can "capture" pesticides and prevent them from reaching waterways. In addition, the timing and location of applications should be thoroughly evaluated. Preventing runoff and leaching of pesticides is heavily influenced by weather and irrigation scheduling. Pesticide applications followed by heavy rain or irrigation can cause the pesticides to leach into groundwater. This leaching can occur even for nonpersistent pesticides (those with a short half-life). Pesticide applications on saturated soils following heavy rain or irrigation can also lead to surface runoff. In addition, avoid applying pesticides in sensitive areas.

### 9.2.2 Preventing Drift

Drift can potentially cause water quality impacts, damage to susceptible nontarget crops, and a lower than intended rate to the turfgrass, thus reducing the effectiveness of the pesticide. Two types of drift occur: airborne (spray) drift and vapor drift. Spray drift is influenced by many interrelated factors including droplet size, nozzle type and size, sprayer design, weather conditions, and the operator. The amount of vapor drift depends upon a pesticide's volatility and atmospheric conditions such as humidity and temperature. Volatile turfgrass pesticides should be avoided. In some cases, the pesticide label may indicate low volatility. Low volatility, however, does not mean that a chemical will not volatilize under conducive conditions, such as high temperatures or low relative humidity. For more information, see Appendix H, Preventing Drift.

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- Ensure full compliance with existing pesticide regulations, including applicator and technician certification and following all label directions.
- Adapt or implement as many NYSDEC pesticide storage guidelines as possible.
- Assess site and weather conditions thoroughly before applying pesticides.

# 10 MAINTENANCE FACILITIES

Every golf course has a central area for the maintenance and storage of equipment and supplies. These areas can potentially become point sources of pollution because of unintended releases of chemicals such as pesticides, fertilizers, or fuel during storage or handling of these materials. Maintenance and storage facilities are high priority areas to address in protecting water quality. Containment measures in these areas can easily prevent chemicals from becoming point sources of pollution.

## 10.1 Regulatory Considerations

While federal and state regulations or guidelines may apply to maintenance facilities, these areas are more likely to be subject to a number of local requirements, which may vary by county or town. Local building inspectors should be consulted during planning for new facilities to outline the permitting process and local requirements. Also, consider meeting with a representative from a NYSDEC regional office and the local fire marshal. The NYSDEC requests a State Environmental Quality Review (SEQR) for new construction, which is administered by local governments. NYSDEC comments on SEQR as well as other interested and involved agencies.

### 10.1.1 Pesticide and Fertilizer Storage

Pesticides are labeled with legal requirements for proper storage and disposal requirements. New York State (NYS) has published guidelines for the storage of pesticides as discussed in Chapter 9. These guidelines are also relevant for fertilizer storage, as the potential water quality impacts from spills of fertilizer are the same, particularly for large containers (greater than 55 gallons) of liquid fertilizers. Fertigation often has large tanks for the liquid fertilizer and the storage/containment structure can be large (often part of the irrigation pump house).

### 10.1.2 Fuel and Fuel Oil Storage

NYS has regulations for above and below ground storage of fuel and fuel oil in Part 613 of the ECL. Every facility manager should review this regulation carefully. The regulations require daily inspection logs be kept and annual inspections. Counties and towns may also have their own fuel storage regulations.

### 10.1.3 Other Materials Storage

Use caution when storing other hazardous material including lubricants, cleaners, flammable paints, and other volatile organic compounds (VOCs). Incompatible and flammable materials should be stored separately in approved storage cabinets.

### 10.1.4 Mixing and Loading

NYS guidelines recommend mixing and loading areas to be contained and bermed, with impervious surfaces. These areas should also be well ventilated. Precautions should be in place to effectively respond to emergencies such as the availability of proper PPE, spill response kits, and emergency wash stations. New York State also requires the use of backflow prevention

devices (BPDs) to protect potable water supplies, unless an air gap is maintained between water sources and container.

### 10.1.5 Washing

Currently no federal, state, or county regulations exist for the design and operation of wash stations. However, NYS guidelines recommend wash areas to be contained and bermed, with impervious surfaces.

Wastewater or rinse water can be reapplied to turf areas by certified pesticide applicators. Discharge of wastewater from wash stations with low concentrations of pesticides and fertilizers onto the ground does not require any special permits. However, USEPA and the NYSDEC do not permit wastewater to be discharged into a stormwater runoff system or any groundwater recharge area without special permits.

### 10.1.6 Stormwater

The concentration of activities in and around the facility may increase the levels of chemical residues that would be susceptible to runoff from heavy precipitation. Stormwater collection areas may need to be established to capture runoff in accordance with NYSDEC specifications. Discharges may require a SPDES general permit and compliance testing. In addition to chemical contamination limits (CCLs) for nitrites, nitrates, and pesticides, the NYSDEC also has a limit for phosphorus levels in stormwater of 0.1 mg P per liter.

### 10.1.7 Waste Management

Golf courses may generate a number of different types of wastes. Examples of wastes that may be generated at a golf facility include, but are not limited to, the following:

- parts wash solvents
- waste gasoline
- cleaning materials
- paints
- waste oil
- lead-acid batteries
- aerosol cans
- spent fluorescent bulbs
- unusable pesticides and inner bag liners
- unusable herbicides and inner bag liners
- antifreeze

A waste is a hazardous waste if it exhibits a specific characteristic (ignitability, corrosivity, reactivity, toxicity) or if it is included in any of the four specifically listed categories of hazardous waste. Many waste fluorescent lamps are hazardous wastes due to their mercury content. Other examples of lamps that, when spent, are commonly classified as hazardous waste include: high-intensity discharge (HID), neon, mercury vapor, high pressure sodium, and

metal halide lamps. In New York State, the hazardous waste regulations are found in 6 NYCRR Parts 370 through 374-3 and 376.

USEPA issued the Universal Waste Rule in 1995 to streamline compliance with hazardous waste regulations. This rule is designed to reduce the amount of hazardous waste in the municipal solid waste stream, to encourage the recycling and proper disposal of some common hazardous wastes and to reduce the regulatory burden on generators. Universal wastes include such items as hazardous batteries, hazardous mercury-containing thermostats, certain pesticides, and hazardous lamps. Although handlers of universal wastes must meet less stringent standards for storing, transporting, and collecting wastes, the wastes must comply with full hazardous waste requirements for final recycling, treatment, or disposal. Therefore, every golf club is responsible (and liable) for the safe handling of the product and proper waste disposal by a reputable waste removal service. These services should be certified and bonded for transporting your waste to similarly accredited processing centers.

For more information, see:

- NYSDEC State Environmental Quality Review: http://www.dec.ny.gov/permits/357.html
- NYSDEC regulations on handling and storing petroleum: http://www.dec.ny.gov/regs/4433.html
- NY policies on backflow prevention devices: www.dec.ny.gov/regulations/23471.html
- NY Stormwater Design Manual: http://www.dec.ny.gov/chemical/29072.html
- Regulated Hazardous Wastes in New York: http://www.dec.ny.gov/chemical/8486
- New York State Solid Waste Management: http://www.dec.ny.gov/chemical/8498.html
- NYSDEC: Hazardous Waste Management: www.dec.ny.gov/chemical/8486.html
- Lead Acid Batteries: www.dec.ny.gov/chemical/86024.html
- NYSDEC Waste Transporter Permit Program: www.dec.ny.gov/chemical/8483.html

## 10.2 Maintenance Facilities Design and Operation

A site analysis can identify and assess risk for ground or surface water contamination. The first step is to determine the environmentally sensitive areas, potential release points, and containment strategies currently employed. This analysis should address aspects of storage and handling of chemicals.

### 10.2.1 Storage

The goal of an ideal storage facility is the safe siting and storage of potential contaminants that ensures a high level of water quality protection (Figure 10-1). NYSDOH does not allow chemical storage or mixing and loading facilities within 100 feet of a potable well. Other requirements include local zoning for the siting of maintenance facility and operations, which vary by town and county. Requirements often include a minimum distance (set-back) from wetlands, surface wells and property lines. The Freshwater Wetlands Act (http://www.dec.ny.gov/lands/4937.html) requires a 100 ft buffer around wetlands. Some townships have even broader requirements.

**Figure 10-1. Chemical storage building organization. Source: Robert Alonzi.**

Modular or independent containment units can be installed in many sizes. The units are typically self-contained, fireproof and secure and can be temperature controlled with ventilation. Options include fire suppression, eye washes, and safety showers.

**Figure 10-2. Modular containment units can be installed in many sizes. Source: Robert Alonzi.**

Floor drains should include a sump and a chemical pump to move the chemicals discharged to a waste tank as in Figure 10-1. The material can be reclaimed, diluted to label concentrations, and applied to turf areas or collected for disposal using certified hazmat haulers.

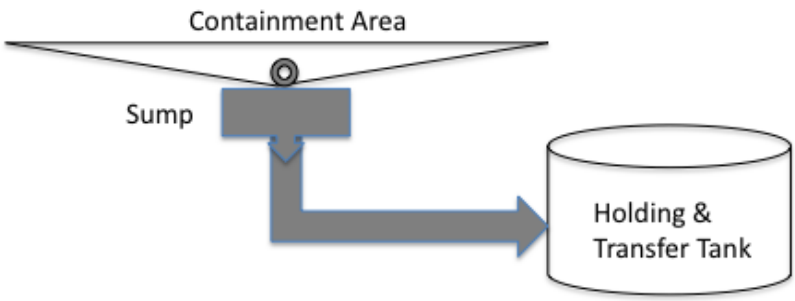


**Figure 10-3. Containment area with sump and transfer to holding tank.**

Updating chemical storage areas does not necessarily require a new building. Many changes can be easily attained:

- impervious flooring
- flooring sloped to a drain
- curbing to contain at least 25% of the volume of liquid chemicals and fertilizers stored
- ventilation to exhaust any fumes in the event of a spill
- PPE for workers and emergency wash stations

### 10.2.2 Mixing and Loading

As with the storage areas, the handling area (mixing and loading) of pesticides and fertilizers should be contained to minimize release of concentrated or diluted pesticides and fertilizers. These compounds should be mixed and loaded on a covered impervious surface properly sized and sloped to capture the maximum potential spill. Backflow preventers should be installed on fresh water supplies used for filling. The station could also be upgraded to pre-mix pesticide/fertilizer loads in a controlled environment then transferred to the sprayer. See Figures 10-4 through 10-6 for proper mixing and loading practices.

**Figure 10-4. Loading fill spray tank from premix. *Source*: Robert Alonzi.**

**Figure 10-5. Recovery lines and trans pump in the equipment mixing and loading area. *Source*: Robert Alonzi.**

**Figure 10-6. Mixing and loading recovery tanks. *Source*: Robert Alonzi.**

### 10.2.3 Wastewater Handling

The release of organic waste associated with equipment cleaning needs the same level of protection afforded liquid and granular nutrients and pesticides. When debris is removed from equipment, it should not be released into open surface waters or in a location near well heads or shallow groundwater. Figure 10-7 shows a well designed wash area.

**Figure 10-7. Equipment wash area. *Source*: Old Oaks County Club.**

Often effective equipment cleaning areas can be maintained as mixing and loading areas with impervious flooring and drains that allow for some separation of organic solids and liquids (Figure 10-7). When using the simple wash-pad and collection area be sure to direct any uncontained liquid to be dispersed along the land, preferably along a designed bio-filtration system. Closed system cleaning stations are available that separate clippings/solids and treat the wash water. The recycled water is reused as wash water. The EPA suggests the stages of treatment, as shown in Figure 10-8. Another approach to wastewater treatment uses microbes to break down chemical compounds (Figure 10-9). Both types of systems may require additional purification steps to remove odors and harmful bacteria. These systems must be carefully sized to process the peak water volume anticipated for contaminant levels expected. The equipment varies in costs but increases with structural requirements and permits.

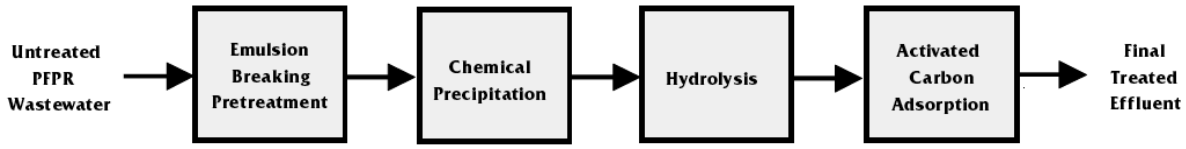


**Figure 10-8. Stages of treating wastewater, as shown for an activated carbon adsorption system (EPA, P2 Guide).**

**Figure 10-9. Microbial system for treating wastewater. *Source*: Robert Alonzi.**

### 10.2.4 Integrated Chemical Management

New construction designs should consider integrating storage, mixing, and washing operations in an integrated chemical management system. Buildings and infrastructure are designed to account for the traffic and usage. The resulting design should provide a much better envelope of the operations compared to separately constructed areas. Integrated designs often include fuel storage and filling stations within the same containment areas.

### 10.2.5 Organic Matter Management

Nutrient BMPs recommend that clipping be widely redistributed to turf. Research has shown that nitrate levels in leachate increased to as much as 30 mg/L in areas that received four times the normal clippings return. Some clubs elect to collect clippings from fairways and then dump these clippings as yard waste. The accumulation of clippings and other yard wastes such a leaves, tree limbs, and other plant debris can be a substantial source of contamination to surface water and groundwater if placed close to water courses.

**Figure 10-10. Clippings removal unit. *Source*: John J. Genovesi, CGCS, Maidstone Club.**

Clippings should be screened and collected when cleaning equipment in the maintenance area (Figure 10-13). They should not be allowed into the stream of wastewater. The inherent concentration of organic nitrogen and phosphorus, along with any pesticide residues, can contaminate the wastewater or reduce the effectiveness of wastewater treatment equipment. Ideally, clippings should be blown off using compressed air and then collected

(Figure 10-11). If water is being used, sumps should screen and convey clippings and other solids prior to wastewater disposal or treatment.

**Figure 10-11. Prior to washing equipment, removing clippings while over grass (top) or a pad (bottom) with an air hose or prewash reduces the amount of organic debris in the wash water. Source: Robert Alonzi.**

**Figure 10-12. Typical equipment wash area with drain. *Source*: Robert Alonzi.**

**Figure 10-13. A Retrofitted RGF system separates solids in the wash water. *Source*: Robert Alonzi.**

**Figure 10-14. A retrofitted RGF system solid separation pad. *Source*: Robert Alonzi.**

Many clubs have contracted with local composting companies to haul their organic waste. Material is generally accumulated in dumpsters and then frequently removed.

### 10.2.6 Lubricants, Greases, Paints, and Solvents

Lubricants, greases, paints and solvents should be stored appropriately, typically in fireproof enclosures, separately from pesticides and fertilizers. Special cleaning stations are commercially available that contain and recycle solvents and degreasers.

In addition to any handling precautions specified on the product label or MSDS sheet, added steps should be taken to prevent and contain any spills. Spills should be cleaned up using approved dry absorbants. Contaminated material should be stored in containers specially marked as hazardous waste and disposed of using licensed waste haulers and hazmat processors.

## 10.3 Emergency Planning

Planning and preparations should be made for potential emergencies. Local emergency personnel such as local fire departments should be consulted and notified of the locations of pesticides and fertilizers storage as well as regularly updated lists of chemicals stored. Storage areas should be properly placarded. Training and orientation should also be conducted with employees to review those plans and preparations.

New York State responds to reports of petroleum and other hazardous material releases through the Spill Response Program maintained by the NYSDEC. Spill response staff throughout the State investigate such spill reports and take action based on the type of material spilled, the potential environmental damage, and safety risks to the public. Releases to the environment should be reported to the NYSDEC Spills Management Hotline at 1-800-457-

7362. See http://www.dec.ny.gov/chemical/8428.html for more information on reporting of spills.

### 10.3.1 Safety Data Sheets (SDS)

The Hazard Communication Standard (HCS) (29 CFR 1910.1200(g)), revised in 2012, requires that the chemical manufacturer, distributor, or importer provide Safety Data Sheets (SDSs) (formerly MSDSs or Material Safety Data Sheets) for each hazardous chemical to downstream users to communicate information on these hazards. The information contained in the SDS is largely the same as the MSDS, except now the SDSs are required to be presented in a consistent user-friendly, 16-section format. More information on SDS can be found at: https://www.osha.gov/Publications/OSHA3514.html.

### 10.3.2 First Aid

Adequate provisions should be provided to immediately treat any person exposed to chemical exposure including eye wash stations and showers. First aid kits should be maintained to treat skin contact, ingestion, or inhalation.

Cornell's Occupational and Environmental Health Department (OEHD) at the Cornell College of Agricultural Sciences have guidelines that can be used a template for spill management:

- Evacuate personnel from the immediate area of the spill.
- Control the spill. Do not endanger yourself. To the extent possible, shut off the source and block the flow.
- Call 911 if:
    - anyone is injured
    - the spill is too large for a local clean up
    - the spill migrates off-site
    - the spill threatens the health and safety of anyone
- Identify the spilled material(s).
- Barricade the area and notify others in surrounding areas not to enter the spill area.
- Wait for help to arrive.

Spill kits (Appendix I) can be used for incidental releases and the following procedures followed:

- Consult the appropriate SDS and label (for pesticides).
- Wear the appropriate PPE.
- Contain the spill. Prevent spread or escape from the area by using sorbents.
- Clean up the spill. Never hose down an area until the cleanup is completed.

To clean up pesticides:

- Recover as much product as possible in a reusable form. Store and use as intended. Recover the rest of the product as a waste product by using an adsorbent or sweeping compound.

- When all recoverable material is secured, clean contaminated surface residues using triple-rinse technique; for instance, a spill of liquid on the floor requires that the area be damp-mopped three times.

To clean up all other chemicals:

- Small liquid spills can be cleaned up with a commercially available absorbent. Avoid using paper towels; they increase the surface area and the rate of evaporation, increasing the fire hazard.
- For acid or base spills, use a sorbent that will neutralize the liquids (trisodium phosphate, sodium bicarbonate, or other commercially available products).
- Use a dustpan and brush to sweep up the absorbed spill. Wash the contaminated area with soap and water.

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- Assess potential point source pollution risk.
- Manage organic and inorganic waste to minimize potential point source pollution.
- Ensure compliance with regulatory requirements designed to prevent point source pollution.

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# APPENDICES

## Appendix A: Glossary

*Aquifer* – An underground source of water made up of porous rock, like sand, shell or limestone.

*Available Water* – The difference between soil moisture content at field capacity and the point at which plants wilt due to lack of moisture little water remains available to the plant.

*Biological control* – The use of living organisms to reduce populations of other living organisms-namely pests.

*Environmental Impact Quotient (EIQ)* – A method for quantifying the effect of pesticides on the environment, people, water and wildlife.

*Eutrophication* – The enrichment of bodies of fresh water by inorganic plant nutrients (e.g. nitrate, phosphate). It may occur naturally but can also be the result of human activity (cultural eutrophication from fertilizer runoff and sewage discharge) and is particularly evident in slow-moving rivers, shallow lakes, and impoundments.

*Evaporation* – The process by which water changes from a liquid into a gas.

*Evapotranspiration* - The sum of evaporation and plant transpiration from the Earth's land surface to atmosphere.

*Flow* – The movement of water from one place to another.

*Groundwater Recharge* – The hydrologic process by which water enters into groundwater.

*Hypoxia* - Very low levels of dissolved oxygen in the water column

*Infiltration* – The process by which water is absorbed into the ground.

*Leaching* - The downward movement of a chemical or nutrient (e.g. pesticide or nitrogen from fertilizer) through the soil and potentially into groundwater.

*Nonpoint Source* – Nonpoint source pollution is caused by water moving over and through the ground picking up and carrying away natural and human-made pollutants and finally depositing them into lakes, rivers, wetlands, coastal waters and ground waters.

*Nutrients* – Elements as nitrogen and phosphorus compounds necessary for plant growth and survival. Elevated levels can cause unwanted growth of algae, and can result in the lowering of the amount of oxygen in the water when the algae die and decay.

*Runoff* – the movement of water across the turf and soil surface, typically following a storm event or heavy irrigation

*Sedimentation* – The deposition of loose particles of sand, clay, silt, and other substances that settle at the bottom of a body of water. Sediment can come from the erosion of soil or from the decomposition of plants and animals.

*Pesticide Drift* – The U.S. Environmental Protection Agency defines spray or dust draft as "the physical movement of pesticide droplets or particles through the air at the time of pesticide application or soon thereafter from the target site to any non- or off-target site".

*Pesticide Resistance* – The decreased susceptibility of a pest population to a pesticide that was previously effective at controlling the pest.

*Pesticide Volatilization* – the chemical process whereby pesticide surface residues change from a solid or liquid to a gas or vapor after application. Once airborne, volatile pesticides may drift off site. Pesticide volatility varies, and not all pesticides volatilize.

*Point Source*- A point source is a source of pollution from originating from a single identifiable source. However, this does not legally include agricultural storm water discharges and return flows from irrigated agriculture, including turf.

S*tormwater* - Water that originates in some form of precipitation as either rainfall or snowmelt.

*Transpiration* – Loss of water through the leaves of plants.

*Watershed* – An area of land that drains into a body of water (e.g. river, lake, reservoir, etc.) and includes the network of rivers, streams and lakes that convey the water, as well as the land surfaces from which water runs off.

*Water Table* – Marks the very top of the ground water layer, and is the border between the unsaturated and saturated zone.

## Appendix B: Groundwater quality of eastern long island, ny, golf courses

In New York, groundwater quality has been tested on 27 golf courses in Suffolk County by the Suffolk County government. From 1999 to 2010, up to 42 wells were sampled for a total of 366 sampling events. The samples were tested for a wide range of compounds from nutrients like nitrate and ammonia; metals like arsenic, cooper and cadmium; and 54 organic compounds, including pesticides and metabolites. These sample tests resulted in over 20,000 individual results. These test results are provided on the next page and as a download from the NY BMP web site.

Nitrate was found to be a common contaminate of groundwater in some areas, although 57% did not have a detectable level of nitrate. Twenty nine percent had nitrate concentrations of less than 5 mg/L, 10 % had concentration from 5 to 10 mg/l and only 4 % were greater than 10 mg/L, the drinking water standard. The Nitrogen Challenge with Suffolk County golf courses and the Peconic Estuary Program has set a target goal of groundwater of no greater than 2 mg nitrate/L. Sixty eight percent of the samples tested were below this goal level.

The most commonly detected golf course pesticide was metalaxyl. Fourteen percent of the samples tested had detectable levels of metalaxyl, with concentration ranging from 0.1 to 2.74 ppb (ug/L). An old no longer used herbicide dacthal (the acid metabolite) was detected in 9% of the samples, at concentration as high as 272 ppb. Imidacloprid was detected in 6% of the samples in concentrations no greater than 10 ppb. Several other pesticides (PCNB, propiconazole and iprodione) were occasionally detected at very low concentrations (<1 ppb).

The results of this testing would suggest than golf courses are having at most a minor impact on the groundwater quality of eastern Long Island.

# Appendix D: Conversion Tables

| | | |
|---|---|---|
| Hectare = | 107,639.10 | sq ft |
| Acre = | 43,560.00 | sq ft |
| Hectare = | 2.47 | acres |
| | | |
| kilogram = | 2.20 | lbs |
| | | |
| inch = | 2.54 | cm |
| cm= | 0.39 | in |
| | | |
| gallon $H_2O$ = | 8.35 | lbs |
| gallon H2O = | 3.79 | kg |
| | | |
| gallon = | 0.13 | cu ft |
| gallon = | 3.79 | L |
| | | |
| cu ft = | 7.48 | gal |
| cu ft = | 1,728.00 | cu in |

# Appendix E: Guidelines for Using Recycled Wastewater for Golf Course Irrigation in the Northeast

**Joann Gruttadaurio and A. Martin Petrovic, Cornell University**

## Introduction

The availability of fresh water for irrigation in many parts of the United States is becoming critically limited. This is especially true for irrigation of non-food and fiber productions sites including parks, commercial and residential lawns, athletic fields, golf courses, cemeteries, sod farms and other landscape plantings. This is true even for the northeastern US where many people perceive an abundance of fresh water. In order to meet demand, major metropolitan water suppliers in the northeastern US are required to double the supply capacity of their systems for the three summer months that are dominated by landscape irrigation demands.

As urban and suburban sprawl continues, the demand for freshwater resources also increases. Water conservation and/or the use of alternative water sources, such as waste water for landscape irrigation can help address the growing demand for fresh water. Most large-scale waste water irrigation comes from sewage treatment plant effluent. The southwestern US has successfully used treated sewage effluent and gray water for irrigation for many years.

The benefits of using waste water as an irrigation source include: conservation of freshwater that would be used for irrigation, supply of small amount of nutrients to enhance plant growth every time the site is watered, and a reduction of pollutant (phosphorus and nitrogen) discharge in to surface water.

The potential hazards from waste water irrigation involve salt injury to plants, long term effects on soil health (reducing in drainage and increase in runoff/erosion), other soluble compounds in the water and human pathogens in the waste water. Proper water treatment has all but eliminated the human pathogen issue. Long-term use of waste water irrigation of turfgrass sites in the desert southwest, a low rainfall area, has shown to increase salts levels in the soil which could harm plant growth and impede drainage by destroying the structure of soils with clay. However, in areas with 30 to 60 inches of rainfall per year, will waste water irrigation harm plant growth and soil health?

In the Northeast, waste water use for irrigation has been very limited. For example,, in New York State only two golf course complexes out of 850 golf courses use waste water for irrigation. One golf course (45 holes) in Lake Placid, NY, gets all its irrigation water from the Village of Lake Placid and the Village of Lake Placid has reduced its phosphorus loading into Lake Champlain by 25 percent. At the Turning Stone Casino Resort, four of the five courses use recycled waste water, which is generated by on-site use, exclusively for irrigation. To date, neither the Lake Placid golf courses nor the Turning Stone Casino golf courses have reported any observable turf damage from the use of recycled waste water.

**Water as an Essential Resource**

Potable water reserves comprise only 2-5% of the total global water supply. Ground water makes up only 1.7% of that total. Ground water supplies only 30% of the water resources used for human and industrial purposes, the remaining 70% comes from surface water sources.

The demand for fresh water for human consumption and uses continues to increase. Interest in conserving fresh water and finding alternative water sources to be used for agriculture and landscape management has become important societal concerns/issues.

**What is Waste Water?**

Waste water is water that has been reclaimed from municipal waste water or sewage treatment plants. Waste water is also referred to as recycled water, reclaimed water, effluent water and gray water. Recycled water can beneficially be used for agricultural or landscape purposes and for recharging ground water supplies.

Before being recycled or discharged into streams or lakes, the waste water goes through a primary, secondary or tertiary treatment process. The primary treatment process removes the sediments and is not recommended for use. The secondary treatment uses a process of biological oxidation and disinfection. The resulting effluent can be used to irrigate non-food crops, and possibly for industrial cooling processes, wetland and wildlife habitat, stream augmentation and ground water recharge of aquifers not supplying potable water. Tertiary treatment involves chemical coagulation, filtration and disinfection. This water can be used for golf course and landscape irrigation, food crop irrigation and other uses.

Using recycled waste water for golf course irrigation can decrease the diversion of freshwater from sensitive ecosystems, decrease the discharge of waste water to sensitive water bodies, may be used to enhance wetlands and riparian habitats and prevent or reduce pollution.

**Why golf courses?**

Golf courses serve important environmental, recreational and economical roles in our communities as sites for recreation, wildlife sanctuaries and comprise land that can help to filter recycled water.

The typical Northeast 18-hole golf course uses between 15-30 million gallons of water per year. The Northeast is currently fortunate to have access to water to meet this demand under most non-drought conditions. Other parts of the country with low rainfall have had to switch to alternative water sources for irrigation so enough freshwater would be available for human consumption.

**Use of Recycled Waste Water for Golf Course Irrigation**

Golf course managers in the Northeast are largely unfamiliar about using recycled waste water for irrigation. Many questions have slowed the adoption of this practice including:

1. Will the waste water be harmful to the turf?
2. Will I have a consistent water supply when I need it for irrigation?
3. Would extra equipment or retrofitting the current irrigation system be necessary?
4. How would the public or clients react to the use of this water on the golf course?
5. Is it necessary and easy to get approval to use waste water for irrigation?
6. How must management be changed when using waste water?
7. What are the costs or savings associated with using waste water?

Potential benefits of irrigating with waste water include the opportunity to conserve a precious natural resource, to provide a site that would serve as a biofilter (thus reducing the amount of effluent water reaching streams and lakes), to use a water source that contains some nutrients (which would reduce the need for some additional fertilization) and to find a less expensive water source than potable water.

## New York Golf Course Experiences with Recycled Waste Water for Irrigation

We are using the experiences of three New York golf courses to provide insight on using waste water for irrigation: Lake Placid Resort Golf Course, Turning Stone Casino and Resort, and Indian Island Golf Course.

**Lake Placid Resort Golf Course**

The Lake Placid Resort Golf Course is a rather large operation with 45 holes of resort golf turf. For the last 7 years, 12 - 20 million gallons of recycled waste water have supplied all their irrigation needs. The Lake Placid Resort Golf Course had the opportunity to be part of a New York State Energy Research Development grant associated with the Lake Champlain Basin program with the objective of helping to reduce the amount of phosphorus reaching the lake. The grant funded the testing of the river water and ground water as well as some startup costs at the treatment plant and the golf course.

The close supply of recycled water, within a mile of the golf course, aided a quick start up. The water was tested weekly and a close working relationship with treatment plant manager was established. Joe De Forest, assistant golf course superintendent, stated that access to this waste water allowed the golf course to irrigate the fairways which previously were not irrigated. He found that the turf was healthier and better able to handle periods of stress. The regular

fertilizer program could be reduced slightly and there was a dramatic increase in the turf quality which led to increased revenue from more play.

With the ability to irrigate areas not previously irrigated, such as the fairways and by keeping the turf growing during the summer period, there was a slight increase in disease, insect and weed pressure and expense to manage these changes. More labor was needed to handle the extra mowing and pest management which was an expected outcome when increasing the amount of irrigated land.

When irrigating with waste water, Deforest suggests:

1) Developing a good relationship with the treatment plant personnel so they can keep you informed of plant operations that might affect your water supply.

2) Having the water tested on a routine basis, monthly as a minimum and weekly if the water has a high salt content.

3) Keeping or developing an alternate water supply in case there is an interruption of water supply from the treatment plant.

The overall environmental impact to the community included a 25% reduction of phosphorus loading into the Lake Champlain Basin from the Village of Lake Placid Sewage Treatment Plant. On average the golf course used 20 million gallons of waste water per year and served as a bio-filter thus reducing the amount of waste water directly discharged into the Chubb River.

**Turning Stone Casino and Resort**

Turning Stone Casino and Resort had the unique opportunity to build their golf courses knowing that waste water would be the main source for irrigation. This is a very large complex with three 18-hole and two 9-hole golf courses. Four of the five courses use waste water exclusively for irrigation. The golf course managers anticipated certain benefits of using waste water including the ability to conserve a natural resource by using recycled waste water, have a constant reliable supply of water that contained some needed nutrients and have a relatively inexpensive source of water. However the managers had some concerns which focused on water quality issues for growing turf including: 1) the pH of the waste water, 2) whether there would be a slight odor, any pathogens or trace organics, and 3) the heavy metal and salinity content.

The Oneida County Waste Water Treatment Facility is a two stage aerobic processes in which the water passes through a series of filters and screens, then a chlorine contact, next through a tertiary filter, chlorinated and finally discharged. Water is tested four times a day for non-turf related water quality parameters before it leaves the plant.

Turning Stone has two of their 18-hole courses and one 9-hole par three course certified in the Audubon International Sanctuary Program. This certification program requires water quality analysis be made twice a year for total phosphorus, pH, total calcium carbonate (CaC03), total metals, total kjeldhal nitrogen as nitrogen, chloride, nitrate nitrogen, sulfate, alkalinity as CaC03 and total dissolved salts. The results indicated the water was suitable for irrigation with minor modification.

Daily 1.1 million gallons of waste water is pumped to the golf course regardless of demand and held in a holding pond. The unused water or extra water moves through an overflow system which drains into a stream that has many opportunities for the water to be filtered before it exits the golf course and finally reaches Oneida Lake.

The golf course director, Andy Knappenburger and the course manager Frank Albino have been quite pleased with the quality of the turf and playability. They advise regular water testing so informed management decisions can be made throughout the growing season.

**Indian Island Golf Course on Riverhead, Long Island**

In this situation, the Waste Water Treatment Plant in Riverhead discussed with the Suffolk County Parks Committee the possibility of using effluent water from the plant to irrigate the golf course which was right next to the plant. The goal was to conserve their fresh water supply and hopefully reduce the effluent discharged into the Peconic Estuary. The golf course agreed to consider using the waste water for irritation if the Health Department verified a lack of public safety concerns and if trial applications demonstrated the recycled water was suitable for growing turf.

The golf course built a practice green, tee and fairway as a test model to see how the use of this recycled water would affect the turf. They replicated the grasses and management regime used elsewhere on the golf course and began testing the soil and water. The results from the demonstration site showed no impact from using recycled waste water.

However, in order to meet the daily quality and quantity requirement of 350,000 gallons of high quality water for the golf course, the existing water treatment system at the plant would need to be upgraded. The original cost of the system upgrade was estimated in 2004 to be almost two million dollars. Current estimates now come close to three million dollars so the project is on hold until supplemental funding is procured to launch this project.

**When considering recycled water for irrigation, plan ahead and use the following steps:**

- Determine what town, county and state permits and approvals are necessary when considering using recycled waste water for irrigation.
- The ideal situation would be to have the recycled water source fairly close to the golf course. If this is not possible the costs to set up a deliver system can be extremely costly.

- Visit the water treatment plant, learn about their water treatment process, ask for an analysis of the water and begin to develop a relationship with the plant manager.
- Your course may need some additional equipment to be able to utilize the new water source efficiently. A booster pump and electricity may be needed for the additional pump capacity.
- Where will the extra recycled water be stored? Are there lakes or ponds on the golf course that could serve as holding areas? These ponds may have an odor problem.
- Be prepared to devote more time to management. More time will be necessary to monitor soil nutrient levels and water quality. With the increase in acreage irrigated there will be more mowing and possibly more pest pressure to deal with. Depending on water quality more time will be necessary to monitor drainage.
- If weeds and algae build up in the irrigation pond a herbicide treatment may be necessary to reduce aquatic weed growth. Be sure the herbicide treatment will not harm golf course grasses or have any restrictions for use as an irrigation source.
- Be sure your membership is aware that recycled water is being used.
- Take steps to be sure the irrigation water does not reach adjacent properties or potable water sources by runoff off or overspray into wetlands or water courses.
- Make sure it will not be used for drinking.

## Evaluating Recycled Waste Water for Growing Turf

**Begin with a water sample**

Be sure to use a certified water testing laboratory. Each water testing laboratory has specific guidelines for sampling water and submitting samples for testing so be sure to follow their instructions. Generally, the water should be sampled from the irrigation head after it has run for a few minutes so that stagnant water can be flushed from the line. Do not sample directly from the pond or well. Laboratories usually require about 12-16 oz for a sample. If the laboratory does not supply a sampling bottle, place the sample in a clean plastic bottle after it has been rinsed with the same water to be tested. Avoid using bottles containing carbonated beverages, sports drinks or food. Be sure to label the sample and keep notes regarding the location of where the sample was taken. See appendix for a list of a few labs that test waste water for irrigation.

**Which parameters should you test?**

When assessing irrigation water quality the following components should be evaluated: the salt content, which is expressed as electric conductivity (ECw) or total dissolved salts (TDS), the sodium (Na) hazard expressed as the sodium adsorption ratio (SARw), the levels of carbonate,

bicarbonate, residual sodium carbonate (RSC), calcium, magnesium, boron, chlorine, and pH. Table A lists the common units used to report water test results.

**Table B. Water Components and Units**

| **Quality Factor** | **Preferred Units** |
|---|---|
| **Water** – degree of acidity/alkalinity | Ph |
| **Total Salinity** – impact on plant growth from higher total salts | |
| Electrical conductivity (EC) | dS/m, mmhos/cm |
| Total dissolved salts (TDS) | mg $L^{-1}$ |
| **Carbonates and Bicarbonates** | mg $L^{-1}$, ppm, meq $L^{-1}$ |
| **Sodium Permeability Hazard – impact on soil structure** | |
| Sodium adsorption ratio (SAR) | meq $L^{-1}$ |
| Adjusted SAR (adj SAR) | meq $L^{-1}$ |
| Residual sodium carbonate (RSC) | meq $L^{-1}$ |
| **Ion Toxicity – impact on root and foliar contact** | |
| Na – sodium | meq $L^{-1}$, mg $L^{-1}$ |
| Cl – chloride | mg/L |
| B – boron | mg/L |
| **Nutrients** | mg $L^{-1}$, meq $L^{-1}$ |

*Note: 1 milligram per liter (mg $L^{-1}$) equals 1 part per million (ppm). Another unit is miliequivalent per liter (meq $L^{-1}$).*

Additional water quality factors impacting irrigation water include the presence of solid particles which can be organic (organic matter) or inorganic in nature (sand, silt, clay). These particles can clog irrigation heads and nozzles, cause wear and tear on equipment and plug soil pores causing a reduction in drainage. A filtering system should be added to the golf course irrigation system to prevent this. Weed seeds, algae and chemical materials can also be found in recycled water.

Water testing labs may use different units when reporting results. Table B provides conversion factors to convert mg $L^{-1}$ to meq $L^{-1}$. For a more comprehensive listing of conversion factors, see Table K at the end of this document.

**Table C. Conversion Factors**

| Component | To convert mg $L^{-1}$ to meq $L^{-1}$, multiply by | To convert meq $L^{-1}$ to mg $L^{-1}$, multiply by |
|---|---|---|
| Sodium ($Na^+$) | 0.043 | 23 |
| Calcium ($Ca^{++}$) | 0.050 | 20 |
| Magnesium ($Mg^{++}$) | 0.083 | 12 |
| Bicarbonate ($HCO_3^-$) | 0.016 | 61 |
| Carbonate ($CO_3^{--}$) | 0.033 | 30 |
| Chloride ($Cl^-$) | 0.029 | 35 |

For example, if your water test report states the calcium level was 1.6 meq $L^{-1}$ and you wanted to know the level in mg $L^{-1}$, take 1.6 x 20 = 32 mg $L^{-1}$of calcium.

**Soluble Salts**

Salts found in the soil originate from mineral weathering to form soil, from fertilizers or irrigation water. All irrigation water will contain some soluble salts and traces of other materials. Soluble salts include sodium chloride, calcium chloride or magnesium sulfate and at high concentrations can inhibit growth. Insoluble salts, which do not inhibit growth but can clog soil pores, include limestone, calcium carbonate and gypsum (magnesium sulfate).

Some salts are nutrients and are beneficial to turf but many can be toxic at high concentrations. Salt is the most common problem with recycled water.

Caution must be used if the waste water being used to establish turf or renovate turf is high in soluble salts and if rainfall is limited. Young plants are more sensitive to salt injury than well established mature plants.

High levels of salt in the soil inhibit water uptake by the roots causing reduced growth, discoloration, wilting, leaf curling and eventually desiccation or leaf firing. High salt levels

in the soil influence water infiltration into and percolation through the soil resulting in poor drainage.

The salt content of the waste water will depend on the water source. High levels of salt can accumulate if the irrigation water is high in salts, if there is limited rainfall and if capillary rise of water brings salts to the soil surface due to evapotranspiration. Soils with high levels of salt are called saline soils.

The salinity of the water is reported in several ways, as electric conductivity (ECw) and stated as milimhos per centimeter (mmhos $cm^{-1}$), micromhos per centimeter (umhos $cm^{-1}$), decisiemens per meter ($dSm^{-1}$) or siemens per meter ($Sm^{-1}$) or as total dissolved salts (TDS) in units of milligrams per liter (mg $L^{-1}$) or parts per million (ppm). Most sewage effluent contains 200-3000 mg $L^{-1}$ TDS or 0.30 – 4.7 $dSm^{-1}$. (Feigin et al.1991). Table C lists the total salinity hazard based on electric conductivity (ECw) and total dissolved salts (TDS).

**Table D. Total Salinity Hazard Classification Guidelines for Variable Quality Irrigation Water based on Electric Conductivity (ECw) and Total Dissolved Salts (TDS) (Adapted from Carrow and Duncan, 1998)**

| **Salinity Hazard Class** | **ECw ($dSm^{-1}$)** | **TDS (mg $L^{-1}$)** | **Management Requirements** |
|---|---|---|---|
| Low | <0.75 | <500 | no detrimental effects expected |
| Medium | 0.75 – 1.50 | 500 - 1,000 | moderate leaching* to prevent salt accumulation |
| High | 1.5 – 3.00 | 1,000 – 2,000 | turf species/cultivar selection, good irrigation, leaching*, drainage |
| Very High | >3.00 | >2,000 | most salt-tolerant cultivars, excellent drainage, frequent leaching*, intensive management |

** It has not been determined that leaching is required in higher rainfall areas like the Northeastern US.*

**Turfgrasses tolerance to salt**

Turfgrasses differ in the tolerance to salt (see Table D). Cultivars within a species can also vary in their salt tolerance. Acceptable levels for turf irrigation water ranges from 200-800 mg $L^{-1}$. Soluble salt levels greater than 2000 mg $L^{-1}$ may injure turf.

**Table E. Turfgrasses Tolerance to Total Salinity (Adapted from Harivandi and Beard, 1998)**

| Sensitive | Moderately Tolerant | Tolerant | Very Tolerant |
|---|---|---|---|
| **0-3 $dSm^{-1}$** | **3.1-6 $dSm^{-1}$** | **6.1-10 $dSm^{-1}$** | **>10 $dSm^{-1}$** |
| Annual bluegrass | Annual ryegrass | Perennial ryegrass | Bermudagrass |
| Colonial bentgrass | Creeping bentgrass | Tall fescue | Seashore Paspalum |
| Kentucky bluegrass | Fine-leaf fescues | | |
| Rough bluegrass | | | |
| Most zoysia spp. | | | |

In the Northeast, the annual rainfall ranges between 30" and 60". We do not expect the accumulation of high levels of salt with this amount of rainfall. However, under serious periods of drought and when the irrigation water has high soluble salts, management strategies may be employed to reduce the salt concentration.

In situations where the salt concentration is medium (500-1000 mg $L^{-1}$), leaching with fresh water may be necessary to prevent salt accumulation. The volume of water applied should be increased by 12.5% for each 640 mg $L^{-1}$ rise in TDS in the irrigation water. Additional management strategies must be used when trying to manage sites with very high concentrations of salt, >2000 mg $L^{-1}$. Along with frequent leaching with good quality water, salt tolerant species should be used, and a routine aeration program should be established, comprised of frequent shallow core aeration and deep tine cultivation (8-12" once or twice a year) to help maintain excellent drainage (Duncan, Carrow and Huck 2000). Leaching could lead to ground water quality problems, so do it as little as possible!

**Sodium Permeability Hazard**

The sodium (Na) concentration and the quantity of other salts in the irrigation water can affect soil permeability, which is the ability of water to infiltrate into the soil and move through the profile. When irrigation water has sodium levels > 200 mg $L^{-1}$ sodium (Na) may build up over time and will affect permeability. Calcium which is important to soil structure stability is displaced by sodium which causes the soil structure to break down resulting in reduced water and oxygen infiltration and percolation. This problem can become a more serious problem on fine-texture clayey soils, than sand-based systems. (See Table E).

To assess the potential of the problem you need to know the following:

1) **sodium adsorption ratio** (SARw) which incorporates the influence of sodium, calcium and magnesium concentrations. SAR values >6 meq $L^{-1}$ contain sodium (Na) high enough to cause structural deterioration of some soils.

2) **bicarbonate and carbonate levels.** The bicarbonate ion can combine with calcium and or magnesium and precipitate out as calcium carbonate and magnesium carbonate. This increases the Sodium Adsorption Ratio because it lowers the amount of dissolved calcium concentration.

Also, high levels of bicarbonate in the water can raise the pH to undesirable level.

3) **type of clay in the soil**. Expanding clays like montmorillonite and illite are more susceptible to structural breakdown than other clays that do not crack when drying.

**Table F. Sodium Permeability Hazard (Adapted from Harivandi and Beard, 1998: Carrow and Duncan, 1998)**

| Irrigation Water Components | Degree of Problem | | |
|---|---|---|---|
| **SARw or adj SARw** | | | |
| (sodium adsorption ratio by clay type (mg $L^{-1}$) | | | |
| | **Low** | **Moderate** | **High** |
| Clay type unknown | <10 | 10 – 18 | >18 |
| Clays that shrink and swell* | <6*-8** | 6*-16** | >9*->16** |
| Clays do not crack on drying *** or swell on wetting | <16 | 16 – 24 | >24 |
| Sands with ECw >1.5 $dSm^{-1}$ | <10 | 10 – 18 | >18 |
| Sands with ECw <1.5 $dSm^{-1}$ | <6 | 6 -9 | >9 |
| **RSC** (residual sodium carbonate) | <1.25 | 1.25 – 2.50 | >2.50 |

* *Montmorillonite clays (2:1); ** Illite clays (2:1); *** Kaolinite (1:1). Other 1:1 types are Fe/Al oxides and allophones.*

Another fact to keep in mind is that sodium (Na) is absorbed by plant roots and transported to the leaves, where it can accumulate and can cause plant injury.

The Residual Sodium Carbonate (RSC) is also used to assess the sodium permeability hazard and includes the influence of bicarbonates and carbonates as compared to the calcium and magnesium concentration. To determine the residual sodium carbonate (RSC) the levels of bicarbonate and carbonate are added and the combined calcium and magnesium levels are subtracted and reported as meq $L^{-1}$. RSC = (CO3 + HCO3) – (Ca + Mg), in meq $L^{-}$. If the RSC is >1.25 meq $L^{-1}$ and the SARw is >6 meq $L^{-1}$, water acidification may be necessary.

The total salt content of the water (ECw) and the sodium adsorption ratio (SARw) must be considered together when determining the sodium permeability hazard. The high soluble salt concentration inhibits or counteracts the dispersing influence sodium. The electric conductivity and the sodium adsorption ratio of the waste water can be used to assess the potential for irrigation problems (Table F).

**Table G. Assessing Soil Permeability* and Potential Irrigation Problem using Electric Conductivity (ECw) and Sodium Adsorption Ratio (SAR) together (Adapted from Harivandi 1998)**

| | Degree of Restriction on Use | | | |
|---|---|---|---|---|
| | | Slight to | | |
| **Soil water infiltration** | **None** | **Moderate** | | **Severe** |
| if SARw = 0-3 & ECw= | >.7 | 0.7 – 0.2 | <0.2 | |
| if SARw = 3–6 & ECw = | >1.2 | 1.2 – 0.3 | <0.3 | |
| if SARw = 6-12 & ECw = | >1.9 | 1.9 – 0.5 | <0.5 | |
| if SARw =12-20 & ECw = | >2.9 | 2.9 – 1.3 | <1.3 | |
| if SARw =20-40 & ECw = | >5.0 | 5 – 2.9 | | <2.9 |

** Soil permeability is the ability of water to infiltrate into the soil and percolate/drain. Gas exchange is also reduced by low soil permeability.*

## Ion Toxicities

Ions that can cause some toxicity problems include sodium ($Na^{+}$), chloride ($Cl^{-}$), boron ($B^{+}$), bicarbonate ($HCO_3^{-}$), and pH ($H^{+}$ or $OH^{-}$). (See Table G). Germinating seeds and young seedlings are especially sensitive to high levels of these ions. Use Table G to assess the risk factor in terms of toxicity to roots or leaves.

**Table H. Specific Toxic Ion Reference Points (Adapted from Harivandi and Beard, 1998: Carrow and Duncan, 1998)**

| Specific Toxic Ions | | Risk | | |
|---|---|---|---|---|
| | | Low | Moderate | High |
| **Sodium Content** | | | | |
| toxicity to roots | SARw | <3 | 3 -9 | >9 |
| | mg $L^{-1}$ | <70 | 70 – 210 | >210 |
| toxicity to leaves | meq $L^{-1}$ | <3 | >3 | |
| | mg $L^{-1}$ | <70 | >70 | |
| **Chloride Content** | | | | |
| toxicity to roots | meq $L^{-1}$ | <2 | 2 – 10 | >10 |
| | mg $L^{-1}$ | <70 | 70 – 355 | >355 |
| toxicity to leaves | meq $L^{-1}$ | <3 | >3 | |
| | mg $L^{-1}$ | <100 | >100 | |
| **Residual Chlorine ($Cl_2$)** | mg $L^{-1}$ | <1 | 1 – 5 | >5 |
| **Boron** | | | | |
| toxicity on roots | mg $L^{-1}$ | <0.7 | 0.7 – 3.0 | >3 |
| **Bicarbonate** | meq $L^{-1}$ | <1.5 | 1.5 – 8.5 | >8.5 |
| | mg $L^{-1}$ | <90 | 90 – 500 | >500 |

## Nutrient Levels

Recycled water contains a number of different nutrients that can have an impact on the golf course fertility program and can have an environmental effect. Routine testing is necessary so in season adjustments can be made to reduce supplemental fertilization when sufficient nutrients are supplied by the recycled waste water. Table H offers some general guidelines for interpreting the nutrient content of the recycled waste water.

**Table I. Nutrient Guidelines in Irrigation Water (mg L-1) (Adapted from Duncan, Carrow and Huck, 2000)**

| Nutrient | Low | Normal | High | Very High |
|---|---|---|---|---|
| | mg $L^{-1}$ | | | |
| P | <0.01 | 0.1 – 0.4 | 0.4 – 0.8 | >0.8 |
| $PO_4^-$ | <0.3 | 0.3 – 1.21 | 1.21 – 2.42 | >2.42 |
| $P_2O_5$ | <0.23 | 0.23 – 0.92 | 0.92 – 1.83 | >1.83 |
| K | <5 | 5 – 20 | 20 – 30 | >30 |
| $K_2O$ | <6 | 6 – 24 | 24 – 36 | >36 |
| Ca | <20 | 20 – 60 | 60 – 80 | >80 |
| Mg | <10 | 10 -25 | 25 -35 | >35 |
| N | <1.1 | 1.1 – 11.3 | 11.3 – 22.6 | >22.6 |
| $NO_3^-$ | <5 | 5 – 50 | 50 – 100 | >100 |
| S | <10 | 10 – 30 | 30 – 60 | >60 |
| $SO_4^-$ | <30 | 30 – 90 | 90 -180 | >180 |

By calculating the ratios of specific nutrients you may be able to detect a possible nutrient deficiency. Concerns should be verified by a plant tissue analysis before making major fertilizer program changes.

**Table J. Nutrient Ratios in Irrigation Water and Potential Deficiencies* (Adapted from Duncan, Carrow and Huck. 2000)**

| | | |
|---|---|---|
| Ca: Mg | <3:1 | Ca deficiency |
| | >8.1 | Mg deficiency |
| Ca:K | <10.1 | Ca deficiency |
| | >30:1 | K deficiency |
| Mg:K | <2:1 | Mg deficiency |

| | |
|---|---|
| >10.1 | K deficiency |

** Irrigation water with nutrient concentrations outside these ranges can be used; the fertility program may be adjusted to avoid deficiencies*

## Example Waste Water Report

The reference tables provided can be used to assess the suitability of the waste water for turf irrigation. The following is a sample water test report.

**CAYUGA LABORATORIES**

Green Valley Golf Club — File Number: 736548

Pleasantville, NJ — Date Received:

Sample

Sample Location:

Sample Description:

| | | |
|---|---|---|
| pH | 8.43 | |
| Hardness | 304.36 | mg $L^{-1}$ |
| Hardness | 17.80 | grains/gal |
| Conductivity | 1.61 | $dSm^{-1}$ |
| Sodium Adsorption Ratio | 5.23 | |
| Adjusted SAR | 9.62 | |
| pHc | 7.56 | |
| Residual Sodium Carbonate | -2.10 | |

| | | mg $L^{-1}$ | meq/L | lbs/ac in |
|---|---|---|---|---|
| Calcium | (Ca) | 57.95 | 2.89 | 13.14 |
| Magnesium | (Mg) | 38.66 | 3.18 | 8.77 |

| | | | | |
|---|---|---|---|---|
| Potassium | (K) | 16.05 | 0.41 | 3.64 |
| Sodium | Na) | 209.66 | 9.12 | 47.55 |
| Iron | (Fe) | < 0.30 | | |
| | | | | |
| Total Alkalinity | $CaCO_3$) | 198.36 | | 44.99 |
| Carbonate | ($CO_3$) | 21.90 | 0.73 | 4.97 |
| Bicarbonate | ($HCO_3$) | 197.53 | 3.24 | 44.80 |
| Hydroxide | (OH) | 0.00 | | |
| Chloride | (Cl) | 319.99 | 9.02 | 72.57 |
| Sulfur as | ($SO_4$) | 76.52 | 1.59 | 17.36 |
| | | | | |
| Salt Concentration | (TDS) | 1033.60 | | 234.42 |
| Boron | (B) | 0.18 | | 0.04 |

Use the following steps to determine the suitability of the water represented in the above water sample report (Modified from Carrow).

1. Check **Electric Conductivity (ECw)** and **total dissolved salts (TDS)** for their impact on turfgrass.

   **Check the values listed in the sample report for conductivity 1.61 mmhos/cm* and the TDS level of 1033.60 mg $L^{-1}$ with Table C. Both values are considered high.**

   *** 1 mmhos $cm^{-1}$ = 1dS$m^{-1}$**

   High total salinity values in conjunction with low sodium $Na^+$ and bicarbonate $HCO_3^-$ levels would indicate the potential to create a saline soil condition. Do not use this water if possible or other management practices may be needed such as aeration and leaching.

2. Check sodium (Na) level.

   **Use Table G to evaluate the sodium (Na) level which is 209.66** mg $L^{-1}$**. Although this is a moderate level, Na levels >200** mg $L^{-1}$ **can build up over time.**

3. It may be worthwhile to note the Sodium Adsorption Ratio (SARw) at this time especially if the soils are more fine-textured. These soils are more susceptible to structure deterioration when the salt concentration is high.

   **According to Table G. the SARw level of 5.23 meq $L^{-1}$ is under the level of concern for plant roots.**

4. The permeability hazard can be determined by evaluating the electric conductivity (ECw) in conjunction with the sodium adsorption ratio (SAR) levels. Knowledge of the clay type will be useful. These values will determine the level of aerification, amendments and leaching that may be needed.

   **Use Table F to see that with ECw at 1.61 (mmhos/cm which = $dSm^{-1}$ ) and a SARw of 5.23 there would be no restriction in permeability with this water.**

5. Now check for bicarbonates and carbonates in the water. If concentrations are greater than 120 mg $L^{-1}$ and 15 mg $L^{-1}$, respectively, you will have to take an additional step.

   **The report states the bicarbonate and carbonate levels at 197.53 + 21.90 = 219.43** mg $L^{-1}$ **Both levels are higher than the cautionary levels.**

6. Check the Adjusted Sodium Adsorption Ration (adj SAR) and the Residual Sodium Content (RSC) to verify the degree of impact that these ions will have on Ca and Mg activity. A SARw level >6 meq $L^{-1}$ and a RSC level >1.25 mg L-1 may indicate that acid treatment plus lime or gypsum applications are needed.

   **The SARw level of 5.23 meq $L^{-1}$ and the RSC level of -2.10 are under the level for concern as shown in Table D.**

7. Use Table H to check sulfur (S) and or sulfate ($SO^4$) levels in the water. If S >60 mg $L^{-1}$ or SO4 > 180 mg $L^{-1}$, you may need to use lime as an amendment. The high sulfates (sulfur) in the water will combine with lime to form gypsum. Removing the excess sulfur and sulfates will help minimize anaerobic problems and black layer formation when regular aeration and leaching are used in management protocols.

   **Sulfur reported as sulfate is 76.52** mg $L^{-1}$**. Table H indicates this level is in the normal range and below the level of concern which is 180** mg $L^{-1}$**.**

8. Check actual Chloride (Cl) and Boron (B) levels for their specific ion toxicity potential. These ions normally will affect susceptible turf cultivars but continued accumulation can eventually

influence even tolerant species. Plants tolerant to high total salinity also are generally tolerant to high levels of these specific ions.

**The value for Cl it is 319.99 mg $L^{-1}$ and for B it is 0.18 mg $L^{-1}$. Both levels are considered moderate according to Table G.**

9. Check levels of actual nutrients and make appropriate adjustments in your fertility program to account for nutrient additions or any induced deficiencies. Check the report levels for the following nutrients and compare with Table H. Calcium at 57.95 ppm is in the normal range, magnesium at 38.66 ppm is considered very high and potassium 16.05 ppm is in the normal range.

10. Calculate Ca:Mg, Ca:K and Mg:K ratios and adjust the fertility program accordingly.

**The ratio of Ca: Mg is 1.5:1, for Ca:K it is 3.5:1 and for Mg:K 2.4:1. According to Table I, these ratios indicate there could be calcium and magnesium deficiencies. At this point, you could look for symptoms of calcium and magnesium deficiencies and have a tissue test done to confirm this possibility.**

In summary, this water poses some concerns if used because of its high electric conductivity, moderate sodium level and high bicarbonates and possible calcium and magnesium deficiencies.

## How much nutrients are supplied by waste water irrigation?

Another useful management step is to determine the amount of nutrients supplied with the irrigation water so that the total amount of supplemental fertilization can be reduced accordingly. Table J lists the amount of nutrients supplied per inch of irrigation water per 1000 sq. ft.

**Table K. Nutrients Supplied by Waste Water Irrigation per 1000 sq ft per Inch of Irrigation at a concentration of 1 mg L-1**

| **Nutrient or Element** | **Concentration** mg $L^{-1}$ | **Lb of nutrients/ 1000 sq ft/ Inch of irrigation** |
|---|---|---|
| N | 1 | .005 |
| $NO_3^-$ | 1 | .001 |
| P | 1 | .012 |
| $PO_4^-$ | 1 | .004 |
| $P_2O_5$ | 1 | .005 |
| K | 1 | .006 |

| | | |
|---|---|---|
| $K_2O$ | 1 | .005 |
| $Ca^{++}$ | 1 | .005 |
| $Mg^{++}$ | 1 | .005 |
| S | 1 | .005 |
| $SO_4^{-2}$ | 1 | .002 |

The below sample water test results will be used to demonstrate how to calculate the nutrients provided given the analysis of this particular irrigation water.

**Sample**

**Waste Water Results from Sun Mountain Golf Course**

| **Parameter** | | |
|---|---|---|
| Ammonium | $NH_4$ | 12.07 mg $L^{-1}$ |
| Nitrate Nitrogen | $NO_3$ | 3.17 mg $L^{-1}$ |
| Phosphorus | P | .32 mg $L^{-1}$ |
| Potassium | K | 8.62 mg $L^{-1}$ |
| Calcium | Ca | 85.69 mg $L^{-1}$ |
| Magnesium | Mg | 15.17 mg $L^{-1}$ |
| Sulfur | S | .33 mg $L^{-1}$ |
| Sodium* | Na | 21.36 mg $L^{-1}$ |
| Chloride* | Cl | 230.85 mg/kg |
| Electric Conductivity * | EC | .82 dS/m |

During the 2005 growing season, Sun Mountain Golf Course irrigated with 20" of the above waste water. The manager wanted to determine if an adjustment in their fertilizer program would be necessary after applying 20" of this particular water.

To calculate the amount of nutrients supplied by waste water irrigation follow the steps below.

1. **Add the ammonium (**$NH_4$**) and nitrate nitrogen (**$NO_3$**) amount to come up with total nitrogen.**

   12.07 + 3.17 = 15.24 mg $L^{-1}$ total nitrogen.

   From Table J note that each mg $L^{-1}$ of nitrogen contributes .005 lb of nutrients with each inch of irrigation. Multiply 15.24 by .005 which = .077 mg $L^{-1}$ of nitrogen per inch of water. Multiply this by 20 (the amount of total irrigation) to come up with **1.5 lb of nitrogen** which was supplied per 1000 sq ft last year with the waste water irrigation.

2. **Phosphorus (P) fertilizer recommendations are reported in the oxide form $P_2O_5$.**

   To calculate the $P_2O_5$ when you have the P value multiply the P value by 2.29.

   Take the P value of 0.32 multiple it by 2.29 to come up with 0.73 mg $L^{-1}$ of $P_2O_5$. Then multiply this by .005 (the pounds of nutrients supplied with each inch of irrigation) which totals .004 mg $L^{-1}$ and then multiply by 20 (the total inches of irrigation) to see that **0.07lb of $P_2O_5$** was supplied per 1000 sq ft last year with the waste water irrigation.

3. **Potassium (K) fertilizer is reported as K20 so you will have to make this calculation first.**

   To calculate the $K_20$ when you have the K value multiply K by 1.2.

   8.62 mg $L^{-1}$ of potassium multiplied by 1.2 equals 10.3 mg $L^{-1}$ of $K_20$. Multiply this by .005 (the pounds of nutrients supplied with each inch of irrigation) to get .05 mg $L^{-1}$ then multiply this by 20 (the total inches of irrigation) to see that **1.0 lb of $K_20$** was supplied per 1000 sq ft last year with the waste water irrigation.

* Other reported parameters:

According to Table G, the sodium level of 21.36 mg $L^{-1}$ is very low and is not of concern, but the chloride level of 230.85 mg/kg is in the moderate risk category. Table C indicates salinity as reported as electric conductivity is in the medium range.

With 20" of irrigation water applied in 2005 the turf was receiving a total of 1.5 lb of nitrogen, 0.07 lb of $P_2O_5$ and 1.0 lb of $K_20$. The golf turf manager should take this nutrient contribution into consideration and adjust the fertilization program accordingly.

## Summary

This initial survey of the potential for using waste water to irrigate golf course shows great promise. Managers found that the benefits of using the recycled waste water out weighed the costs. Especially when the waste water source was close to the golf courses, waste water offered less expensive water for irrigation.

It was acknowledged that extra management would be necessary to monitor the water and soil nutrient content through routine testing so timely adjustments could be made throughout the growing season. Managers found that having access to waste water would increase the areas irrigated and offered more play. Extra mowing and pest management may be necessary.

The community would reap environmental benefits by having more water from the treatment plants diverted to the golf course where the soil would serve as a bio-filter and reduce the amount of phosphorus and nitrogen reaching streams and lakes.

These guidelines provide the necessary information on what testing should be done on waste water and how to interpret the results to use waste water safely.

Golf course managers and community members are encouraged to learn all they can about their local water sources. The references listed at the end of this publication contain in-depth information which should be thoroughly reviewed by all interested parties.

## References

1. Carrow, R.N. and R.R. Duncan. 1998. Salt affected turfgrass sites: Assessment and Management. Ann Arbor Press, Chelsea, MI. 185p.

2. Duncan, R.R. and R.N. Carrow and M. Huck. Understanding Water Quality and Guidelines to Management. USGA Green Section Record. Sep/Oct 2000.

3. Feigin, A.L. and J. Shalhevet.1991. Irrigation with treated sewage effluent. Management for environmental protection. Springer-Verlag. Berlin

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5. Harivandi, M.A. Evaluating Recycled Waters for Golf Course Irrigation. USGA Green Section Record. November/December 2004.

6. Harivandi, M.A., and J. B. Beard. 1998. How to Interpret a Water Test Report. Golf Course Mgmt. 66(6):49-55

7. Huck, M., R.N. Carrow and R.R. Duncan. Effluent Water: Nightmare or Dream Come True? USGA Green Section Record. March/April 2000.

8. Stowell, L. 1999. Pointers on reclaimed water contract negotiations – Pace Pointers (June). Web page (www.pace.ptricom)

**Examples of Water Testing Labs that do complete waste water analysis:**

Brookside Farms Laboratories, Inc., 308 South Main St., New Knoxville, OH 45871
419-753-2448. www.blinc.com

CLC Labs, 325 Venture Dr., Westerville, OH 43081. 614-888-1663

A & L Great Lakes Lab, Inc. , 3505 Conestoga Drive 209, Fort Wayne, IN 46808
260-483-4759. www.algreatlakes.com

MDS Harris -Agronomic Services, 624 Peach St., Lincoln, NE 68502
402-476-2811. http://ag.mdsharris.com

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Will Maxwell, superintendent, Indian Point Golf Course.

**Table L. Conversion factors**

| | **To convert mg $L^{-1}$ to meq/L, multiply by:** | **To convert meq/L to mg $L^{-1}$, multiply by** |
|---|---|---|
| Sodium $Na^+$ | 0.043 | 23.0 |
| Calcium $Ca^{++}$ | 0.050 | 20.0 |
| Magnesium $Mg^{++}$ | 0.083 | 12.2 |
| Chloride Cl | 0.029 | 35.4 |
| Potassium $K^+$ | 0.026 | 39.0 |
| Sulfate $SO_4^{--}$ | 0.021 | 48.0 |
| Carbonate $HCO_3$ | 0.016 | 61.0 |

**Note: 1 mg $L^{-1}$ = 1 ppm**

For example, to convert 220 mg $L^{-1}$ $Na^+$ to meq $L^{-1}$: (220 mg $L^{-1}$) x (0.043) = 9.46 meq $L^{-1}$ $Na^+$

| | **Convert ECw** | **Multiply by:** |
|---|---|---|
| **Electrical Conductivity of Water** | $mSm^{-1}$ to $dSm^{-1}$ | 0.01 |
| | $dSm^{-1}$ to $mSm^{-1}$ | 100 |

| | |
|---|---|
| $mScm^{-1}$ to $mSm^{-1}$ | 100 |
| $mSm^{-1}$ to ppm | 6.4 |
| $dSm^{-1}$ to ppm | 640 |
| $mScm^{-1}$ to ppm | 640 |
| ppm to $dSm^{-1}$ | 0.0016 |

**Other Conversion Factors:**

1 mmhos $cm^{-1}$ = 1 $dSm^{-1}$ = 1,000 umhos $cm^{-1}$ = 0.1 $Sm^{-1}$

1 umhos $cm^{-1}$ =0.001 $dSm^{-1}$ = 0.001 mmhos $cm^{-1}$

1 ppm = 1 mg $L^{-1}$ (solution) = 1 mg $kg^{-1}$ (soil)

1% concentration = 10,000 ppm

1 $mmolc^{-1}$ = 1meq $L^{-1}$

1 ECw ($dSm^{-1}$) = 640 ppm (TDS = Total Dissolved Salts)

TDS (ppm) = ECw x 640; TDS (lb./ac.ft.) ≈ TDS (ppm x 2.72)

ppm = grains per gallon x 17.2

(grains/gallon is still used by domestic effluent water purveyors to report hardness)

Sum of cations and anions (meq $L^{-1}$) ≈ EC ($dSm^{-1}$) x 10

# Appendix F: Conversion Factors And Example For Calculating Pounds Nutrient Per Acre-Foot Of Irrigation Water

(Duncan, R. R., Carrow, R. N., & Huck, M. T. (2009). *Turfgrass and landscape irrigation water quality: Assessment and management*. Boca Raton: CRC Press.)

11.3 ppm N = 0.71 Ib. N per 1,000 sq. ft.
50 ppm $N0_3^-$ = 0.71 Ib. N per 1,000 sq. ft.
0.4 ppm P = 0.057 lb. $P_20_5$ per 1,000 sq. ft.
1.21 ppm $P0_4^-$ = 0.057 lb. $P_20_5$ per 1,000 sq. ft.
0.92 ppm $P_20_5$ = 0.057 lb. $P_20_5$ per 1,000 sq. ft.
20 ppm K = 1.5 lb. $K_2O$ per 1,000 sq. ft.
24 ppm $K_2O$ = 1.5 lb. $K_2O$ per 1,000 sq. ft.
60 ppm Ca = 3.75 lb. Ca per 1,000 sq. ft
25 ppm Mg = 1.56 lb. Mg per 1,000 sq. ft.
30 ppm S = 1.87 lb. S per 1,000 sq. ft.
90 ppm $S0_4^-$ = 1.87 lb. S per 1,000 sq. ft.

1 acre = 43,560 sq. ft.

**Example: Irrigation water has 15 mg/L $N0_3^-$**

| | |
|---|---|
| 15 mg/L | = (15)(0.226 mg/L N) |
| | = 3.39 mg/L as N |
| lb N per acre-foot of water | = (mg/L of N)(2.72) |
| | =(3.39 mg/L of N)(2.72) |
| | =9.22 lb N per acre-foot water |

Or, 9.22/43.56 = 0.21 lb N per 1000 sq. ft. per 12 in. irrigation water

## Appendix G: WIN PST Example

WIN PST can be used for golf course conditions such as a sand green. In this example, the soil is sand at a typical greens depth of 12 inches and the average organic content for the 12 inch profile is 1%, by weight. The pesticides were applied to the turf foliage under two rainfall conditions: low potential for rainfall and a high potential for rainfall. Appendix G contains the WIN PST risk screening for pesticide leaching for most pesticides registered in NYS for use on golf courses. Under the low rainfall potential scenario, most of the pesticides evaluated had a low or very low risk (four had a high/extra high) to humans (long term exposure as a drinking water source) and only one pesticide has a high or extra high risk to fish, even when applied to this very high leaching-groundwater contamination soil like sand. When applied under a high potential rainfall scenario, however, 15 pesticides had a high/extra high risk to humans, and 20 had high/extra high risk to fish.

Based on these result, one of the BMPs for this example is to only apply pesticides when the potential for rainfall is low. On sites where greens drainage is discharged near streams or near drinking water wells, extreme care needs to be taken if a pesticide application is needed during a period with a high potential for rain. Appendix G can be used to select pesticides that have a low risk even under these conditions.

# Appendix H: Preventing Drift

Drift can potentially cause not only water quality impacts, but also damage to susceptible off-target crops, and a lower than intended rate to the turfgrass, thus reducing the effectiveness of the pesticide. There are two types of drift, airborne (spray) drift and vapor drift.

## Spray Drift

Spray Drift is influenced by many inter-related factors including droplet size, nozzle type and size, sprayer design, weather conditions and the operator.

### Droplet Size

Lower spray volumes can result in smaller droplets that enhance leaf coverage although there is a limit to droplet size due to drift. Droplets under 150 microns generally pose the greatest hazard; droplets less than 50 microns have insufficient momentum for impaction as they remain suspended in the air indefinitely or until they evaporate. Research in England concluded that a 100 micron droplet takes 11 seconds approximately to fall ten feet in still air; when a similar size droplet is released into a 5mph wind drifts about 75 feet before hitting the ground. The higher the operating pressure, the smaller the droplet. Conversely, low pressure produces large droplets that may bounce off the target. Certain spray surfactants can change the droplet spectrum, reducing the number of driftable droplets.

### Nozzle Type and Size

Correct nozzle selection is one of the most important, yet inexpensive, aspects of pesticide application. A nozzle's droplet size spectrum determines deposition and drift. Conventional flat fan nozzles fitted to a turfgrass sprayer produces droplets in the range of 10 – 450 microns. (Note: 25,000 microns = 1 inch.) Drift is a concern with droplets less than 100 microns. Increasing the Volume Median Diameter (VMD) reduces drift, but droplets that are too bounce off the leaves to the ground.

### Sprayer Design

Shields are better at targeting the spray into the grass, reducing drift and increasing deposition. They vary from the simple to the complex. Shielded sprayers allow managers to apply pesticides in variable weather conditions.

### Weather Conditions

Wind speed and direction, relative humidity, temperature and atmospheric stability affects drift. Applying the correct product to the correct target at the correct time with the correct equipment is the key to good spraying.

### Operator

Correct sprayer calibration ensures that all the nozzles are discharging the correct amount of liquid at the correct distance and angle to the target and at the correct forward speed.

## Vapor Drift

The amount of vapor drift depends upon a pesticide's volatility and atmospheric conditions such as humidity, temperature. Turfgrass pesticides with known volatility should be avoided. In some cases, the pesticide label may indicate low volatility. However, low volatility does not mean that a chemical will not volatilize under conducive conditions, such as high temperatures or low relative humidity.

## Best Practices for Spraying

Before spraying:

1. Train the operator to use the sprayer correctly.
2. Plan the spraying operation; consider the use of spray instruction cards as a good management tool.
3. Read and follow the pesticide label.
4. Select the correct nozzle for the target. Adjust the size and position of the nozzles to achieve correct distribution within the grass canopy,
5. Consider the use of sprayer nozzles which direct the spray to the target.
6. Consider spray additives to reduce drift.
7. Improve spraying logistics to ensure adequate time to spray within 'ideal' conditions.
8. Only spray when weather conditions are ideal; avoid spraying on days when conditions are favorable for atmospheric inversion or wind drift.
9. Calibrate the sprayer with water to ensure that everything is working correctly.

During spraying:

1. Stay alert: ensure the spray is not allowed to drift on to non-target areas and watch for changes in wind speed and direction.
2. Keep spray pressure as low as possible and ensure an accurate gauge is used.
3. Maintain a constant speed and pressure. If an automatic regulator is fitted, remember, small increases in speed result in large increases in pressure.
4. Avoid spraying near sensitive crops or watercourses; use a buffer zone.

## Appendix I: Spill kits

Spill kits should contain:

- Gloves (nitrile, at least; foil barrier laminate better)
- Tyvek® coverall
- Goggles
- Temporary storage container for spill
- Sorbent pads and/or socks
- Loose absorbent (SlikWik®, vermiculite)
- Sweeping compound
- Warning sign or caution tape
- Chalk (for marking spill area on floor)
- Dust pan or small shovel (plastic preferable)
- Small broom
- Permanent marker (for marking spill container after clean-up)
- Recommended materials and suppliers are provided by Cornell's Occupation & Environmental Health Department at http://oeh.cals.cornell.edu/Spill_Kit_Contents.html

Forms of Sorbents

- Booms: cylindrical shape; vary in length and width; used to control and contain spills
- Socks or mini booms: cylindrical shape; vary in length and width; used in facility spill response or maintenance; contain spills or leaks (placed around equipment)
- Pillows: rectangular in shape; used for medium size spills; can be used for leaks and drips
- Pad and rolls: flat sorbent sheets of various lengths can be used to line shelves, catch leaks under machinery and clean up spills
- Loose sorbents: sorbent media that is not contained in any type of pillow or mesh; typically used on small spills

Sorbent Categories

- Universal sorbents: designed to absorb any liquid; they will absorb aggressive liquids such as acids and bases as well as non-aggressive liquids and solvents, such as cleaners, water-based fluids, gasoline and alcohol; made of polypropylene or expanded silicate materials.
- Petroleum sorbents ("oil-only sorbents"): designed for absorption of oil and/or petroleum-based liquids; these sorbents are hydrophobic (will not absorb water or water-based liquids); can be used in maintenance applications for hydraulic and engine oil cleanup; made of polypropylene or treated cellulose.
- Maintenance sorbents: absorb non-aggressive liquids commonly found in manufacturing and maintenance operations (coolants, lubricants, oils, cut-ting fluids);

will pick up water-based as well as oil-based fluids; made of recycled materials, such as cotton, wool, cellulose or corn cob; can also be made of polypropylene or any combination of the materials listed.

Sorbent capacity: the amount of weight the sorbent will absorb in relation to itself (e.g., absorbs 12 times its weight) or the liquid capacity of the sorbent (e.g., absorbs 8 gallons). Because all liquids don't weigh the same per gallon, the weight capacity of the sorbent actually varies from liquid to liquid. A more accurate way to assess the sorbent capacity is by its liquid capacity.

# Appendix 2
# Fine Fescue & Colonial Bent Grass Research

# Fine fescues and colonial bentgrasses for fairways

With proper fertility treatments, some fine fescues show promise for fairway use.

Environmental Institute for Golf

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Regardless of the agronomic practices being implemented to reduce inputs, superintendents today are faced with an interesting paradox: Golfers want perfection, but environmental and budget constraints limit perfection. With this in mind that researchers are attempting to identify management strategies for low-input turfgrass systems without sacrificing overall quality.

Fine fescues (*Festuca* species) and colonial bentgrasses (*Agrostis tenuis* Sibth.) have been used for years on fairways and roughs in the United Kingdom, but these grasses have not been as popular in the United States. Recently, however, fine fescues have been used as unmowed rough and, in a few cases, on fairways in the U.S. (1,10) as improvements in fine fescue and colonial bentgrass cultivars during the last decade have provided better turf quality.

Fine fescues have significantly lower water and fertility requirements than most other turfgrasses (3,7). Both fine fescues and colonial bentgrass are superior to creeping bentgrass (*A. palustris*) in terms of resistance to snow molds and tolerance to dollar spot (5,6,9), and colonial bentgrass at fairway height has greater wear tolerance than creeping bentgrass (2). Chewings fescue (*F. rubra* subspecies *communtata* Gaud.) and hard fescue (*F. trachyphylla*) are also more wear-tolerant than other fine fescues (2,11).

Research data for cultivar selection for fine fescues and/or colonial bentgrass for fairways are limited to monostands of each species. Other data have shown that the positive attributes of single cultivars are not necessarily expressed when blended or mixed (4).

Information on the ideal type of fertilizer is also lacking. Superintendents from the U.K. routinely use organic nitrogen sources and believe synthetic, water-soluble nitrogen sources are not suitable for fine fescue or colonial bentgrass fairways (10). Furthermore, some cultivars that perform well at fairway height may have higher nitrogen requirements than cultivars that are not mowed low and not subjected to traffic.

## Objectives

The objectives of this research were to determine the best cultivars and combination(s) of fine fescues and colonial bentgrasses for use as a fairway turf by evaluating wear tolerance and the effect of organic versus water-soluble fertilizer on turf quality, fine fescue-colonial bentgrass competition and divot recovery.

## Materials and methods

Two identical research studies were conducted at the University of Minnesota Turfgrass Research Center in St. Paul on a loam soil and at the O.J. Noer Turfgrass Research and Education Facility in Verona, Wis., on a silt loam soil. Because of space constraints, this article will discuss the Minnesota location in detail and will summarize the Wisconsin location.

Plots were seeded in September 2003 with two

colonial bentgrasses (Tiger II and SR 7100), two chewings fescues (SR 5100 and Longfellow II), one hard fescue (SR 3100) and one strong creeping red fescue (Jasper II) as monostands, blends and mixtures. Fine fescue and colonial bentgrass mixtures were composed of 80% fine fescue and 20% colonial bentgrass (by weight). Equal parts of each cultivar of a given species were used in blends. The cultivars were selected based on top performance in National Turfgrass Evaluation Program trials (8). One creeping bentgrass (Penncross) and a Kentucky bluegrass blend (Blue Carpet) were used for comparisons. The cultivars, blends and mixtures tested are listed in Table 1.

*Fertilizer treatments*

Fertilizer rate and source treatments were initiated in May 2004. The following fertilizer treatments were applied to all the species treatments.

- *Low-rate organic:* 1 pound nitrogen/1,000 square feet (4.9 grams/square meter) split into two 0.5-pound (2.45 grams/square meter) nitrogen applications in May and October
- *Low-rate water-soluble:* 1 pound nitrogen/1,000 square feet (4.9 grams/square meter) split into two 0.5-pound nitrogen (2.45 grams/square meter) applications in May and October
- *High-rate organic:* 3 pounds nitrogen/1,000 square feet (14.6 grams/square meter) applied monthly at 0.5-pound nitrogen (2.45 grams/square meter) from May through October
- *High-rate water-soluble:* 3 pounds nitrogen/1,000 square feet (14.6 grams/square meter) applied monthly at 0.5-pound nitrogen (2.45 grams/square meter) from May through October

The water-soluble nitrogen source was urea combined with triple superphosphate to achieve 2% $P_2O_5$, which is equivalent to the rate in Milorganite, the organic nitrogen source.

*Mowing and irrigation*

The plot area was mowed with a rotary mower two to three times per week at 1 inch (2.5 centimeters) during the 2005 season. The rotary mower could not mow the plots at the desired height of 0.75 inch because of numerous undulations that resulted in scalped areas. In 2006, a walking reel mower was used successfully to mow the plots at 0.75 inch (1.9 centimeters) without scalping. Irrigation was provided only to prevent significant stand loss during drought.

*Traffic*

Starting in May 2005, all plots were subjected to traffic three times a week with two passes of a custom-built golf-car traffic simulator towed behind a turf utility vehicle. The traffic simulator consisted of two 1,000-pound traffic units on an axle containing five golf car tires. Traffic continued weekly through September.

*Divots*

Divot recovery trials were initiated in May 2005 using a custom-built divot maker. After divots were made, they were removed and filled with topdressing sand up to the level of the surrounding soil.

*Measurements*

Plots were rated for percent living ground cover (0%-100%), monthly turfgrass quality (on a scale of 1 to 9, where 9 is ideal turf and 1 is dead turf), and weed and disease infestation (as needed). Divot recovery was measured twice a month by counting the number of plants within a template that was identical in size to the original divot created. This allowed a divot recovery rate to be calculated. Species composition was measured each growing season in May and September with a 100-point grid on plots with mixtures of colonial bentgrass and fine fescues. The grass species beneath each intersection within the grid was identified and counted.

## Ground cover and turf quality

| Treatment No./cultivar name/species | % living ground cover | | Turf quality |
|---|---|---|---|
| | Oct. 2005 | May 2006 | 2005-06 avg. |
| 1. SR 7100 colonial bentgrass | 92 | 91.6 | 4.3 |
| 2. Tiger II colonial bentgrass | 92.3 | 888 | 4.44 |
| 3. SR 5100 chewings fescue | 89.9 | 92.2 | 4.89 |
| 4. Longfellow II chewings fescue | 91.3 | 93.4 | 4.93 |
| 5. Jasper II strong creeping red fescue | 90.7 | 91.3 | 4.38 |
| 6. SR 3100 hard fescue | 92.1 | 91.6 | 4.74 |
| 7. Penncross creeping bentgrass | 85.8 | 92.2 | 4.43 |
| 8. Blue Carpet Kentucky bluegrass blend | 92.1 | 77.2 | 4.30 |
| 9. SR 7100 colonial bentgrass + Tiger II colonial bentgrass | 86 | 89.7 | 4.38 |
| 10. Jasper II strong creeping red fescue + SR 5100 chewings fescue | 89.6 | 91.3 | 4.85 |
| 11. Tiger II colonial bentgrass + SR 7100 colonial bentgrass + Jasper II strong creeping red fescue + SR 5100 chewings fescue | 90.2 | 89.1 | 4.46 |
| 12. SR 5100 chewings fescue + Longfellow II chewings fescue | 86.9 | 89.1 | 4.60 |
| 13. Tiger II colonial bentgrass + SR 7100 colonial bentgrass + Jasper II strong creeping red fescue + SR 5100 chewings fescue + Longfellow II chewings fescue + SR 3100 hard fescue | 91.8 | 90 | 4.52 |
| 14. Tiger II colonial bentgrass + SR 7100 colonial bentgrass + Jasper II strong creeping red fescue + SR 5100 chewings fescue + Longfellow II chewings fescue | 90.6 | 91.6 | 4.44 |
| 15. Jasper II strong creeping red fescue + SR 5100 chewings fescue + SR 3100 hard fescue | 91.3 | 94.1 | 4.60 |

**Table 1.** Treatment % living ground cover and turf quality averaged over fertilizer source and fertilizer rate in 2005 and 2006.

Fifteen species treatments received four different fertilizer treatments over two seasons at the University of Minnesota Turfgrass Research Center in St. Paul. Photos by B. Horgan

Data were analyzed as a split-split-plot design, where whole plots were species and subplots were fertilizer source (organic and synthetic) and fertility rate (high and low). The 15 whole plots (with four replications) were 10 feet × 10 feet, yielding a total of 60 whole plots. Each whole plot contained four subplots that were 5 feet × 5 feet, yielding a total of 240 discrete rating plots.

## Results and discussion

What makes a higher-quality low-input turfgrass fairway: creeping bentgrass or fine fescue/colonial bentgrass? U.S. golfers often define quality as turf with dark green color and high density, firm soil and a consistent playing surface. In general, Scottish golf course conditions do not satisfy today's American golfer, which is unfortunate, because courses in Scotland receive fewer pesticides and less fertilizer and water — the ultimate in low-input turfgrass management.

Although our turfgrass quality ratings may seem low on the traditional 1 to 9 scale (where 9 is ideal turf, and 1 is dead turf), recall that a management program was implemented to evaluate these grasses as low-input. Irrigation was applied only when we risked losing the entire turf stand; fertilizer rates were 1 to 3 pounds/1,000 square feet (4.9-14.6 grams/square meter) applied as either urea or Milorganite. No pesticides were applied, and plots were mowed between 0.75 and 1.0 inch (1.9-2.5 centimeters).

*Percent living ground cover*

In spring 2006, plots were rated for percent living ground cover, which differed significantly among species. Among the single-species plots, Longfellow II (93.4%) and SR 5100 (92.2%) chewings fescues had the highest percent living ground cover, and Tiger II colonial bentgrass (88.8%) and Blue Carpet Kentucky bluegrass blend (77.2%) had the lowest (Table 1). In both years there were significant differences between fertilizer source and fertilizer rate for percent living ground cover. Plots receiving water-soluble fer-

## Turf quality vs. fertilizers and rates

| Treatment | 2005-2006 average | | | |
|---|---|---|---|---|
| | High-rate | | Low-rate | |
| | Water-soluble | Organic | Water-soluble | Organic |
| 1. SR 7100 | 5.58 | 4.75 | 3.84 | 3.43 |
| 2. Tiger II | 5.67 | 4.70 | 3.83 | 3.42 |
| 3. SR 5100 | 6.10 | 5.07 | 4.28 | 4.10 |
| 4. Longfellow II | 5.82 | 5.54 | 4.30 | 4.07 |
| 5. Jasper II | 5.24 | 4.44 | 4.0 | 3.85 |
| 6. SR 3100 | 5.71 | 4.93 | 4.30 | 4.05 |
| 7. Penncross | 5.60 | 4.32 | 3.49 | 3.12 |
| 8. Blue Carpet | 5.61 | 4.23 | 3.69 | 3.42 |
| 9. SR 7100 + Tiger II | 5.65 | 4.39 | 3.76 | 3.58 |
| 10. Jasper II + SR 5100 | 5.88 | 4.97 | 4.19 | 4.07 |
| 11. Tiger II + SR 7100 + Jasper II + SR 5100 | 6.04 | 4.50 | 3.96 | 3.35 |
| 12. SR 5100 + Longfellow II | 6.12 | 4.82 | 3.96 | 3.41 |
| 13. Tiger II + SR 7100 + Jasper II + SR 5100 + Longfellow II + SR 3100 | 6.00 | 4.95 | 4.03 | 3.59 |
| 14. Tiger II + SR 7100 + Jasper II + SR 5100 + Longfellow II | 5.92 | 4.65 | 4.11 | 3.52 |
| 15. Jasper II + SR 5100 + SR 3100 | 5.66 | 5.11 | 4.48 | 3.98 |
| LSD (0.05) | 0.67 | 0.49 | 0.56 | 0.50 |

**Table 2.** Turf quality for plots receiving high and low rates of water-soluble fertilizer (urea and triple super phosphate) and for plots receiving high and low rates of organic fertilizer (Milorganite). Quality was rated visually on a 1-9 scale, where 1 = totally dead, 9 = optimal turf quality, and 6 = acceptable fairway turf quality.

In the fertility treatments, Penncross creeping bentgrass did not fare well in comparison to most of the other species treatments in study.

tilizer had 91.5% living ground cover in 2005 and 92.9% in 2006, whereas plots receiving organic fertilizers had 88.8% living ground cover in 2005 and 87.5% in 2006. Plots receiving high rates of fertilizer had 95.6% living ground cover in 2005 and 95.4% in 2006, whereas plots receiving the low rate of fertilizer had 84.7% living ground cover in 2005 and 85.0% in 2006.

*Turf quality*

Turf quality was significantly different among species for all rating dates in 2005 and all dates for 2006 except for September. Turf-quality data were analyzed for the 2005 and 2006 seasons and the average of the two seasons combined (Table 2). When averaged over the 2005 season, the turf quality of the chewings fescues Longfellow II (4.90) and SR 5100 (4.88) and the hard fescue SR 3100 (4.87) was significantly better than that of the colonial bentgrass SR 7100 (4.19). In 2005 the three mixtures containing colonial bentgrass had turf quality scores of 4.54 (treatment 13), 4.55 (treatment 11) and 4.38 (treatment 14). Average turf quality ratings for 2006 again show that the chewings fescues Longfellow II (4.96) and SR 5100 (4.89) had significantly better turf quality than the colonial bentgrasses SR 7100 (4.41) and Tiger II (4.2). All three mixtures containing colonial bentgrass had turf quality scores of 4.5, 4.49 and 4.36. When turf quality was averaged over the 2005 and 2006 seasons, the chewings fescues Longfellow II (4.93)and SR 5100 (4.89) had significantly better quality than the colonial bentgrasses Tiger II (4.44) and SR 7100 (4.30).

*Water-soluble and organic fertilizers*

Turf quality was significantly better for plots receiving water-soluble fertilizer (4.87 in 2005 and 4.92 in 2006) than for plots receiving organic fertilizer (4.46 in 2005 and 3.96 in 2006). Turf quality was also significantly better for plots receiving high rates of fertilizer (5.21 in 2005 and 5.30 in 2006) rather than low rates (4.12 in 2005 and 3.58 in 2006).

*Species analysis for fertilizer source and rate*

Because of the interaction between fertilizer source and rate, the species were analyzed for each combination of fertilizer source and rate. The analysis was based on average turf quality for 2005, 2006 and the average over both seasons (Table 2).

Longfellow II chewings fescue received high ratings for turf quality at high and low rates of organic fertilizer (5.54 and 4.07, respectively) and at the low rate of water-soluble fertilizer (4.30). Treatment 15 (Jasper II, SR 5100 and SR 3100) had the highest turf quality at the low rate of water-soluble fertilizer

## Wisconsin turf quality

| Turf group | Low nitrogen | High nitrogen |
|---|---|---|
| | Turf quality† | |
| Colonial bentgrass | 5.1 b | 6.1 d |
| Creeping bentgrass | 4.2 e | 5.4 f |
| Chewings fescue | 5.3 a | 6.9 a |
| Strong creeping red fescue | 5.0 b | 6.2 d |
| Hard fescue | 4.9 c | 6.4 c |
| Fine fescue species mixtures | 5.4 a | 6.8 ab |
| Fine fescue/colonial bentgrass mixtures‡ | 5.4 a | 6.7 b |
| Elite Kentucky bluegrass blend | 4.5 d | 5.9 e |

†Turf quality was rated visually on a 1-9 scale, where 1 = totally dead turf, 9 = optimal turf quality and 6 = acceptable fairway turf quality. Means within the same column followed by the same letter are not significantly different from each other.
‡Mixture contains 80% fine fescue and 20% colonial bentgrass by seed weight.

**Table 3.** Data for the Wisconsin research location. Mean annual turf quality in 2004 at two different nitrogen rates. The low nitrogen rate was 1 pound/1,000 square feet (4.9 grams/square meter) annually and the high nitrogen rate was 3 pounds/1,000 square feet (14.6 grams/square meter) annually.

The fine fescue fairways on courses in Scotland are maintained with fewer inputs and less intensive cultural practices. The ideal is not a blemish-free, dark green turf.

(4.48) and the second-highest rating at the high rate of organic fertilizer (5.11). SR 5100 chewings fescue had the highest quality rating at the low rate of organic fertilizer (4.10), and SR 3100 hard fescue had the second-highest rating at the low rate of water-soluble fertilizer (4.30).

At the high rate of water-soluble fertilizer, only Jasper II strong creeping red fescue, with a turf quality rating of 5.24, was statistically lower than the five top-performing species treatments (Table 2). For the low rates of both water-soluble and organic fertilizer, Penncross had the lowest quality ratings, and it had the second-lowest ranking, just above Blue Carpet, for the high rate of organic fertilizer.

When the fertilizer source and rate combinations were visually observed in the field, it was evident that the fine fescues, but more specifically the chewings fescues (Longfellow II and SR 5100), consistently outperformed creeping bentgrass or Kentucky bluegrass if the fertilizer rate was low or if the fertilizer was organic (slowly available). When water-soluble fertilizer was applied monthly, both the fine fescues and the colonial bentgrasses performed adequately.

*Percent colonial bentgrass*

A separate analysis of percent colonial bentgrass was performed for plots with a mixture of colonial bentgrasses and fine fescues (treatments 11, 13 and 14) for 2005 and 2006. This prevented plots composed entirely of either colonial bentgrass or fine fescues from skewing the results. There were no significant differences among the three species treatments (11, 13 and 14) or between the effects of water-soluble and organic fertilizers on the turf quality of the three mixtures, but plots receiving high rates of fertilizer had a significantly higher percentage of colonial bentgrass than plots receiving low rates of fertilizer.

In 2005, the percentage of colonial bentgrass dropped from 28% for the July rating date to 9% for the September rating date. Because this was the first season of traffic, this drop was expected as plants died out that did not tolerate traffic or suffered from the lack of moisture.

In 2006, an increase in colonial bentgrass to 56% in May and 62% in September was attributed to the application of fertilizer treatments and to adequate moisture from rainfall received in fall 2005 and spring 2006.

*Divot recovery*

Divots created in May 2005 and 2006 had significantly better recovery when treated with water-soluble fertilizers and when receiving the high rate of fertilizer, regardless of fertilizer source (data for divot recovery are not shown). In 2006, there was a significant difference among species in their rate of recovery. Overall, the plots containing chewings fescue (Longfellow II or SR 5100) recovered more quickly than the other plots.

*Weeds*

The percentage of weeds in plots differed significantly among species and among fertilizer rates, but not between fertilizer sources in 2005 (data not shown). The plots of Jasper II strong creeping red fescue and Blue Carpet Kentucky bluegrass blend had significantly more weeds than other plots. The plots receiving high rates of fertilizer had significantly fewer weeds than the plots receiving low rates of fertilizer.

In 2006, plots were rated for clover, which was the predominant weed (data not shown). Clover percentages differed significantly among species, among fertilizer sources and among fertilizer rates. Again, Jasper II and Blue Carpet had the highest percentage of clover. The plots receiving water-soluble fertilizer had significantly less clover than those receiving organic fertilizer, and the plots receiving high rates of fertilizer had less clover than those receiving low rates of fertilizer.

*Wisconsin results*

Mean quality for eight different turf classifications representing 15 different monostands, blends and mixtures is presented in Table 3. All turf groups provided better turf quality when fertilized with 3 pounds nitrogen/1,000 square feet (14.6 grams/square meter) annually. Regardless of the amount of nitrogen applied, the chewings fescues and the fine fescue species mixtures

consistently provided the best turf quality. Mixtures of fine fescue and colonial bentgrass also provided good overall turf quality, but they did not consistently provide acceptable turf quality throughout the growing season as they were stressed by dollar spot and drought in summer. Creeping bentgrass, which was in the study for comparison, provided the worst turf quality due to severe drought stress and dollar spot outbreaks. Results from Wisconsin suggest that chewings fescue is responsible for the high turf quality of the fine fescue species mixture.

## Conclusions

It is often thought that combining fine fescue and colonial bentgrass could bring out the positive characteristics of both species. For example, fine fescues use less water and require less fertilizer and less mowing than colonial bentgrass. Unlike fine fescues, colonial bentgrasses can tolerate low mowing heights and have good recuperative ability because they spread by rhizomes and stolons. Combining the two could provide the low-input benefits of the fescues and the ability to recover from divot damage and traffic stress. In addition, mixing the two species may be advantageous because fine fescues often green up faster in the spring and remain green late into the fall when colonial bentgrass tends to lose color, whereas colonial bentgrass remains green in summer when some fine fescues may thin out and lose color. When the two species are planted together, there is the potential to have good-quality turf for the entire growing season.

The results of this study suggest that fine fescue and colonial bentgrass mixtures will provide good turf quality under proper environmental conditions. If reducing irrigation, fertilizer and pesticide inputs is the goal, however, a monostand of chewings fescue may be a better option where rainfall is inadequate and fungicides are not applied. In this study, the fine fescues, especially the chewings fescues, maintained better turf quality than the fine fescue and colonial bentgrass mixtures when subjected to water stress and disease pressure. Observations of plots seeded with fine fescue and colonial bentgrass mixtures indicated that the colonial bentgrass in the sward seemed to use water in the soil to the point where the fine fescue in the sward began to undergo drought stress.

### Funding

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Creeping bentgrass turfgrass on courses in the United States requires more inputs, including more irrigation and more turf-care products than the fine fescue courses in Scotland.

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## The research says

→ **There were no significant differences among mixtures containing colonial bentgrass and fine fescues regardless of the fertility source or rate.**

→ **Water-soluble fertilizer provided better turf quality, higher percent living ground cover, fewer weeds, higher colonial bentgrass percentages and quicker divot recovery.**

→ **Because plots were irrigated only to prevent turf death, the lack of moisture in summer may have limited mineralization of organic fertilizers and thus led to lower turf quality.**

→ **Overall, monostands of chewings fescues SR 5100 and Longfellow II provided the best turf quality in sites receiving traffic and limited supplemental irrigation.**

# Appendix 3
# USGA Recommendations for Putting Green Construction

*USGA Recommendations*
*For a Method of*

# PUTTING GREEN CONSTRUCTION

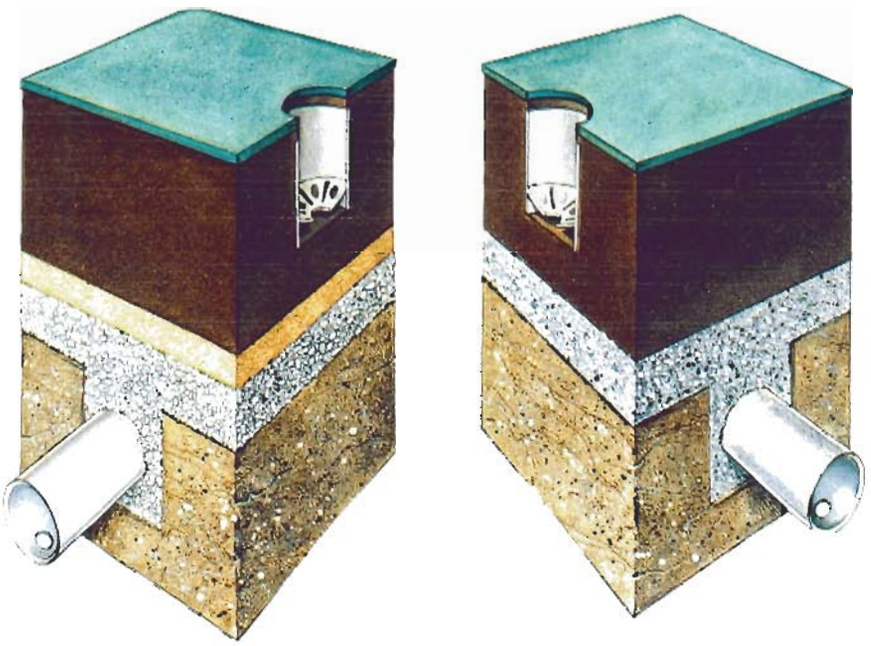
*2004 revision of the USGA Recommendations for a Method of Putting Green Construction*

*by the*
**United States Golf Association**
**Green Section Staff**

PG 1110

*For more than 40 years the USGA recommendations for green construction have been the most widely used method of green construction throughout the United States and in other parts of the world. When built and maintained properly, USGA greens have provided consistently good results for golf courses over a period of many years. These guidelines are periodically reviewed and updated as a result of scientific research and as new techniques and materials are proven reliable.*

*This document specifically represents the USGA Green Section's recommendations for green construction. It does not include a discussion of construction techniques or methods. Additional documents are available from the USGA that describe construction methods, offering tips for success and providing guidance for green management.*



## Step 1 ■ The Subgrade

The slope of the subgrade should conform to the general slope of the finished grade. The subgrade should be established approximately 16 inches (400 mm) below the proposed surface grade - 18 to 20 inches (450 to 500 mm) when an intermediate layer is necessary - and should be thoroughly compacted to prevent further settling. Water collecting depressions should be avoided.

If the subsoil is unstable, such as with an expanding clay, sand, or muck soil, geotextile fabrics may be used as a barrier between the subsoil and the gravel blanket. Install the fabric as outlined in Step 2.

Construct collar areas around the green to the same standards as the putting surface itself.

Figure 1 – The subgrade must be smooth, firmly compacted, and be free of water-collecting hollows.

## Step 2 ■ Drainage

A subsurface drainage system is required in USGA greens. The pattern of drainage pipes should be designed so that the main drain(s) is placed along the line of maximum fall, and laterals are installed at an angle across the slope of the subgrade, allowing a natural fall to the main. Lateral drains shall be spaced not more than 15 feet (5 m) apart and extended to the perimeter of the green. Laterals should also be placed in water-collecting depressions if they exist. At the low end of the gradient, where the main drain exits the green, drainage pipe should be placed along the perimeter of the green, extending to the ends of the first set of laterals. This will facilitate drainage of water that may accumulate at the low end of that drainage area. Drainage design considerations should be given to disposal of drainage waters away from play areas, and to the laws regulating drainage water disposal.

Figure 2 – Lateral lines should be spaced not more than 15 feet (5m) apart and have a natural fall to the mainline of at least 0.5%.

Drainage pipe shall be perforated plastic, minimally conforming to ASTM 2729 or ASTM F 405, with a minimum diameter of 4 inches (100 mm). Waffle drains or any tubing encased in geotextile sleeves are not recommended. Drainage trenches minimally 6 inches (150 mm) wide and 8 inches (200 mm) deep shall be cut into a thoroughly compacted subgrade so that drainage pipes maintain a consistent slope to the outlet of at least 0.5%. Spoil from the trenches should be removed from the subgrade cavity, and the floor of the trench should be smooth and clean. If a geotextile fabric is to be used as a

barrier between unstable subsoil and the gravel drainage blanket, it should be installed at this time. Under no circumstances should the fabric cover the drainage pipes or trenches. A layer of gravel (see Step 3 for size recommendations) should be placed in the trench to a minimum depth of 1 inch (25 mm). It may be deeper, as necessary, to ensure minimal slope requirements. All drainage pipes should be placed on the gravel bed in the trench. PVC drainpipe, if used, should be placed in the trench with the holes facing down. Pipe connections shall not impair the overall function of the pipeline. The trenches should then be backfilled with additional gravel, taking care not to displace any of the drainage pipes.

As an alternative to round pipe placed in a trench, flat pipe placed directly on the prepared subgrade may be employed, provided the flat pipe conforms to ASTM D 7001 (provisional), is a minimum of 12 inches (300 mm) in width, and is not covered by a geotextile sleeve. The flat pipe shall be stapled to the subgrade, or otherwise held in place to prevent shifting during construction. Rational combinations of round and flat pipe may be employed within a greens drainage system. All other guidelines for drainage system installation shall apply for this alternative construction method.

## Step 3 ■ Gravel and Intermediate Layers

Place grade stakes at frequent intervals over the subgrade and mark them for the gravel drainage blanket layer, intermediate layer (if included), and root zone layer.

The entire subgrade then shall be covered with a layer of clean, washed, crushed stone or pea gravel to a minimum thickness of four inches (100 mm), conforming to the proposed final surface grade to a tolerance of ±1 inch.

Soft limestones, sandstones, or shales are not acceptable. Questionable materials should be tested for weathering stability using the sulfate soundness test (ASTM C-88). A loss of material greater than a 12% by weight is unacceptable.

The LA Abrasion test (ASTM C-131) should be performed on any materials suspected of having insufficient mechanical stability to withstand ordinary construction traffic. The value obtained using this procedure should not exceed 40. Soil engineering laboratories can provide this information.

The need for an intermediate layer is based on the particle size distribution of the root zone mix relative to that of the gravel. When properly sized gravel (see Table 1) is available, the intermediate layer is not necessary. **If the properly sized gravel cannot be found, an intermediate layer must be used.**

Figure 3 – Gravel drainage blanket installed to proper depth by using grade stakes.

## TABLE 1

| Particle Size Description of Gravel and Intermediate Layer Material | |
|---|---|
| **Material** | **Description** |
| **Gravel:** Intermediate layer is used | Not more than 10% of the particles greater than ½" (12 mm) |
| | At least 65% of the particles between ¼" (6 mm) and ⅜" (9 mm) |
| | Not more than 10% of the particles less than 2 mm |
| **Intermediate Layer Material** | At least 90% of the particles between 1 mm and 4 mm |

## TABLE 2

| Size Recommedations for Gravel When Intermediate Layer is not Used | |
|---|---|
| **Performance Factors** | **Recommendation** |
| Bridging Factor | D15 (gravel) less than or equal to 8 X D85 (root zone) |
| Permeability Factor | D15 (gravel) greater than or equal to 5 X D15 (root zone) |
| Uniformity Factors | D90 (gravel) / D15 (gravel) is less than or equal to 3.0 |
| | No particles greater than 12 mm |
| | Not more than 10% less than 2 mm |
| | Not more than 5% less than 1 mm |

### A. Selection and Placement of Materials When the Intermediate Layer Is Used

Table 1 describes the particle size requirements of the gravel and the intermediate layer material when the intermediate layer is required.

The intermediate layer shall be spread to a uniform thickness of two to four inches (50 to 100 mm) over the gravel drainage blanket (*e.g.*, if a 3-inch depth is selected, the material shall be kept at that depth across the entire area), and the surface shall conform to the contours of the proposed finished grade.

## B. Selection of Gravel When the Intermediate Layer Is Not Used

If an appropriate gravel can be identified (see Table 2), the intermediate layer need not be included in the construction of the green. In some instances, this can save a considerable amount of time and money.

Selection of this gravel is based on the particle size distribution of the root zone material. The architect and/or construction superintendent must work closely with the soil testing laboratory in selecting the appropriate gravel. Either of the following two methods may be used:

Send samples of different gravel materials to the lab when submitting samples of components for the root zone mix. As a general guideline, look for gravel in the 2 mm to 9.5 mm range. The lab first will determine the best root zone mix, and then will test the gravel samples to determine if any meet the guidelines outlined below.

Submit samples of the components for the root zone mix, and ask the laboratory to provide a description, based on the root zone mix tests, of the particle size distribution required of the gravel. Use the description to locate one or more appropriate gravel materials, and submit them to the laboratory for confirmation.

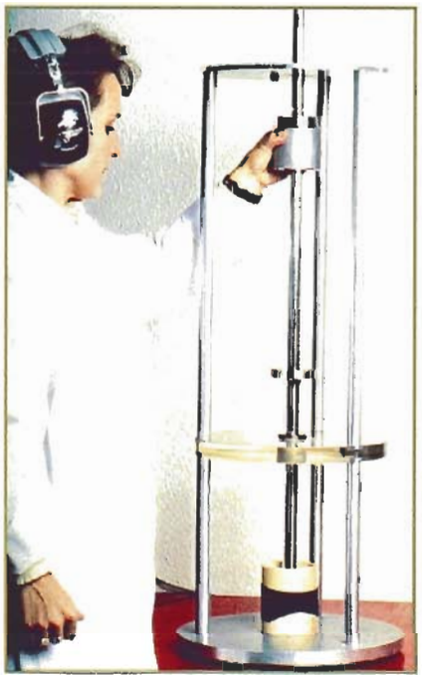


Figure 4 – Laboratory testing of gravel and rootzone materials is mandatory to ensure the success of a green built to USGA guidelines.

Gravel meeting the criteria below will not require the intermediate layer. It is not necessary to understand the details of these recommendations; the key is to work closely with the soil testing laboratory in selecting the gravel. **Strict adherence to these criteria is imperative; failure to follow these guidelines could result in greens failure.**

The criteria are based on engineering principles that rely on the largest 15% of the root zone particles "bridging" with the smallest 15% of the gravel particles. Smaller voids are produced, and they prevent migration of root zone particles into the gravel yet maintain adequate permeability. The D85 (root zone) is defined as the particle diameter below which 85% of the soil particles (by weight) are smaller. The D15 (gravel) is defined as the particle diameter below which 15% of the gravel particles (by weight) are smaller.

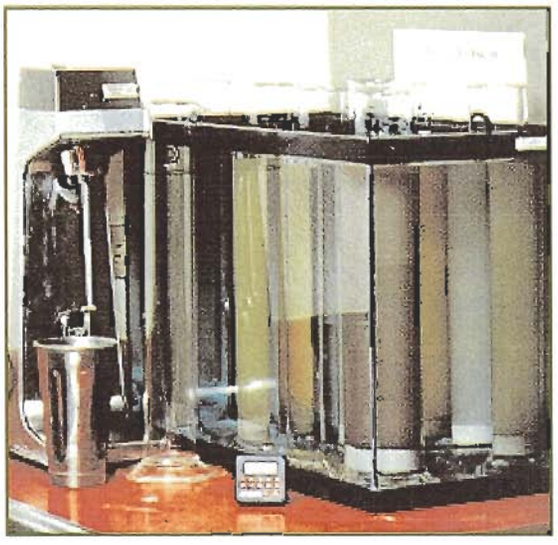


Figure 5 – Testing requires specialized equipment and skills and should be accomplished only by an accredited laboratory.

- For **bridging** to occur, the D15 (gravel) must be less than or equal to eight times the D85 (root zone).
- To maintain adequate **permeability** across the root zone/gravel interface, the D15 (gravel) shall be greater than or equal to five times the D15 (root zone).
- The gravel shall have a **uniformity coefficient** (Gravel D90/Gravel D15) of less than or equal to 3.0.

Furthermore, any gravel selected shall have 100% passing a 1/2" (12 mm) sieve and not more than 10% passing a No. 10 (2mm) sieve, including not more than 5% passing a No. 18 (1mm) sieve.

## Step 4 ■ The Root Zone Mixture

### Sand Selection:

The sand used in a USGA root zone mix shall be selected so that the particle size distribution of the **final root zone mixture** is as described in Table 3.

### TABLE 3

**PARTICLE SIZE DISTRIBUTION OF USGA ROOT ZONE MIX**

| Name | Particle Diameter | Recommendation (by weight) |
|---|---|---|
| Fine Gravel | 2.0 – 3.4 mm | Not more than 10% of the total particles in this range, including a maximum of 3% fine gravel (preferably none) |
| Very Coarse Sand | 1.0 – 2.0 mm | |
| Coarse Sand | 0.5 – 1.0 mm | Minimum of 60% of the particles must fall in this range |
| Medium Sand | 0.25 – 0.50 mm | |
| Fine Sand | 0.15 – 0.25 mm | Not more than 20% of the particles may fall within this range |
| Very Fine Sand | 0.05 – 0.15 mm | Not more than 5% |
| Silt | 0.002 – 0.05 mm | Not more than 5% |
| Clay | less than 0.002 mm | Not more than 3% |
| Total Fines | very fine sand + silt + clay | Less than or equal to 10% |

### Soil Selection:

If soil is used in the root zone mix, it shall have a minimum sand content of 60%, and a clay content of 5% to 20%. The final particle size distribution of the sand/soil/peat mix shall conform to that outlined in these recommendations, and meet the physical properties described herein.

### Organic Matter Selection:

**Peats** – The most commonly used organic component is a peat. If selected, it shall have a minimum organic matter content of 85% by weight as determined by loss on ignition (ASTM D 2974 Method D).

Figure 6 – Rootzone components must be blended uniformly. Mechanical blenders are best suited to this task.

**Other organic sources** – Organic sources such as rice hulls, finely ground bark, sawdust, or other organic waste products are acceptable if composted through a thermophilic stage, to a mesophilic stabilization phase, and with the approval of the soil physical testing laboratory. Composts shall be aged for at least one year. Furthermore, the root zone mix with compost as the organic amendment must meet the physical properties as defined in these recommendations.

Composts can vary not only with source, but also from batch to batch within a source. Extreme caution must be exercised when selecting a compost material. Unproven composts must be shown to be nonphytotoxic using a bentgrass or bermudagrass bioassay on the compost extract.

## Inorganic and Other Amendments:

Porous inorganic amendments such as calcined clays (porous ceramics), calcined diatomites, and zeolites may be used in place of or in conjunction with peat in root zone mixes, provided that the particle size and performance criterion of the mix are met. Users of these products should be aware that there are considerable differences among products, and long term experience with some of these materials is lacking. It should also be noted that the USGA requires any such amendment to be incorporated throughout the full 12-inch (300 mm) depth of the root zone mixture. Polyacrylamides and reinforcement materials are not recommended.

## Physical Properties of the Root Zone Mix:

The root zone mix shall have the properties summarized in Table 4, as tested by USGA protocol (proposed ASTM Standards).

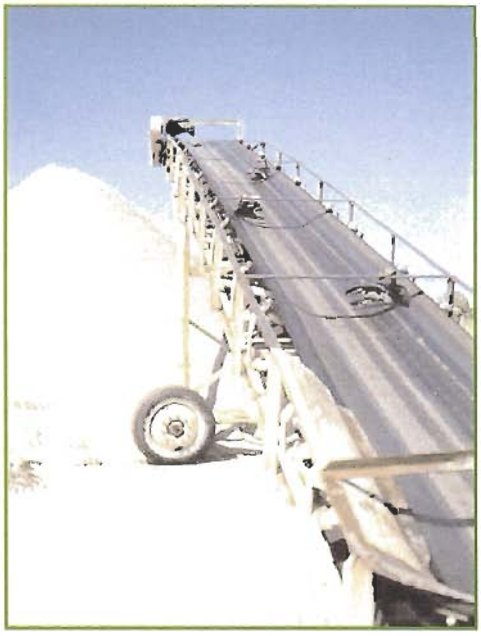


Figure 7 – The final product.

## TABLE 4

**Physical Properties of the Root Zone Mix**

| Physical Property | Recommended Range |
|---|---|
| Total Porosity | 35% – 55% |
| Air-filled Porosity | 15% – 30% |
| Capillary Porosity | 15% – 25% |
| Saturated Hydraulic Conductivity | Minimum of 6 inches/hr (150 mm/hr) |

## Related Concerns

**IT IS ABSOLUTELY ESSENTIAL TO MIX ALL ROOT ZONE COMPONENTS OFF-SITE.** No valid justification can be made for on-site mixing, since a homogeneous mixture is essential for success.

**A QUALITY CONTROL PROGRAM DURING CONSTRUCTION IS STRONGLY RECOMMENDED.** Documents describing quality control programs in detail can be found on the USGA's Web site at *www.usga.org/green/coned.* Arrangements should be made with a competent laboratory to routinely check gravel and root zone mixtures during production and blending. It is imperative that these materials conform to the recommendations approved by the laboratory in all respects.

Care should be taken to avoid overshredding the peat, since it may influence performance of the mix in the field. Peat should be moist during the mixing stage to ensure uniform mixing and to minimize peat and sand separation.

## Step 5 ■ Top Mix Covering, Placement, Smoothing, and Firming

The thoroughly mixed root zone material shall be placed on the green site and firmed to a uniform depth of 12 inches (300 mm), with a tolerance of ± 1 inch (25 mm). Be sure that the mix is moist when spread to discourage migration into the gravel and to assist in firming.

## Step 6 ■ Seed Bed Preparation

Sterilization: Sterilization of the root zone mix by fumigation should be decided on a case by case basis, depending on regional factors. Fumigation always should be performed:

In areas prone to severe nematode problems.

In areas with severe weedy grass or nutsedge problems.

When root zone mixes contain unsterilized soil.

Check with your regional office of the USGA Green Section for more information and advice specific to your area.

## Step 7 ■ Fertilization

Contact your regional USGA Green Section office for establishment fertilizer recommendations and grow-in procedures.

## Conclusion

This document details the recommendations of the USGA Green Section for the construction of golf greens. A great deal more information regarding various construction techniques used to build the USGA green can be obtained from the regional Green Section offices and the Green Section's Construction Education Program. The Construction Education Program can be reached at the following address:

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## Appendix I

### Test Methods and Material Specifications

**ASTM C 88-99a.** Standard Test Method for Soundness of Aggregates by Use of Sodium Sulphate or Magnesium Sulfate. American Society for Testing and Materials.

**ASTM C 131-03.** Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine. American Society for Testing and Materials.

**ASTM C 136-96a.** Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates. American Society for Testing and Materials

**ASTM D 75.-97.** Standard Practice for Sampling Aggregates. American Society for Testing and Materials.

**ASTM D 854-02.** Standard Test Method for Specific Gravity of Soil Solids by Water Pycnometer. American Society for Testing and Materials.

**ASTM D 2729-03.** Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings. American Society for Testing and Materials.

**ASTM D 2974-00.** Standard Test Methods for Moisture, Ash, Organic Matter of Peat and Other Organic Soils. American Society for Testing and Materials.

**ASTM D 2976-71.** Standard Test Method for pH of Peat Materials. American Society for Testing and Materials.

**ASTM 4972-01.** Standard Test Method for pH of Soils. American Society for Testing and Materials.

**ASTM D 7001-XX.** Standard Specification for Geocomposites for Pavement Edge Drains and Other High-Flow Applications

**ASTM F 405-97.** Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings. American Society for Testing and Materials.

**ASTM F 1632-03.** Standard Test Method for Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sports Field Rootzone Mixes. American Society for Testing and Materials.

**ASTM F 1647-02a.** Standard Test Method for Organic Matter Content of Putting Green and Sports Turf Root Zone Mixes. American Society for Testing and Materials.

**ASTM F 1815-97.** Standard Test Methods for Saturated Hydraulic Conductivity, Water Retention, Porosity, Particle Density, and Bulk Density of Putting Green and Sports Turf Root Zone Mixes. American Society for Testing and Materials.

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# Appendix 4
# Landschoot, "Using Compost to Improve Turf Performance"

Penn State **Extension**

# Using Composts *to Improve Turf Performance*

PENNSTATE
1855
Cooperative Extension
*College of Agricultural Sciences*

# Using Composts *to Improve Turf Performance*

If you have been searching for ways to improve turf performance in marginal or poor soils, consider using compost as a soil amendment. In clay soils, good quality compost will improve structure, reduce surface crusting and compaction, promote drainage, and provide nutrients. In sandy soils, compost increases water and nutrient retention, supplies nutrients, and increases microbial activity. These improvements promote faster turf establishment, improved turf density and color, increased root growth, and less need for fertilizer and irrigation.

In many cases, compost production sites are located near areas of intensive turf use, providing a readily available and reasonably priced source of organic matter. Depending on your location, compost may be less expensive than topsoil and peat. When considering costs, keep in mind that compost usually produces better turf than equal or greater amounts of topsoil.

## Selecting a Compost—Some Guidelines

Before selecting a compost, realize that not all products are alike. Composts are made from many different materials, including household refuse (municipal solid waste), leaves and grass clippings (yard trimmings), sewage sludge (biosolids), animal manure, paper mill by-products, and food residuals, to name a few. Compost quality varies depending on the source and how it is produced.

Because of differences in quality among composts, it is important to have some basis for determining suitability for use on turf. Ideally, the product in question has been field tested at a university and/or has been used successfully by other turf managers. Using a compost with a proven track record can take some of the guesswork out of the selection process, provided that the product is consistent from batch to batch.

Whether you are using a field-tested product or one that has never been used on turf, obtain a sample of the compost prior to use and examine it for undesirable objects and peculiar or offensive odors. If the producer does not have an analysis of chemical and physical properties, submit a representative sample to a laboratory that will conduct appropriate tests and provide recommendations that you can understand.

The following are some basic guidelines for evaluating the suitability of a compost for use on turf:

### Appearance

Although the appearance of compost will differ slightly among products, the color should resemble a dark topsoil and have a light, crumbly structure. It should be free of large stones, large pieces of wood, trash (especially glass), and other objectionable objects.

### Particle size

The size of compost particles can vary depending on the method of application and how the turf is used. For use in surface applications on athletic fields or lawns, a compost should be able to pass through a 3/8-inch screen. Composts with slightly larger particles can be used as soil amendments if thoroughly tilled into the soil prior to seeding or sodding.

### Odor

A good quality compost should have an "earthy" aroma (similar to that of a forest) and should not emit peculiar or offensive odors, such as those associated with ammonia or sulfur. These odors may be an indication that the compost is not mature (not fully composted). Immature composts may have adverse effects on turf and should not be used.

*Using a compost with a proven track record can take some of the guesswork out of the selection process.*

*Figure 1. Composts should be free of large stones, large pieces of wood, trash (especially glass), and other objectionable objects.*

### Weed seeds

If the product has been properly composted and stored, weed seed contamination will not be a problem. The composting process should destroy nearly all viable seeds. Occasionally, temperature control in some composting operations is not monitored adequately, and some weed seeds survive. Another source of contamination is weeds growing on compost piles that have been stored outdoors for long periods. If these weeds are not controlled, they can deposit seeds in the compost.

Although a few weed seeds do not necessarily preclude the use of a compost as a soil amendment for turf, composts containing large amounts of weed seeds are unacceptable. If possible, inspect the production site to make sure that weeds are not growing in or around the compost piles.

### Moisture content

The moisture content of a compost is important when uniform application and good mixing with soil is desired. Composts with moisture contents between 30 and 50 percent are usually ideal for handling, surface applications, and soil incorporation.

Wet composts (greater than 60 percent moisture content) tend to form clumps and do not spread evenly when applied to turf surfaces. Tilling wet material into soil may result in poor mixing and poor establishment. Wet composts also are heavy and difficult to handle.

Dry composts (less than 20 percent moisture content) are easy to handle and spread easily, but may produce excessive dust. On windy days, this dust may leave a film on the windows or siding of

nearby buildings. The dust also may be inhaled or may get into the eyes of the equipment operator. Dry composts that are high in organic matter tend to "float" on the soil surface during attempts to incorporate them. In this case, the equipment operator may have to spend more time and effort working the material into the soil.

### *Organic matter and ash content*

When using compost as an organic matter supplement, keep in mind that not all of the product is organic. In fact, some products contain less that 50 percent by weight of organic matter. Organic matter content can be determined by a lab test, but the most common procedure employed by laboratories considers everything that is combustible as organic matter (including wood chips, bark, leaves, and plastic). Hence, a lab test may not tell you everything about the *quality* of the organic matter. Although it is impossible to determine how much organic matter is present simply by looking at the product, a visual examination may tell you if the compost contains mostly decomposed, humus-like material or undecomposed organic matter, such as wood.

Some test labs report a value called "ash content." Ash is the mineral matter that remains after the compost sample has been subjected to extremely high temperatures in a furnace. Assuming that everything burned off in the furnace is organic matter, the percentage of ash in the sample can be subtracted from 100 to provide an estimate of percent organic matter. For example, an ash content of 20 percent indicates that there is an estimated 80 percent organic matter in the sample. Keep in mind that this process only *estimates* organic matter. In reality it measures weight loss of any material that is combustible at high temperatures.

*Figure 2. Try to find a product that is consistent from batch to batch and preferably one that has been used successfully by other turf managers.*

### *Carbon-to-nitrogen ratio*

The amount of carbon (C) relative to the amount of nitrogen (N) in a compost is an important indicator of nitrogen availability. The carbon-to-nitrogen (C:N) ratio of a compost should equal or fall below 30:1. If it's above 30:1, soil microorganisms can immobilize nitrogen, making it unavailable to the turf. Fortunately, most commercial composts have C:N ratios below 30:1.

### *Nutrients*

When compared with fertilizers, composts generally contain low amounts of nutrients. Whereas a small amount of quick-release nitrogen (ammonium) is present in some composts, most nitrogen is in the organic form and is slowly available to turf. Studies of biosolids composts show that only about 10 percent of the nitrogen is available to plants during the first growing season. Little is known about the nitrogen release characteristics of other composts.

Other nutrients, such as phosphorus, potassium, calcium, and magnesium can be present in significant quantities in composts. Some composts, however, may contain very low concentrations of one or more of these nutrients, and fertilizer supplements may be required to meet the turf's nutrient needs.

*When using compost as an organic matter supplement, keep in mind that not all of the product is organic.*

Typically, large amounts of compost must be applied to supply all or most of turf's nutrient requirements. This is difficult to achieve with surface applications since only a small amount of material can be applied in a single application. However, a 1- to 2-inch layer of compost tilled 4 to 6 inches into a soil can supply all of the nutrients necessary for turf growth and development for an entire year and possibly longer. The amounts of nutrients supplied by a compost depend on the source (animal manure composts are typically higher in plant nutrients than yard trimmings composts) and the availability of the nutrients. More research is needed to determine the availability of nutrients from different composts.

## ■ *pH*

Most composts have a pH of between 6.0 and 8.0, a range favorable for turf root growth. A few composts, however, fall outside of this range. The pH of a compost may be detrimental to turf when very high (greater than 8.5) or very low (less than 5.5). Extremes in pH may result in reduced availability of some plant nutrients and/or toxicity problems. In a turf establishment study at Penn State, seedling inhibition occurred following incorporation of a 2-inch layer of poultry manure compost (pH of 9.1) into a clay loam soil. It is likely that the high pH and presence of ammonium in the compost caused ammonia toxicity and subsequent death of the seedlings. Fortunately, most soils are buffered against rapid and drastic changes in pH, and even composts with extremes in pH may not alter the overall soil pH a great deal. To be on the safe side, however, try using materials with a pH as near to neutral (7.0) as possible.

**Guidelines for choosing a compost.**

***Appearance, size, and odor***

| | |
|---|---|
| Color | Brown to black |
| Size (surface applications) | 1/4 to 3/8 inch |
| Size (incorporated) | 1/4 to 1/2 inch |
| Odor | "Earthy" |

***Physical properties***

| | |
|---|---|
| Moisture content | 30 to 50 percent |
| Organic matter | Greater than 30 percent |
| Ash content | Less than 70 percent |

***Chemical properties***

| | |
|---|---|
| Carbon: nitrogen ratio | Below or equal to 30:1 |
| Nitrogen | 0.5 to 3.0 percent |
| Phosphorus | Greater than 0.2 percent |
| Potassium | Greater than 0.2 percent |
| pH | 6.0 to 8.0 |
| Metals | Determined by state and federal agencies. |
| Soluble salts | Depends on turf species, type of salt, concentration, and application method. Consult test lab or other expert to determine how this will affect the turf. |

**Note: Use this information only as a general guide. Some composts have properties that do not fall within these guidelines yet are acceptable in certain situations. Others, though they may fit these criteria, may have serious drawbacks.**

## ■ *Metals*

Composts made from biosolids often have higher metal concentrations than those made from other sources. State and federal government agencies have established maximum levels of metals in biosolids composts that are to be used for land application. Composts used for turf usually have to meet the same standards set for other crops. There are several biosolids composts that have been used successfully on turf in Pennsylvania that fall below the maximum allowable metal concentrations for land application.

## ■ *Soluble salts*

High concentrations of soluble salts may be present in certain types of compost, such as those made with spent mushroom substrates or animal manures. Excessive soluble salts can cause injury to turf by reducing water absorption, by toxicity, or by a combination of both of these factors. A common question among turf managers concerning soluble salts is: at what salt concentration will turf injury occur? The answer is that it depends on the *type* of salt, the salt tolerance of the turf species or variety, and the method of application.

Most soil laboratories can analyze composts for salt content. However, the salt concentration by itself may be somewhat misleading since the *type* of salt may be more important in determining potential plant injury. For example, salts containing sodium are more toxic to turfgrasses than potassium salts.

Turfgrass species and varieties vary in their tolerance to soluble salts. Salt-sensitive grasses such as

*Figure 3. Composts are typically applied to the soil surface at a 1- or 2-inch layer, then incorporated into the soil with rotary tilling equipment.*

Kentucky bluegrass may be injured at concentrations of about 3 mmhos/cm in the germination and seedling stage (turfgrasses are particularly vulnerable in the early stages of growth). A moderately salt-tolerant grass, such as tall fescue, may not be injured unless the compost has a higher salt level (greater than 6 mmhos/cm).

The method of compost application may also influence the degree of salt injury. When composts are incorporated into soils, the salt concentrations are greatly diluted. Irrigation further diminishes salt concentrations by leaching them out of the root zone. In a recent establishment study at Penn State, a spent mushroom substrate compost with a soluble salt content of 8.10 mmhos/cm was incorporated into a clay loam soil and irrigated daily until Kentucky bluegrass seeds germinated (approximately 20 days). Despite this high salt concentration, no noticeable seedling inhibition occurred, presumably due to the dilution effect of soil incorporation and leaching. The salts were primarily composed of potassium and calcium, and the results might have been different if high levels of sodium were present.

*A 1- or 2-inch layer of compost tilled 4 to 6 inches into a soil can supply all the nutrients necessary for turf growth and development for an entire year.*

Surface applications of high-salt composts may cause injury to established grasses, especially during hot weather. Always irrigate to leach salts from the compost/soil mix immediately following surface applications to avoid the possibility of salt injury.

## Summary of Guidelines

The preceding paragraphs serve only as a *general* guide. Some composts may meet these criteria but could have other properties that make them unsuitable for turf

use. Others may have properties that do not fall within these guidelines, yet are acceptable for use in some situations. When choosing a compost as a soil amendment prior to seeding or for surface application, it is important that you are familiar with the product and how it will affect the turf. Try to find a product that is consistent from batch to batch—preferably one that has been thoroughly researched and/or used successfully by other turf managers.

If you are unfamiliar with the product, be sure to examine it for color, objectionable objects, particle sizes, and odors. It may be worthwhile to visit the site where the compost is stored to make sure it is not contaminated with weeds or weed seeds. Other important considerations are moisture content, organic matter content, C:N ratio, nutrients, pH, metals, and soluble salts.

**Suggested amounts of compost (in cubic yards) per unit area to apply to established turf as surface applications or to till into soil prior to establishment.**

| | Inches of compost applied | | | | |
|---|---|---|---|---|---|
| | Surface application | Tilled into soil | | | |
| Unit area in square feet | 1/4 | 1/2 | 1 | 1 1/2 | 2 |
| 1,000 | 1* | 2 | 3 | 5 | 6 |
| 5,000 | 4 | 8 | 15 | 23 | 31 |
| 10,000 | 8 | 15 | 31 | 46 | 62 |
| 20,000 | 15 | 31 | 62 | 93 | 123 |
| 30,000 | 23 | 43 | 93 | 139 | 185 |
| 40,000 | 31 | 62 | 123 | 185 | 247 |

*Amounts of compost in cubic yards rounded to nearest whole numbers.

## Methods of Applying Compost

### *Soil incorporation prior to turf establishment*

In most cases, composts are applied to the soil surface at a rate of between a 1-inch layer (approximately 3.1 cubic yards per 1,000 $ft^2$) and a 2- inch layer (about 6.2 cubic yards per 1,000 $ft^2$), then incorporated into the soil to a depth of 4 to 6 inches. In order to obtain maximum performance from your application, make sure that the compost is thoroughly mixed with the soil and is not forming a layer at the soil surface. Depending on the product, this may require several passes with a rototiller. The lower rate (1-inch layer) is better suited for marginally good soils, and the higher rate (2-inch layer) for very sandy soils, clay soils, or subsoils low in organic matter. We have found that if more than two inches are applied, it may be difficult to mix the material 4 to 6 inches into the soil. On clay or compacted soils, it is helpful to rototill the soil first, then apply and incorporate the compost.

Although high nutrient-containing composts, such as biosolids composts or composted animal manures, can usually supply enough nutrients for good establishment, some composts (such as those made from yard trimmings or municipal solid wastes) may require additional phosphorus and potassium as well as starter fertilizer for vigorous seedling growth. Although many composts can raise the pH of slightly acid soils, soils with a very low pH (below 5.5) may require additional lime. If you plan to use a compost with a high soluble salt concentration, make sure to thoroughly irrigate the site after incorporation and prior to seed germination in order to leach the salts.

### *Surface applications on established turf*

Composts are frequently used as surface applications (topdressings) on established turf. This practice provides a means of gradually incorporating organic matter into the soil without causing extensive disruption of the surface. The two most limiting factors associated with this practice are finding suitable application equipment and working the material into the soil.

Since compost is light and bulky, a spreader with a large hopper is preferred. Modified manure spreaders with conveyor belts and brushes mounted on the back are ideal for spreading compost over large areas. Conventional tractor-mounted fertilizer spreaders have been used successfully but may require many refills. If spreaders

*Figure 4. Modified spreaders with conveyor belts and brushes mounted on the back are ideal for surface applications of compost.*

are not available, compost can be applied to the surface by spreading piles into a thin layer with a York rake or a grading blade. For applications over small areas, the compost can be spread with a shovel and worked into the turf with a leaf rake.

When applying compost as a topdressing, it is important to apply a thin layer (about 1/4 inch) and work it into the soil. Successive applications of thick layers without soil incorporation will result in a build-up of organic matter at the soil surface, which may cause rapid drying of turf roots and may form a layer that restricts root growth into the soil. The best way to incorporate compost into the soil is through aeration. A good method is to apply the compost first, followed by several passes with an aerator equipped with hollow tines and a heavy drag mat attached. The drag mat will break up the cores and mix the compost with the soil, dragging some of the mix back into the holes. This operation is best performed during cool and moist seasons when grass is actively growing. Aeration and dragging can be stressful to turf during hot, dry weather.

*Applications of thick layers without soil incorporation will result in a buildup of organic matter at the soil surface.*

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Prepared by Peter Landschoot, professor of turfgrass management

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# Appendix 5
# The Long Island Central Pine Barrens Plan Sections

# 5. Standards and Guidelines for Land Use

## 5.1 Central Pine Barrens overall area

The following sets forth the standards and guidelines for land use within the Central Pine Barrens.

Standards are to be implemented, and are enforceable, by municipalities, municipal agencies and the Commission, or any other agency with enforcement powers within the Central Pine Barrens. Discretionary decisions regarding standards are to be made by the Commission, under the provisions set forth in Volume I, Chapter 4 of this Plan. These standards are in addition to all other regulatory requirements and do not exempt any entity from complying with applicable federal, state, county, or local laws.

Guidelines are to be utilized by municipalities and municipal agencies with discretionary decisions determined at the municipal level, unless a project is before the Commission due to its location within a Critical Resource Area, because it is a Development of Regional Significance or because there was an assertion of jurisdiction as described in Volume I, Chapter 4 of this Plan.

The municipalities may adopt standards and guidelines which are more restrictive than those contained in this Plan.

Present land uses that comply with existing laws may be continued in accordance with their current approved use.

## 5.2 Core Preservation Area

The Core Preservation Area is to be preserved by a strategy of government land acquisition, the transfer of development rights, conservation easements, gifts, land swaps, and donations. Development in the Core Preservation Area shall be prohibited or redirected, and hardship exemptions granted by this Commission as provided for in the Act.

Allowable uses within the Core Preservation Area shall be limited to those operations or uses which do not constitute development, or hardship exemptions granted by this Commission pursuant to the Act.

Any existing, expanded, or new activity involving agriculture or horticulture in the Core Preservation Area is an allowable use if it does not involve material alteration of native vegetation. The erection of agricultural buildings, including but not limited to barns, greenhouses and farm stands, required for the production of plants or animals as reflected under ECL Section 57-0107(14), shall consitute an allowable use. If such activity does involve

material alteration of native vegetation, the use will require a hardship exemption from the Commission.

## 5.3 Compatible Growth Area

### 5.3.1 Applicability

The Central Pine Barrens Joint Planning and Policy Commission adopts the following standards and guidelines for development in the Compatible Growth Area in accordance with applicable state law.

These standards shall be incorporated into local land use and development review procedures, ordinances and laws by the local municipalities. The Commission shall also apply these standards to those projects that it directly reviews within the Compatible Growth Area.

These guidelines shall be incorporated into land use and development procedures, and utilized by municipalities and municipal agencies on a discretionary basis.

All standards and guidelines for land use in this section are based on the best available scientific evidence and municipal laws and practices.

### 5.3.2 State Environmental Quality Review Act (SEQRA)

A generic environmental impact statement (GEIS) has been completed for the Plan, including the standards and guidelines for land use set forth in this section.

A supplemental environmental impact statement may be required for individual projects by the appropriate town or other governmental agency, if a significant environmental effect is identified that is outside the scope of the standards and guidelines set forth in this chapter. If a potentially significant environmental effect is not identified, a Supplemental Environmental Impact Statement or an Environmental Impact Statement should not be required.

The scope of the supplemental EIS should be limited to subjects that are not addressed by the standards or guidelines or the GEIS.

### 5.3.3 Intent and Compatible Growth Area standards*

The Commission recognizes the need for balanced growth and development consistent with the water resource protection and habitat preservation goals provided for in the Act.

Development projects in the Compatible Growth Area are required to meet all of the standards in this chapter unless a permit has been issued under the provisions of Volume I, Chapter 4 of this

Plan.

Where standards contained in the Plan differ from state, county, or local law, the stricter standard(s) shall apply.

### 5.3.3.1 Nitrate-nitrogen

Nitrate-nitrogen, a contaminant that emanates from numerous types of land uses, is a recognized indicator of groundwater quality. The Suffolk County Department of Health Services abides by the New York State nitrate-nitrogen standard for drinking water.

***Standards***

5.3.3.1.1 **Suffolk County Sanitary Code Article 6 compliance**
All development proposals subject to Article 6 of the Suffolk County Sanitary Code shall meet all applicable requirements of the Suffolk County Department of Health Services. Projects which require variances from the provisions of Article 6 shall meet all requirements of the Suffolk County Department of Health Service's Board of Review in order to be deemed to have met the requirements of this standard.

5.3.3.1.2 **Sewage treatment plant discharge**
Where deemed practical by the County or State, sewage treatment plant discharge shall be outside and downgradient of the Central Pine Barrens. Denitrification systems that are approved by the New York State Department of Environmental Conservation or the Suffolk County Department of Health Services may be used in lieu of a sewage treatment plant.

***Guideline***

5.3.3.1.3 **Nitrate-nitrogen goal**
A more protective goal of two and one half (2.5) ppm may be achieved for new projects through an average residential density of one (1) unit per two (2) acres (or its commercial or industrial equivalent), through clustering, or through other mechanisms to protect surface water quality for projects in the vicinity of ponds and wetlands.

### 5.3.3.2 Other chemical contaminants of concern

In addition to the specific standards for nitrate-nitrogen above, other contaminants of concern may be relevant in specific applications or in specific areas. This is particularly true for organic contaminants of anthropogenic origin.

***Standard***

5.3.3.2.1 **Suffolk County Sanitary Code Articles 7 and 12 compliance**
All development projects must comply with the provisions of Articles 7 and 12 of the Suffolk County Sanitary Code, including any provisions for variances or waivers if needed, and all applicable state laws and regulations in order to ensure that all necessary water resource and wastewater management infrastructure shall be in place prior to, or as part of, the commencement of construction.

### 5.3.3.3 Wellhead protection

The New York State Department of Health advocates the exclusion of potentially contaminating activities from an area extending for 200 feet in all directions from a well site. Although this may have been considered adequate to prevent the rapid drawdown of bacterial contamination or its entry into groundwater through poorly constructed wells, it does not necessarily ensure an adequate level of protection against the suite of organic and inorganic pollutants that may threaten community water supplies.

***Standard***

5.3.3.3.1 **Significant discharges and public supply well locations**
The location of nearby public supply wells shall be considered in all applications involving significant discharges to groundwater, as required under the New York State Environmental Conservation Law Article 17.

***Guideline***

5.3.3.3.2 **Private well protection**
The Suffolk County Department of Health Services' guidelines for private wells should be used for wellhead protection.

### 5.3.3.4 Wetlands and surface waters

Freshwater wetlands that exist within the Central Pine Barrens are considered to be an important natural resource, providing flood and erosion control, the filtering of contaminants and sediments from stormwater runoff, and habitat for plants and wildlife.

Tidal wetlands existing within the marine environment bordering portions of the Central Pine Barrens are equally valuable natural resources. These wetlands support the reproduction of finfish and shellfish, provide habitat for waterfowl, and contribute a scenic quality that supports recreational economies.

Surface waters, including freshwater ponds, lakes, streams, rivers, and creeks, occur throughout

the Central Pine Barrens. These are considered to be resources of significant value in economic, aesthetic and ecological terms. Their protection is judged to be vital to the dynamics of the pine barrens.

***Standards***

5.3.3.4.1 **Nondisturbance buffers**

Development proposals for sites containing or abutting freshwater or tidal wetlands or surface waters must be separated by a nondisturbance buffer area which shall be no less than that required by the New York State Tidal Wetland, Freshwater Wetland, or Wild, Scenic and Recreational Rivers Act or local ordinance. Distances shall be measured horizontally from the wetland edge as mapped by the New York State Department of Environmental Conservation, field delineation or local ordinance. Projects which require variances or exceptions from these state laws, local ordinances and associated regulations, shall meet all requirements imposed in a permit by the New York State Department of Environmental Conservation or a municipality in order to be deemed to have met the requirements of this standard.

5.3.3.4.2 **Buffer delineations, covenants and conservation easements**

Buffer areas shall be delineated on the site plan, and covenants and/or conservation easements, pursuant to the New York State Environmental Conservation Law and local ordinances, shall be imposed to protect these areas as deemed necessary.

5.3.3.4.3 **Wild, Scenic and Recreational Rivers Act compliance**

Development shall conform to the provisions of the New York State Wild, Scenic and Recreational Rivers Act, where applicable. Projects which require variances or exceptions under the New York State Wild, Scenic and Recreational Rivers Act shall meet all requirements imposed by the New York State Department of Environmental Conservation in order to be deemed to have met the requirements of this standard.

***Guideline***

5.3.3.4.4 **Additional nondisturbance buffers**

Stricter nondisturbance buffer areas may be established for wetlands as appropriate.

### 5.3.3.5 Stormwater runoff

Development of lands within the pine barrens inevitably results in an increase of runoff water following precipitation. Runoff water originating from the roofs of buildings and from

driveways is usually discharged directly to subsurface dry wells situated on the building lot. However, the great volume of runoff water originating from paved streets and roads is usually discharged by pipes into large open recharge basins or sumps. These basins may cover several acres and require the removal of considerable native vegetation to the detriment of the site's ecology and aesthetics.

***Standard***

5.3.3.5.1 **Stormwater recharge**
Development projects must provide that all stormwater runoff originating from development on the property is recharged on site unless surplus capacity exists in an off site drainage system.

***Guidelines***

5.3.3.5.2 **Natural recharge and drainage**
Natural recharge areas and/or drainage system designs that cause minimal disturbance of native vegetation should be employed, where practical, in lieu of recharge basins or ponds that would require removal of significant areas of native vegetation.

5.3.3.5.3 **Ponds**
Ponds should only be created if they are to accommodate stormwater runoff, not solely for aesthetic purposes.

5.3.3.5.4 **Natural topography in lieu of recharge basins**
The use of natural swales and depressions should be permitted and encouraged instead of excavated recharge basins, whenever feasible.

5.3.3.5.5 **Soil erosion and stormwater runoff control during construction**
During construction, the standards and guidelines promulgated by the New York State Department of Environmental Conservation pursuant to state law, which are designed to prevent soil erosion and control stormwater runoff, should be adhered to.

### 5.3.3.6 Natural vegetation and plant habitat

Clearing is defined, for the purposes of this standard, as the removal of any portion of the natural vegetation found on a site exclusive of any vegetation associated with active agricultural or horticultural activity or formalized landscape and turf areas. Excessive clearing of natural vegetation can result in severe soil erosion, excessive stormwater runoff, and the destruction or reduction of pine barrens plant and wildlife habitat.

Further, the *Long Island Comprehensive Waste Treatment Management Plan* (the "208 Study"; Long Island Regional Planning Board, Hauppauge, NY, 1978) indicated that fertilizers are a significant source of nitrogen and phosphorous contamination to ground and surface waters. Due to the low fertility, soils common to the pine barrens (e.g., Carver, Haven, Plymouth and Riverhead) require both irrigation and fertilizer application for establishment and maintenance of turf and nonnative vegetation. As native pine barrens vegetation is replaced with turf through development, increased contamination and a general change in the ecosystem may be expected.

***Standards***

5.3.3.6.1 **Vegetation Clearance Limits**

The clearance of natural vegetation shall be strictly limited. Site plans, surveys and subdivision maps shall delineate the existing naturally vegetated areas and calculate those portions of the site that are already cleared due to previous activities.

Areas of the site proposed to be cleared combined with previously cleared areas shall not exceed the percentages in Figure 5-1. These percentages shall be taken over the total site and shall include, but not be limited to, roads, building sites and drainage structures. The clearance standard that would be applied to a project site if developed under the existing residential zoning category may be applied if the proposal involves multi-family units, attached housing, clustering or modified lot designs. Site plans, surveys and subdivision maps shall be delineated with a clearing limit line and calculations for clearing to demonstrate compliance with this standard.

To the extent that a portion of a site includes Core property, and for the purpose of calculating the clearance limits, the site shall be construed to be the combined Core and CGA portions. However, the Core portion may not be cleared except in accordance with Section 5.2 of the Plan.

5.3.3.6.2 **Unfragmented open space**

Subdivision and site design shall support preservation of natural vegetation in large unbroken blocks that allow contiguous open spaces to be established when adjacent parcels are developed. Subdivision and site designs should also be configured in such a way so as to prioritize the preservation of native pine barrens vegetation to the maximum extent practicable.

For the purpose of this paragraph, native pine barrens vegetation shall include pitch pines and various species of oak trees, understory and ground cover plants such as blueberry, wintergreen, bearberry and bracken fern, grasses and sedges such as little bluestem, Pennsylvania sedge and indian grass as well as those ecological communities listed in sections 5.6 and 5.7 in Chapter 5, Volume 2 of

the Plan.

It is recognized that the preservation of nonnative but ecologically important habitats may be consistent with the intent and goals of the plan when such action would result in the creation of large contiguous natural open space areas and or the protection of rare, threatened or endangered species or their habitat.

5.3.3.6.3 **Fertilizer-dependent vegetation limit**

No more than 15% of an entire development project site shall be established in fertilizer-dependant vegetation including formalized turf areas. Generally, nonnative species require fertilization therefore, planting of such nonnative species shall be limited to the maximum extent practicable. The use of the nonnative plants in Figure 5-2 is specifically not recommended.

5.3.3.6.4 **Native Plantings**

Development designs shall consider the native planting suggestions contained in Figure 5-2.

## Figure 5-1: Clearance standards

*(This table shows total site clearance including lots, roads, drainage and other improvements.)*

| **Zoning lot size** (*) | **Maximum site clearance** (**) |
|---|---|
| 10,000 square feet residential (1/4 acre) | 90 % |
| 15,000 square feet residential (1/3 acre) | 70 % |
| 20,000 square feet residential (1/2 acre) | 60 % |
| 30,000 square feet residential (2/3 acre) | 58 % |
| 40,000 square feet residential (1 acre) | 53 % |
| 60,000 square feet residential (1.5 acre) | 46 % |
| 80,000 square feet residential (2 acres) | 35 % |
| 120,000 square feet residential (3 acres) | 30 % |
| 160,000 through 200,000+ square feet residential (4 - 5+ acres) | 20 %<br>Clearance limitations on lots in this category shall not include the clearance necessary for the construction of driveways and septic systems. In no case shall the total clearance in this category exceed 25%. |
| Commercial, Industrial and Other or Mixed Use | 65 % |

*Notes:*

(*) These entries are the minimum lot sizes required by zoning, not the size of the subject parcels.

(**) In calculating the percentage of land cleared, the preserved areas in a development should preferably be native vegetation. These are maximum clearance standards, and more restrictive standards may be imposed during the review by the local municipality due to consideration of other standards, especially those addressing preservation of rare or endangered species, or unique flora or vegetation.

## Figure 5-2: Planting recommendations

*(Native plants are more drought tolerant than nonnative species, are adapted to our local environment, maintain natural ecological diversity, perpetuate fast disappearing native genotypes, and comprise a form of habitat restoration.)*

| **Scientific name** *(In alphabetic order)* | **Common name** |
|---|---|
| **Recommended native plants** | |
| *Andropogon gerardi* | Big bluestem |
| *Andropogon scoparius* | Little bluestem |
| *Betula lenta* | White Birch |
| *Betula populifolia* | Grey birch |
| *Celtis occidentalis* | Hackberry |
| *Dennstaedtia punctilobula* | Hay scented fern |
| *Epigea repens* | Trailing arbutus |
| *Hamamelis virginia* | Witch hazel |
| *Ilex glabra* | Inkberry |
| *Ilex opaca* | American holly |
| *Myrica pensylvanica* | Northern bayberry |
| *Parthenocissus quinquefolia* | Virginia creeper |
| *Pinus rigida* | Pitch pine |
| *Populus tremuloides* | Quaking aspen |
| *Prunus maritima* | Beach plum |
| *Prunus serotina* | Black cherry |
| *Pteridum aquilinum* | Bracken fern |
| *Quercus alba* | White oak |
| *Quercus coccinea* | Scarlet oak |
| *Quercus rubra* | Red oak |
| *Rosa virginiana* | Virginia rose |
| *Rubus allegheniensis* | Northern blackberry |
| *Salix discolor* | Pussy willow |
| *Sassafras albidum* | Sassafras |
| *Solidago* species | Goldenrod |
| *Spirea latifolia* | Spirea |
| *Vaccinium angustifolium* | Lowbush blueberry |
| *Vaccinium corymbosum* | Highbush blueberry |

*Continued ...*

| Invasive, nonnative plants specifically not recommended | |
|---|---|
| *Acer platinoides* | Norway maple |
| *Acer pseudoplatanus* | Sycamore maple |
| *Ampelopsis brevipedunculata* | Porcelain berry vine |
| *Berberis thunbergii* | Japanese barberry |
| *Celastrus orbiculatus* | Asiatic bittersweet |
| *Coronilla varia* | Crown vetch |
| *Eleagnus umbellata* | Autumn olive |
| *Lespedeza cuneata* | Himalayan bushclover |
| *Ligustrum sinense* | Chinese privet |
| *Lonicera japonica* | Japanese honeysuckle |
| *Lonicera maackii* | Amur honeysuckle |
| *Lonicera tartarica* | Tartarian honeysuckle |
| *Lythrum salicaria* | Purple loosestrife |
| *Miscanthus sinensis* | Eulalia |
| *Pinus nigra* | Black pine |
| *Polygonum cuspidatum* | Mexican bamboo |
| *Pueraria lobata* | Kudzu |
| *Robina pseudoacacia* | Black locust |
| *Rosa multiflora* | Multiflora rose |
| *Rosa rugosa* | Rugosa (salt spray) rose |
| *Rudbeckia hirta* | Black eyed susan |

### 5.3.3.7 Species and communities of special concern

The pine barrens ecosystem hosts several species of rare, endangered or threatened animals and plants, as well as species of special concern. The State of New York has identified such species and has enacted laws to protect their number and habitat. The New York State Natural Heritage Program has also identified unique natural communities and habitats of special concern.

***Standard***

5.3.3.7.1 **Special species and ecological communities**

Where a significant negative impact upon a habitat essential to those species identified on the New York State maintained lists as rare, threatened, endangered or of special concern, or upon natural communities classified by the New York State Natural Heritage Program as G1, G2, G3 or S1, S2 or S3, or on any federally listed endangered or threatened species is proposed, appropriate mitigation measures as determined by the appropriate state, county or local government agency shall be taken to protect these species.

### 5.3.3.8 Soils

Disturbance of, and construction on, steep slopes within the pine barrens involves considerable removal of native vegetation resulting in excessive surface water runoff and severe soil erosion. Steeply sloped areas are also subject to more rapid spread of wildfire than flat ground.

***Guidelines***

5.3.3.8.1 **Clearing envelopes**
Clearing envelopes should be placed upon lots within a subdivision so as to maximize the placement of those envelopes on slopes less than ten percent (10%).

5.3.3.8.2 **Stabilization and erosion control**
Construction of homes, roadways and private driveways on slopes greater than ten percent (10%) may be approved if technical review shows that sufficient care has been taken in the design of stabilization measures, erosion control practices and structures so as to mitigate negative environmental impacts.

5.3.3.8.3 **Slope analyses**
Project review is facilitated if submissions contain a slope analysis showing slopes in the ranges 0-10%, 11-15% and 15% and greater. In areas with steep slopes, slope analysis maps should be required. This can be satisfied with cross hatching or shading on the site plan for the appropriate areas.

5.3.3.8.4 **Erosion and sediment control plans**
Erosion and sediment control plans should be required in areas of fifteen percent (15%) or greater slopes.

5.3.3.8.5 **Placement of roadways**
Roads and driveways should be designed to minimize the traversing of slopes greater than ten percent (10%) and to minimize cuts and fills.

5.3.3.8.6 **Retaining walls and control structures**
Details of retaining walls and erosion control structures should be provided for roads and driveways which traverse slopes greater than ten percent (10%).

### 5.3.3.9 Coordinated design for open space management

Comprehensive, coordinated planning and design of development proposals within the pine barrens is essential to ensure maximum preservation of open space and habitat linkages. Developments should not be designed without adequate consideration of the existing development and known future plans for the adjacent parcels. Otherwise, inefficient road patterns may require unnecessary clearing and lot layout that may hinder or prevent the

preservation of large, unbroken blocks of open space.

The use of the clustering technique within the Central Pine Barrens preserves open space, preserves habitat, protects important resource areas, improves infrastructure efficiency and furthers the statute's goals of compact, efficient and orderly development in the Central Pine Barrens.

Additionally, proper management of these areas is essential in order to protect open spaces from illegal dumping, clearing, motor vehicle trespass and other abuses.

***Standard***

5.3.3.9.1 **Receiving entity for open space dedications**
Applications must specify the entity to which dedicated open space will be transferred.

***Guidelines***

5.3.3.9.2 **Clustering**
Municipalities are strongly urged to maximize the use of the clustering technique where its usage would enhance adjacent open space or provide contiguous open space connections with adjacent open space parcels.

5.3.3.9.3 **Protection of dedicated open space**
Proposed open space should be protected with covenants, conservation easements or dedications that specify proper restrictions on its use and contingencies for its future management.

### 5.3.3.10 Agriculture and horticulture

Scattered throughout the pine barrens are parcels devoted to agricultural and horticultural uses.

***Guideline***

5.3.3.10.1 **Best management practices**
Any existing, expanded, or new activity involving agriculture or horticulture in the Compatible Growth Area should comply with best management practices, as defined herein, and relevant requirements including local law. Best management practices are, for purposes of this Plan, the same practices stated in the most recent version of *Controlling Agricultural Nonpoint Source Water Pollution in New York State* (Bureau of Technical Services and Research, Division of Water, New York State Department of Environmental Conservation, 1991 and as later amended).

### 5.3.3.11 Scenic, historic and cultural resources

The Long Island Pine Barrens Protection Act specifies that the Plan shall consider and protect unique scenic, cultural or historic features. The Plan includes an inventory of many of these resources, and separate inventories for these items exist in local, state, county, federal or private inventories.

The Commission's policy is to protect and enhance those landscape based features of a community which define it, provide for its distinction from neighboring communities, provide for natural areas among the communities which complement the protection of the pine barrens ecosystem, and contribute to a regional diversity, both natural and cultural.

***Guidelines***

5.3.3.11.1 **Cultural resource consideration**

Development proposals should account for, review, and provide protection measures for:

1. Established recreational and educational trails and trail corridors, including but not limited to those trail corridors inventoried elsewhere in this Plan.
2. Active recreation sites, including existing sites and those proposed as part of a development.
3. Scenic corridors, roads, vistas and viewpoints located in Critical Resource Areas, and along the Long Island Expressway, Sunrise Highway, County Road 111 and William Floyd Parkway.
4. Sites of historical or cultural significance, including historic districts, sites on the State or National Registers of Historic Places, and historic structures listed on the State or National Registers of Historic Places, or recognized by local municipal law or statute.
5. Sensitive archaeological areas as identified by the New York State Historic Preservation Office or the New York State Museum.

5.3.3.11.2 **Inclusion of cultural resources in applications**

Development proposals should note established recreation and educational trails and trail corridors; active recreation sites; scenic corridors, roads, vistas and viewpoints located in Critical Resource Areas and undisturbed portions of the roadsides of the Long Island Expressway, Sunrise Highway, County Road 111 and William Floyd Parkway; sites on the State or National Register of Historic Places, and historic structures and landmarks recognized by municipal law or statute, or listed on the State or National Registers of Historic Places; and sensitive archaeological areas as identified by the New York State Historic Preservation Office or the New York State Museum within a five hundred (500) foot radius of the outside perimeter of the project site, including any project

parcels which are physically separate from the bulk of the proposed development area.

A development proposal may be disapproved or altered if the local municipality determines that the development proposal, in its current form, may have a significant negative impact on any of the above resources.

5.3.3.11.3 **Protection of scenic and recreational resources**
Protection measures for scenic and recreational resources should include, but not be limited to, retention of visually shielding natural buffers, replacement of degraded or removed natural visual buffers using native species, use of signs which are in keeping in both style and scale with the community character, and similar measures.

5.3.3.11.4 **Roadside design and management**
Undisturbed portions of the roadside should be maintained in a manner that protects the scenic features of these areas. Clearing (including that for aisles, driveways, access and parking) is not precluded within these roadside areas, provided that appropriate buffers are maintained, and that manmade structures meet standards consistent with the character of the area.

### 5.3.3.12 Commercial and industrial development

Throughout the Compatible Growth Area, there are parcels of land that are zoned for commercial or industrial use. Future development of these parcels should occur in a manner which is consistent with the goals and objectives of the Act.

***Standard***

5.3.3.12.1 **Commercial and industrial compliance with Suffolk County Sanitary Code**
All commercial and industrial development applications shall comply with the provisions of the Suffolk County Sanitary Code as applied by the Suffolk County Department of Health Services, and all other applicable federal, state or local laws. Projects which require variances from the provisions of the Suffolk County Sanitary Code shall meet all requirements of the Department of Health Service's Board of Review in order to be deemed to have met the requirements of this standard.

* Denotes May 16, 2012 Ministerial CLUP Amendments adopted by the Commission

# Appendix 6
# Technical Review of Test Results and Implementation of the Groundwater Monitoring Protocol The Bridge Golf Course Southampton, NY Part 1 & Review of Protocols and Recommendations Part 2.

# TECHNICAL REVIEW OF TEST RESULTS AND IMPLEMENTATION OF THE GROUNDWATER MONITORING PROTOCOL THE BRIDGE GOLF COURSE Southampton, NY PART 1

# And

# REVIEW OF PROTOCOL MODIFICATION PROPOSALS AND RECOMMENDATIONS PART 2

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## APRIL 18, 2011

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# EXCECUTIVE SUMMARY: FINDINGS AND RECOMMENDATIONS

In accordance with the Town Resolution No. 2010-412, the town contracted both Dr. A. Martin Petrovic and Thomas Cambareri on June 15, 2010 to provide a review of the groundwater monitoring program (GWMP) conducted at The Bridge golf course and provide recommendations based upon that review upon which the Town will base any amendment or change to the Groundwater Monitoring Protocol.

This separate section presents the summary findings and recommendations of the review of the GWMP. The Final Technical Review Report, which contains our review of pertinent subject matter, proposed changes to the ground water monitoring protocol (the "Protocol") and the management plan, and recommendations, should be referred to for further explanation of the following summary points and recommendations.

## FINDINGS

PROTOCOL DEVIATIONS: Based on our review there have been infrequent, but justifiable deviations that have not affected the overall monitoring program.

GROUNDWATER SAMPLING PROCEDURES: Based upon a review of the available quarterly and annual reports and Independent Review reports, field log books, sample shipments are made according to the Protocol.

QUALITY CONTROL SAMPLES: Based upon a review of the available quarterly and annual reports and Independent Reviewer reports, sampling, handling and testing protocols have been followed very closely over the nine years of the monitoring program.

LABORATORY QUALITY CONTROL: Based upon a review of the available quarterly and annual reports and Independent Reviewer reports, all quality control samples indicate that by 2002 the program gained consistency in all matters and the Underwriters Laboratory is meeting the quality control requirements.

NITRATE IN GROUNDWATER: The background well (BW-1) is not useful to compare to other wells because this well is on the other side of the divide and is impacted by several different land uses and its nitrate concentration is nearly always higher than the downgradient wells. Turf management has not significantly impaired water quality, and nitrate concentrations in groundwater have generally remained below 25% of the agreed upon threshold of 5 ppm. The groundwater monitoring program can be improved and optimized.

PHOSPHORUS IN GROUNDWATER: The concentrations of phosphorus in groundwater are basically below the quantitation limit and it is recommended that phosphorus be removed as an analyte.

PESTICIDES IN GROUNDWATER: Of the 13 wells tested, there were 60 detections of pesticides above the reporting limit, which is 0.1 ppb for most analytes. In all but five cases, the detection was below 0.5 ppb. The concentrations of detections individually and cumulatively for any well are below 5ppb, the lowest of the two general public health thresholds (POCs [5 ppb] and GVs [50 ppb]). Thus, the overall quality of the groundwater has not been significantly affected by the golf course pest management operations at The Bridge golf course.

LYSIMETERS RESULTS:. The goal of the lysimeters is for early warning about the potential mass of nitrogen or pesticides that can potentially leach further through the soil to groundwater. Long term data has shown that where nitrate is being detected, lysimeter concentrations are higher than groundwater as would be expected. Overall the average lysimeter nitrate concentrations are not extremely high and there have only been few exceedences above the 10 ppm action level, which have a reasonable maintenance explanation. The lysimeter results also show a mixed performance of the biofilters in which biofilters at one set of locations appears to work extremely well in contrast to other locations. The lysimeter sampling program can be improved and optimized.

TURF AREA: The total fertilized area is 78.27 acres, which is slightly less than 80.38 acres, the amount allowed.

APPLIED FERTILIZER: Based on the superintendent's annual reports, as contained in the comprehensive annual water quality monitoring reports, and reviewed by the Independent consultant, the fertilizer application amount is below the lowest end of the specified range of 6,386-11,627 pounds N per year. The average over the 9 year period (2001-2009) is 4,539 lbs/yr. This is 71% of the low end range of the allowable amount. The last five years of turf management have only used an average of 2905 lbs/yr or 45% of the lowest end of the allowable amount.

PESTICIDES APPLIED: The reports outline the occurrence, identifies the pest, and the action thresholds for pesticide application. The actions taken are in conformance with the Natural Resource Management Plan. Targeted pesticide application generally corresponds to the pest occurrence as found in the field pest history reports.

GROUNDWATER FLOW MAPS: Quarterly reports contain the water level measurements and the Annual reports contain four quarterly water table maps. The water table flow directions show some variability in flow directions particularly at the top of the groundwater divide and impart a higher degree of variability to the BW-1 and MW-1S nitrogen concentrations.

IRRIGATION: There are four irrigation wells located along the 15 fairway. The four wells have a combined capacity of 1,100 gallons per minute. Irrigation amounts were obtained from the Independent Review reports. Overall the irrigation amount averages 24.3 million gallons per year. The golf course has made recent use of drip irrigation in the perimeter turf to the sand traps with very favorable results in turf growth and health.

## CONCLUSION

The Groundwater Monitoring Protocol and its amendments have been effectively implemented over the last nine years and based upon our review can be improved and optimized.

## RECOMMENDATIONS

A summary of the recommendations to improve and optimize the Protocol are presented in the Executive Summary below. The basis of each recommendation is the technical review that is contained within Part 1 and 2 of report. The collective recommendations of this report are focused on ensuring the long term goal of groundwater protection

MONITORING WELLS: The original 14 monitoring wells now number 13, which are sampled quarterly (Table ES-1). It is recommended to reduce the number of regularly sampled wells to 7 wells including four (4) that had elevated nitrate levels or frequent pesticides detections (referred to as turf response monitoring wells MW-2D, MW-3S, MW-5 and MW-2S), two (2) monitoring wells not influenced by the golf course operations (referred to as Ambient wells MW-1D and MW-3D) and the perched well PW-1. The seven monitoring wells are recommended to be sampled semi-annually for total Kjeldahl nitrogen (TKN), nitrate, S150 pesticides and field parameters. However, semi-annual monitoring of method S150 pesticides for the two ambient wells will only be triggered if nitrate concentrations are greater than 1 ppm in those wells. If that occurs, they will be sampled in the next sampling event immediately following the > 1ppm detection(s). Every two years, the entire remaining network of 12 monitoring wells will be sampled. Every fourth year will include analysis for a comprehensive list of compounds for the Turf Response Wells and others as indicated on Table ES-2.

| | **Well** | **Category** | Semi | 2-yr |
|---|---|---|---|---|
| 1 | BW-1 | Drop | | |
| 2 | PW-1 | Misc | X | X |
| 3 | MW-1S | Misc | | X |
| 4 | MW-1D | Ambient | X | X |
| 5 | MW-2S | Turf Response | X | X |
| 6 | MW2D | Turf Response | X | X |
| 7 | MW-3S | Turf Response | X | X |
| 8 | MW-3D | Ambient | X | X |
| 9 | MW-4/4R | Turf | | X |
| 10 | MW-5 | Turf Response | X | X |
| 11 | MW-6 | Ambient | | X |
| 12 | MW-7 | Turf | | X |
| 13 | MW-8 | Turf | | X |
| 14 | MW-9 | Abandoned | | |
| | Total Wells | | 7 | 12 |

LYSIMETERS: We recommend that two of the current eight sets of lysimeters continue to be monitored for nitrogen and S150 pesticides on a semi-annual basis. These lysimeter sets include two fairway locations, F1-3 and F3-3 that have a consistent response and can be used to reduce turf management impacts. As for green lysimeter testing, we recommend that The Bridge discontinue sampling the current green biofilter lysimeters and install angled lysimeters through the use of a small tracked Geoprobe at 9 to 12 ft below the front end of the green at Holes 4, 7, and 14.

FIVE YEAR REVIEW: The Protocol should be reviewed in five years to evaluate its implementation, cumulative groundwater conditions and consideration of future modifications. The Study Director should initiate this (currently, Stuart Cohen), and the Town and the SCWA should act promptly on the recommendations. We recommend that this review be accomplished within six months to one year of the date the submission is received from the Study Director.

## RESPONSE TO DETECTIONS AND OTHER ISSUES:

1. The Town should adopt a new lower limit of nitrogen fertilization where no more than 3000 lbs of nitrogen be applied to the current land area per year which translates to 0.9 lb N/1000 ft2. The annual report should present and discuss the amounts of fertilizer applied in relation to the concentrations of nitrogen found in groundwater.

2. In regards to nitrate in groundwater, we recommend that a new long term average goal (since 2005) shall be 2 ppm average annual for all turf wells and 1 ppm for ambient wells. Based upon the results of the nine years of data, these goals can be achieved by adopting a new lower nitrogen fertilization application of no more than 3000 total pounds per year. This outstanding long term average for nitrogen in groundwater has been achieved by The Bridge due to their diligent turf management. The 2 ppm annual average is well below the 10 ppm state and federal drinking water standard and 5 ppm nitrogen loading standard. This lower nitrogen limit is consistent with the Peconic Estuary nitrogen management challenge to which The Bridge has agreed to meet.

3. An evaluation of the relationship of heavy single rain events/periods (pages 34-36) and nitrate-nitrogen concentrations in groundwater indicated that there was little correlation and therefore should not be used as the basis of a management response. To be more responsive to spikes in nitrate-nitrogen concentrations, we recommend that the Protocol resampling threshold of 5 ppm be lowered to a nitrate-nitrogen concentration of 4 ppm.

4. Based upon the recommendation of the reduction of sampling from quarterly to semi-annually we recommend reducing the trigger to resample in any well (except PW-1) from 5 ppm of nitrate-nitrogen to 4 ppm. The well (s) in question will be immediately resampled within two weeks of receipt of the results. If the concentration is confirmed in the offending well (s), all fertilization will stop in the surface watershed and groundwater area upgradient of the offending well(s).

An evaluation will then be conducted by the Study Director in consultation with the Town to determine the conditions and issues that caused the large increase (fertilizer, rainfall, irrigation, runoff). A report to the Town will be made by the Study Director within one month of receiving the resampling-confirmation results indicating the cause and remediation plans related to the high nitrate-nitrogen level. Fertilization will resume when the concentration of the offending well is less than 2 ppm of nitrate-nitrogen or as outlined in the remediation plan.

5. We agree with the recommendation of ETS that the threshold for re-sampling a well for pesticides can be increased and recommend variable a "Resampling and Management Triggers" These triggers acknowledge the wide disparity of Health references for pesticides, which for those listed on Table 9 range from 0.44 to 50 ppb and reflect the prudent management decisions made by The Bridge over the past nine years relative to pesticide use on the golf course and will reduce the effort of resampling that has given little useful information in the past.

6. If the Management Trigger for pesticides is exceeded in any well then the sampling will revert back to quarterly for all 12 wells (not including the Background BW-1 or abandoned MW-9 well) until the level drops below the Management Trigger.

7. The response triggers for the lysimeters are recommended to be <5 ppm nitrate as a goal and >10 ppm nitrate as a management response. A Resample Trigger for pesticides of greater than 1 ppb is recommended. A Management Trigger of 5 ppb for any pesticide detection is recommended. Pesticide detections for all past lysimeter data and current on-going pesticide detections is recommended to be formatted for presentation in the 2011 monitoring report and all future reports.

8. Phosphorus in groundwater monitoring wells has seldom been above the detection limit and does not appear to be related to turf management at The Bridge. Therefore, it is recommended that phosphorus be dropped from the required analysis.

9. Semi-annual and Annual reports of nitrate in groundwater shall adopt a new comparative structure recommended in this review and compare the results of the Turf and Turf Response wells to the Ambient Wells and not to the background well (BW-1). The reports shall present the data by updating the long term concentration graphs of this report.

10. The four year comprehensive monitoring shall be applied to the four turf response wells, MW-2S, MW-2D, MW-3S, and MW-5. The four year comprehensive testing will be expanded to include the ambient wells (1D and 3D) and all other wells if there is a detection using the methods S150 or 515.3 in any of the previous semi-annual or two year events or if the average annual nitrate-N concentration is above the 2 ppm average annual nitrogen goal.

11. Comprehensive monitoring shall include methods L300, L311, S150 and EPA methods 547 (only if glyphosate has been used above 3 lbs of active ingredient in one year), 200.8 (only if MSMA has been used), and 515.3.

12. The results thus far of the Volatile Organic Compounds analysis by EPA Method 524.2 have been below the detection limit for all but background concentrations of chloroform and MTBE. It is recommended that this suite of compounds be dropped from the four-year comprehensive program in all wells except for MW-1S since it is downgradient of the current operations facility.

13. The management response to nitrate detections at the perched well (PW-1) should be increased to 10 ppm, since it does not sample the principle aquifer (see the Perch Water Well section of the Report for explanation). However, if the well exceeds 5 ppm for more than one year (more than two-semi-annual events) then the well shall be pumped off with the use of a submersible pump (>20gpm) and sampled for nitrate and S150 pesticides. This method of sampling the perched well could be used in place of the low flow pump for future sampling events.

14. The preparation of groundwater flow maps can be reduced from quarterly to once per year which would include annual snap shot measurements of all wells. Long term hydrographs should be presented in the reports for all semi-annual sampled wells.

15. A capture area to the irrigations wells under average annual and monthly peak flow conditions should be prepared using a groundwater model. This has been prepared by Mr. Cambareri and the results included in the Report Attachments.

16. The response to detections in monitoring wells now requires that a delineation of the area affecting the well(s) be used to reduce or stop the use of fertilizers and detected pesticides. Because surface runoff may play more of a role through drainage basins and underlying materials, such as the old Bridgehampton Raceway, a map of surface watersheds to monitoring wells shall be developed including the location of drains and their discharge locations by the Bridge as part of the 2011 annual report.

17. At an October 14, 2010 Town Board work session, Dr. Cohen of ETS (the Study Director), offered that the golf course would consider potential impacts on beneficial insects (pollinators) in future requests for new pesticides, in addition to the ground water contamination risk assessment procedures it established at the time of the 1995 risk assessment. We concur with this recommendation.

## OPERATIONAL RECOMMENDATIONS

REPORTING: Pesticide and fertilizer application records, on daily time steps, shall continue to be included in the semi-annual and annual reports as required by the original Protocol with recommendations of this review. This shall be done on a hole-by-hole basis. Also, the procedure to select areas for the reduced amounts of either pesticides or fertilizer in response to detections of pesticides and/or nitrates in wells should be explained in the report(s).

Proposed "new" pesticides shall be requested in advance according to the Natural Resource Management Plan. The request shall contain: the compound name, its proposed use, estimated quantities to be applied and risk assessment.

Two semi-annual reports per year shall be prepared and submitted to the Town and SCWA. The reports shall contain all figures and graphs and attachments of data. These reports shall be submitted in digital form and one paper copy and posted on the Town Website by the Town.

CART PATHS: It was noted that the use of golf cart paths on the wooded areas had been appreciably reduced from the earlier years. The Bridge should continue this practice and prepare a site map for the first annual report that shows their locations. The map shall be updated when ever changes are made to the location of cart path and maintenance vehicle paths/roads.

BIO-FUNGICIDES: The Bridge shall implement a systematic testing program for bio-fungicides that can potentially be used in the golf course disease control program. The systematic approach would include on-site testing of the materials compared to the golf course's traditional fungicide program along with un-treated areas to determine the effectiveness of the bio-fungicides. The Bridge should consider evaluating the risk of several new fungicides introduced since 2000 that are considered to have a much lower risk by USEPA including, but not limited to, boscalid a reduced risk pesticide (Emerald), and a mineral oil (Civatas). Potential impacts to beneficial insects (pollinators) will be considered in the risk assessment, as volunteered by the golf course (see above).

IRRIGATION: The Bridge shall equip all 18 greens with soil moisture sensors to further refine the amount of irrigation applied. The Bridge shall install time domain refractomitry (TDR) soil moisture probes to map greens, tees and fairway soil moisture variation to further refine and make adjustments in the amount of water applied to very specific locations on the golf course. The use of drip irrigation bunker surrounds shall be expanded as practicable. These irrigation improvements shall be accomplished within the five year review period.

FERTILIZATION
If the golf course should require more than the fertilization limit, a request shall be sent to the town six months in advance indicating the reasons (need for more nitrogen) and why such an increase will not lead to an exceedence of the 2 ppm average annual threshold.

**Figure ES-1  Aerial Figure of Golf at the Bridge**

**Table ES-2 Groundwater Monitoring Protocol Frequency and Response**

| Well | Category | NITRATE (ppm) | | | PESTICIDES | | | | 4 YR+ COMP | WT** |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Semi N^ | GOAL | Mgmt Response | Semi Pest^^ | 2-YEAR | Resampling Trigger | Management Trigger | | |
| BW-1 | Drop | | | | | | 5x Quant Limit Or 3x Quant Limit if Ref Pt < 5(ppb) Or upon detection if Ref Pt< 1ppb | 10% Ref Pt Or 3x Quant Limit Or upon detection if Ref Pt < 1 ppb | Cond | yes |
| PW-1 | Misc | yes | <5 | 10* | S150 | 515.3 | | | Cond | yes |
| MW-1S | Misc | | 2 | 4 | | N, S150 +VOC | | | Cond | yes |
| MW-1D | Ambient | yes | <1 | 4 | S150 if N > 1 | S150 | | | Cond | yes |
| MW-2S | Turf Response | yes | 2 | 4 | S150 | 515.3 | | | Yes | yes |
| MW2D | Turf Response | yes | 2 | 4 | S150 | 515.3 | | | Yes | yes |
| MW-3S | Turf Response | yes | 2 | 4 | S150 | 515.3 | | | Yes++ | yes |
| MW-3D | Ambient | yes | <1 | 4 | S150 if N > 1 | S150 | | | Cond | yes |
| MW-4/4R | Turf | | 2 | 4 | | N, S150, 515.3 | | | Cond | yes |
| MW-5 | Turf Response | yes | 2 | 4 | S150 | 515.3 | | | Yes | yes |
| MW-6 | Ambient | | <1 | 4 | | N S150 + 515. | | | Cond | yes |
| MW-7 | Turf | | 2 | 4 | | N S150 + 515.3 | | | Cond | yes |
| MW-8 | Turf | | 2 | 4 | | N S150 + 515.3 | | | Cond | yes |
| MW-9 | Abandoned | | | | | | | | | |

* Remedial Action if > 5 ppm.

** WT measured at sampled wells and long term hydrographs updated semi-annual, annual WT snap shot with Water table map. + Includes methods L300, L311, S150 and EPA methods 547, 200.8, and 515.3. Volatile Organic Compounds analysis by 524.2. ^ If any well exceeds 4 ppm, then the well will be immediately sampled and if confirmed, all fertilization will stop in the upgradient area until concentrations drop below 2 ppm. or as indicated in the remedial plan ^^ If the Management Trigger is exceeded in any well then the sampling will be revert back to quarterly for all wells until the level drops below the Management Trigger in all wells. Semi-annual sampling in ambient wells shall include pesticides in the next round of semi-annual sampling if N > 1 ppm. TKN will be included in the semi-annual, 2-Year and 4 Year comprehensive sampling round.

# PART 1. TECHNICAL REVIEW OF GROUNDWATER MONITORING PROTOCOL

## BACKGROUND AND PURPOSE

In order to comply with the Southampton Town Board conditions of approval for groundwater protection, the property owners Bridgehampton Road Races Corp. retained Environmental & Turf Services, Inc. (ETS) to develop a sophisticated, comprehensive turf management plan and ground water risk assessment to ensure that turf chemicals would not impact ground water quality at The Bridge Golf Course. A significant tool to achieve this end was the Ground Water Monitoring Protocol. The protocol is the agreement, which describes how the groundwater monitoring program will be conducted, the results will be reported, and the responses that will be triggered by detections.

The original 1997 Groundwater Monitoring Protocol that was endorsed by the Suffolk County Water Authority, was amended ten times to address the following topics: 1) Well Locations and Depth; 2) Baseline Analyses; 3) Pesticide Analytes; 4) Construction of New Deep Wells; 5) Protocol Review after Five Years; 6) Low Flow Sampling Procedures; 7) Annual Interpretive Report; 8) Response Triggers; 9) Lysimeter Sampling and 10) add new pesticides to the list in 2002. The Declaration of Covenants and Restrictions was amended in 2009 to abandon well MW-9.

These amendments were written in response to comments received by the Planning Board's peer reviewers (Petrovic and Cambareri) in October 1998 and the State Attorney General's (AGs) office after the protocol was endorsed by the SCWA and the protocol authors.

The Groundwater Monitoring Protocol is subject to a five year review according to Amendment #5. In early 2006, ETS submitted a request with justification to modify the Groundwater Monitoring Protocol. The Town's Independent consultant reviewed and offered recommendations relative to proposed protocol modifications. The monitoring protocol has continued since that time so there are now 9+ years of monitoring under the original protocol as amended.

In accordance with the Town Resolution No. 2010-412, the town contracted both Dr. A. Martin Petrovic and Thomas Cambareri on June 15, 2010 to provide a review of the groundwater monitoring program conducted at The Bridge Golf Course and provide recommendations based upon that review, upon which the Town will base any amendment or change to the Groundwater Monitoring Protocol (GWMP).

This report presents the findings of the review of the GWMP and its quarterly and annual reports and other data that was made available. The report consists of our review of pertinent subject matter followed by a review of the proposed changes to the GWMP.

# GROUNDWATER MONITORING PROTOCOL

The rationale of the Groundwater Monitoring Protocol is:

1) "meet the requirements of the Suffolk County Water Authority (SCWA) guidance;
2) help ensure the study will be conducted in a quality manner; and
3) help ensure the management plan and risk assessment have resulted in a golf course operation that will not impact ground water quality."

Prior to the construction of the golf course, the Town Board retained the services of A. Martin Petrovic, PhD. to oversee the work of ETS and provide an independent review of the groundwater monitoring and test results. In addition to being reviewed by ETS and Dr. Petrovic, the groundwater test results are also reviewed by the Suffolk County Water Authority (SCWA).

## IMPLEMENTATION OF PROTOCOL

There are 14 monitoring wells and 22 suction lysimeters, in accordance with the 1997 protocol as amended. The lysimeters test leachate water quality from the putting greens and fairways to provide early warning for detection of any contaminants. One background monitoring well, three down-gradient wells and one shallow perched water well were installed prior to golf course construction. The remaining wells were installed in 2000, at the beginning of the construction phase when the well sites could be cleared. Two baseline-sampling rounds were taken prior to golf course clearing. The wells have been sampled quarterly for the last nine years. Results of the groundwater testing are received concurrently by the SCWAand ETS, and submitted to Dr. Martin Petrovic and the Southampton Department of Land Management in the form of quarterly and annual reports. Dr. Petrovic also receives, Superintendent Annual reports containing scouting reports, amounts of applied fertilizers, pesticides, chain of custody and laboratory quality control data, weather station data and irrigation volumes. His review is reported in quarterly and annual reports that include an annual site visit. The body of these reports from ETS and Dr. Petrovic forms the basis of this review. A complete listing of the available digital reports is included in the Attachments to this report.

A brief chronology of the initial implementation years of the Monitoring Protocol is listed below.

1998 – Clearing the Site, August installation of the initial wells BW, PW and MW-1, 2 & 4, Baseline sampling- two rounds.
1999 – Shaping of the course.

2000 – July Grassing the course, First fertilizer and pesticide applications, March-June installation of MW-3 and 8 additional wells, Baseline sampling- two rounds.
2001 – May Lysimeters installed. October EHL becomes the prime laboratory
2002 – Dec – First Annual Report for 2001, May Dedicated sampling pumps installed, new analytical methods with lower detection limits

*The Ground Water Monitoring Program contains a multitude of requirements and procedures including the installation of state-of-the-art equipment for monitoring, irrigation and facility operations, reporting, thresholds, and responses. The Ground Water Monitoring Program and Course operations has been implemented according to the Protocol and gained consistency in all matters by the 2002 sampling year. This is a tremendous accomplishment and shows long term capacity for attention to detail.*

## PROTOCOL DEVIATIONS

Every quarterly and annual report provides an opportunity for the Bridge to identify areas where there have been deviations from the Protocol. Over the course of the nine year period there have been infrequent deviations. A typical deviation might be dependent on not having enough lysimeter water to run the complete analysis or temperature of samples exceeding 4 degrees C.

*Based on our review there have been infrequent, but justifiable deviations that have not affected the overall monitoring program.*

## GROUNDWATER SAMPLING PROCEDURES

This includes a review of sampling procedures to insure that representative samples are taken and delivered to the laboratory. Items that are regularly reviewed include: a copy of the actual field log book with dates and signatures, chain of custody forms and overnight shipping receipts.

*Based upon a review of the available quarterly and annual reports and Independent Review reports, field log books, sample shipments are made according to the Protocol.*

## QUALITY CONTROL SAMPLES

Quality Control Samples are required by the Protocol including one field trip blank, a duplicate for every ten samples, and decontamination rinse water if needed for lysimeter samples.

*Based upon a review of the available quarterly and annual reports and Independent review reports, sampling, handling and testing protocols have been followed very closely over the nine years of the monitoring program.*

### LABORATORY QUALITY CONTROL

Laboratory Quality Control is required to include: method detection limit, practical quantification limit and results of matrix blank, matrix spike and matrix spike duplicate recovery analyses. Early in the groundwater monitoring program the initial laboratory was not meeting all the Quality Control requirements and the Bridge changed labs to Underwriters Laboratory, (formerly EHL). Some of the early results have different detection and reporting limits.

*Based upon a review of the available quarterly and annual reports and Independent Reviewer Reports, all quality control samples, by 2002 the groundwater monitoring program gained consistency in all matters. The Environmental Health Laboratory, which subsequently became Underwriters Laboratory is meeting the quality control requirements of the Protocol.*

## NITROGEN IN GROUNDWATER

A review of nitrogen data indicates that nitrogen concentrations in groundwater beneath the golf course have increased over pre-existing concentrations in some of the monitoring wells. However, the nitrogen concentrations over the last five years appear stable; below the action threshold of 5 ppm and well below the federal and state drinking water standard of 10 ppm. Water quality data indicate that the background well may affected by being both near the groundwater divide and impacted by other land uses, which does not allow a comparison of turf management impacts to ambient conditions.

### BACKGROUND CONDITIONS

The U.S. Environmental Protection Agency (1992) states that a background level is "the concentration of a (sic) substance that provides a defensible reference point that can be used to evaluate whether or not a release from the site has occurred." Additionally, "background levels do not necessarily represent pre-release conditions, nor conditions in the absence of influence from source(s) at the site." In the case of the monitoring program at The Bridge, the background monitoring location (BW-1) was chosen based upon 1998 groundwater flow information that showed it was in an upgradient location from the proposed managed turf areas and thus its water quality could be compared to the downgradient monitoring wells.

BW-1 is located on the southern side of the groundwater divide in the vicinity of a fairly intense area of land use consisting of heavy construction, the club house, parking lot and pre-existing land clearing. A review of the nitrate concentrations indicates that there is much variability in its concentration as shown in the graph below. This is due to the variety of land uses in proximity to it and the fact that this particular well is subject to much more variation of groundwater flow paths than the other wells since it is located at the top of the regional groundwater divide.

The water quality impacts from turf management are completely different from the impact resulting from a variety of other land uses as measured at the BW-1 well. Comparing the two, ETS can say that the impact of other land use is higher, lower or the same as the impact of turf management. When comparing the background well to the downgradient wells (except the perched water table well), ETS reports the yearly average nitrate concentration in 6 of 9 years (2001-2009) was higher in the background well relative to the downgradient wells. For the purposes of our review we chose to make the comparison to wells that provide a reference to water quality that is not impacted by turf management conditions.

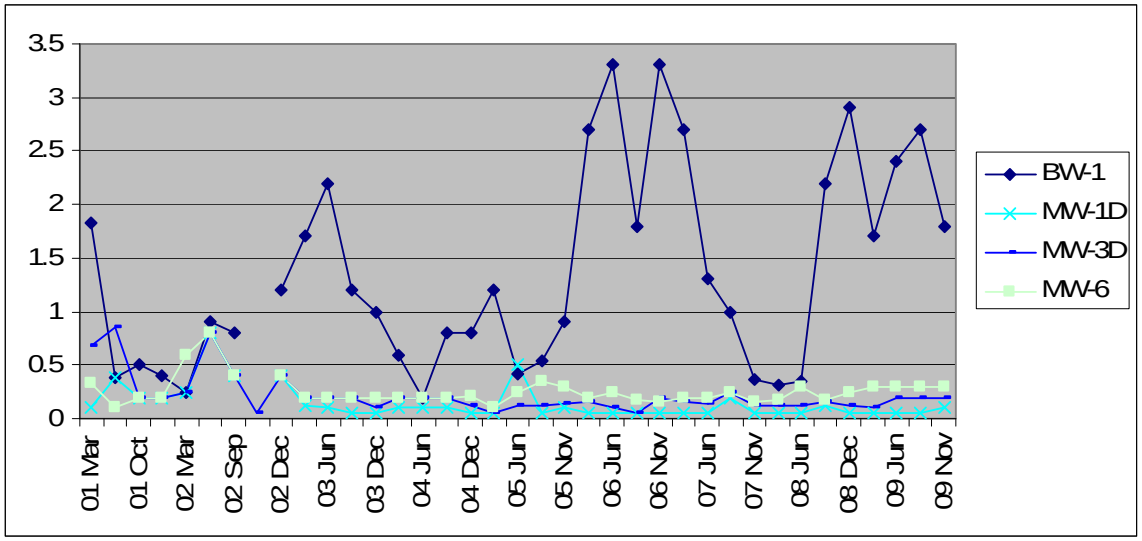



**Figure 1. Nitrate-Nitrogen in the Background Well and MW-1D, MW-3D & MW-6**

A review of the water quality data suggest several other wells should be considered as indicating ambient conditions. The locations MW-1D, MW-3D and MW-6 have low stable concentrations throughout the entire 9 year period of record as compared to the "background" well BW-1 as shown in the graph above. The combined long term (9 yr) average nitrate concentration of the three ambient wells is 0.21 ppm. Although these three wells are located in the managed area, it is evident that the nitrate concentrations have not appreciably changed after the variability of the initial years of the monitoring program.

The deep wells, including MW-1D and MW-3D were added to the monitoring well network to evaluate the potential of substances subject to a vertical hydraulic gradient. The deep wells typically have their 10 ft screens located 25 ft into the water table whereas the shallow wells have their screen straddle the water table. It is apparent that in these two cases there has been no increase of nitrogen at all and no presence of pesticides. It is not until the groundwater flow paths approach MW-2D at the farthest

downgradient edge do we see evidence of a vertical path with higher nitrogen in the deeper well.

MW-6 is a "shallow" well but has similar consistent low concentration results to the other ambient wells MW-1D and 3D. The well log of MW-6 indicates that it has a 40 ft screen located below a low permeable zone as compared to the other shallow wells that are typically screened at the water table. The fact that wells MW-3D, 1D and MW-6 are located in proximity to other wells that are experiencing statistically significant N increases makes a strong case that they represent the true ambient water quality conditions at The Bridge Golf Course. For the purposes of our review, we have categorized the monitoring wells for making water quality comparisons as miscellaneous (uncertain conditions), Turf Wells (ones influenced by turfgrass management activities) and Ambient Wells (ones not influenced by turfgrass activities) in the Table below.

**Table 1. Categories of Monitoring Wells and N Concentrations**

| **Nitrate in Groundwater (mg/L) (2005 to 2009)** | | | | |
|---|---|---|---|---|
| **WELL TYPES** | **WELL ID** | **AVERAGE** | **MAX** | **MIN** |
| **MISCELLANEOUS** | BW-1 | 1.69 | 3.30 | 0.31 |
| **MISCELLANEOUS** | PW-1 | 2.87 | 4.40 | 0.57 |
| | | | | |
| **TURF** | MW-1S | 0.67 | 1.30 | 0.05 |
| **TURF** | MW-2S | 1.38 | 2.60 | 0.67 |
| **TURF** | MW-2D | 1.51 | 1.80 | 1.30 |
| **TURF** | MW-3S | 2.19 | 3.00 | 0.44 |
| **TURF** | MW4/4R | 1.94 | 2.40 | 1.50 |
| **TURF** | MW-5 | 1.80 | 2.40 | 0.90 |
| **TURF** | MW-7 | 1.34 | 1.80 | 0.95 |
| **TURF** | MW-8 | 1.02 | 1.30 | 0.60 |
| **ABANDONED** | MW-9 | 2.26 | 3.10 | 0.20 |
| 5-YR AVERAGE | | 1.48* | | |
| * not including MW-9 | | | | |
| **AMBIENT WELLS** | MW-1D | 0.07 | 0.50 | 0.05 |
| | MW-3D | 0.14 | 0.24 | 0.05 |
| | MW-6 | 0.23 | 0.34 | 0.11 |
| 5-YR AVERAGE | | 0.15 | | |

It is noted that the use of the Mann-Kendall test in the 2009 ETS Annual report found that the three recommended ambient wells had decreasing concentrations. ETS has indicated that the variability of nitrogen concentrations in the earlier sampling years might be due to the release of dissolved solids from the initial land clearing as will as the potential for greater nitrogen movement into groundwater during the establishment of the golf course. The variability could account for the anomalous higher nitrate results at the beginning of the monitoring program for the ambient wells, which results in an apparent decreasing trend. However, it appears on the graph (Figure 1) that they are consistently low over the last five or more years.

The Mann-Kendall test also indicated the increases in the nine Turf Wells (eight now that MW-9 is abandoned). The increasing trends of the eight Turf Wells are evident in the graph below (Figure 2). Low nitrate concentrations, generally below 0.5 ppm, are observed in the beginning of the monitoring program, before the course was built and the early years of fertilizer application. The low pre-existing concentrations are followed by an increasing trend, and then a general leveling off. MW-1S is the most variable and like BW-1 its location close to the regional divide results in more variable groundwater flow paths. Over the last three quarters, an increasing trend at the end of the monitoring period is seen in MW-2S. The early outlier of 6.6 ppm nitrate in Well MW-3S, which was not confirmed by resampling, is omitted for this analysis.

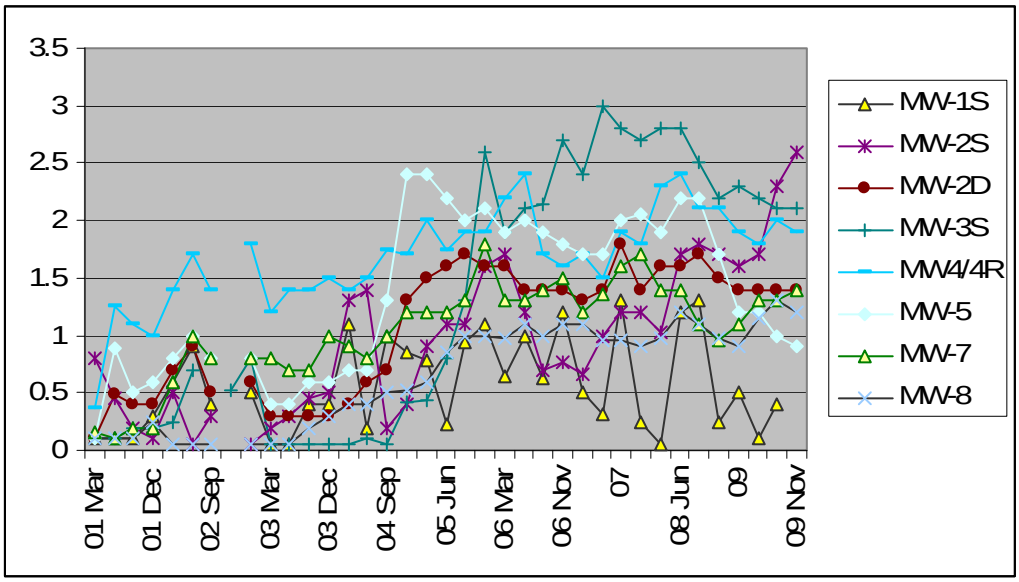



**Figure 2 Nitrate-Nitrogen Concentration in Eight Wells Affected by Turf Management**

If we omit the BW-1, PW-1 and even MW-9 in the calculations, and identify MW-1D, 3D and MW-6 as ambient wells, we can make better comparisons to the water quality in the eight remaining turf wells to evaluate the impact of turf management at the golf course as shown below.

| Nitrate (ppm) | |
|---|---|
| 0.21 | Nine Year Average (2001-2009) of the three ambient wells |
| 0.15 | Last 5 year (2005-2009) average of the three ambient wells |
| 1.08 | Nine Year Average of the 8 turf wells w/o BW-1, PW-1 or MW-9 |
| 0.87 | Nine Year Average increase of nitrogen over ambient (0.21 ppm) |
| 1.48 | Last five year average of 8 turf wells w/o BW-1, PW-1 or MW-9 |
| 1.33 | Last five year average increase over ambient (.15 ppm) |
| 0.67 to 2.19 | Last five year range of average nitrogen of 8 turf wells |
| 2.87 | Last five year average in perched groundwater (PW-1) |

There has been an overall average N increase of 0.9 ppm observed in the eight turf management wells over the nine year period of record (2001-2009). If we use only the last five years in which the increase appears to flatten-out, as suggested in the 2009 Annual report, then the average nitrate concentration is 1.48 ppm. This is a 1.33 ppm average increase over the ambient concentration of 0.15 ppm. The average ambient nitrate concentration is less because the last five years do not include the higher concentrations from front-end variability in the early years of the data. Conversely, the eight turf management wells have a higher nitrate concentration because the low concentrations of the pre-build and early years are not included.

Individual maximum N concentrations over the last five years (2005-2009) are 3.1 ppm in MW-9 (abandoned) and 3.0 ppm in MW-3S. The maximum nitrate increase over the average ambient concentration of 0.15 ppm is 2.85 ppm.

## PERCHED WATER TABLE

The perched monitoring well PW-1 presents an interesting case. The nitrate concentration in PW-1 is nearly a straight line increase from 0.2 to 4.5 ppm as shown in the graph below (Figure 3). The two points below the "straight line" are suspect. The perched water table is only 32 feet below the land surface whereas the average depth to the aquifer's water table is 99 to 219 feet depending on topography. Review of the well log indicates that the thickness of the perched water table is about 10-15 feet. A review of the well logs from other sites on the course indicates that the aquitard does not have an appreciable thickness or extent. However, a USGS study by Schubert (WRI-R98-4181) of groundwater flow paths in the Southfork area indicates a sub-regional perched aquifer in the moraine deposits in this vicinity. In any case, the perched aquifer is shallow, has less water, and is not replenished by the principle aquifer. Therefore, the nitrogen mass that leaches is subject to less dilution than what occurs in the principle aquifer. Groundwater in perched areas typically "leak" through the supporting clay at very slow rates that can change the character of its quality before eventually contributing to the principal aquifer.

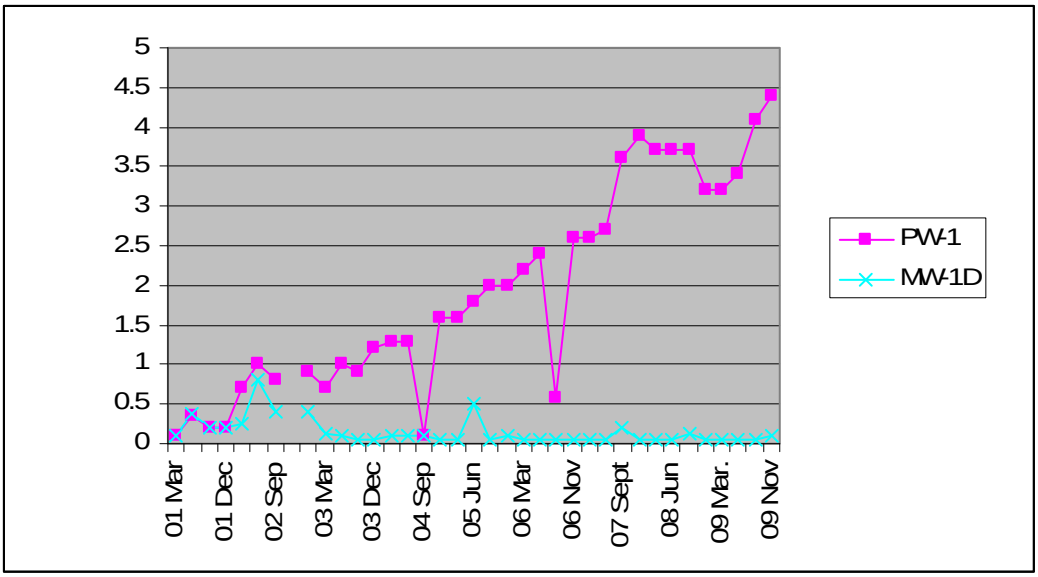



**Figure 3 Nitrogen Concentration (ppm) in PW-1 (2001-2009)**

There are a host of questions that the water quality increase of the perched water table raises. At what concentration will N level off? The perched well is also located in close proximity to a drainage pond, which receives drainage from at least two drains on Fairway 8 that were observed during the site visit. Does the drainage pond concentrate dissolved nitrogen from surface drainage that subsequently leaches to the perched aquifer? What is the N concentration in the pond? Should the 5 ppm trigger level be applied to the perched aquifer? A long term hydrograph of PW-1 should be prepared and compared to the other wells to evaluate fluctuations and determine if the perched water

table has a net gain due to irrigation. Is the perched zone extensive enough to use as a limited source of enriched irrigation water? A long term pump test and water quality assessment of PW-1 using a high yield submersible pump should be considered in the interim to evaluate its use as a source of recycled nitrogen. Discharge of the water pumped from PW-1 into the pond due to its potential for nitrogen uptake is another potential alternative.

**NITRATE SUMMARY**

*The quarterly and annual reports use the BW-1 well to compare the impacts of turf management. The comparison may not be useful because the well is on the other side of the divide and is impacted by several different land uses and its concentration is nearly always higher than the downgradient wells.*

*Although turf management has a demonstrated nitrate impact on groundwater quality, the results are low enough below the 5 ppm threshold to conclude that it has not significantly impaired water quality. Thus, the turf management protocols have kept nitrate concentrations in groundwater below 25% of the agreed upon threshold of 5 ppm.*

*It is apparent that application of fertilizers to turf aided by irrigation can result in the migration of solutes through over 100 feet of the unsaturated zone that results in water quality impacts at the water table.*

*In regard to the perched water monitored in PW-1, a case can be made that the threshold should not be 5 ppm since it is not part of the principle aquifer; however, if the concentration should exceed 5 ppm, then remedial action should be required (i.e., use it for irrigation). The questions raised above may be useful to evaluate if it appears that the 5 ppm threshold is being approached.*

*Continued monitoring of a number of the deep wells is important to evaluate long term ambient ground water.*

## PHOSPHORUS IN GROUNDWATER

Phosphorus is sampled in groundwater monitoring wells and lysimeters. We used the summary table from the 2009 Annual report to comment on its occurrence in groundwater. Overall, the detected amounts of phosphorus are very low. Phosphorus is subject to attenuation by the iron and aluminum particulates in the soil aquifer matrix. A certain amount of phosphorus is natural. The data below (Figure 4) are qualified in the large number of non-detects that are averaged as ½ of the detection limit of 0.05 ppm.

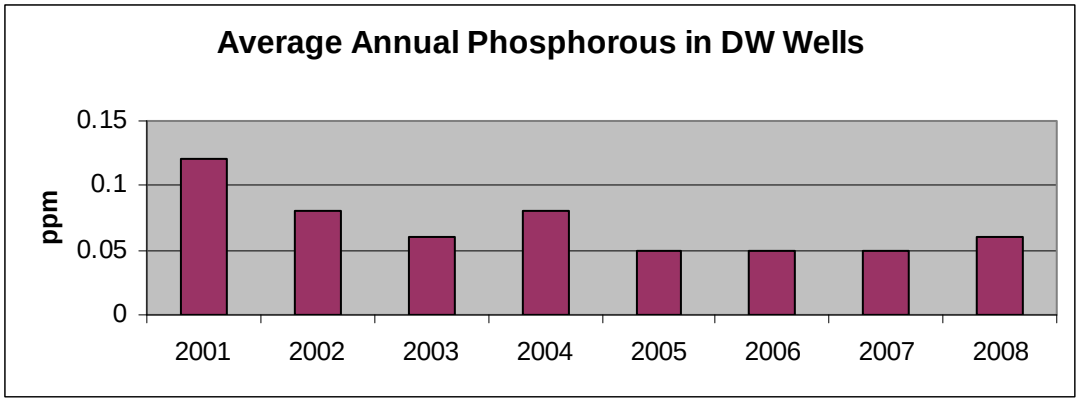



**Figure 4 Average Annual Phosphorus in Downgradient Wells (DW) (without BW-1 and PW-1)**

*The 1998 Independent Review indicated that phosphorus loading would not likely be a problem to downgradient surface water bodies. The monitored groundwater concentrations are basically below detection limit so it is recommended that phosphorus be removed as an analyte in future monitoring events.*

## PESTICIDES IN GROUNDWATER

Of the 13 wells tested, excluding the background well, there were 60 detections (see Table 2) of pesticides above the reporting limit, which is 0.1 ppb for most analytes. In all but five cases, the detections were below 0.5 ppb. The five detections that were above 1 ppb occurred in the early monitoring years 2001-2002 at the MW-4 site well, which was replaced with well MW-4R. The detections were associated with a surface water sump located in close proximity to MW-4. In addition, the well casing was cracked. Those compounds have not been detected since the well was replaced. The recent number of detections has occurred at the MW-2 well site where myclobutanil, propiconazole isomers, and chlorothalonil have been detected in the years 2007 to 2009. Chlorathalonil has also recently been detected at PW-1, MW-5, 7, 6, and 8. Many of these are first time detections that are just at the reporting limit (0.1 ppb) and should be evaluated in the future if the levels increase and are persistent. Other than MW-4 during 2001-2002, specific pesticide concentrations both individually and cumulatively in any well were below the New York State Principle Organic Compound public health thresholds of 5 ppb, the 50 ppb DEC Guidance Values, or ETS Health Advisory Levels, whichever is lower and appropriate for the particular pesticide.

**Table 2. Average Annual Phosphorus in Downgradient Wells (without BW-1 and PW-1)**

| Well* | Paclobutrazol | Triadimenol | Myclobutanil | Chlorothalonil | Propic a | Propic b | PCNB | Total Detects |
|---|---|---|---|---|---|---|---|---|
| **MW-4/4R** | 5 | 8 | | | | | | |
| **MW-2S** | | | 6 | 1 | | 2 | | |
| **MW-2D** | | | 8 | 1 | 10 | 10 | | |
| **PW-1** | | | | 1 | | | | |
| **MW-5** | | | | 1 | | | | |
| **MW-6** | | | | 1 | | | | |
| **MW-7** | | | | 2 | | | 2 | |
| **MW-8** | | | | 2 | | | | |
| **Total Detects** | 5 | 8 | 14 | 9 | 10 | 12 | 2 | 60 |
| **Total Analysis** | 533 | 533 | 533 | 533 | 533 | 533 | 533 | 533 |
| **Percent detects** | 0.94% | 1.50% | 2.63% | 1.69% | 1.88% | 2.25% | 0.38% | 11.26% |

* The results from the abandoned well, MW-9, are not included in this table.

*The Bridge has taken an aggressive response to the detection of pesticides. They have voluntarily agreed to eliminate the use of paclobutrazol, myclobutanil, and triadimefon. The Protocol indicates that pesticide application shall be reduced to one half the amount over the golf course. An interpretative decision to apply the reductions over specific areas based upon detections is a more recent application to this response and should be evaluated. For instance, the 3rd quarterly report in 2009 indicates that only one-half of certain pesticides (chlorothalonil and propiconazole-a) used in the past will be applied to hole areas 6, 7, 9 and 13. The reduction is also indicated in the 2009 4$^{th}$ quarterly report. Although this type of information is contained in the paper quarterly reports the information needs to be in much greater detail (i.e.a hole by hole analysis including specific location, i.e. greens, tees, fairways or roughs, by date of application for each pesticide should be included in the semi-annual reports to track how these reductions are implemented over time. It is also recommended that, the procedure to select areas for the reduced amounts should be explained and included in any future report.*

*In the case of pesticides, the overall quality of the groundwater has not been significantly affected by the golf course operations at The Bridge Golf Course.*

## LYSIMETERS

Lysimeters are used to sample shallow soil water and to serve as an early warning/response method to protect groundwater quality. In sandy soil it is often difficult to obtain enough of a water sample for both pesticide and fertilizer inorganic compounds. The nitrogen threshold for response action at the Lysimeters is 10 ppm. This level was exceeded several times: twice at G4-3 and G4-6 (2004), four times at G7-3 (2007-2008) and nearly exceeded (9.7 ppm) at F10-3 in 2005. The exceedence at G4 was explained as a result of mis-application of fertilizer directly above the lysimeters. The exceedence at G7 was explained as a result of no bio-filter over the lysimeters. The long-term trend analyses of the nitrogen lysimeter data are shown in Table 3 that is derived from the 2009 Annual Report below. Over the period of 2001 to 2009 the annual average nitrate concentration in the lysimeters ranged from a low in 2006 of 0.77 mg/L to a high of 4.14 mg/L in 2008 with no clear pattern.

**Table 3. Mean Nitrate-Nitrogen Concentrations in all Lysimeters**

| Year | Mean N Concentration (ppm) | Standard Deviation (±; ppm) | Number of Data Points | Number of Non-detects (% ND*) |
|---|---|---|---|---|
| 2001 | 1.1 | 1.21 | 10 | 0 (0) |
| 2002 | 1.21 | 1.01 | 25 | 3 (12) |
| 2003 | 1.13 | 1.37 | 30 | 9 (30) |
| 2004 | 2.61 | 4.37 | 34 | 11 (32) |
| 2005 | 1.1 | 2.09 | 28 | 11 (39) |
| 2006 | 0.77 | 0.79 | 31 | 10 (32) |
| 2007 | 2.40 | 2.95 | 32 | 8 (25) |
| 2008 | 4.14 | 10.25 | 32 | 8 (25) |
| 2009 | 1.90 | 1.88 | 32 | 8 (25) |

*ND = non-detects

The quarterly occurrence of nitrate in lysimeters was plotted and graphed below (Figure 5). The graph shows that except for the initial sample results, the lysimeters at G14 (at both the 3 and 6 foot depths) had relatively few detections. In fact, the eight non-detects for the 2007 to 2009 years, as indicated in Table 3 above, are from the lysimeters at this location. It is also apparent that the nitrate concentrations at the couplet lysimeters G14-3 & 6 have a similar track to each other**.** The statistics of nitrate at each location are shown in the Table 4. The average nitrate concentration of six of the eight lysimeters is above 2.28 ppm and the maximum concentration was reported at a N concentration greater than 5 ppm. Overall, however, there were only 18 out of 260 lysimeter samples that were greater than 5 ppm. It would be expected that the lysimeters would have higher maximum and average concentrations than the monitoring wells because the lysimeters catch relatively undiluted "runoff" from the course or receive drainage from the greens. It is also evident that the lysimeter data is used to manage turf as when in the 2008 quarterly report, less nitrogen fertilizer was specified in response to a detection of 21 ppm at G7-3.

The lysimeter data indicate a mixed performance of the biofilters. The biofilters at the G14 location appear to work extremely well in contrast to the biofilter at G7 at some of the sampling events, even accounting for the outlier detections from unintentional applications. It is unclear at the moment if there are parameters that can account for the contrast and it is therefore recommended that monitoring the biofilters be dropped from the protocol in favor of actual green infiltration.

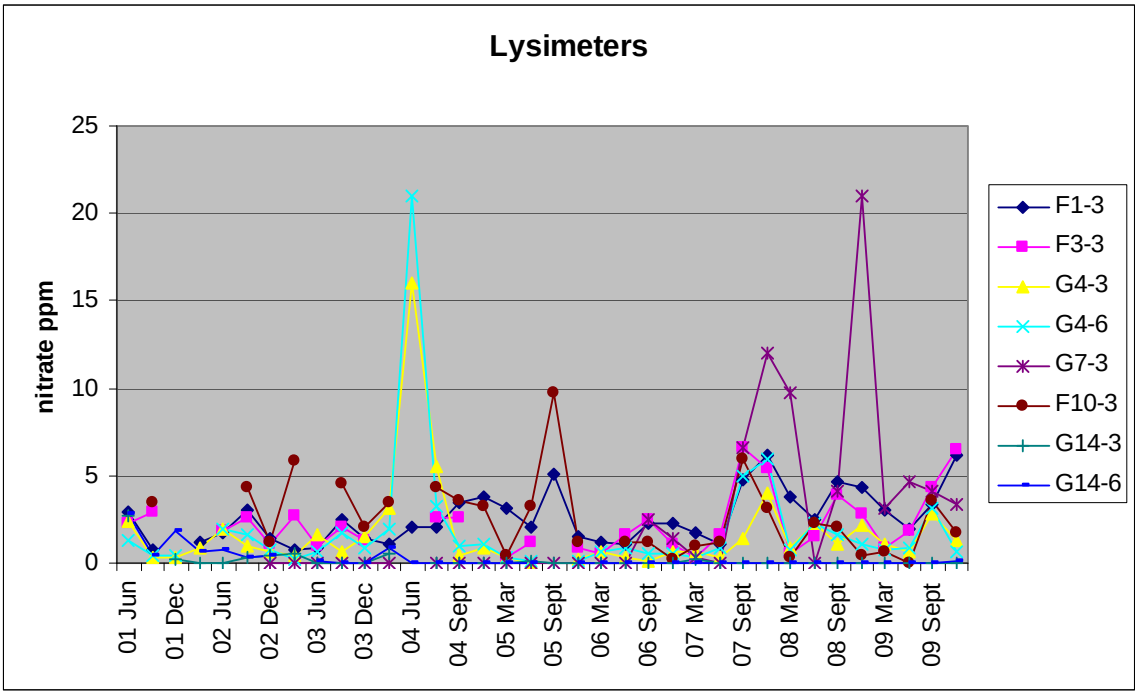



**Figure 5 Graph of Nitrate Concentrations in Lysimeters**

**Table 4. Nitrate Concentrations (ppm) in Lysimeters (2001-2009)**

| | mean | max | min | n | NDs |
|---|---|---|---|---|---|
| **F1-3** | 2.61 | 6.2 | 0.8 | 35 | 0 |
| **F3-3** | 2.24 | 6.6 | 0.34 | 30 | 0 |
| **G4-3** | 1.67 | 16 | 0.13 | 35 | 1 |
| **G4-6** | 1.90 | 21 | 0.15 | 34 | 0 |
| **G7-3** | 2.63* | 21 | 0.29 | 28 | 16 |
| **F10-3** | 2.61 | 9.7 | 0.23 | 29 | 1 |
| **G14-3** | 0.18 | 2.68 | 0.16 | 34 | 26 |
| **G14-6** | 0.28 | 2.77 | 0.1 | 34 | 24 |

N= number of samples; NDs = number of non-detects
* 56 ppm was not included in this result

*Overall, the results of the lysimeters are used as an early warning as to the mass of nitrogen or pesticides that can potentially leach further through the soil to groundwater. Long term data has shown that where nitrate is being detected, lysimeter concentrations are higher than groundwater. The lysimeters also show that the installation of bio-filters to attenuate nitrogen has worked reasonably well to protect groundwater as seen in the*

*performance between G14 and G7, before G7 was reconstructed. Furthermore, the use of couplet lysimeters appears to produce redundant data.*

The detections of pesticides in lysimeters are presented as text in the body of the quarterly and annual reports. The following are some highlighted occurrences. In 2003, there were detections of triadimenol in F3 and F10 at concentrations of 10 to 3.7 ppb and 1.1. to 1.3 ppb, respectively. Also there were detections of triadimenol, fenarimol and propiconazole-a,b in G14 -3 and G14-6. In 2004 there were detections of fenarimol in G14-3 and G14-6 and a detection of myclobutanil in F10. In 2005, there were detections of fenarimol, myclobutanol, propiconazole. In 2006, there were detections of myclobutanil, fenarimol and propicnazole-b, all less than 1 ppb. In 2007, there were no detections of pesticides at all, but in 2008 there were detections of propiconazole, chlorothalonil, myclobutanil, fenarimol, and PNCB. In 2009, there were detections of propiconazole, chlorothalonil, and PNCB all less than 1 ppb. A complicating issue is where there have been detections of triadimenol and myclobutanil where the fungicide Bayleton and Eagle were not applied. However, it is known that these pesticides are used on sod farms in the area, and these parts of the golf course have sod purchased from those farms.

## GOLF COURSE OPERATIONS

The Protocol and Natural Resource Management Plan provide for a number of operational requirements. These include Turf Area, applied fertilizer, applied pesticides, irrigations, site visits, and general management. The quarterly and annual reports of both ETS and Dr. Petrovic provide the basis of our review of several key areas.

### TURF AREA

The Decision on the Golf at the Bridge Course specified that the 281 acre total project area in the Quasi-Public Service Use District would have approximately 122 aces in managed turf. The decision allowed a breakdown of 80.38 acres in managed turf and 50.18 acres of perimeter turf in which there would be low maintenance with no fertilizer or irrigation.

| | |
|---|---|
| 3.74 | Tees |
| 2.72 | Greens |
| 33.05 | Fairways |
| 40.87 | Intermediate Rough |
| 80.38 | Total Acres |

50.18 Perimeter Rough – Low Maintenance – No fertilizer or Irrigation

We asked for an as-built assessment of the area of turf. The Bridge Superintendent Gregg Stanley provided us with a GPS assessment of the area of managed turf. These were provided as pdf files containing two maps of the front and back nine holes (found in the Attachments) as well as the range area, and a table listing the total acreage.

*The total fertilized area as mapped is actually 78.27 acres, which is slightly less than 80.38 acres, the amount allowed.*

## APPLIED FERTILIZER

### Nitrogen

The Protocol requires the reporting of the types and amounts of fertilizers and pesticides applied to the course. The quarterly and annual reports contain the information as required in the Protocol. The Independent review provided by AM Petrovic has verified information contained in the Superintendent's notes and annual reports.

The golf course is allowed to apply the following amount of nitrogen (N) fertilizer:

| | |
|---|---|
| 6.46 acres of greens and tees at 2.5-4 lbs. N/1000 sq. ft. | 704 to 1,126 lbs. N/year |
| 30.05 acres of fairways at 3-4 lbs. N/1000 sq. ft. | 3,927 to 5,236 lbs. N/year |
| 40.29 acres of roughs at 1-3 lbs. N/1000 sq. ft. | 1,755 to 5,265 lbs. N/year |
| Totals | 6,386 to 11,627 lbs. N/year |

The following chart shows the annual amount of fertilizers applied to the golf course relative to the recommended low end of the cumulative limit of 6,386 pounds per year.

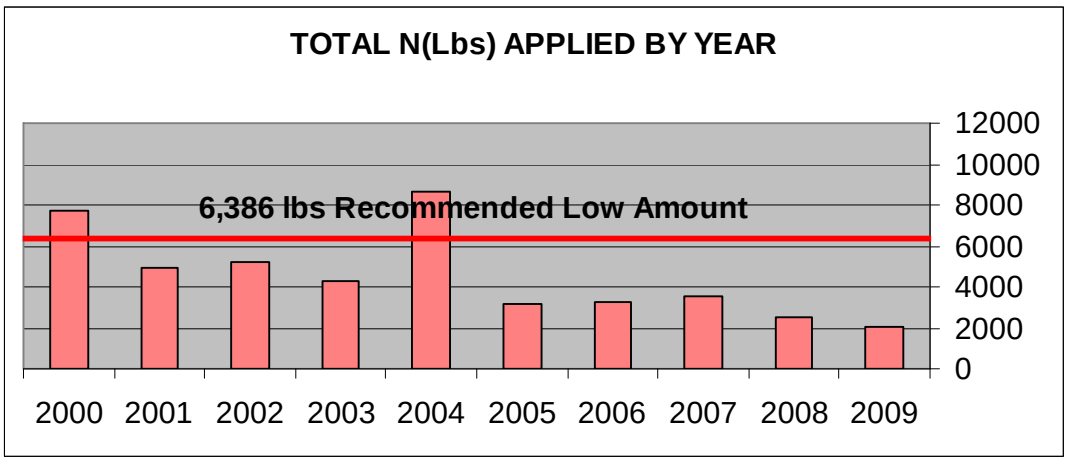



**Figure 6. Total Nitrogen Fertilizer Applied**

*As reported in the superintendent's annual reports and reviewed by the Independent consultant, fertilizer amounts have been below the specified amount of 6,386 pounds N per year since 2004. The average over the 9 year period is 4,539 lbs/yr. This is 71% of the low end range of the allowable amount. During the last five years (2005-2009) of turf management, the Superintendent has only used an average of 2,905 lbs/yr or 45% of the low end of the allowable amount (6,386 lb N/yr). It is noted that the higher amount of fertilizer (8,667 lbs/yr) used in 2004 preceded significant increases of groundwater nitrogen concentrations in several of the 8 turf and turf response wells as shown on the earlier graph; however, the amount used in 2004 was within the range of the total amount allowed.*

*Water quality data in the eight turf monitoring wells over the five year period of 2005-2009 indicate a "plateau" average N concentration of 1.48 ppm, which is approximately 30% of the 5 ppm threshold. A maximum concentration of 3 ppm or 60% of the 5 ppm threshold was observed in one of those eight wells. The original Protocol allows a doubling of the fertilizer applications beyond that used over the last 5 years. A doubling of the fertilizer amount may result in a doubling of resultant average nitrogen concentrations (assuming it is a linear relationship, which it is not) that approach 3 ppm and maximum concentrations that could exceed 5 ppm.*

*The 1995 Integrated Golf Course Management Plan and Water Quality Risk Assessment predicted increases of resultant nitrogen concentrations in groundwater of approximately 0.3 ppm above background (a range of 0-0.5 ppm was given). The Independent Review of 1998 used a nitrogen loading model to estimate that nitrogen concentrations from the highest recommended application rates would range from 2.4 to 1.4 ppm depending on leaching rates from 15 to 25%. First order calculations of non-point source loading impacts to groundwater are based on a number of simplifying assumptions.*

*Now that there is nine years of groundwater water quality data we revisited the calculation of relative nitrogen leaching to groundwater. The 9 years of quarterly sampling allowed for the characterization of distinct turf wells with higher N concentrations than ambient wells. The water quality trend in groundwater from turf wells over the last five years maintains consistent nitrogen concentrations as compared to the initial years, as discussed earlier, which indicates an average increase of 1.33 ppm nitrogen. We calculated a comparative mass of nitrogen in the volume of aquifer consistent with the annual recharge, by incorporating 22.7 inches of recharge (50% of the average long term precipitation) over 80 acres of turf. The calculated annual mass of nitrogen in the aquifer is 19% of the average annual nitrogen application rate over the last five years of 2,900 lbs/yr.*

*ETS presented an alternative method in which they calculated the nitrogen mass from the 1.33 ppm concentration in a pre-determined volume of aquifer. This was compared to the total amount of nitrogen applied over 5 years. An adjustment of an additional one-half that amount was incorporated to account for groundwater travel time which results in a leaching rate of 12%.*

*We compared the estimates to nine scientific research studies on golf course turf, of which more than half are greenhouse studies. The studies cover a wide range of factors that influence nitrogen leaching including cultivar and species differences, amendments of sand, nitrogen sources and rates of application, cultivars of bentgrass with different rooting depths, clipping management, soil types, and an actual green on a golf course.*

*The amount of leaching ranged from none to a high of 71% of the amount of fertilizer nitrogen applied with an average from all studies of 13.34%. Half of all the results (84 values) were below 3% of the amount applied. Field studies are considered a better representation of what actually occurs in the real world and greenhouse studies are good to compare factors and often give higher leaching values. When only considering the four field studies, the percent of fertilizer nitrogen that leached averaged 3.0%, ranging from 0.02% to 13.2%. The golf green turf had the highest amount of fertilizer nitrogen that leached. The factors found to increase fertilizer nitrogen leaching were: applying increasing amount of nitrogen fertilizer especially to pure sand greens compared to ones with peat or other amendments, much more leaching occurred during the establishment phase that in subsequent years (up to 3yrs), bentgrass cultivars with shorter roots than ones with deeper roots had more leaching, the more irrigation was applied more fertilizer nitrogen leaching, the sandier the soil the greater the amount of fertilizer nitrogen that leached, and annual bluegrass had much more leaching than bentgrasses especially annual bluegrass from Canada.*

*The Bridge has agreed to be a part of the Peconic Challenge to achieve the goal of no more than 2 ppm nitrogen in groundwater. Based on the nitrogen application values and present average nitrogen concentration in groundwater of 1.48 ppm, it is recommended change in the protocol that the town adopt a qualified limit of no more than 3,000 lbs of nitrogen applied per year.*

*Additional recommendations by Dr. Petrovic to further reduce fertilizer applications and yet maintain a healthy playable surface should continue to be implemented such as use of clippings on rough areas.*

*As indicated in the Annual and Independent Reviewer reports, the Superintendent continues to use soil test results to guide fertilizer application.*

## PESTICIDES APPLIED

The application of pesticides follows the requirements of the approved 1998 Natural Resource Management Plan (NRMP) as amended in 2000 with review and recommendations of Dr. Petrovic.

The NRMP allows the use of 32 specific pesticides. Over the course of operations only 14 pesticides have been used. The majority of pesticides used are fungicides followed by herbicides and very infrequent use of insecticides. The following are the types and names of the actual pesticides used on the golf course by year. The amounts of pesticides applied are available in the Superintendent's Annual reports. The Independent Reviewer evaluates the Superintendent's scouting and total pesticide application amounts. Scouting is performed daily and observations of pests are recorded as part of the field history/scouting reports. Those reports outline the occurrence, identify the pests, and the action thresholds for pesticide application. The actions taken are in conformance with the Natural Resource Management Plan. Pesticide application generally corresponds to the pest occurrence as found in the field pest history reports.

**Table 5. Number of compounds of each type of pesticide**

| | Insecticide | Herbicide | Fungicide |
|---|---|---|---|
| 2009 | 0 | 1 | 5 |
| 2008 | 0 | 1 | 5 |
| 2007 | 0 | 1 | 5 |
| 2006 | 0 | 1 | 4 |
| 2005 | 0 | 0 | 5 |
| 2004 | 1 | 0 | 7 |
| 2003 | 1 | 0 | 6 |
| 2002 | 1 | 0 | 6 |
| 2001 | 0 | 0 | 8 |

**Table 6. Pesticides Applied by Year**

2009 azoxystrobin, iprodione, chlorothalonil, propiconazole, 2-4D, dicamba, MCPP-H
2008 azoxystrobin, iprodione, chlorothalonil, propiconazole, 2-4D, dicamba, MCPP-H
2007 azoxystrobin, iprodione, chlorothalonil, propiconazole, 2-4D, dicamba, MCPP-H
2006 azoxystrobin, iprodione, chlorothalonil, 2-4D, dicamba, MCPP-H
2005 azoxystrobin, iprodione, myclobutanil, chlorothalonil, PCNB, trinexapac-ethyl
2004 thiophanate methyl, thiram, iprodione, triadimefon, propamocarb, propiconazole, chlorothalonil, chlorpyrifos -turfmate and tea
2003 thiram, iprodione, triadimefon, fenarimol, propamocarb, propiconazole, chlorpyrifos -turfmate and tea
2002 thiram, iprodione, triadimefon, fenarimol, propamocarb, propiconazole, chlorpyrifos

2001 thiram, iprodione, triadimefon, fenarimol, propamocarb, propiconazole, thiophanate methyl -Turfshield & paclobutrazol,-GReg

* 2002 Annual report indicates that triadimefon and paclobutrazol were stopped in June 2003 and Sept 2001, respectively, and fenarimol was stopped in 2003.

*The amounts of pesticides applied are contained in the appendices of the quarterly water quality monitoring reports and summarized in the Annual reports. The Independent Reviewer reviews all of The Bridge reports submitted to the Town. The scouting is performed daily and observations of pests are recorded as part of the field history. The reports outline the occurrence, identifies the pest, and the action thresholds for pesticide application. The actions taken are in conformance with the Natural Resource Management Plan. Targeted pesticide application generally corresponds to the pest occurrence as found in the field pest history reports. No insecticides have been applied since last used in 2004.*

## GROUNDWATER FLOW MAPS

Measurement of static water levels and preparation of water table maps are required by the protocol. Quarterly reports contain the water level measurements and the Annual reports contain four quarterly water table maps. The water table flow maps show some variability in flow directions, particularly at the top of the groundwater divide. Although the difference in flow directions seems to impart a higher degree of variability to wells BW-1 and MW-1S and their nitrogen concentrations, the flow maps do not have a great bearing on the management of the course, except the selection of reduced pesticide area applications as a response to a threshold exceedence, as discussed above.

*Water table maps should continue to make use of measurements at the TW-wells and be contoured by hand.*

*The collection of water table measurements and preparation of water maps should continue. However, long term hydrographs of the wells should be prepared and compared and regularly included in the semi-annual and annual reports. These can be used to supplement irrigation and precipitation reporting and as discussed earlier compare to the perched well.*

## IRRIGATION

There are four irrigation wells located along the 15$^{th}$fairway. These four wells have a combined capacity of 1,100 gallons per minute. Irrigation amounts were obtained from the Independent Reviewer's reports. Overall, the irrigation amount averages 24.3 million

gallons per year. The irrigation period is from April to October for 7 months with the highest rates being in the summer. This translates into a daily average pumping rate of 115,700 gallons per day over the seven month period. The annual average amount can be pumped over a period of approximately 105 minutes.

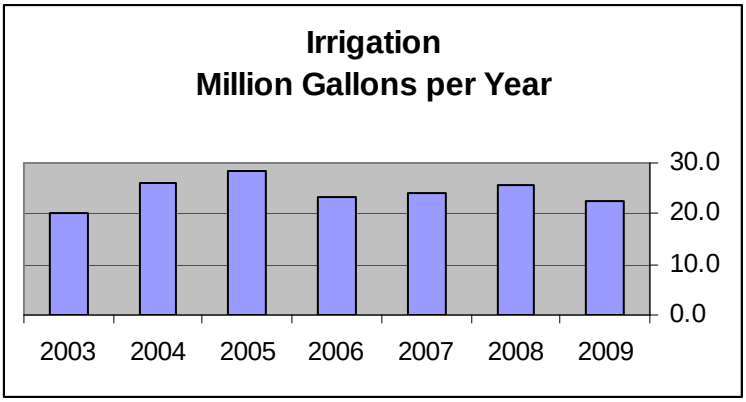



**Figure 7. Annual Irrigation Applied**

The irrigation amounts are recorded by the Toro weather station. The data are used to evaluate the net amount of annual evapo-transpiration (ET) in inches that would be required by the irrigation system. The inches of ET and the amount applied are fairly equal except for 2004 and 2005. It is assumed that a much higher rate of irrigation was needed during these yearly grow-in years prior to 2001 and a more accurate way to incorporated ET data was implemented following 2005.

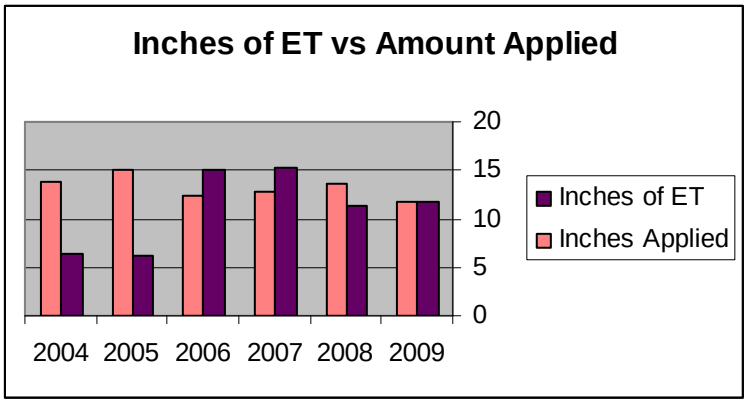



**Figure 8. Inches of Evapotranspiration vs. Amount of Irrigation**

*The pumping of 24 million gallons per year will result in slight variations of groundwater flow near the pumping well, resulting in a potential dilution of substances in groundwater proximal to the wells. The locations of irrigation wells should be shown on the groundwater table map. A groundwater flow capture area for the irrigation wells using*

*a simple groundwater model was prepared by the Technical Review Team and the results are attached to this report. The golf course has made recent use of drip irrigation in the perimeter turf to the sand traps with very favorable results in turf growth and health. The Independent Review has encouraged a wider application of this technology to promote healthy and more resistant growth and reduction in irrigation amounts and it is recommended to be added to the amended Protocol.*

## SITE VISIT

On August 11, 2010 Thomas Cambareri and Marty Petrovic conducted a site visit to the Bridge Golf Course. The site visit was attended by Jeff Murphree, the Town's Director of Land Management, Stuart Cohen of Environmental & Turf Services, Inc. (ETS), Gregg Stanley, Golf Course Superintendent, and Filip Sinni and Steve Colabufo of the Suffolk County Water Authority (SCWA). The meeting started at 12:30 PM. After introductions, general discussion, and site description, a site visit was conducted with the use of several golf carts. Mr. Cambareri rode with Gregg Stanley and Mr. Petrovic rode with Stuart Cohen. The party visited well sites MW-3, MW-5, MW-2, LG-7, PW-1, passed by the irrigation wells, MW-4R and the general area of abandoned well MW-9. The party met again at the golf course Superintendent's office to discuss impressions and to hear Mr. Cohen's specific ideas about updating his request for modifications to the monitoring program. It was noted that the use of golf cart paths on the turf areas had been appreciably reduced from the earlier years

## TECHNOLOGY ALTERNATIVES

### PEST MANAGEMENT

The Bridge should consider a systematic testing program for bio-fungicides that can potentially be used in the golf course disease control program and it is recommended to be added to the amended Protocol. The Bridge has conducted a non-technical evaluation of some of the bio-fungicides (see Table 8, from 2010 Pest Management Guides for Commercial Turfgrass, Cornell University). The reason to consider the use of bio-fungicides is that they are often much less toxic than conventional fungicides. The systematic approach would include on-site testing of the materials below compared to the golf courses traditional fungicide program along with un-treated areas to determine effectiveness of the bio-fungicides.

Except for one occasion, The Bridge has not requested to have any new pesticides added to the list of approved pesticides for use on the golf course. Since most of the pest problems are diseases, The Bridge should consider evaluating the risk of several new fungicides introduced since 2000 that are considered to have a much lower risk by USEPA: boscalid a reduced risk pesticide (Emerald) and a mineral oil (Civatas). Any new pesticides must be approved by the Town. The request for such approval must be accompanied with a ground water quality risk assessment, pursuant to the process suggested by ETS by its 1995 report or with more state of the art methods that were developed since 1995.

**Table 7. Biofungicides from 2010 Pest Management Guidelines for Turf Grass**

Bio-fungicides.

| Common Name | Sample Trade Name(s)[1] | Formulation[2] | EPA Reg. No. |
|---|---|---|---|
| ***Bacillus licheniformis* strain SB 3086** | EcoGuard Biofungicide | 0.14EC | 70127-2 |
| ***Trichoderma harzianum*** | Rootshield Granules | 1.15G | 68539-3 |
| ***Bacillus subtillis*, strain QST 713** | Serenade Garden Lawn Disease Control | 1.34 F | 69592-12 |
| | Rhapsody | 1.34F | 69592-19 |
| ***Pseudomonas aureofaciens* strain TX-1** | Spot-Less Biofungicide | 1L | 75801-1 |
| **Polyoxin D Zinc salt** | Endorse | 2.5W | 66330-41-1001 |
| **Mono and di-potassium salts of phosphorus acid** | Alude | 45.8EC | 71962-1-1001 |
| | Vital | 54.5EC | 42519-24 |
| **Phosphorus acid** | Magellan | 52.6L | 228-387 |

[1] Trade names shown are examples of products available and are not meant to be an exhaustive list. [2]AS = aqueous suspension; DF = dry flowable; EC = emulsifiable concentrate; F = flowable; G = granular; L = liquid; SC = soluble concentrate; W or WP = wettable powder; WDG = water-dispersible granule; WSB = water-soluble bag; WSP = water-soluble packet

## WATER MANAGEMENT

Most of the fertilizer and pesticides are applied during the period of the year when irrigation occurs. Over irrigation has been repeatedly shown to cause greater movement of nitrogen and pesticides through soils, likely leading to greater groundwater contamination. Thus, to protect groundwater quality everything possible must be done to ensure that over irrigation doesn't occur. The Bridge has done many things to reduce the likelihood of over irrigation: using an irrigation system with very accurate coverage; using evapotranspiration (ET) to guide the amount of water applied; and using drip irrigation to further reduce the amount of water applied in the greens surrounds. In 2010, The Bridge installed 12 soil moisture sensors in 6 greens to further fine tune the amount of irrigation applied. The Bridge should consider equipping all 18 greens with soil moisture sensors to further refine the amount of irrigation applied. The Bridge should also consider using TDR soil moisture probes to map greens, tees and fairway soil moisture variation to further refine and make adjustments in the amount of water applied to very specific locations on the golf course.  These suggestions are part of the recommendations to the amended Protocol.

# PART 2 REVIEW OF PROTOCOL MODIFICATION PROPOSALS AND RECOMMENDATIONS

Section III(B) of the 1997 protocol states that there will be quarterly sampling for five years, followed by annual sampling in perpetuity. This section was amended in 1999 (Protocol Amendment #5) to indicate that, following five years of monitoring (early 2006), the Study Director (ETS/Cohen) would submit recommendations for changes to the sampling based on a comprehensive evaluation of all data.

## PROTOCOL MODIFICATION PROPOSALS

On February 17 and 24, 2006, ETS submitted a five year review of the Ground Water Monitoring Program with a request for modifications in accordance with Amendment #5 of the 1997 Protocol. The Town's Independent Reviewer responded to the proposal and ETS provided alterations to the initial modifications. Subsequent to the submittal of the 2010 Part 1 Report on the Findings of the monitoring protocol, ETS submitted a revised request for amendments.

### ETS PROPOSAL – February, 2006

The requested modifications consist of the following:

Reduce the number of sampling rounds from quarterly for all lysimeters and monitoring wells to semi-annual for 8-wells and Annual for 5 wells and drop the Perched Well as follows.

**Table 8. Proposed Sampling Frequency in 2006**

| Semi-Annual | Annual | Drop |
|---|---|---|
| MW-1 | MW-1S | PW-1 |
| MW-2S | MW-1D | |
| MW-3S | MW-2D | |
| MW-4R | MW-3D | |
| MW-5 | MW-6 | |
| MW-7 | | |
| MW-8 | | |
| MW-9(abandoned) | | |

Lysimeters were proposed to be sampled annually. The monitoring wells had a proposed sampling schedule of Semi-Annual during: March-April and October-November.

Annual Sampling during: October-November

Proposed Pesticide Analysis included:
S150 for myclobutanil, fenarimol and propiconazole
515.3 for Dicamba, 2-4 D and MCPP

Proposed inorganic analyses included: Nitrate, phosphorus, and field parameters

A proposed two year window was proposed before it would be reviewed again.

**INDEPENDENT REVIEW RESPONSE (Petrovic) – August 1, 2006**

The Independent Reviewer made the following comments on the ETS request in a letter on August 1, 2006.

> Using only the S150 analytical method for three compounds was too narrow when it covers more than 20 analytes.
>
> Inorganic methods should also include Total Nitrogen
>
> The number and location of all 14 monitoring well sites are appropriate.
>
> The Fairway lysimeters should continue to be monitored. The green lysimeters in the drainage areas should be abandoned and new angled lysimeters 9 to 12 ft below the greens should be installed.
>
> The frequency should not be reduced drastically because of the lag-time that would occur before a responsive action could be taken.
>
> Any modified program should continue for at least five years before being reviewed.

**ETS ALTERATIONS OF INITIAL MODIFICATIONS – September 22, 2006**

ETS responded to the recommendations in a letter on September 22, 2006 containing the following alterations.

- Reduce only pesticide sampling to semi-annual.
- Continue Nitrogen and field parameters on a quarterly basis.
- Continue comprehensive 3-Year testing program containing methods L300, L311, S150 and EPA methods 547, 200.8, 515.3 and 524.2

**ETS PROTOCOL RECOMMENDATIONS -September 7, 2010**

ETS submitted a four page wish list for amendments as summarized below. This request was further refined in the final request September 28, 2010 letter.
Expand analyte list to include all pesticides used within the previous 12 months
Drop wells PW-1, MW-1D, MW-3D, MW-6, MW-7, and MW-8
Delete the Method 515.3 unless dicamba, 2-4D , MCPP have been used in the previous 12 months
Reduce monitoring frequency from quarterly to semi-annually in seven wells: BW-1, MW-1S, MW-2S, MW-2D, MW-3S, MW-4R, and MW-5
Establish new pesticide detection response threshold
Delete lysimeter sampling

**ETS REQUEST TO AMEND PROTOCOL - September 28, 2010**

The request to amend the Monitoring Protocol consists of the following:

A. Expand list of analytes to all pesticides used in the last 12 months, and analyze all pesticides ever used every 5 years

B. Reduce Monitoring in Lysimeters and Wells
    1. Eliminate all Lysimeters
    2. Delete Perched Well (PW-1) after pump test or switch to semi-annual
    3. Delete Background well (BW-1)
    4. Delete five Wells
        i. MW-1D, MW-3D, MW-6, MW-7 and MW-8
    5. Reduce Monitoring Frequency
        i. Semi-annually for PW-1, MW-2S and MW-7
        ii. Annually for MW-1S, MW-2D, MW-3S, MW-4R and MW-5
        iii. Sampled in June and September (turbidity + field parameters)

C. Reduce Analytes
    1. Eliminate Total Phosphorus (TP)
    2. Semi-Annual Pesticides
       MW-1S, MW-2S, MW-3S, MW-4R and MW-5
    3. Herbicides
       Eliminate 515.3 except for every 5 years
    4. Eliminate triennial sampling and replace with comprehensive annual and five-year sampling
    5. New Response Triggers
       Re-sampling for detect of 0.5 ppb or 10% HAL, MCL or DOH (POC or GV) level, whichever is lower.

# RECOMMENDATIONS FOR MONITORING PROTOCOL MODIFICATIONS

The technical review of test results and implementation of the Groundwater Monitoring Program found that it was carried out according to the protocol. Furthermore, the nine years of data allowed a long term perspective of the response of the aquifer to the turf management activities at The Bridge. From this perspective we find that the protocol could be optimized without compromising the protection of groundwater resources of the South Fork. The optimization that we recommend contains some reductions in aspects of the protocol and more specific response actions to the data that will continue to be collected.

## MONITORING WELLS

Three categories of monitoring wells are evident from the long term data; miscellaneous wells, which tend to respond to other variables than just turf management, turf wells, turf response wells and ambient wells. Of the turf wells, we find that MW-2S, MW-2D, MW-3S, and MW-5 have a strong response to turf management as indicated in the response to higher irrigation and fertilizer applications in the 2004 to 2005 period as shown in the graph below. We refer to these wells as Turf Response Wells and recommend these wells be sampled semi-annually. Further, we recommend that two of the three ambient wells, MW-1D and MW-3D be monitored on a semi-annual basis. These two ambient wells were chosen because they are located downgradient of managed turf, whereas MW-6, the other ambient well is located in the interior of the course (on the fairway of the 7$^{th}$ hole). Every two years, the entire remaining network of 12 monitoring wells will be sampled. Every fourth year will include analysis for a comprehensive list of compounds for the Turf Response Wells and others as indicated on Table 10.

The fluctuating nitrate concentrations at MW-1S are caused by its proximity to the groundwater divide, which is evident in Figure 2. The graph in Figure 9 shows the uniform response of the turf management wells. Because MW-1 does not have a uniform response, we have recommended that MW-1S be classified as a miscellaneous well and be sampled every two years. We have recommended that sampling for volatile organic compounds every three years as specified in the Protocol, is no longer necessary because of the long term lack of detections. However, due to the proximity of the storage shed and facility maintenance area upgradient of MW-1S, we recommend that MW-1S be sampled for volatile organic compounds as a pre-caution, in addition to the S150 pesticides and nitrogen for the two-year sampling round.

The perched well (PW-1) is another miscellaneous well that serves as an indication of impacted water that can subsequently reach the principle aquifer. We agree that PW-1 should continue to be monitored semi-annually with the turf response wells, and recommend that the management response for N be increased to 10 ppm. However, if the well exceeds a N concentration of 5 ppm, then that well should be pumped off in the next routine sampling round with the use of a submersible pump (>20gpm) and sampled for

nitrogen and S150 pesticides. This method of sampling the perched well could be used in place of the low flow pump for future sampling events.

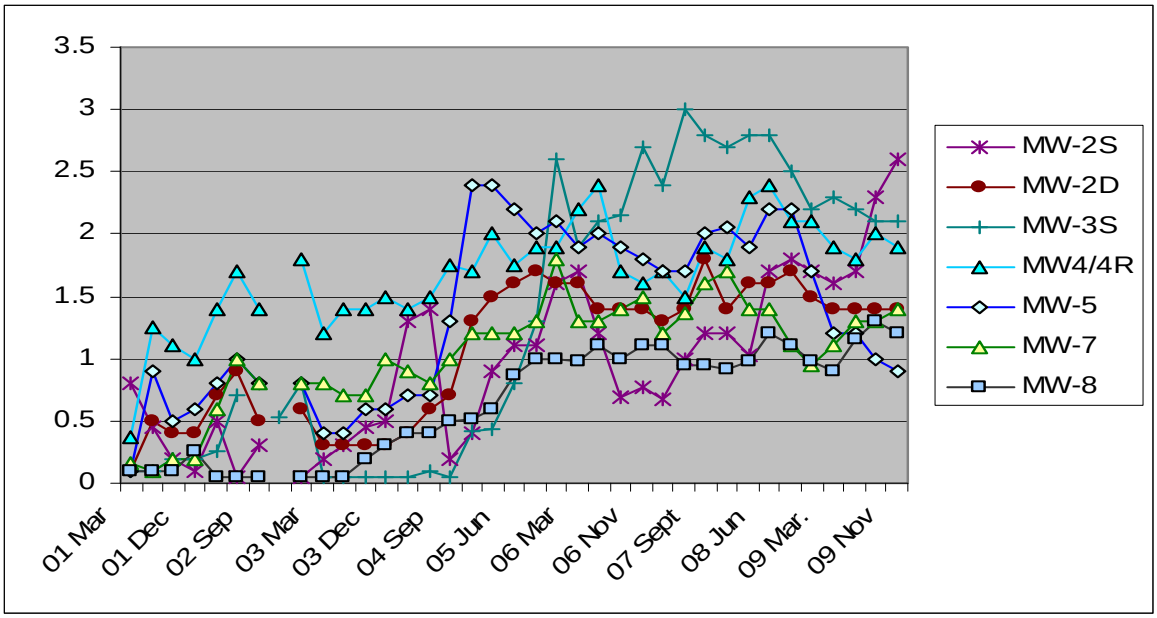



**Figure 9. Concentration of nitrate in selected wells over 9 years**
Note the elevated nitrate concentration in MW-2D, 3S and 5 in 2004-2005.

In summary, the turf response monitoring wells MW-2D, MW-3S, MW-5, and MW-2S, which has had consistent detections of pesticides, ambient wells MW-1D and MW-3D, and the perched well PW-1 are recommended to be sampled semi-annually for total Kjeldahl nitrogen (TKN), nitrate, S150 pesticides, and field parameters.

## LYSIMETERS

Based on further review of the findings of the long term lysimeter data (see graph below), we recommend that some of the lysimeters continue to be monitored for nitrogen and S150 pesticides on a semi-annual basis. These lysimeters include F1-3 and F3-3 that have a consistent response and can be used to reduce turf management impacts. As for green lysimeter testing, we recommend that as an alternative to the green biofilter lysimeters that angled lysimeters be installed through the use of a small tracked Geoprobe at 9 to 12 ft below the greens at the front end of the greens at holes 4, 7, and 14. These lysimeters would measure the overall soil moisture leaching directly from the greens and at a greater depth could avoid low flow soil moisture conditions.

The biofilter on Green 7 was replaced in 2008. Prior to that, this lysimeter was problematic with high concentrations of nitrogen and multiple detections of pesticides. The replacement improved the performance of the new biofilter.

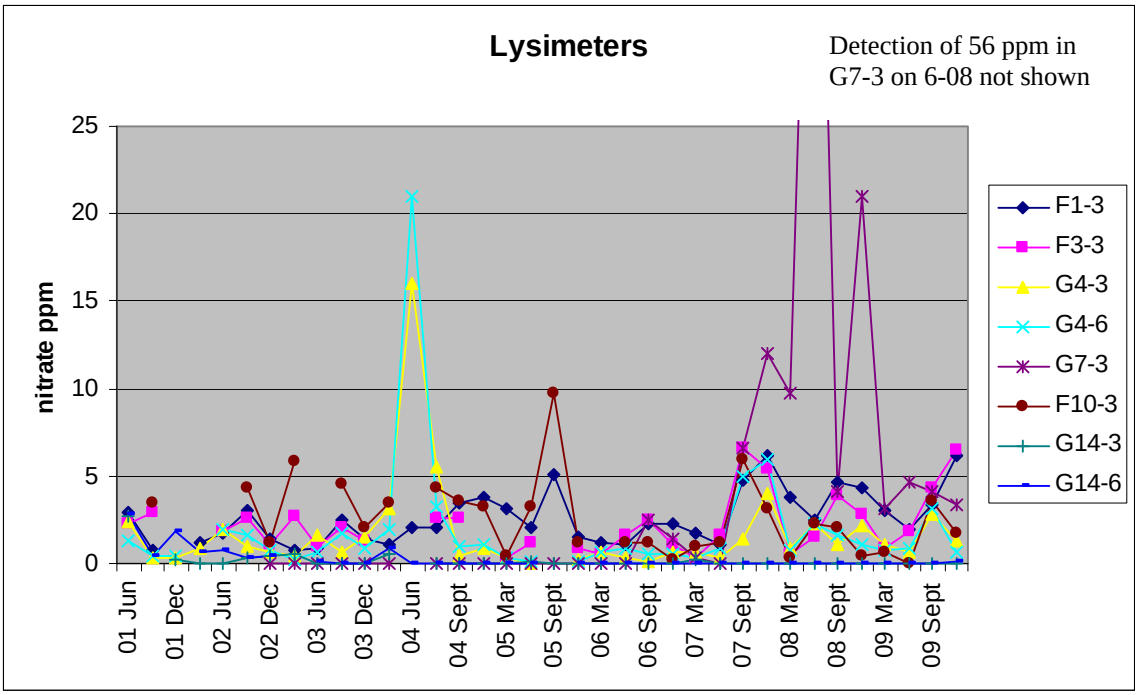



**Figure 10 Nitrate concentrations in lysimeters**

## RESPONSE TO DETECTIONS AND OTHER ISSUES

We recommend that the Town adopt a lower allowable amount of applied nitrogen fertilizer. The average amount of nitrogen fertilizer used over the last five years (2005-2009) is 2,900 lb N/year. The amount of fertilizer used in these last five years is 45% of the current allowable low end amount of 6,386 lb N, and average groundwater concentrations are at 30% of the 5 ppm threshold. Therefore, the Town should adopt a high end limit that no more than 3,000 lb of nitrogen be applied to the current turf area per year, which translates to 0.9 lb N/1,000 $ft^2$. The annual report should present and discuss the amounts of fertilizer applied with the concentration of nitrogen found in groundwater.

In regards to nitrate in groundwater, the long term annual average goal (since 2005) shall be no more than 2 ppm for all turf and turf response wells ( The drinking water MCL is 10 ppm). This goal will be achieved by adopting a nitrogen fertilization application of no more than 3,000 total pounds N per year. This average threshold will allow an individual nitrate detection in any well to exceed 2 ppm; however, if any of the semi-annual turf response wells exceeds 4 ppm N, then that well will be re-sampled within two weeks of receipt of the results for confirmation. If the nitrate concentration is confirmed, then all fertilization will stop in the surface watershed and groundwater area upgradient of that well. An evaluation will then be conducted by the Study Director in consultation with the Town to determine the conditions and issues that caused the large increase (fertilizer, rainfall, irrigation, runoff). A report to the Town will be made by the Study Director within one month of receiving the resampling-confirmation results indicating the cause

and remediation plans related to the high nitrate-nitrogen level. Fertilization will resume when the concentration of the offending well is less than 2 ppm of nitrate-nitrogen or as outlined in the remediation plan.

If the golf course should require more than the fertilization limit, a request shall be sent to the town six months in advance indicating the reasons (need for more nitrogen) and why such an increase will not lead to an exceedence of the 2 ppm average annual threshold.

Currently a detection of a pesticide or metabolite at any level requires a response of resampling. Often the initial sample concentration is just above or at the reporting limit, less than 0.5 ppb. The resampling often results in a similar trace concentration to the first sample. We agree to a method that incorporates the Reference Point (Ref Pt), as defined by either the HAL, MCL or DOH level (whichever is lower) to trigger resampling and reversion to quarterly sampling,. We recommend that the threshold to trigger resampling as 5 times the laboratory method quantitation limit (QL) or 3 times the QL if the Ref Pt is less than or equal to (≤)5 ppb or upon detection if the Ref Pt is < 1 ppb. In addition, given the reduction of sampling from quarterly to semi-annually, we recommend a stringent Management Trigger of 10% of the Ref Pt or 3 times the QL if the Ref Pt is less than 5 ppb or upon detection if the Ref Pt is less than 1 ppb. These variable triggers acknowledge wide disparity of Reference Points (from 0.44 to 50 ppb) and the basis of prudent management decisions made by The Bridge over the last nine years relative to pesticide use on the golf course. If the Management Trigger is exceeded then sampling will revert back to quarterly for all turf wells until the level drops below the Management Trigger. Table 9 that shows the 11 analytes that are/have been typically run including the method, detection limit, Ref Pt, and resampling and management response triggers for reference.

**Table 9. Major Pesticides used, laboratory methods, and Response Thresholds**

| | | | | | |
|---|---|---|---|---|---|
| MCPP | 515.3 | 0.5 | 0.44 | RESAMPLING TRIGGER 0.5 | MANAGEMENT TRIGGER 0.5 |
| | Lab Method | Quantitation Limit (ppb) | Ref Pt (ppb) | 5x Quant Limit Or 3x Quant Limit if Ref Pt < 5(ppb) Or upon detection if Ref Pt< 1ppb | 10% Ref Pt Or 3x Quant Limit Or upon detection if Ref Pt < 1 ppb |
| Paclobutrazol | L300/302 | 1 | 50 | 5 | 5.0 |
| Triadimifon | L300/302 | 1 | 50 | 5 | 5.0 |
| Myclobutanil | S150 | 0.1 | 50 | 0.5 | 5.0 |
| Propiconazole | S150 | 0.1 | 50 | 0.5 | 5.0 |
| PCNB | S150 | 0.1 | ND | ND | ND |
| Chlorothalonil | S150 | 0.1 | 2 | 0.3 | 0.3 |
| Ethofumesate | S150 | 0.1 | 50 | 0.5 | 5.0 |
| Fenarimol | S150 | 0.1 | 50 | 0.5 | 5.0 |
| Dicamba | 515.3 | 0.1 | 0.44 | 0.1 | 0.1 |
| 2-4 D | 515.3 | 0.1 | 50 | 0.5 | 5.0 |

The two triggers described in the table and text above are relevant to monitoring – resampling and frequency. The triggers for management responses to detections remain as they were written in the original 1997 Protocol (Section VI).

Phosphorus does not appear to be a concern from turf management at The Bridge. It is recommended that phosphorus be dropped from the required analyses.

The Semi-annual and Annual reports describing nitrate in groundwater should adopt the comparative structure recommended in this review and compare the results of the turf and turf response wells to the ambient Wells. The reports shall present the data by updating the long term concentration graphs.

Comprehensive monitoring shall continue every four years. This includes Underwriters Laboratories' methods L300, L311, S150 and EPA methods 547, 200.8, and 515.3. Method 547 will only be used if the glyphosate herbicide has been used anytime in the past four years if more than 3 lbs of active ingredient was applied. Method 200.8 will only be used if the MSMA herbicide has been used anytime in the past four years or if sod used on the site had MSMA applied to it. The results of the Volatile Organic Compounds analysis by 524.2 have been below the detection limit for all but background concentrations of chloroform and MTBE. It is recommended that this suite of compounds be dropped from the four-year comprehensive program except for MW-1S since it is downgradient of the operations facility. The four year comprehensive monitoring shall apply to the four turf response wells MW-2S, MW-2D, MW-3S, and MW-5. The four year comprehensive testing will be expanded to include all other wells if there is detection greater than the management threshold for the S150 or 515.3 pesticides (Table 10) in any of the previous semi-annual or two year events.

The preparation of groundwater flow maps can be reduced to once per year, which would include annual snap shot measurements of all wells. Long term hydrographs should be presented in the reports for all semi-annual sampled wells. The water table map should still be hand drawn but a more refined presentation graphic should be developed that also shows the location of the irrigation wells. A capture area to the irrigation wells under average annual and monthly peak flow conditions was prepared using a groundwater model by Mr. Cambareri and is included in the Attachments to this report.

The response to detections in monitoring wells has required a delineation of the affected area to be used to reduce or stop the use of fertilizers and detected pesticides. Because surface runoff may play more of a role through drainage basins and underlying materials, such as the compacted area of the Bridgehampton Raceway, a map of surface watersheds to monitoring wells shall be developed including the location of drains and their discharge locations.

We evaluated the relationship of heavy rain events/periods and an increase in the nitrate-nitrogen concentration in both monitoring wells and lysimeters. We observed a large increase in the nitrate-nitrogen concentration in lysimeters in June 2004, September 2005, September/December 2007, and June/December 2008. Figure 11. below shows nitrogen

in the turf wells and the occurrence of exceptional 3 inch or more daily rain events observed in April 2004 (3.9”), July 2004 (3.5”), October 2005 (6.3” and 12.6” in 4 days), April 2007 (2.9”), and in September 2008 (3.0” and 3.1”). The graph indicates that it is difficult to show cause and effect with the mix of daily and quarterly time scales except for the Nov 05 peak of nitrogen in several wells that is concurrent with an extreme rainfall event of greater than 3 inches. However, nitrogen concentrations were on the increase prior to and then decreased after that event. We also prepared a direct comparison of the quarterly nitrogen concentrations to quarterly rain amounts from 2003 to present as shown in Figure 12.

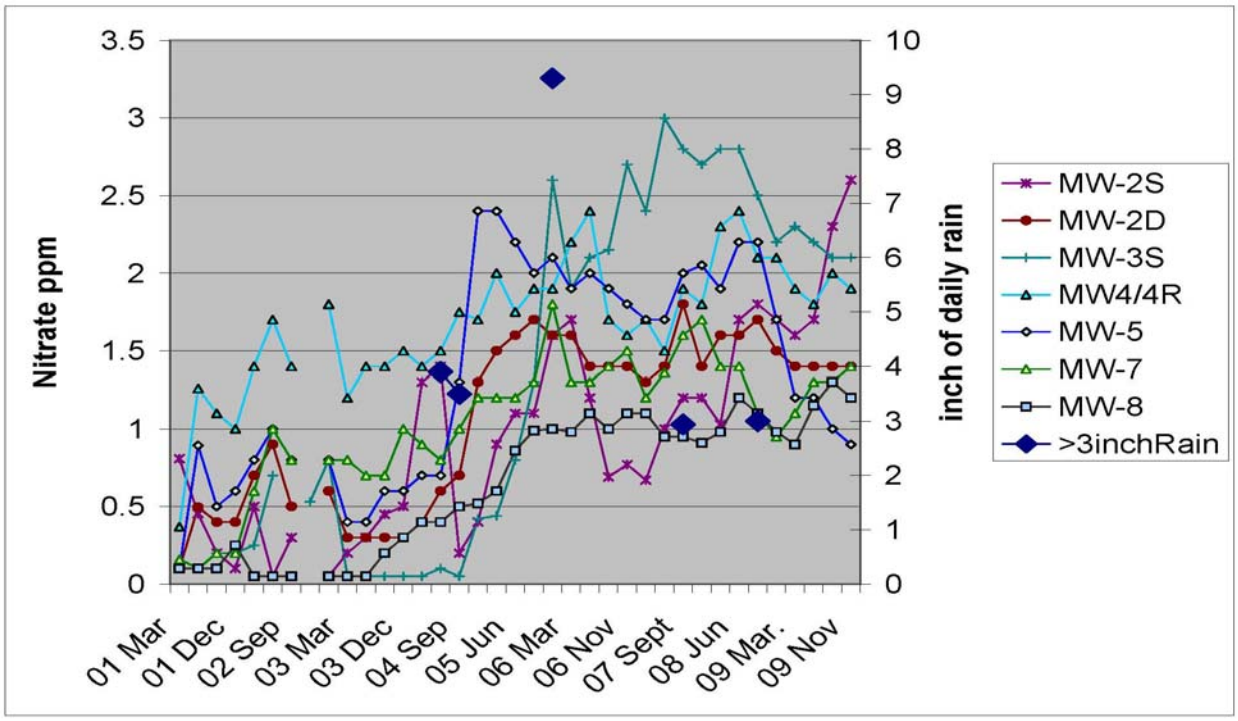



**Figure 11. Quarterly nitrate concentrations in relation to episodes of 3 or more inches of rain over 24 hours**

While the Figure 12 also shows a good match to the November 2005 event, the comparison does not offer the basis of a rational response to a single episode or even quarterly rain amount. The goal of the monitoring protocol is to ensure the long term protection of the groundwater resource. To be more responsive to higher or spikes in nitrate-nitrogen concentrations, we recommend that the action threshold of 5 ppm be lowered to a nitrate-nitrogen concentration of 4 ppm.

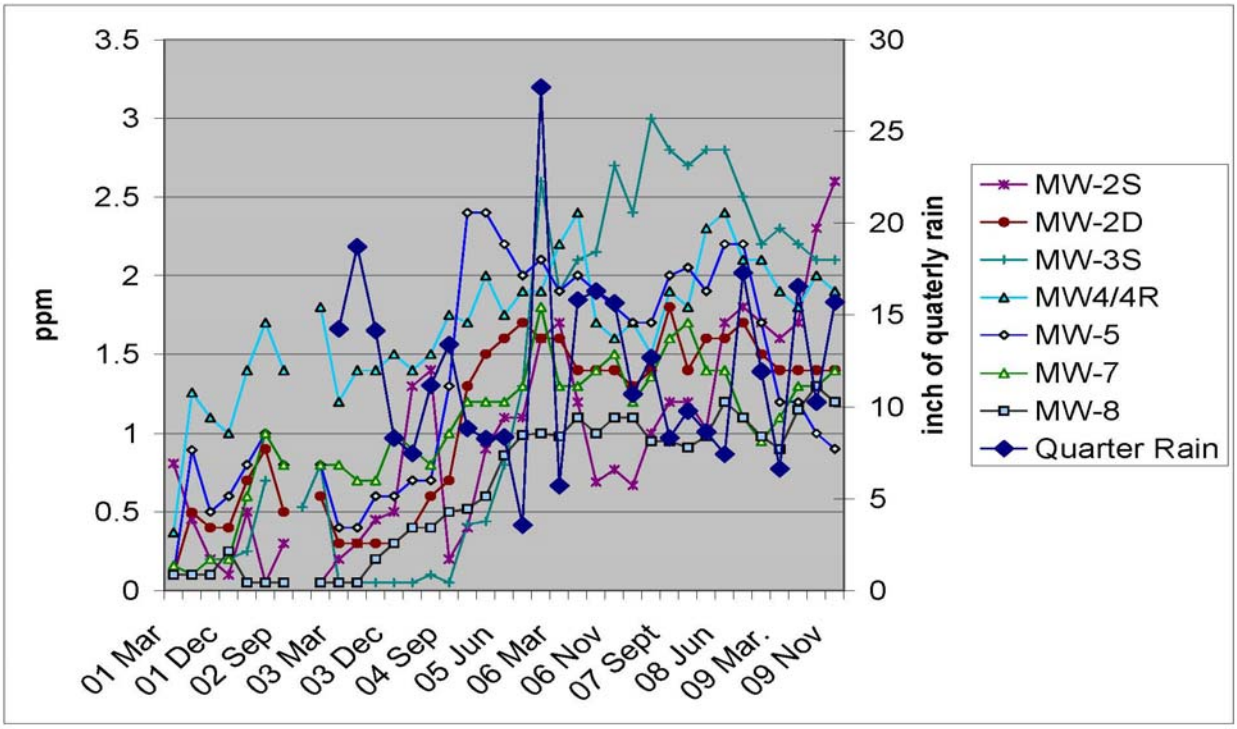



**Figure 12. Quarterly nitrogen concentrations in relation to rainfall totals for each quarter.**

Our collective recommendations to adopt an average annual nitrate-nitrogen concentration goal of 2 ppm; reduce the nitrogen applications to less than 3,000 lb N/per year; and reduce the threshold management response to a single N concentration of 4 ppm from the original 5 ppm nitrate-nitrogen concentration; are focused on ensuring the long term goal of groundwater protection (Table 10).

The protocol should be reviewed in five years to consider further modifications.

## OPERATIONAL REPORTING

Operational reporting shall continue to be included in all reports as required by the original Protocol and with the recommendations of this review.

**Table 10. Groundwater Monitoring Protocol Frequency and Response**

| Well | Category | NITRATE (ppm) | | | PESTICIDES | | | | 4 YR+ COMP | WT** |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Semi N^ | GOAL | Mgmt Response | Semi Pest^^ | 2-YEAR | Resampling Trigger | Management Trigger | | |
| BW-1 | Drop | | | | | | 5x Quant Limit Or 3x Quant Limit if Ref Pt < 5(ppb) Or upon detection if Ref Pt< 1ppb | 10% Ref Pt Or 3x Quant Limit Or upon detection if Ref Pt < 1 ppb | Cond | yes |
| PW-1 | Misc | yes | <5 | 10* | S150 | 515.3 | | | Cond | yes |
| MW-1S | Misc | | 2 | 4 | | N, S150 +VOC | | | Cond | yes |
| MW-1D | Ambient | yes | <1 | 4 | S150 if N > 1 | S150 | | | Cond | yes |
| MW-2S | Turf Response | yes | 2 | 4 | S150 | 515.3 | | | Yes | yes |
| MW2D | Turf Response | yes | 2 | 4 | S150 | 515.3 | | | Yes | yes |
| MW-3S | Turf Response | yes | 2 | 4 | S150 | 515.3 | | | Yes++ | yes |
| MW-3D | Ambient | yes | <1 | 4 | S150 if N > 1 | S150 | | | Cond | yes |
| MW-4/4R | Turf | | 2 | 4 | | N, S150, 515.3 | | | Cond | yes |
| MW-5 | Turf Response | yes | 2 | 4 | S150 | 515.3 | | | Yes | yes |
| MW-6 | Ambient | | <1 | 4 | | N S150 + 515. | | | Cond | yes |
| MW-7 | Turf | | 2 | 4 | | N S150 + 515.3 | | | Cond | yes |
| MW-8 | Turf | | 2 | 4 | | N S150 + 515.3 | | | Cond | yes |
| MW-9 | Abandoned | | | | | | | | | |

* Remedial Action if > 5 ppm.

** WT measured at sampled wells and long term hydrographs updated semi-annual, annual WT snap shot with Water table map. + Includes methods L300, L311, S150 and EPA methods 547, 200.8, and 515.3. Volatile Organic Compounds analysis by 524.2. ^ If any well exceeds 4 ppm, then the well will be immediately sampled and if confirmed, all fertilization will stop in the upgradient area, and evaluation and remedial plan shall be submitted until concentrations drop below 2 ppm or as specified in the remedial plan ^^ If the Management Trigger is exceeded in any well then the sampling will be revert back to quarterly for all wells until the level drops below the Management Trigger in all wells. Semi-annual sampling in ambient wells shall include pesticides in the next round of semi-annual sampling if N > 1 ppm. TKN will be included in the semi-annual, 2-Year and 4 Year comprehensive sampling round.

**Table 11. Lysimeter Protocol Frequency and Response**

| Lysimeters | NITRATE-NITROGEN (ppm) | | | PESTICIDES (ppb) | | | |
|---|---|---|---|---|---|---|---|
| | Semi N | GOAL | Mgmt Response | Semi Pest | 2-YEAR | Resample | Mgmt Response |
| F1-3 | yes | <5 | 10 | S150 | 515.3 | >1 | >5 |
| F3-3 | yes | <5 | 10 | S150 | 515.3 | >1 | >5 |
| G7* | yes | <5 | 10 | S150 | 515.3 | >1 | >5 |
| G4* | yes | <5 | 10 | S150 | 515.3 | >1 | >5 |
| G14* | yes | <5 | 10 | S150 | 515.3 | >1 | >5 |

* New angled lysimeters installed through the use of a small tracked Geoprobe at 9 to 12 ft below the greens at the front end of the green.

REFERENCES

U.S. Environmental Protection Agency, 1992, Hazard Ranking System Guidance Manual, Office of Solid Waste and Emergency Response Directive 9345.1-07.

Schubert, C.E. 1998., Ground-Water Flow Paths and Travel time to Three Small Embayments within the Peconic Estuary, Eastern Suffolk County, New York, USGS, WRIR 98-4181

# ATTACHMENTS INDEX

| | |
|---|---|
| A. Available reports for public review | ATT-1 |
| B. Map of well locations | ATT-2 |
| C. Aerial of well locations | ATT-3 |
| D. Water Table Map | ATT-5 |
| E. As built maps of turf areas | ATT-6 |
| F. Detections of Pesticides | ATT-8 |
| G. Irrigation Capture Areas | ATT-9 |

**Available Digital Bridge Monitoring Reports**
**as of September 12, 2010**

| | Report | | Review | |
|---|---|---|---|---|
| | Date | Pages | Date | Pages |
| 2001 | | | | |
| Background Report | 9/28/2001 | 101 | | |
| Annual | 12/30/2002 | 55 | | |
| 2002 | | | | |
| 1st | | | | |
| 2nd | | | | |
| 3rd | | | | |
| 4th | | | | |
| Annual | 5/1/2003 | 68 | | |
| 2003 | | | | |
| 1st | | | | |
| 2nd | | | | |
| 3rd | | | | |
| 4th | 1/19/2004 | 19 | 3/4/2004 | 5 |
| Annual | 4/9/2004 | 57 | | |
| 2004 | | | | |
| 1st | 5/24/2004 | 4 | 7/9/2004 | 5 |
| 2nd | 11/2/2004 | 4 | 10/6/2004 | 6 |
| 3rd | 11/19/2004 | 4 | 12/8/2004 | 4 |
| 4th | 2/11/2005 | 4 | 3/15/2005 | 5 |
| Annual | 4/15/2005 | 68 | 5/31/2005 | 18 |
| Site Visit | | | 5/31/2005 | 18 |
| 2005 | | | | |
| 1st | 5/9/2005 | 21 | | **na** |
| 2nd | 8/2/2005 | 21 | 12/9/2005 | 5 |
| 3rd | 11/11/2005 | 20 | 12/20/2005 | 5 |
| 4th | 1/23/2006 | 20 | 5/17/2006 | 5 |
| Annual | 8/31/2006 | 85 | 8/1/2006 | 4 |
| Site Visit | | | 8/1/2006 | 8 |
| 2006 | | | | |
| 1st | 6/7/2006 | 20 | 10/18/2006 | 5 |
| 2nd | 8/21/2006 | 21 | 10/24/2006 | 4 |
| 3rd | 11/1/2006 | 20 | 7/12/2007 | 5 |
| 4th | 1/23/2007 | 20 | 7/12/2007 | 4 |
| Annual | 5/31/2007 | 68 | 7/27/2007 | 17 |
| Site Visit | | | 10/20/2006 | 4 |
| 2007 | | | | |
| 1st | 5/30/2007 | 24 | 11/29/2007 | 4 |
| 2nd | 8/23/2007 | 21 | 11/30/2007 | 4 |
| 3rd | 11/12/2007 | 20 | 12/3/2007 | 4 |
| 4th | 12/28/2008 | 20 | 9/19/2008 | 4 |
| Annual | 6/24/2008 | 99 | 9/26/2008 | 17 |
| Site Visit | | | 9/26/2008 | 17 |
| 2008 | | | | |
| 1st | 5/8/2008 | 5 | 12/29/2008 | 4 |
| 2nd | 9/9/2008 | 23 | 12/30/2008 | 4 |
| 3rd | 12/5/2008 | 30 | 1/23/2009 | 4 |
| 4th | 2/112009 | 29 | 10/19/2009 | 5 |
| Annual | 5/28/2009 | 124 | 10/22/2009 | 19 |
| Site Visit | | | 10/20/2009 | 3 |
| 2009 | | | | |
| 1st | 6/19/2009 | 23 | 2/10/2010 | 4 |
| 2nd | 8/12/2009 | 19 | 2/11/2010 | 4 |
| 2nd | 9/9/2009 | 21 | 2/16/2010 | 4 |
| 3rd | 11/6/2009 | 19 | 2/16/2010 | 4 |
| 4th | 2/8/2010 | 20 | 3/24/2010 | 5 |
| Annual | 5/28/2010 | 154 | 6/30/2010 | 19 |
| Site Visit | | | 6/30/2010 | 3 |

| | | |
|---|---|---|
| 2006 5-Year Review | | |
| ETS | 2/17/2006 | 9 |
| Petrovic Review | 8/1/2006 | 4 |
| Petrovic Response | 12/14/2006 | 5 |

MAP SHOWING

# MONITORING WELLS

AT

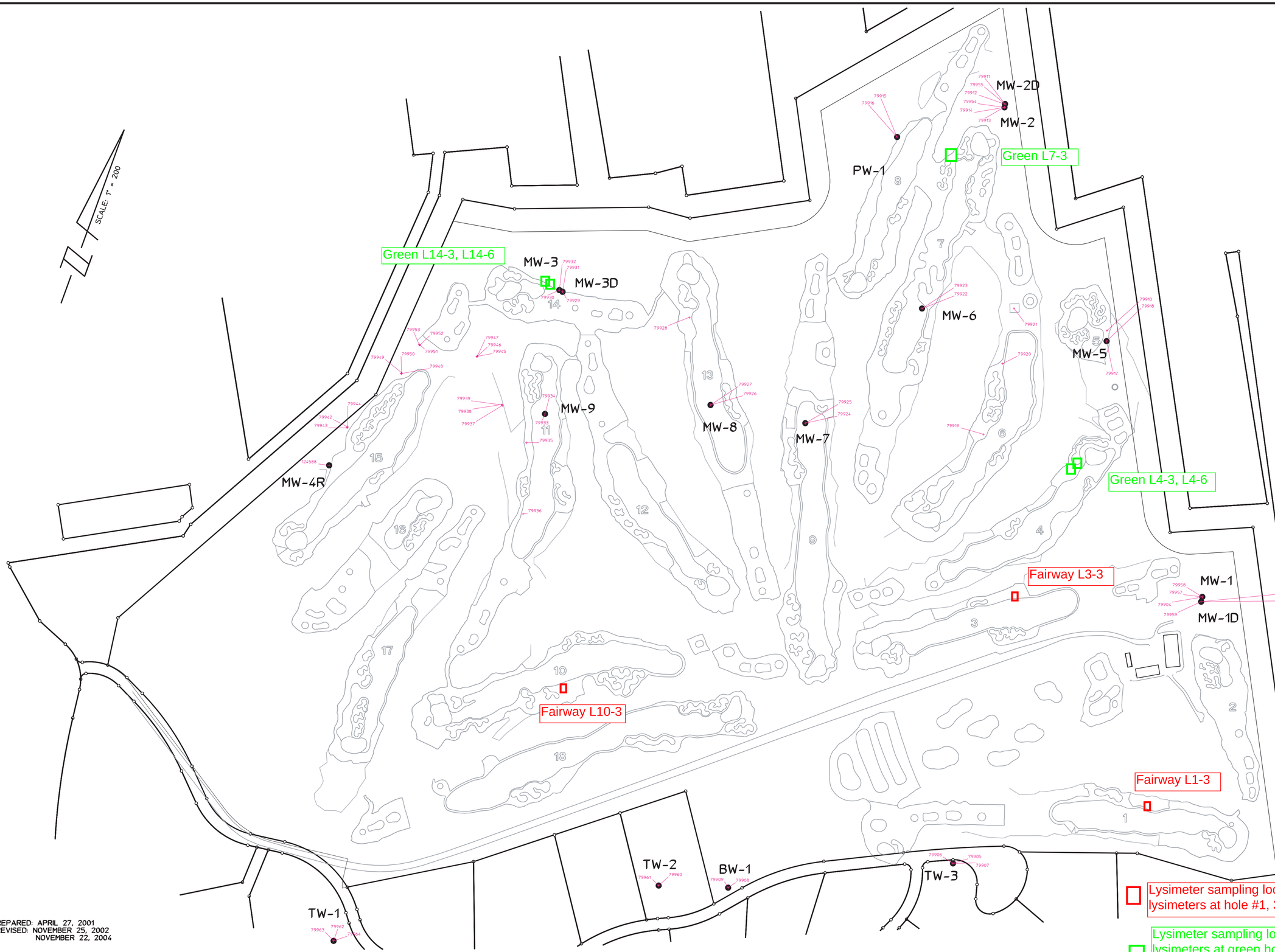
# THE BRIDGE

SITUATE

# NOYACK

TOWN OF SOUTHAMPTON
SUFFOLK COUNTY, NEW YORK

SCALE: 1" = 200




| | | |
|---|---|---|
| 79903 | 163.199 | Ex Spot Elevation, General Elev. GROUND AT MW-1D |
| 79904 | 162.268 | Ex Spot Elevation, General Elev. GROUND AT MW-1 |
| 79905 | 220.640 | Ex Test Well, C/L TW-3 TOP PIPE AT MARK |
| 79906 | 216.222 | Ex Spot Elevation, General Elev. GROUND AT TW-3 |
| 79907 | 216.127 | Ex Spot Elevation, General Elev. GROUND AT TW-3 |
| 79908 | 241.355 | Ex Test Well, C/L BW-1 2IN PVC TOP PIPE |
| 79909 | 239.927 | Ex Spot Elevation, General Elev. GROUND AT BW-1 |
| 79910 | 128.793 | Ex C.B. Grate, 2.0 S GREEN |
| 79911 | 127.908 | Ex Test Well, C/L MW-2D 2IN PVC TOP PIPE |
| 79912 | 128.012 | Ex Spot Elevation, General Elev. GROUND AT MW-2D |
| 79913 | 128.113 | Ex Spot Elevation, General Elev. GROUND AT MW-2 |
| 79914 | 128.094 | Ex Test Well, C/L MW-2 4IN PVC TOP PIPE |
| 79915 | 100.947 | Ex Test Well, C/L PW-1 4IN PVC TOP PIPE |
| 79916 | 101.232 | Ex Iron MH Cover, 0.7 PW-1 |
| 79917 | 132.403 | Ex Iron MH Cover, 0.7 MW-5 |
| 79918 | 132.033 | Ex Test Well, C/L MW-5 4IN PVC TOP PIPE |
| 79919 | 146.882 | Ex C.B. Grate, 2.0 6TH DOGLEG |
| 79920 | 134.076 | Ex C.B. Grate, 2.0 6TH FAIRWAY RIGHT |
| 79921 | 126.342 | Ex C.B. Grate, 2.0 AT FRONT 6TH TEE |
| 79922 | 164.573 | Ex Iron MH Cover, 0.7 MW-6 |
| 79923 | 164.231 | Ex Test Well, C/L MW-6 4IN PVC TOP PIPE |
| 79924 | 175.925 | Ex Iron MH Cover, 0.7 MW-7 |
| 79925 | 175.476 | Ex Test Well, C/L MW-7 4IN PVC TOP PIPE |
| 79926 | 150.781 | Ex Test Well, C/L MW-8 4IN PVC TOP PIPE |
| 79927 | 151.144 | Ex Iron MH Cover, 0.7 MW-8 |
| 79928 | 130.086 | Ex C.B. Grate, 2.0 S OF 13TH GREEN |
| 79929 | 131.555 | Ex Iron MH Cover, 0.7 MW-3D |
| 79930 | 131.579 | Ex Iron MH Cover, 0.7 MW-3 |
| 79931 | 131.220 | Ex Test Well, C/L MW-3D 2IN PVC TOP PIPE |
| 79932 | 130.831 | Ex Test Well, C/L MW-3 4IN PVC TOP PIPE |
| 79933 | 147.615 | Ex Iron MH Cover, 0.7 MW-9 |
| 79934 | 147.324 | Ex Test Well, C/L MW-9 TOP 4IN PVC |
| 79935 | 138.993 | Ex C.B. Grate, 2.0 11TH FAIRWAY |
| 79936 | 142.442 | Ex C.B. Grate, 2.0 11TH FAIRWAY |
| 79937 | 116.812 | Ex Iron MH Cover, 2.0 PUMP PIT |
| 79938 | 116.769 | Ex Iron MH Cover, 2.0 PUMP PIT |
| 79939 | 116.524 | Ex Drain. Struct., C/L 8dia.Pool PUMP PIT |
| 124588 | 122.750 | Ex Test Well, MW-4R TOP PVC PIPE UNDER COVER |
| 79942 | 120.217 | Ex Iron MH Cover, 2.0 |
| 79943 | 120.187 | Ex Iron MH Cover, 2.0 |
| 79944 | 119.975 | Ex Drain. Struct., C/L 8dia.Pool PIT |
| 79945 | 113.484 | Ex Drain. Struct., C/L 8dia.Pool PIT |
| 79946 | 113.686 | Ex Iron MH Cover, 2.0 |
| 79947 | 113.726 | Ex Iron MH Cover, 2.0 |
| 79948 | 116.421 | Ex Iron MH Cover, 2.0 |
| 79949 | 116.399 | Ex Iron MH Cover, 2.0 |
| 79950 | 116.175 | Ex Drain. Struct., C/L 8dia.Pool |
| 79951 | 111.156 | Ex Drain. Struct., C/L 8dia.Pool |
| 79952 | 111.402 | Ex Iron MH Cover, 2.0 |
| 79953 | 111.422 | Ex Iron MH Cover, 2.0 |
| 79954 | 128.423 | Ex Iron MH Cover, 0.7 MW-2 |
| 79955 | 128.196 | Ex Iron MH Cover, 0.7 MW-2D |
| 79956 | 163.399 | Ex Test Well, C/L MW-1D 2IN PVC TOP PIPE |
| 79957 | 162.351 | Ex Test Well, C/L MW-1 4IN PVC TOP PIPE |
| 79958 | 162.642 | Ex Iron MH Cover, 0.7 MW-1 |
| 79959 | 163.685 | Ex Iron MH Cover, 0.7 MW-1D |
| 79960 | 232.670 | Ex Test Well, TW-2 MARK CHISELED IN TOP CASING |
| 79961 | 229.315 | Ex Spot Elevation, General Elev. GROUND AT TW-2 |
| 79962 | 214.919 | Ex Spot Elevation, General Elev. GROUND AT TW-1 |
| 79963 | 214.875 | Ex Spot Elevation, General Elev. GROUND AT TW-1 |
| 79964 | 217.980 | Ex Test Well, TW-1 TOP COVER AT ARROW IN CASING |

Lysimeter sampling locations for fairways: L1-3 = 3 lysimeters at hole #1, 3 ft depth under fairway

Lysimeter sampling locations for greens: L4-3 = 3 lysimeters at green hole #4 at 3 ft depth drainage from green, L4-6 = two 6 ft depth lysimeters

PREPARED: APRIL 27, 2001
REVISED: NOVEMBER 25, 2002
NOVEMBER 22, 2004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ATT-2

Sept 2009

Sep 5, 2009
MW-2
MW-7
MW-6
MW-8
MW-5
MW-3
MW-9
MW-1
MW-4
BW-1
© 2010 Google
© 2010 Europa Technologies
Image USDA Farm Service Agency
Google
40°58'49.50" N 72°20'31.13" W elev 191 ft
Eye alt 5749 ft

April  1994 – Pre Construction showing future well locations

MAP SHOWING
**MONITORING WELLS**
AT
# THE BRIDGE
SITUATE
## NOYACK
TOWN OF SOUTHAMPTON
SUFFOLK COUNTY, NEW YORK

SCALE: 1" = 200

| | | |
|---|---|---|
| 79903 | 183.199 | Ex. Spot Elevation, General Elev. GROUND AT MW-1D |
| 79904 | 182.294 | Ex. Spot Elevation, General Elev. GROUND AT MW-1 |
| 79905 | 339.049 | Ex. Test Well, CA, TW-3 TOP PIPE AT PARK |
| 79906 | 316.272 | Ex. Spot Elevation, General Elev. GROUND AT TW-3 |
| 79907 | 316.187 | Ex. Spot Elevation, General Elev. GROUND AT TW-3 |
| 79908 | 313.085 | Ex. Test Well, CA, BW-1 3in PVC TOP PIPE |
| 79909 | 339.587 | Ex. Spot Elevation, General Elev. GROUND AT BW-1 |
| 79910 | 339.793 | Ex. Spot Elevation, General Elev. GROUND AT |
| 79911 | 67.968 | Ex. Test Well, CA, PW-3D 3in PVC TOP PIPE |
| 79912 | 69.072 | Ex. Spot Elevation, General Elev. GROUND AT PW-3D |
| 79913 | 68.115 | Ex. Spot Elevation, General Elev. GROUND AT PW-2 |
| 79914 | 68.684 | Ex. Test Well, CA, PW-2 4in PVC TOP PIPE |
| 79915 | 68.647 | Ex. Test Well, CA, PW-1 4in PVC TOP PIPE |
| 79916 | 61.232 | Ex. Iron Rft Corner, 0.7 PW-1 |
| 79917 | 62.483 | Ex. Iron Rft Corner, 0.7 PW-2 |
| 79918 | 62.693 | Ex. Test Well, CA, PW-4 4in PVC TOP PIPE |
| 79919 | 64.882 | Ex. C.B. Grate, 2.0 6TH DOGLEG |
| 79920 | 64.074 | Ex. C.B. Grate, 2.0 4TH FAIRWAY RIGHT |
| 79921 | 68.543 | Ex. C.B. Grate, 2.0 AT FRONT 6TH TEE |
| 79922 | 64.571 | Ex. Iron Rft Corner, 0.7 PW-4 |
| 79923 | 65.531 | Ex. Test Well, CA, PW-5 4in PVC TOP PIPE |
| 79924 | 67.375 | Ex. Iron Rft Corner, 0.7 PW-5 |
| 79925 | 71.918 | Ex. Test Well, CA, PW-6 4in PVC TOP PIPE |
| 79926 | 69.791 | Ex. Test Well, CA, PW-7 4in PVC TOP PIPE |
| 79927 | 69.141 | Ex. Iron Rft Corner, 0.7 PW-6 |
| 79928 | 69.088 | Ex. C.B. Grate, 2.0 S OF 6TH GREEN |
| 79929 | 69.859 | Ex. Iron Rft Corner, 0.7 PW-3D |
| 79930 | 69.879 | Ex. Iron Rft Corner, 0.7 PW-3 |
| 79931 | 69.330 | Ex. Test Well, CA, PW-3D 3in PVC TOP PIPE |
| 79932 | 69.631 | Ex. Test Well, CA, PW-3 4in PVC TOP PIPE |
| 79933 | 67.438 | Ex. Iron Rft Corner, 0.7 PW-5 |
| 79934 | 67.384 | Ex. Test Well, CA, PW-8 TOP 4in PVC |
| 79935 | 69.992 | Ex. C.B. Grate, 2.0 9TH FAIRWAY |
| 79936 | 143.443 | Ex. C.B. Grate, 2.0 9TH FAIRWAY |
| 79937 | 76.812 | Ex. Iron Rft Corner, 2.0 PUMP PIT |
| 79938 | 76.760 | Ex. Iron Rft Corner, 2.0 PUMP PIT |
| 79939 | 76.523 | Ex. Drain, Struct., CA, Bolts/Post PUMP PIT |
| 79940 | 63.780 | Ex. Test Well, Rim-Elev TOP PVC PIPE UNDER COVER |
| 79941 | 80.317 | Ex. Iron Rft Corner, 2.0 |
| 79942 | 80.167 | Ex. Iron Rft Corner, 2.0 |
| 79943 | 78.875 | Ex. Drain, Struct., CA, Bolts/Post PIT |
| 79944 | 78.484 | Ex. Drain, Struct., CA, Bolts/Post PIT |
| 79945 | 75.686 | Ex. Iron Rft Corner, 2.0 |
| 79946 | 75.781 | Ex. Iron Rft Corner, 2.0 |
| 79947 | 75.420 | Ex. Iron Rft Corner, 2.0 |
| 79948 | 76.389 | Ex. Iron Rft Corner, 2.0 |
| 79949 | 74.127 | Ex. Drain, Struct., CA, Bolts/Post |
| 79950 | 74.167 | Ex. Drain, Struct., CA, Bolts/Post |
| 79951 | 74.663 | Ex. Iron Rft Corner, 2.0 |
| 79952 | 74.824 | Ex. Iron Rft Corner, 2.0 |
| 79953 | 69.633 | Ex. Iron Rft Corner, 0.7 PW-2 |
| 79954 | 69.320 | Ex. Iron Rft Corner, 0.7 PW-3D |
| 79955 | 63.389 | Ex. Test Well, CA, PW-D 3in PVC TOP PIPE |
| 79956 | 63.381 | Ex. Test Well, CA, PW-1 4in PVC TOP PIPE |
| 79957 | 62.443 | Ex. Iron Rft Corner, 0.7 PW-1 |
| 79958 | 63.440 | Ex. Iron Rft Corner, 0.7 PW-D |
| 79959 | 230.670 | Ex. Test Well, TW-2 Name CARVED IN TOP CASING |
| 79960 | 227.243 | Ex. Spot Elevation, General Elev. GROUND AT TW-2 |
| 79963 | 214.318 | Ex. Spot Elevation, General Elev. GROUND AT TW-1 |
| 79964 | 214.588 | Ex. Spot Elevation, General Elev. GROUND AT TW-1 |
| 79964 | 217.968 | Ex. Test Well, TW-1 TOP COVER AT ARROW IN CASING |

SCALE: 1" = 200

MW-3
MW-3D
MW-4R
MW-9
MW-8
MW-7
MW-6
MW-5
MW-2D
MW-2
PW-1
MW-1
MW-1D
TW-1
TW-2
BW-1
TW-3

C
M, P
M, C
13
12
9
8
7
6
5
4
1

GW DIVIDE

PREPARED: APRIL 27, 2001
REVISED: NOVEMBER 25, 2002
NOVEMBER 22, 2004

JOHN J. RAYNOR, P.E. & L.S., P.C.
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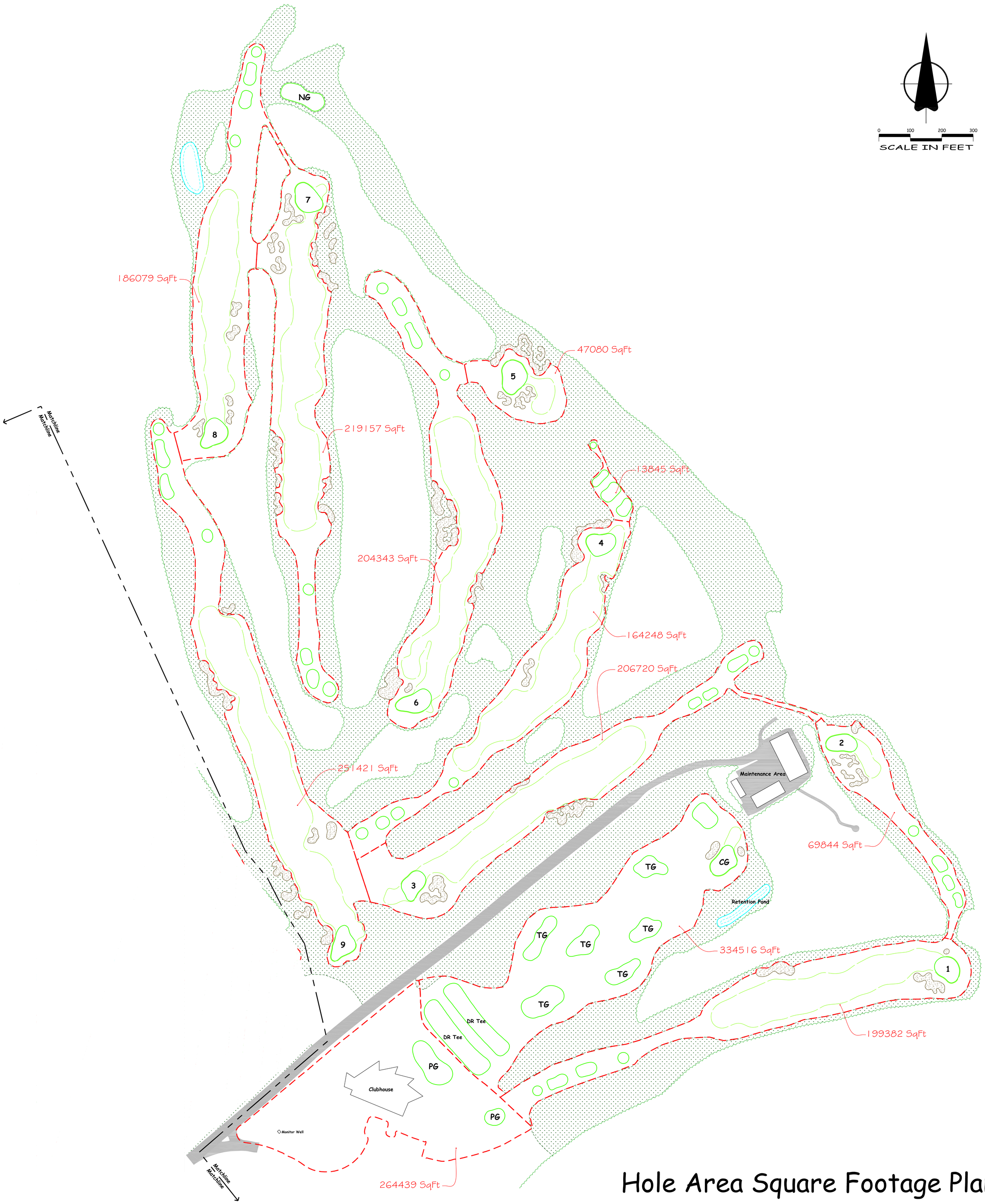
SURVEYORS SITE PLANNERS
GREENPORT, NEW YORK P.O. BOX 728
WATER MILL, N.Y. 11976 (631) 726-7600

↑ GW flow

C = chlorothalonil
M = myclobutanil
P = propiconazole

work map B
10/20/09

AS-BUILT COURSE W/ WELLS - 9(0.10)PF: 094701 10538 22-NOV-04 04:59 PM / 967-1




# Hole Area Square Footage Plan 1

C-Tech Solutions, Inc.

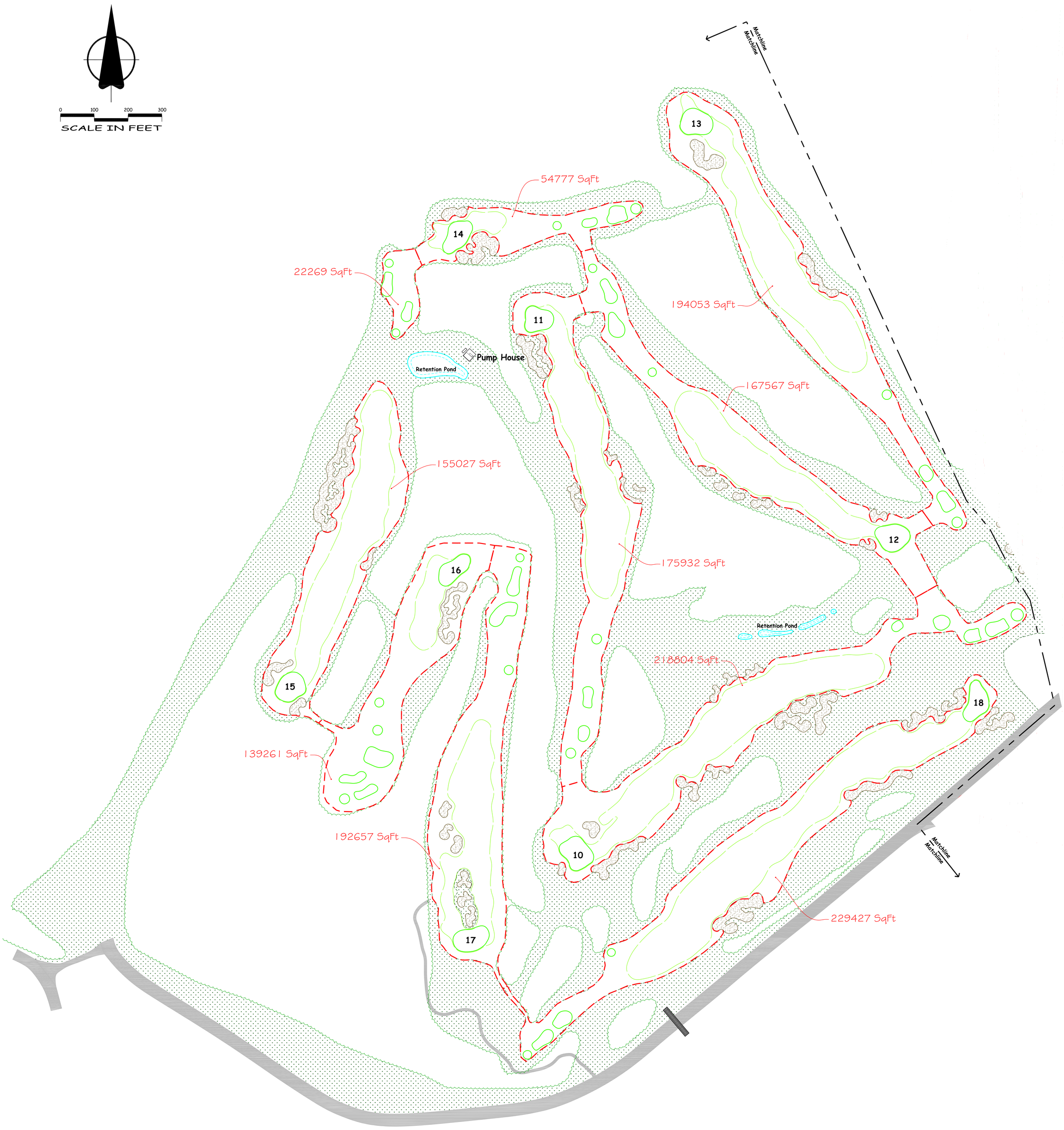
Ross, Ohio
513-738-3456

Technical Solutions for
GPS * GIS * Irrigation

# The Bridge

| | |
|---|---|
| DATE 07/08/09 | SCALE 1' - 100' |
| SHEET Golf at the Bridge_b20.dwg | |
| FILE NAME Hole Area Square Footage Plan 1 | |
| DRAWN BY | |

ATT-6




# Hole Area Square Footage Plan 2

C-Tech Solutions, Inc.

Ross, Ohio
513-738-3456

Technical Solutions for
GPS * GIS * Irrigation

# The Bridge

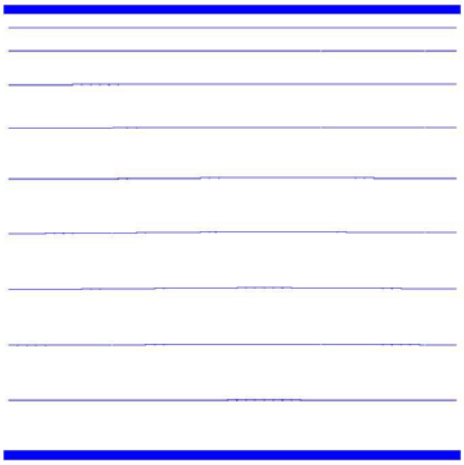
| | |
|---|---|
| DATE 07/08/09 | SCALE 1" - 100' |
| SHEET Golf at the Bridge_b20.dwg | |
| FILE NAME Hole Area Square Footage Plan 2 | |
| DRAWN BY | |

ATT-7

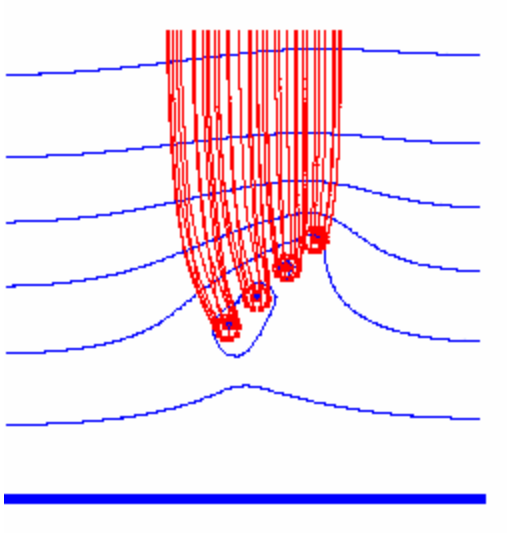
The Bridge Pesticide detections
10.26.09 triennial montoring March 2004 and 2007

| MW-4/4R | | | | MW-2S | | | | MW-2D | | | | | PW-1 | MW-5 | | MW-6 | | MW-7 | | | MW-8 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Paclobut | Myclo | Tri-nol | | Myclo | Chloro | Prop (b) | | Myclo | Prop (a) | Prop (b) | Chloro | Chloro | | Chloro | | Chloro | | Chloro | PCNB | | Chloro |
| Mar-01 | | | 1.0 | Mar-01 | | | | Mar-01 | | | | | Mar-01 | Mar-01 | | Mar-01 | | Mar-01 | | | Mar-01 | |
| Jun-01 | | | | Jun-01 | | | | Jun-01 | | | | | Jun-01 | Jun-01 | | Jun-01 | | Jun-01 | | | Jun-01 | |
| Oct-01 | 4.2 | | | Oct-01 | 0 | | | Oct-01 | | | | | Oct-01 | Oct-01 | | Oct-01 | | Oct-01 | | | Oct-01 | |
| Dec-01 | 1.3 | | | Dec-01 | 0 | | 0 | Dec-01 | | 0 | 0 | | Dec-01 | Dec-01 | | Dec-01 | | Dec-01 | | | Dec-01 | |
| Jan-02 | 3.8 | | | Jan-02 | 0 | | 0 | Jan-02 | | 0 | 0 | | Jan-02 | Jan-02 | | Jan-02 | | Feb-02 | | | Feb-02 | |
| Mar-02 | 1.95 | | | Mar-02 | 0 | | 0 | Mar-02 | | 0 | 0 | | Mar-02 | Mar-02 | | Mar-02 | | Mar-02 | | | Mar-02 | |
| May-02 | 1.75 | | | May-02 | 0 | | 0 | May-02 | | 0 | 0 | | May-02 | May-02 | | May-02 | | May-02 | | | May-02 | |
| Jun-02 | 0 | | | Jun-02 | 0 | | 0 | Jun-02 | | 0 | 0 | | Jun-02 | Jun-02 | | Jun-02 | | Jun-02 | | | Jun-02 | |
| Sep-02 | 0 | | | Sep-02 | 0 | | 0 | Sep-02 | | 0 | 0 | | Sep-02 | Sep-02 | | Sep-02 | | Sep-02 | | | Sep-02 | |
| Dec-02 | 0 | | | Dec-02 | 0 | | 0 | Dec-02 | | 0 | 0 | | Dec-02 | Dec-02 | | Dec-02 | | Dec-02 | | | Dec-02 | |
| Mar-03 | 0 | | | Mar-03 | 0 | | 0 | Mar-03 | | 0 | 0 | | Mar-03 | Mar-03 | | Mar-03 | | Mar-03 | | | Mar-03 | |
| Jun-03 | 0 | | | Jun-03 | 0 | | 0 | Jun-03 | | 0 | 0 | | Jun-03 | Jun-03 | | Jun-03 | | Jun-03 | | | Jun-03 | |
| Sep-03 | 0 | 0 | | Sep-03 | 0 | | 0 | Sep-03 | 0 | 0 | 0 | | Sep-03 | Sep-03 | | Sep-03 | | Sep-03 | | | Sep-03 | |
| Dec-03 | 0 | 0 | | Dec-03 | 0 | | 0 | Dec-03 | 0 | 0 | 0 | | Dec-03 | Dec-03 | | Dec-03 | | Dec-03 | | | Dec-03 | |
| Mar-04 | | 0 | | Mar-04 | 0 | | 0 | Mar-04 | 0 | 0 | 0 | | Mar-04 | Mar-04 | | Mar-04 | | Mar-04 | | | Mar-04 | |
| Jun-04 | | 0 | | Jun-04 | 0 | | 0 | Jun-04 | 0 | 0 | 0 | | Jun-04 | Jun-04 | | Jun-04 | | Jun-04 | | | Jun-04 | |
| Sep-04 | | 0 | | Sep-04 | 0 | | 0 | Sep-04 | 0 | 0 | 0 | | Sep-04 | Sep-04 | | Sep-04 | | Sep-04 | | | Sep-04 | |
| Dec-04 | | 0 | | Dec-04 | 0 | | 0 | Dec-04 | 0 | 0 | 0 | | Dec-04 | Dec-04 | | Dec-04 | | Dec-04 | | | Dec-04 | |
| Mar-05 | | 0.2 | | Mar-05 | 0 | | 0 | Mar-05 | 0 | 0 | 0 | | Mar-05 | Mar-05 | | Mar-05 | | Mar-05 | | | Mar-05 | |
| May-05 | | 0.2 | | May-05 | 0 | | 0 | May-05 | 0 | 0 | 0 | | May-05 | May-05 | | May-05 | | May-05 | | | May-05 | |
| Jun-05 | | 0.2 | | Jun-05 | 0 | | 0 | Jun-05 | 0 | 0 | 0 | | Jun-05 | Jun-05 | | Jun-05 | | Jun-05 | | | Jun-05 | |
| Sep-05 | | 0.2 | | Sep-05 | 0 | | 0 | Sep-05 | 0 | 0 | 0 | | Sep-05 | Sep-05 | | Sep-05 | | Sep-05 | | | Sep-05 | |
| Nov-05 | | 0.1 | | Dec-05 | 0 | | 0 | Dec-05 | 0 | 0 | 0 | | Dec-05 | Dec-05 | | Dec-05 | | Dec-05 | | | Dec-05 | |
| Mar-06 | | 0 | | Mar-06 | 0 | | 0 | Mar-06 | 0 | 0 | 0 | | Mar-06 | Mar-06 | | Mar-06 | | Mar-06 | | | Mar-06 | |
| Jun-06 | | 0 | | Jun-06 | 0 | | 0 | Jun-06 | 0 | 0 | 0 | | Jun-06 | Jun-06 | | Jun-06 | | Jun-06 | | | Jun-06 | |
| Sep-06 | | 0 | | Sep-06 | 0 | | 0 | Sep-06 | 0 | 0 | 0 | | Sep-06 | Sep-06 | | Sep-06 | | Sep-06 | | | Sep-06 | |
| Nov-06 | | 0 | | Nov-06 | 0 | | 0 | Nov-06 | 0 | 0 | 0 | | Nov-06 | Nov-06 | | Nov-06 | | Dec-06 | | | Dec-06 | |
| Mar-07 | | 0 | | Mar-07 | 0 | | 0 | Mar-07 | 0 | 0 | 0 | | Mar-07 | Mar-07 | | Mar-07 | | Mar-07 | | | Mar-07 | |
| Jun-07 | | 0 | | Jun-07 | 0 | | 0 | Jun-07 | 0 | 0 | 0 | | Jun-07 | Jun-07 | | Jun-07 | | Jun-07 | | | Jun-07 | |
| Sep-07 | | 0 | | Sep-07 | 0 | | 0 | Sep-07 | 0 | 0 | 0 | | Sep-07 | Sep-07 | | Sep-07 | | Sep-07 | | | Sep-07 | |
| Nov-07 | | 0 | | Nov-07 | 0 | | 0 | Nov-07 | 0 | 0.2 | 0.2 | | Nov-07 | Nov-07 | | Nov-07 | | Dec-07 | | | Dec-07 | |
| Mar-08 | | 0.1 | | Mar-08 | 0 | | 0 | Mar-08 | 0 | 0.2 | 0.2 | | Mar-08 | Mar-08 | | Mar-08 | | Mar-08 | | | Mar-08 | |
| Jun-08 | | 0.2 | | Jun-08 | 0.2 | | 0 | Jun-08 | 0.2 | 0.3 | 0.4 | | Jun-08 | Jun-08 | | Jun-08 | | Jun-08 | | | Jun-08 | |
| Sep-08 | | 0 | | Sep-08 | 0 | 0 | 0 | Sep-08 | 0.1 | 0.1 | 0.2 | 0 | Sep-08 | 0 | Sep-08 | 0 | Sep-08 | 0 | Sep-08 | 0 | 0 | Sep-08 | 0 |
| Dec-08 | | 0 | | Dec-08 | 0 | 0 | 0 | Dec-08 | 0.15 | 0.1 | 0.15 | 0 | Dec-08 | 0 | Dec-08 | 0 | Dec-08 | 0 | Dec-08 | 0 | 0 | Dec-08 | 0 |
| Mar-09 | | 0 | | Mar-09 | 0.3 | 0 | 0 | Mar-09 | 0.2 | 0.1 | 0.2 | 0.2 | Mar-09 | 0 | Mar-09 | 0 | Mar-09 | 0 | Mar-09 | 0 | 0 | Mar-09 | 0 |
| | | | | May-09 | 0.4 | 0 | 0.1 | May-09 | 0.25 | 0.1 | 0.2 | 0 | | | | | | | | | | | |
| Jun-09 | | 0.1 | | Jun-09 | 0.4 | 0 | 0.1 | Jun-09 | 0.4 | 0.15 | 0.2 | 0 | Jun-09 | 0 | Jun-09 | 0 | Jun-09 | | Jun-09 | 0.4 | 0.1 | Jun-09 | 0 |
| | | | | | | | | | | | | | | | | | Jul-09 | 0.2 | Jul-09 | 0.2 | 0.1 | | |
| Sep-09 | | 0 | | Sep-09 | 0.2 | 0.2 | 0 | Sep-09 | 0.3 | 0.1 | 0.2 | 0 | Sep-09 | 0.2 | Sep-09 | 0.1 | Sep-09 | 0 | Sep-09 | 0 | 0 | Sep-09 | 0.5 |
| N = >0 | 5 | 8 | | | 5 | 1 | 2 | | 7 | 9 | 9 | 1 | | 1 | | 1 | | 1 | | 2 | 2 | | 1 |

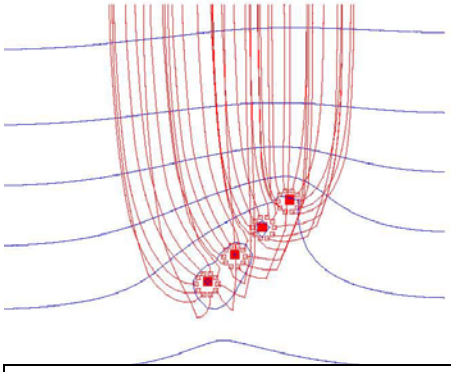
v



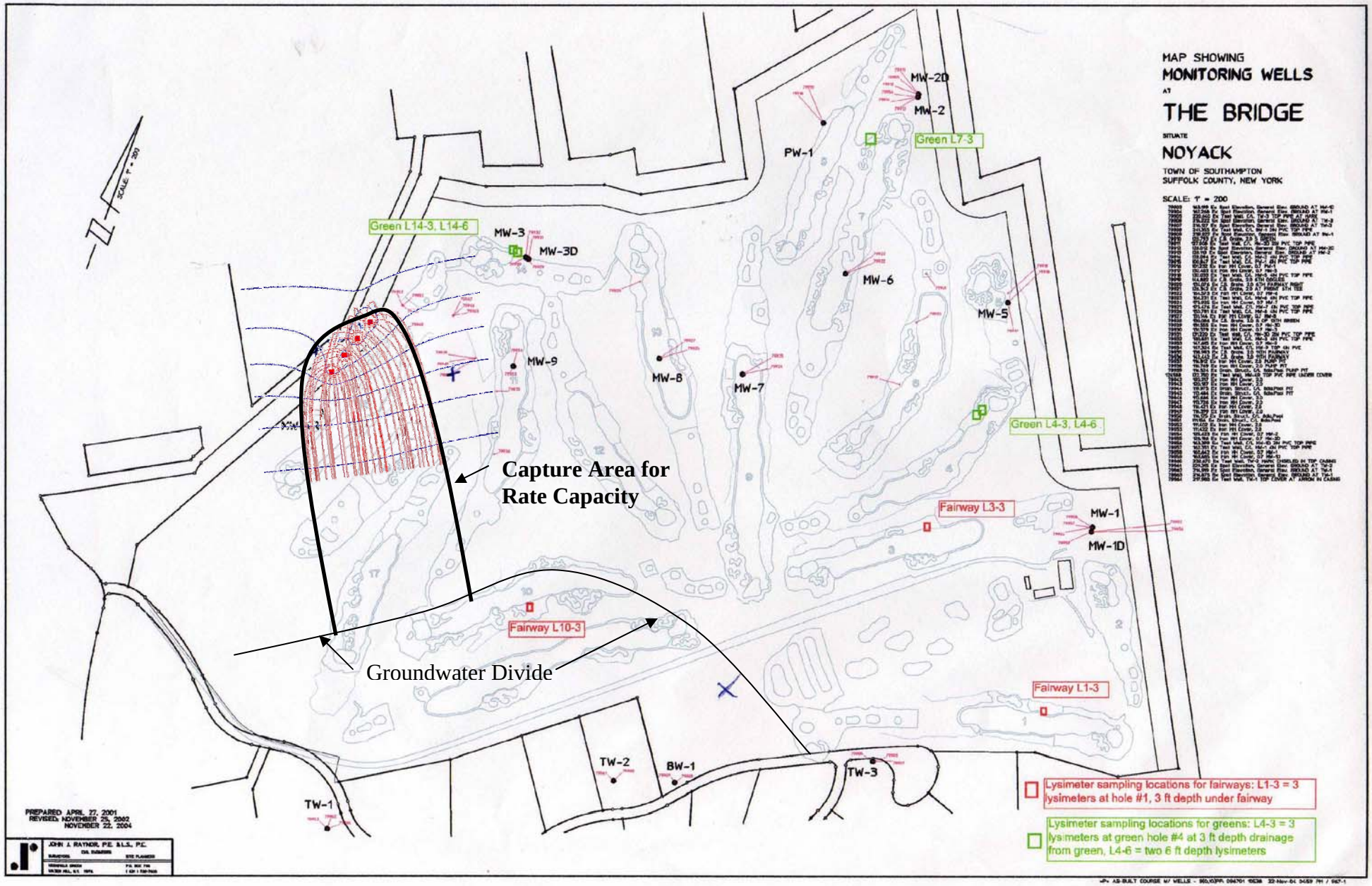
Non- Pumping
Model width 2500 ft



Average Annual Rate
73 gpm each
651 ft wide



Rated Capacity
1080 ft wide
275 gpm each


MAP SHOWING
MONITORING WELLS
AT
THE BRIDGE
SITUATE
NOYACK
TOWN OF SOUTHAMPTON
SUFFOLK COUNTY, NEW YORK
SCALE: 1" = 200
MW-2D
MW-2
PW-1
Green L7-3
Green L14-3, L14-6
MW-3
MW-3D
MW-6
MW-5
MW-9
MW-8
MW-7
Green L4-3, L4-6
Capture Area for
Rate Capacity
Fairway L3-3
MW-1
MW-1D
Fairway L10-3
Groundwater Divide
Fairway L1-3
TW-2
BW-1
TW-3
TW-1
Lysimeter sampling locations for fairways: L1-3 = 3 lysimeters at hole #1, 3 ft depth under fairway
Lysimeter sampling locations for greens: L4-3 = 3 lysimeters at green hole #4 at 3 ft depth drainage from green, L4-6 = two 6 ft depth lysimeters
PREPARED APRIL 27, 2001
REVISED NOVEMBER 25, 2002
NOVEMBER 22, 2004
JOHN J. RAYNOR, P.E. & L.S., P.C.

# Appendix 7
# USEPA Low Risk Pesticides

*USEPA . Reduced Risk (RR)/OP Alternative Pesticides Registered in the United States.*

| Year | Pesticide* | Pesticide type | Site | Reduced risk (RR)/OP alternative† |
|---|---|---|---|---|
| 1994 | *Hexaflumuron* | Insecticide | Belowground bait station (termites) | RR |
| | *Methyl anthranilate* | Repellent | Cherry, blueberry, grape, forestry | RR |
| 1995 | *Flumiclorac-pentyl* | Herbicide | Corn, soybean | RR |
| | *Tebufenozide* | Insecticide | Walnut | RR |
| | *Hymexazol* | Fungicide | Sugar beet (seed treatment) | RR |
| 1996 | *Fludioxonil* | Fungicide | Corn | RR |
| | *Imazapic* | Herbicide | Peanut | RR |
| | *Mefenoxam* | Fungicide | All metalaxyl uses | RR |
| 1997 | *Azoxystrobin* | Fungicide | Non-residential turf | RR |
| | *Spinosad* | Insecticide | Cotton | RR |
| | *Alpha-metolachlor* | Herbicide | All metolachlor uses | RR |
| | *Imazamox* | Herbicide | Soybean | RR |
| | Hexaflumuron | Insecticide | Aboveground bait station (termites) | RR |
| | Azoxystrobin | Fungicide | Grape, banana, peach, tomato, pecan, peanut | RR |
| 1998 | Fludioxonil | Fungicide | Potato and seed treatments (many crops) | RR |
| | Diflubenzuron | Insecticide | Belowground bait station (termites) | RR |
| | *Cyprodinil* | Fungicide | Stone fruit | RR |
| | Spinosad | Insecticide | Almond, apple, citrus, brassica leafy vegetables, fruiting vegetables, and leafy vegetables | RR |
| | Pyriproxyfen | Insecticide | Cotton | RR |
| | Tebufenozide | Insecticide | Pecan | RR |
| | *Carfentrazone-ethyl* | Herbicide | Wheat, corn | RR |
| 1999 | Azoxystrobin | Fungicide | Turf (residential), almond, cucurbit vegetables, rice, wheat, canola, potato, stone fruit | RR |
| | *Diflufenzopyr* | Herbicide | Corn | RR |
| | Tebufenozide | Insecticide | Leafy, brassica, and fruiting vegetables, cranberry, forestry, ornamentals, berry crop group, mint, pome fruit, cotton, sugarcane, turnip, canola | RR/OP |
| | Pyriproxyfen | Insecticide | Pome fruit, walnut | RR/OP |
| | Glyphosate | Herbicide | Glyphosate-tolerant corn, canola, sugar beet | RR |
| | *s-Dimethenamid* | Herbicide | Corn, soybean, peanut | RR |
| | Spinosad | Insecticide | Sweet corn, cucurbit and legume vegetables, stone fruit, cereal grains | RR/OP |
| | *Fenhexamid* | Fungicide | Grape, strawberry, ornamentals | RR |
| | *Bifenazate* | Insecticide | Ornamentals | RR/OP |
| | *Trifloxystrobin* | Fungicide | Pome fruit, grape, cucurbit vegetables, peanut, turf, banana, ornamentals | RR |
| | Fipronil | Insecticide | Outside home use (termites) | OP |
| | *Pymetrozine* | Insecticide | Tuberous and corm vegetables, ornamentals, tobacco | RR/OP |

| Year | Pesticide* | Pesticide type | Site | Reduced risk (RR)/OP alternative† |
|---|---|---|---|---|
| 2000 | Pyriproxyfen | Insecticide | Citrus, fruiting vegetables, tree nuts | RR/OP |
| | Tebufenozide | Insecticide | Ornamentals (residential), tree nuts | RR/OP |
| | *Ecolyst* | Herbicide/ Insecticide/ Plant growth regulator | Orange | RR |
| | Spinosad | Insecticide | Non-grass animal feed crop group, grain amaranth, cilantro, grass, buckwheat, rye, pistachio, oat, barley, millet, apple, popcorn, ti leaves, watercress, tropical fruit, teosinte, turnip greens | RR/OP |
| | Fenhexamid | Fungicide | Almond, stone fruit | RR |
| | *Prohexadione calcium* | Herbicide/ Plant growth regulator | Apple | RR |
| | *Methoxyfenozide* | Insecticide | Cotton, pome fruit | RR/OP |
| | Trifloxystrobin | Fungicide | Almond, fruiting vegetables, hops, potato, sugar beet, wheat, ornamentals | RR |
| | Carfentrazone-ethyl | Herbicide | Cereal grains | RR |
| | *Buprofezin* | Insecticide | Cucurbit vegetables, head lettuce | RR/OP |
| | *Fenpyroximate* | Insecticide | Ornamentals (greenhouse) | RR/OP |
| | *Indoxacarb* | Insecticide | Cotton, fruiting and brassica leafy vegetables, lettuce, sweet corn, pome fruit | RR/OP |
| | *Flucarbazone-sodium* | Herbicide | Wheat | RR |
| | Glyphosate | Herbicide | Many: refer to http://www.epa.gov/opprd001/workplan/completionsportrait.pdf | RR |
| | Azoxystrobin | Fungicide | Barley, onion, citrus, corn (field, sweet, pop), cotton, leafy, root, and tuberous vegetables, soybean | RR |
| 2001 | Fipronil | Insecticide | Home lawn, golf course, commercial and recreational turf and sod farms (fire ant), potting medium mixtures (fire ant) | OP |
| | *Thiamethoxam* | Insecticide | Barley, canola, cotton, sorghum, wheat (all seed treatment), cotton, pome fruit, cucurbit, fruiting, tuberous, and corm vegetables (all foliar) | OP |
| | Fludioxonil | Fungicide | Strawberry, bulb vegetables, turf | RR |
| | Pyriproxyfen | Insecticide | Food handling establishments | RR |
| | | | Pistachio | RR/OP |

| Year | Pesticide* | Pesticide type | Site | Reduced risk (RR)/OP alternative† |
|---|---|---|---|---|
| | Imidacloprid | Insecticide | Leaf petioles, citrus | OP |
| | *Zoxamide* | Fungicide | Grape, cucurbit vegetables, tomato | RR |
| | Prohexadione calcium | Plant growth regulator | Grass (grown for seed) | RR |
| | Pyriproxyfen | Insecticide | Pistachio | RR/OP |
| | *Mesotrione* | Herbicide | Corn (field) | RR |
| | Cyprodinil | Fungicide | Onion (dry, bulb, and green), strawberry | RR |
| | Buprofezin | Insecticide | Almond, citrus, cotton, grape, tomato | RR/OP |
| | Carfentrazone-ethyl | Herbicide | Cotton (defoliant use) | OP |
| | | | Turf | RR |
| | *Fluazinam* | Fungicide | Peanut, potato | RR |
| | zeta-Cypermethrin | Insecticide | Alfalfa, corn (field, pop, sweet), head and stem brassica vegetables, leafy brassica greens, leafy vegetables, onion (green), sugar beet, sugarcane, rice | OP |
| | Azoxystrobin | Fungicide | Leafy brassica greens, blueberry, eggplant, grass (grown for seed), jackfruit, juneberry, lingonberry, loquat, mint (spearmint, peppermint), okra, pawpaw, pepper, persimmon, salal, strawberry, tamarind, tropical fruit, turnip (greens), watercress, wax jambu, white sapote | RR |
| | *Novaluron* | Insecticide | Ornamentals (indoors, non-food) | RR |
| | Spinosad | Insecticide | Artichoke (globe), asparagus, bushberry, cranberry, foliage of legume vegetables, garden beet (root), juneberry, leaves of root and tuber vegetables, lingonberry, okra, pistachio, pome fruit, salal, strawberry, sugar beet (root), tree nuts | RR/OP |
| 2002 | Chlorfenapyr | Insecticide | Post-construction control of termites | OP |
| | Imazamox | Herbicide | Alfalfa, canola, legume vegetables, wheat | RR |
| | Pymetrozine | Insecticide | Cotton, leafy, head and stem brassica, and leafy brassica vegetables, hops | RR/OP |
| | | | Pecans | OP |
| | Bifenazate | Insecticide | Cotton, grapes, hops, nectarine, peach, plum, pome fruit, strawberry | RR/OP |
| | *Acetamiprid* | Insecticide | Cotton, pome fruit, citrus, grapes, brassica leafy, leafy (excl. brassica), and fruiting vegetables, ornamentals | RR/OP |
| | Trifloxystrobin | Fungicide | Citrus, corn (field, pop), pecan, rice, stone fruit | RR |
| | *Cyhalofop-butyl* | Herbicide | Rice | RR |
| | Indoxacarb | Insecticide | Alfalfa, peanut, potato, soybean | RR/OP |
| | Fludioxonil | Fungicide | Caneberry, pistachio, stone fruit, watercress | RR |
| | Pyriproxyfen | Insecticide | Stone fruit, blueberry, lychee, guava | RR/OP |
| | Imazethapyr | Herbicide | Rice | RR |
| | Diflufenzopyr | Herbicide | Corn (pop, sweet), grass (forage, hay) | RR |
| | *Macalayea extract* | Fungicide | Greenhouse ornamentals | RR |

| Year | Pesticide* | Pesticide type | Site | Reduced risk (RR)/OP alternative† |
|---|---|---|---|---|
| | Azoxystrobin | Fungicide | Legume vegetables | RR |
| | Methoxyfenozide | Insecticide | Fruiting, leafy, and brassica leafy vegetables, grapes, corn (field, sweet), stone fruit, tree nuts | RR/OP |
| | *Fenamidone* | Fungicide | Lettuce | RR |
| | Lambda-cyhalothrin | Insecticide | Legume and fruiting vegetables, sugarcane | RR (sugarcane)/ (all) |
| | Spinosad | Insecticide | Berry group, fig, grape, herbs, peanut, root and tuber vegetables | RR/OP |
| 2003 | Lambda-cyhalothrin | Insecticide | Termite barrier | RR |
| | Pyriproxyfen | Insecticide | Brassica leafy and cucurbit vegetables, olive | RR/OP |
| | Cyprodinil | Fungicide | Bushberry, caneberry, pistachio, watercress, brassica leafy vegetables, carrot, herbs, lychee fruits | RR |
| | *EH-2001 Rodenticide* | Rodenticide | Richardson/Wyoming ground squirrel | RR |
| | Mesotrione | Herbicide | Corn (pop) | RR |
| | *Noviflumuron* | Insecticide | Aboveground bait station | RR/OP |
| | Pyriproxyfen | Insecticide | Avocado fruits, fig, okra, sugar apple fruits | RR/OP |
| | *Clothianidin* | Insecticide | Canola, corn (seed treatments) | OP |
| | Methoxyfenozide | Insecticide | Cranberry, cucurbits, okra, peas (black-eyed, southern), turnip (greens) | RR/OP |
| | Azoxystrobin | Fungicide | Artichoke (globe), asparagus, head and stem brassica subgroup, herbs | RR |
| | Emamectin benzoate | Insecticide | Cotton, fruiting vegetables, tobacco | OP |
| | Buprofezin | Insecticide | Bean (succulent), lychee fruits, pistachio | RR/OP |
| | *Boscalid* | Fungicide | Berries, bulb, fruiting, legume (root except sugar beet, garden beet, radish, turnip), tuberous and corm vegetables, grape, lettuce (head, leaf), peanut, stone fruit, strawberry, tree nuts, turf | RR |
| | Thiamethoxam | Insecticide | Ornamentals, succulent beans (seed), stone fruit, sunflower (seed) | OP |
| | Trifloxystrobin | Fungicide | Root vegetables leaf petioles (except sugar beet) subgroup, except radish | RR |
| | *Flonicamid* | Insecticide | Ornamentals (greenhouse) | OP |
| | *Acequinocyl* | Insecticide | Ornamentals (greenhouse) | RR |
| | Bifenazate | Insecticide | Cucurbits, fruiting vegetables, mint, pistachio, tomato (greenhouse), tree nuts | RR |
| | Fenhexamid | Fungicide | Cucumber (greenhouse), fruiting vegetables (except non-bell pepper), kiwifruit, leafy green subgroup (except spinach), stone fruit | RR |
| | Etoxazole | Insecticide | Cotton, pome fruit, strawberry | RR |
| | *Quinoxyfen* | Fungicide | Grape, hops, cherry | RR |

| Year | Pesticide* | Pesticide type | Site | Reduced risk (RR)/OP alternative† |
|---|---|---|---|---|
| | Glufosinate-ammonium | Herbicide | Rice | RR |
| 2004 | Fluroxypyr | Herbicide | Corn (field, sweet) | RR |
| | *Mesosulfuron-methyl* | Herbicide | Wheat | RR |
| | Gamma-cyhalothrin | Insecticide | Alfalfa, brassica head and stem subgroup, canola, corn (field, sweet), cotton, fruiting and legume (edible-podded) subgroup vegetables, garlic, lettuce (head, leaf), tree nuts, onion (dry bulb), pea and bean dry shelled (except soybean) subgroup, pea and bean succulent shelled subgroup, peanut, pome fruit, rice, sorghum, soybean, stone fruit, sugarcane, sunflower, wheat | OP |
| | Novaluron | Insecticide | Cotton, pome fruit | OP |
| | Fenpyroximate | Insecticide | Cotton, grape, pome fruit | RR |
| | Acequinocyl | Insecticide | Strawberry, almond, citrus, pome fruit, field ornamentals | RR |
| | *Lufenuron* | Insecticide | Termite bait station | RR |
| | Indoxacarb | Insecticide | Fire ant bait | RR/OP |
| | Pyrimethanil | Fungicide | Almond, grape, onion (dry bulb, green), pome and stone fruit, strawberry, tomato, tuberous and corm vegetables | RR |
| | *Dinotefuran* | Insecticide | Leafy vegetables | RR/OP |
| | *Penoxsulam* | Herbicide | Rice | RR |
| | Tebufenozide | Insecticide | Citrus, grape, tuberous and corm vegetables | RR |
| | Fenamidone | Fungicide | Cucurbit vegetables, onion (dry bulb, green), potato, tomato | RR |
| | *Cyazofamid* | Fungicide | Cucurbit vegetables, potato, tomato | RR |
| | Bispyribac-sodium | Herbicide | Turf | RR |
| | Deltamethrin | Insecticide | Corn (field), cucurbit, fruiting, root and tuber vegetables, onion (dry, bulb, green), sorghum, tree nuts | OP |
| 2005 | Fenamidone | Fungicide | Ornamentals | RR |
| | Diflubenzuron | Insecticide | Horse oral larvicide feed-through treatment | RR |
| | Dinotefuran | Insecticide | Public health use, cotton, brassica head and stem subgroup, cucurbit and fruiting vegetables, grape, potato | RR/OP |
| | Clothianidin | Insecticide | Turf, ornamentals, pome fruit, tobacco | OP |
| | Thiamethoxam | Insecticide | Mint | OP |
| | Clofentezine | Insecticide | Grape | RR |
| | Mesotrione | Herbicide | Corn (sweet) | RR |
| | Buprofezin | Insecticide | Avocado, guava, peach, pome fruit, sugar apple | RR/OP |
| | Acetamiprid | Insecticide | Potato | RR/OP |
| | Spiromesifen | Insecticide | Brassica leafy, fruiting, tuberous, and corm vegetables, corn (field), cotton, cucurbits, leafy greens, ornamentals, strawberry | RR |
| | Pymetrozine | Insecticide | Asparagus | OP |
| | Etoxazole | Insecticide | Grape, tree nuts | RR/OP |
| | *Pinoxaden* | Herbicide | Barley, wheat | RR |

| Year | Pesticide* | Pesticide type | Site | Reduced risk (RR)/OP alternative† |
|---|---|---|---|---|
| | *Aminopyralid* | Herbicide | Range and pasture lands, rights-of-way, roadsides, industrial vegetation management | RR |
| | Flonicamid | Insecticide | Cotton, cucurbit and fruiting vegetables, pome and stone fruit, potato, nursery and landscape ornamentals | OP |
| 2006 | Boscalid | Fungicide | Celery, spinach | RR |
| | Flumiclorac-pentyl | Herbicide | Cotton defoliant use | RR/OP |
| | Spinosad | Insecticide | Alfalfa, fruit fly bait, mint, onion (green) | RR |
| | Fenhexamid | Fungicide | Ginseng, pear, cilantro, pepper (non-bell), pomegranate | RR |
| | Flonicamid | Insecticide | Head and stem brassica | OP |
| | Trifloxystrobin | Fungicide | Barley, oats | RR |
| | Azoxystrobin | Fungicide | Herbs, spices, safflower, sunflower | RR |
| | Methoxyfenozide | Insecticide | Soybean | RR/OP |
| | Fenpyroximate | Insecticide | Citrus, hops, mint, pistachio, tree nuts | RR |
| | Quinoxyfen | Fungicide | Lettuce (head, leaf), melons, pepper (bell, non-bell), strawberry | RR |
| | Bifenazate | Insecticide | Stone fruit, edible-podded pea, tuberous and corm vegetables | RR/OP |
| 2007 | Fluthiacet-methyl | Herbicide | Cotton | OP |
| | Spiromesifen | Insecticide | Tomato (greenhouse) | RR |
| | *Flazasulfuron* | Fungicide | Turf | RR |
| | Penoxsulam | Herbicide | Turf, aquatic use | RR |
| | Indoxacarb | Insecticide | Grape | RR |
| | Spinosad | Insecticide | Mosquito larvicide use | RR |
| | Spinetoram | Insecticide | Many: refer to http://www.epa.gov/opprd001/workplan/completionsportrait.pdf | RR |
| 2008 | Mandipropamid | Fungicide | Brassica leafy, bulb, cucurbit, fruiting, tuberous and corm, and leafy vegetables, grape | RR |
| | Mesotrione | Herbicide | Berry group, cranberry, flax, turf (sod farm, golf courses) | RR |
| | Chlorantraniliprole | Insecticide | Cotton, grape, pome and stone fruit, potato, turf, ornamentals, brassica leafy, cucurbit, fruiting, and leafy vegetables | RR |
| | Spirotetramat | Insecticide | Almond, citrus, grape, hops, onion (bulb), brassica head and stem, brassica leafy greens, cucurbits, fruiting, leafy, and tuberous and corm vegetables | RR |
| | Etofenprox | Insecticide | Mosquito adulticide use | RR |
| 2009 | Etofenprox | Insecticide | Rice | RR |
| | Mesotrione | Herbicide | Turf (commercial, residential) | RR |
| | Spiromesifen | Insecticide | Corn (pop, sweet), low-growing berry group | RR |
| | Penoxsulam | Herbicide | Grape, tree nuts | RR |
| | Chlorantraniliprole | Insecticide | Tree nuts, pistachio | RR |
| | Cyazofamid | Fungicide | Fruiting vegetables (regional tolerance), okra | RR |
| | Saflufenacil | Herbicide | Cereal grains, citrus, cotton, foliage of legume vegetables, forage, fodder, and straw of cereal grains, grape, legume vegetables, pome and stone fruit, sunflower, tree nuts | RR |
| 2010 | Dinotefuran | Insecticide | Brassica leafy greens, turnip (greens) | RR |

| Year | Pesticide* | Pesticide type | Site | Reduced risk (RR)/OP alternative† |
|---|---|---|---|---|
| | Chlorantraniliprole | Insecticide | Artichoke, asparagus, caneberry, cacao, citrus, coffee, corn (field, sweet, pop), fig, forage, fodder, and straw of cereal grains, grass forage, fodder, and hay, herbs and spices, hops, legume vegetables (ex., soybean), mint, non-grass animal feeds, oilseed crops, okra, olive, peanut, persimmon, pomegranate, prickly pear cactus, rice, small vine-climbing fruits, strawberry, sugar, cane, tea, tobacco, tropical fruits, tuberous and corm vegetables, termiticide use | RR |
| | Tolfenpyrad | Insecticide | Ornamentals (greenhouse) | RR |
| | Cyazofamid | Fungicide | Brassica leafy vegetables, hops, spinach, turnip (greens) | RR |
| | Spiromesifen | Insecticide | Pea, dry | RR |

*New active ingredient reduced risk/OP alternative actions are indicated by italics.

†OP alternative status was not considered by the Reduced Risk Program for conventional pesticides until 1999.

# Appendix 8
# Pesticide Storage Facility Guideline

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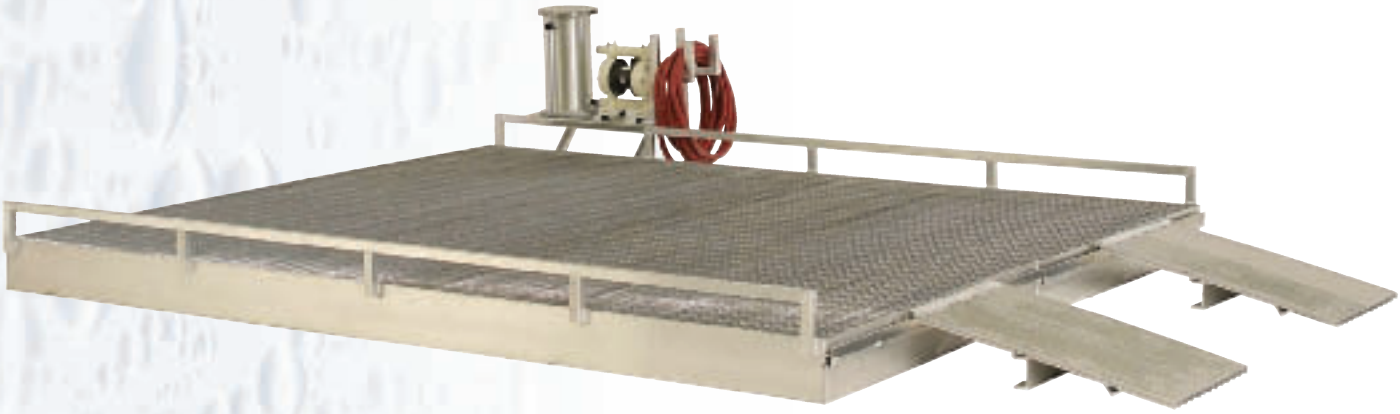
# Chemical Containment and Recovery Pads
## For Turf Care Facilities



**The Chemical Containment & Recovery Pads** by ESD provide an extremely versatile way to create an instant chemical mix and load area in almost any location. The pads can be set up on virtually any flat and level surface. In the event of a chemical spill during the mixing and loading process, the chemical solution will be contained in the pad's large reservoir. Once contained, the spill can be filtered and recovered with the help of a powerful air-actuated pump and a 100 micron reusable filter. Recovered solution can be directed to a spray rig, or to an appropriate chemical container for reuse or proper disposal. The Chemical Containment and Recovery Pads are constructed of marine-grade aluminum for maximum durability and chemical resistance.

### Specifications:

| Approximate Dimensions / Holding Capacity | |
|---|---|
| **Above Ground** | 10'W x 12'L x 8"H / 380 gallons |
| **Above Ground** | 12'W x 16'L x 1'H / 1,048 gallons |
| **Cement Imbed** | 10'W x 12'L x 8"H / 380 gallons |
| **Cement Imbed** | 12'W x 16'L x 1'H / 1,048 gallons |
| **Filtration:** | 100 Microns |
| **Utility Requirement** | 20-100 psi compressed air for air powered diaphragm pump |
| **Approach Ramps** | (2) Included with Above Ground Pads |

*For maximum versatility, Chemical Containment and Recovery Pads can be used:*

- Inside
- Above Ground
- Outside
- Imbedded in Cement

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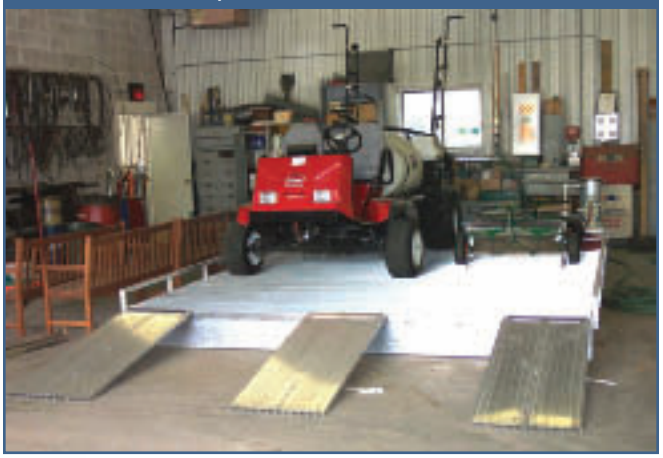
## Chemical Containment and Recovery Pads – Installation Options

### Recessed In Cement

### Outside on a Bed of Rocks

### In-Ground for Temporary Application

### Inside the Shop



### Incorporated into a Complete Environmental Center

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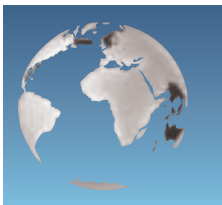

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# Chemical Storage Buildings

**Chemical Storage Buildings** by ESD Waste2Water, Inc. are specifically designed for storing chemicals used in the turf care industry. The buildings are expressly intended for golf course maintenance, park maintenance, and grounds maintenance operations. Constructed of marine-grade aluminum, the buildings will not rust, and do not require routine painting. Each storage unit has the capacity of storing and containing hundreds of gallons of chemical, and is designed to allow for easy clean up, and to reduce the probability of cross-contamination of spilled chemicals. ESD offers the chemical storage units in a variety of sizes, and is able to customize buildings to fit your unique requirements. Portable by design, the buildings can be easily relocated for site flexibility. Coupled with other ESD products and designs, you can use ESD chemical buildings to develop an ideal chemical mix/load/storage area for your turf care maintenance facility.

## Chemical Building Specifications:

| Model | 8x8 | 8x12 | 8x16 | 8x20 |
|---|---|---|---|---|
| Exterior Dimension | 8' D x 8' W x 8' H | 8' D x 12' W x 8' H | 8' W x 16' D x 8' H | 8' D x 20' W x 8' H |
| Elictrical Requirements | 115 V, 20 amps | 115 V, 20 amps | 115 V, 20 amps | 115 V, 20 amps |
| With Heat or Air Conditioning | 240 V, 1 ph, 30amps | 240 V, 1 ph, 30amps | 240 V, 1 ph, 30amps | 240 V, 1 ph, 30amps |
| Sq. Ft. of Shelving | 107 | 128 | 149 | 218 |
| Maximum Chem. Spill Containment | 279 gal. | 419 gal. | 558 gal. | 698 gal. |
| Door(s) | | | | |
| Number of Doors on Bldg. | Single Door | Double Doors | Double Doors | Double Doors |
| OA Door Opening | 36 3/4" W x 77" H | 75 3/8" W x 77" H | 75 3/8" W x 77" H | 75 3/8" W x 77" H |
| Approximate Shipping Weight | 1700 lbs. | 2300 lbs. | 2700 lbs. | 2900 lbs. |
| with optional insulation | 1900 lbs. | 2600 lbs. | 3100 lbs. | 3400 lbs. |

Certified to UL-508A Standards

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## Chemical Storage Building

### A Marine Grade Aluminum Construction.
The ESD Chemical Storage Buildings are constructed of 5052 marine grade aluminum for maximum chemical resistance and absolute minimum maintenance.

### B Easy Placement.
The Buildings can be placed on virtually any flat and level surface whether it is cement, asphalt, crushed rock or dirt. Forklift holes are located in two sides of the buildings for easy placement.

### C Easy Installation.
Once placed, a simple electrical connection to the building's junction box renders the building completely operational and ready to use. Relocating the building to an alternative site can be done easily with a forklift and a screwdriver.

### D Containment Area.
The diamond plate floor of the building is double welded for secure containment of potential spills. For ease of clean up and recapturing spilled chemicals, the floor does not have grating that needs to be removed before cleaning.

### E Shelving.
The building includes 24" deep, 3-tier, diamond plate aluminum shelving around the available inside perimeter. Shelf space is maximized in each building and shelves are extremely sturdy and non-porous.

### F Exhaust Fan.
All buildings are equipped with a 24/7 150 cfm exhaust fan to evacuate chemical fumes from inside the chemical storage area.

### G Lighting.
The buildings include incandescent lighting with smash guards and moisture proof wiring.

### H Hazardous Material Placard.
Each building is shipped with a NFPA 704M, hazardous material placard. The placard can be correctly labeled for the hazard level of the specific chemicals that are being stored in the building.

### Chemical Building Options:
• Insulation • Heating • Air Conditioning • 24/7 Programmable Timer for Exhaust Fan

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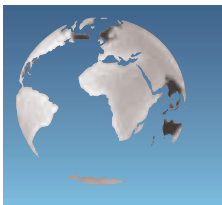

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# Clipping Separator System For Turf Care Wash Operations

**The Clipping Separator System** is designed to help create tidy wash areas by effectively handling grass clippings, sand and other small debris from normal turf care wash operations. The System is also designed for pretreatment for either:

- Waste2Water wash water recycle systems, or
- Discharging wash water to the sanitary sewer

The Clipping Separator can be used for 9, 18, 27 or 36-hole golf courses, and can handle up to 6 wash stations. The system includes pre-engineered in-ground sumps, and above-ground components that make handling grass clippings simple, easy and effective.

## Specifications:

| | |
|---|---|
| **Flow Range:** | 0-50 GPM |
| **Daily Throughput:** | Unlimited |
| **Clipping Separation:** | 432 sq. in.<br>Wedge Wire |
| **Power Requirement:** | 115 Volt 20 AMP |
| **Components Included:** | Round Sump<br>Submersible Pump<br>Clipping Separator<br>Clipping Cart<br>Shallow Sump<br>Solids Separator |
| **Approximate Weight:** | 250 lbs |

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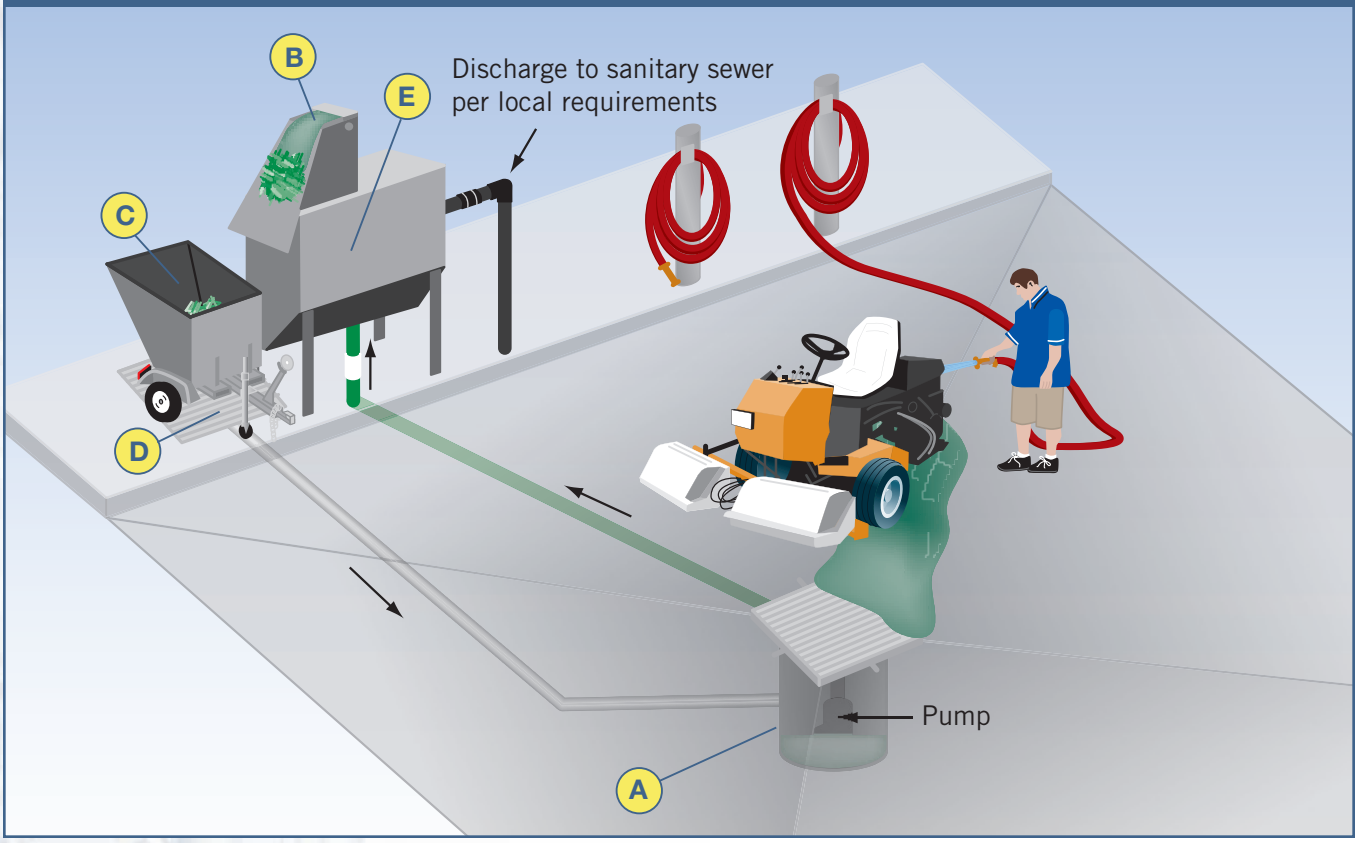
## System Wash Water Flow Diagram and Description




### A Round Sump
Wash water flows into a pre-engineered ESD Round Sump. Water, grass clippings and sand are swooshed around into a slurry. A powerful pump then pushes the slurry to the Clipping Separator.

### B Clipping Separator
The wash water slurry flows over the fine mesh clipping screen where grass and other solids slide down the clipping screen and into the Clipping Cart. At the same time, water drops through the clipping screen and into the Solids Separator.

### C Clipping Cart
The clipping cart captures grass clippings, sand particulates and other solids. The solids are dewatered as they drip-dry in the Clipping Cart. The water drains into a Shallow Sump below the Clipping Cart. Once dewatered, the grass clippings are removed and disposed of appropriately.

### D Shallow Sump
Below the Clipping Cart a Shallow Sump collects excess water where it is drained back to the Round Sump.

### E Solids Separator
Wash water from the Clipping Separator flows through a series of baffles and then gravity feeds into the Biological Treatment System, or to the sanitary sewer (as per local requirements). Fine solids settle, and are drained on a regular basis, through valves in the bottom of the Solids Separator. The solids are then deposited into the Clipping Cart for disposal.

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What is the condition inside the pesticide storage area?

## Pesticide Storage Area Recommendations

- **Temperature…** Avoid storing pesticides in hot places
  Pesticides should be stored out of the sun, away from furnaces or other sources of heat. Building temperatures should be kept under 95 degrees Fahrenheit and above pesticide freezing points. Follow any additional storage instructions provided on the label.

- **Ventilation …..** Must be well ventilated
  The building should have a ventilation system sufficient to prevent accumulation of vapors. Consider installing an electric fan with a switch on the outside of the structure to ensure rapid ventilation.

- **Shelving …** Built with sturdy materials
  Preferably metal or plastic shelves with lips to prevent tumbles.
  All containers are to be off the floor.

- **Lighting …** Storage area needs to be well lit to see labels.

- **Pesticide Weight ……** Heavy drums on lower shelves / Light packs on top shelves.

- **Labels …….**Warning statements need to be clearly visible.

- **Rotation ….** Rotate stock; keep oldest at the front.

- **Floor……..** Base should be impermeable with curbs or dikes to contain leaks.

- **Security ….** Build a fence around the area. At the very least, keep doors locked.

- **Safety…….** List chemicals stored. Have the list of chemicals (or copies of the labels) and a spill kit readily available within the storage area.

*References:* DSHM-PES-0503, Pesticide Storage Guidelines; Colorado State University Cooperative Extension, Mile High Growing Newsletter, April 2000, Vol. 12, No. 4

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Pest Management
Recommendations



What is the condition inside the pesticide storage area?

## Storage Facility Safety Check List

| | | | |
|---|---|---|---|
| ✓ | Separated from office, workshop, food …….. | Y __ | N __ |
| ✓ | Separated from wells and surface water by at least 100 ft... | Y __ | N __ |
| ✓ | Fire resistant building materials …….. | Y __ | N __ |
| ✓ | Impermeable flooring …… | Y __ | N __ |
| ✓ | Liquid spill containment (berms or sump, 25% of liquid storage) … | Y __ | N __ |
| ✓ | Anti-spark electrical components ……... | Y __ | N __ |
| ✓ | Heating system (maintained above 32 degrees F) ……. | Y __ | N __ |
| ✓ | Ventilation system with an outside switch …….. (vent vapors/maintain below 95 degrees F) | Y __ | N __ |
| ✓ | Locked doors …… | Y __ | N __ |
| ✓ | Fenced …… | Y __ | N __ |
| ✓ | Warning signs posted ……. | Y __ | N __ |
| ✓ | Sturdy shelves for off floor storage …….. | Y __ | N __ |
| ✓ | Emergency eyewash and shower immediately available ... | Y __ | N __ |
| ✓ | Routine wash-up facilities near by …… | Y __ | N __ |
| ✓ | Spill kit and fire extinguishers readily available …….. | Y __ | N __ |
| ✓ | Personal protective equipment available …….. (outside of, but near storage area) | Y __ | N __ |
| ✓ | First aid kit ……... | Y __ | N __ |
| ✓ | Prepared emergency response plan on file ……. | Y __ | N __ |
| ✓ | Pesticide inventory on file …….. | Y __ | N __ |

*References:* Core Manual, Northeastern Regional Pesticide Coordinators, 2nd Edition;
Virginia Farmstead Assessment System Fact Sheet No. 7 Pesticide Storage, Handling, and Management
<http://www.ext.vt.edu/pubs/farmasyst/442-907/442-907.html>

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What security measures are taken at the storage area?

## Security Measures

- Storage area should remain locked when not in use.
- The storage area should be fenced in or at least able to be securely locked.
- Prominent, weatherproof warning signs should be posted on every door.
- Have a basic fire response plan prepared and submit it to the fire department.
- Pesticide storage tanks should have locked inlet and outlet controls.
- Tanks should be secured by fences or stored inside locked facilities.

*References:* DSHM-PES-05-03 Pesticide Storage Guidelines; NYS Department of Environmental Conservation Pesticide Safety Education Core Manual

What is the storage duration of pesticides?

## Storage Duration

☑ **It is best not to have surplus pesticides**.
Purchase only what you know you will use.

☑ **If material is stored:**
Always store pesticides in their original containers with the labels securely attached and plainly visible.

☑ **Mark each container with the purchase date.**

☑ **Keep a complete inventory of all products.**
Have list readily accessible in a separate building.

☑ **Store herbicides separately from other pesticides.**
Some herbicides are volatile and readily contaminate other chemicals.

☑ **Inspect containers periodically for signs of leakage, severe damage, or other defects.**

☑ **Pesticides should never be stored in a container other than the original container.** If containers are damaged, transfer contents **immediately** to a clean and suitable larger container which can be sealed and labeled. Remove the label from the damaged container and fasten it firmly to the new container. Or, print a copy of the label from Cornell University's PIMS website to attach to the new container. (http://pmep.cce.cornell.edu/pims/current/)

*References:* Integrated Pest Management Guide, Cornell Cooperative Extension; NYS DEC Pesticide Storage Guidelines, DSHM-PES-05-03



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AEM Tier 2

Pest Management
Recommendations

Pesticide Storage

What is the leachability of stored pesticides?

What is the condition of the containers?

## Pesticide Leachability

- It is best not to have a surplus of pesticides.
- Know the leaching potential of the stored pesticide.
- Choose pesticides with the least potential for leaching into the groundwater.
- Look for characteristics which identify the pesticide as being insoluble, relatively stable and readily adsorbed to soil.
- Read the pesticide label for any warnings of leachability. The Environmental Hazards section often includes groundwater advisories and protection information.
- Pesticide containers should be kept tightly sealed when in storage.
- Inspect periodically for signs of leakage, severe damage, or other defects.

## Pesticide Containers

★ *All pesticide containers should be checked often for leaks and loose caps. You must correct these dangerous conditions immediately. Pesticides should be stored in their original container with the label attached.*

★ ***If containers are damaged, transfer the contents to a sound and suitable larger container which can be sealed and labeled.***

★ *Oftentimes the label from the damaged container can be firmly fastened to the new container. Otherwise, print a copy of the label from Cornell University's PIMS website to attach to the new container. Unlabeled pesticides are illegal and dangerous since you don't know what they are or how to use them. Label them as "not for use", set them aside and hold them for disposal.*

★ ***Partly empty pesticide containers should be resealed & returned to storage. Keep containers well sealed to avoid vapor buildup.***

★ *Pesticides should never be stored in soda bottles, fruit jars, milk cartons, etc. Storing pesticides in improper containers is a common cause of pesticide poisoning.*

*References:* NYS Laws and Regulations, Core Manual Pesticide Safety Education

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What is the proximity of mixing and loading area to wells, surface water, & watercourses?

## Mixing & Loading Guidelines

- If possible, mix and load pesticides on a concrete pad, so that spilled pesticides can be removed and not absorbed into the ground.
- If there is no impermeable mixing and loading pad, the risk of contamination can be minimized by following some basic guidelines:
  - Rotate the mixing site within the field of application to avoid build-up of pesticides in the soil.
  - Avoid mixing and loading on gravel driveways or other surfaces that allow spills to sink quickly through the soil.
  - Carefully choose the pesticide mixing and loading area. It should be outside, away from other people, livestock, and pets.
  - Pesticides should not be mixed in areas where a spill or overflow could get into a water supply.
  - Stay away from any well - including drainage wells and abandoned wells.

    NRCS AMF standard NY-702 requires a minimum of 100 feet from private wells or surface water bodies and 500 feet from wells used for public water supply.
  - Follow any additional state and label requirements.
  - Measure accurately; follow label instructions and mix only the amount you plan to immediately use.
- All measuring devices - spoons, cups, scales - should be labeled and kept in the pesticide storage area and should never be used for other purposes.

### Protect Water Sources

Many groundwater contamination problems are associated with mixing and loading of pesticides near wellheads. Pesticides applied close to wells can contaminate the groundwater by moving through the well.

*References:* van Es H. M. and N. M. Trautmann. 1990. Pesticide Management for Water Quality; Principles and Practices. Cornell University; Southern Nurserymen's Association. 1997. Best Management Practices, Guide for Producing Container-Grown Plants; Natural Resources Conservation Service Conservation Practice Standard 2004; Core Manual Pesticide Safety Education



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# Pesticide Spill Kit

## Spill Kits Should Contain:

- ☐ Gloves (nitrile, at least; foil barrier laminate better)
- ☐ Goggles
- ☐ Chalk or grease pencil (for marking spill area on floor)
- ☐ Dust pan or small shovel (plastic preferable)
- ☐ Small broom
- ☐ Spray bottle (for wetting down small spills)
- ☐ Paper towels
- ☐ Permanent marker (for marking spill container after clean-up)
- ☐ A container with lid to put contaminated waste in
- ☐ Tyvek coveralls
- ☐ 20-gal hazardous material temporary storage bags
- ☐ Sorbent pad or tube sock for water or solvent-based chemicals
- ☐ Loose absorbent (kitty litter, saw dust, etc.)
- ☐ Sweeping compound
- ☐ Warning sign

### In addition:

- ☐ Label the spill kits: "*For Pesticide Use Only*"
- ☐ List items in the kit and tape to the lid or place in a plastic bag in the kit
- ☐ Tape the kit closed after checking contents (lightly but visibly) so you can see when it has been disturbed

References: Pesticide Spill Guide—Ithaca-Cornell University Occupational and Environmental Health College of Agriculture and Life Sciences; CALS Occupational & Environmental Health <http://oeh.cals.cornell.edu/Spill_Kit_Contents.html>



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What type of mixing and loading area is used?

## Mixing and Loading Area

- Carefully choose the pesticide mixing and loading area. It should be outside, away from dwellings, livestock and pets. Pesticides should not be mixed in areas where a spill or overflow could get into a water supply.
- Sites for loading and mixing of pesticides should be located as far away from points of entry to surface or groundwater as possible. The NRCS Agrichemical Mixing Facility standard NY-702 requires a minimum of 100 feet from private wells or surface waterbodies and 500 feet from wells used for public water supply. At least 200 feet from private wells will lower the risk and is suggested whenever feasible.
- Mix and load agricultural chemicals and rinse equipment on an impervious surface with a curb to control spills, minimize soil contamination, and reduce risks of pesticides leaching into groundwater.
- A pesticide that is spilled near water sources, such as wells or streams, could move over or through the soil and reach the water source.
- Small quantities spilled regularly in the same place can go unnoticed, but the chemicals can build up in the soil and eventually reach groundwater. By mixing and loading on an impermeable surface, such as concrete, you can contain and reuse most spilled pesticides.
- Even if there is no impermeable mixing and loading pad, the risk of contamination can be minimized by following some basic guidelines:
  - Rotate the mixing site within the field of application to avoid build-up of pesticides in the soil.
  - Avoid mixing and loading on gravel driveways or other surfaces that allow spills to move quickly into the soil.
  - Stay away from any well (including drainage wells and abandoned wells), stream or sinkhole during mixing and loading operations. Use a nurse tank to transport water to the mixing and loading site.

*References:* DSHM-PES-05 Pesticide Storage Guidelines, NY State DEC Program Policy; Cornell University PMEP; Reducing the Risk of Groundwater Contamination by Improving Pesticide Storage and Handling, New Mexico Farm-A-Syst Fact Sheet #2 <http://cahe.nmsu.edu/farmasyst/pdfs/2fact.pdf>



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What type of backflow prevention is used?

# Backflow Prevention

All certified applicators who draw water from any water source must use a backflow prevention device (BPD) installed between the water source and mixing tank.

**Only 2 types of Backflow Prevention Devices are acceptable for use with pesticides in New York:**

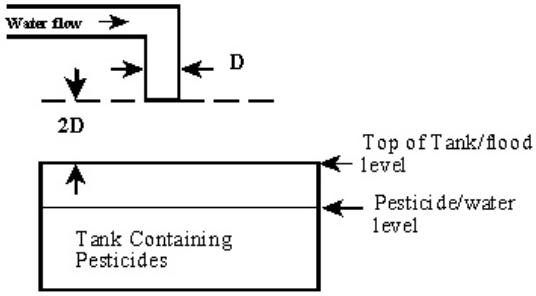
1. **Reduced pressure zone devices (RPZ)**
2. **Air-gap devices**

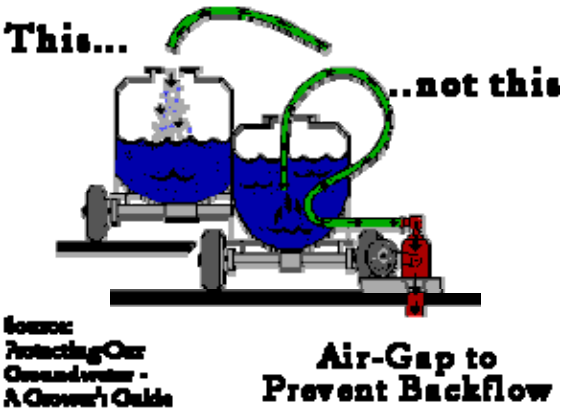
## GUIDELINES FOR FILLING SPRAYER TANK:

- **Never** put the hose into the sprayer tank .
- Maintain a fixed air-gap at least twice the diameter of the fill hose above the tank at all times.
- During filling operations, don't allow the water to back-siphon.
- Use a nurse tank to supply water for mixing so that mixing will occur away from wells and prevent backflow of pesticides into wells.

***Reduced Pressure Zone Device (RPZ):*** ***must contain a minimum of 2 independently-acting check valves, with an automatically-operated pressure differential relief valve located between the 2 check valves. The unit must include tightly closing shutoff valves located at each end of the device. Each device must also be fitted with properly located test locks.***

***For more information about approved devices, contact the NYS DEC.***




*References:* Cornell University PMEP; Cornell Cooperative Extension Suffolk County Best Management Practices for Long Island Growers; Purdue University <http://www.purdue.edu/dp/envirosoft/pest/src/mixing.htm>; DEC TAGM PES-98-09 Backflow Prevention Devices <http://www.dec.state.ny.us/website/dshm/pesticid/9809bf1.html>



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Mixing and Loading Practices

Where is the water source?

How is sprayer cleaned and rinsate disposed of?

## Water Source

**Protect Water Sources –**
Areas where pesticides are mixed and equipment is filled have great potential as sites where groundwater can be contaminated with pesticides. Avoid mixing and loading pesticides near your well or any public drinking water supply wells. Pesticides applied close to wells can contaminate the groundwater by moving through the soil and into the well.

- **Use a separate water tank such as a nurse tank** to transport water to the mixing and loading site. This is the best way to prevent contamination. (Increasing the water supply line so the spray unit can be filled farther from the water source is another option to consider.)
- **The water hydrant** needs to be at least 100 feet from private wells. Mixing and loading needs to take place at least 100 feet from private wells and surface water bodies, and 500 feet from wells used for public water supply.

These standards apply where pesticides are mixed and loaded and where equipment is cleaned. Pesticides should not be mixed or loaded in areas where a spill or overflow could get into a water supply. The mixing and loading area should be located outside of wetland areas and downslope from any well, surface water and watercourse.

## Cleaning Sprayer & Disposing of Rinsate

**Best Management Practices:**

- Mix only what is needed for that day's jobs.
- Always try to end the day with an empty tank.
- Choose the washing area carefully. Avoid contamination of water supplies and injury to plants or animals.
- Always flush with clean water, inside and out, to prevent corrosion and accumulation.
- Dispose of rinsate as directed on the product label. **Waste from equipment cleanup must be kept out of water supplies and streams.**
- Sprayers need to be cleaned to prevent corrosion, to prevent cross-contamination of pesticides or other materials, and to prevent crop injury.
- Do a thorough cleaning with a cleaning solution whenever you change pesticides or prior to storage. Trace amounts of one pesticide can react with another or carry-over to the next spraying causing damage, especially with herbicides. The solution used depends on the pesticide to be removed from the sprayer. Check the pesticide label or the CORE Manual on Pesticide Education Safety for cleaning instructions.

*References:* Natural Resources Conservation Service Conservation Practice Standard 2004; Core Manual Pesticide Safety Education; Cornell University PMEP Fact Sheet "Cleaning Your Sprayer"; Cornell Cooperative Extension Suffolk County Best Management Practices for Long Island Growers

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Mixing & Loading Practices

How are spills handled?

**DEC 24 hour spill hotline**
**1-800-457-7362**

## Pesticide Spills

Spills ~ In spite of all safety precautions, accidents can happen. If a pesticide spills in your storage area, quick action must be taken. If the pesticide gets on anyone, have them get out of the area, wash thoroughly, change clothes, and see a doctor if necessary. Clear the storage area except for a small clean-up crew. Be sure the crew wears the proper personal protective equipment.

If the spill is a liquid ~ Your first step is to contain the spill. Throw absorptive clay, vermiculite, pet litter, or sawdust over the entire spill. Use enough to soak up the liquid. Then sweep or shovel it into a large drum.

If the spill is a dust, granular, or powder ~ Sweep or shovel it directly into a large drum. Sweeping compound can be useful when picking up spills of dry pesticides. Next, cover the spill area with a decontamination agent recommended for that particular pesticide. The manufacturer or your supplier may have to be consulted. Hydrated lime and high pH commercial detergents are often recommended. Repeat this procedure several times.

If the spill is on a pad ~ Rinse the whole area with plenty of water. Collect the rinse water and dispose of it appropriately. (See below.) Check your storage area carefully to see if any other pesticides were contaminated by the spill. If so, dispose of them as well.

If the spill is on soil ~ **DO NOT** hose down the area. Water will spread the pesticide, creating a wider area of contamination. Shovel the top 2-3" of soil into a plastic bag.

***KEY POINTS***

Have a **spill kit and emergency response plan** accessible.

**Clean up spills immediately.**

Identify the source and try to stop it. **Isolate** the area.

**Contain** liquid spills. Construct a dam to prevent from spreading. **Soak up** the spill with absorbent material.

Wear **protective gear**.

**Sweep up** dry spills; reuse pesticide as it was intended.

For soils, shovel the top 2 to 3 inches of soil into a heavy duty plastic bag. Cover with at least 2 inches of lime. **Do not** hose down the area!

Disposal ~ If the spilled chemical is considered hazardous, dispose of all contaminated materials (absorbent materials, soil, porous equipment, gloves, brooms, etc.) through a hazardous waste disposal company. Otherwise, dispose of materials through the normal waste stream. **Questions on disposal and spill guidelines? Contact the product manufacturer or call Chemtrec at 1-800-424-9300 or call DEC at 1-800-462-6553.**

*References:* Core Manual Pesticide Safety Education; Cornell Cooperative Extension Suffolk County Best Management Practices for Long Island Growers; <http://www.thisland.uiuc.edu/50ways/50ways_34.html>

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Is an inspection and emergency plan in place?

## Inspection and Emergency Plan

**A routine inspection plan can help prevent contamination from occurring.** Check application equipment regularly for leaks and malfunctions. Inspect wells and pumps regularly for leaks and insure that the seal is adequate to prevent pesticides from entering the well.

**Prepare an emergency response plan.** All employees or persons having access to the pesticide storage area should be familiar with the plan. In addition, the local fire department, rescue squad and local hospital should also be given copies of this plan.

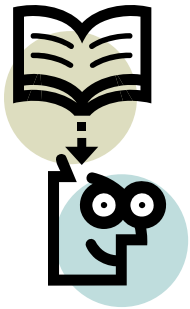
**Maintain a current inventory** of the pesticides in storage. Keep a copy of the inventory list at a location removed from the storage area and accessible in the event of an emergency involving the pesticide storage area.

**Spill kits and fire extinguishers** appropriate for all stored pesticides should be readily available but not kept within the pesticide storage area.

**Provide personal protection equipment** near, but outside of, the storage facility. Emergency response information, written standards for pesticide segregation pertinent to the facility, and postings and warnings in compliance with OSHA Hazard Communication and Worker Protection Standards should be displayed in a central location for all employees.

**Conduct training sessions on safe pesticide handling**; spill prevention and response (containment and cleanup); and selection, use and maintenance of personal protection equipment.

**Farm Emergency Plan Outline**



1. Emergency Phone List
2. Farm Contact Information
3. Location of Emergency Equipment & Supplies
4. Farmstead Site Map including what's stored in each building, location of wells, gas and electricity valves, etc.
5. Equipment Instructions (How to Disengage or Shutoff)
6. Inventory of stored chemicals, as well as PPE, spill kits, etc.
7. Farm Emergency Plan for Spills & Leachates
8. Pesticide Spills
9. Petroleum Spills

References: DSHM-PES-05 Pesticide Storage Guidelines, NY State DEC Program Policy; Pesticides and Groundwater, A Guide for the Pesticide User. Northeast Regional Agricultural Engineering Service Cooperative Extension. 1995; Cyr, D.L.& Johnson, S.B. *Preplanning for Farm Emergencies*. Maine Farm Safety Program, Bulletin 2360.

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How and where are pesticide containers disposed of?

# Recycling and Container Disposal

Unwashed and improperly stored containers can lead to groundwater contamination if chemical residues leak onto the ground.

***Pesticides must be disposed of in accordance with the laws and regulations of NY State.***

**Following these basic guidelines can help prevent groundwater contamination:**

⇒ Pressure-rinse or triple rinse all plastic containers immediately after being emptied, since residue can be difficult to remove after it dries.

⇒ Pour the rinse water into the spray tank to avoid disposal problems.

⇒ Puncture containers and store them in a covered area until you dispose of them.

⇒ Use returnable containers and minibulks, and take them back to the dealer as often as possible.

⇒ Recycle plastic containers through the distributor or at the Long Island Cauliflower Association. Triple-rinsed containers can also be disposed of through your local waste management facility.

⇒ Shake out bags, bind or wrap them to minimize dust, and dispose of them through the local waste management facility.

⇒ Do not bury or burn pesticide containers or bags.

⇒ Do not reuse pesticide containers for any other purposes.

For NY State regulations regarding container cleaning and disposal and reuse of pesticide containers, refer to:
***NYS Department of Environmental Conservation's Rules and Regulations Part 325, Application of Pesticides, Sections 4 and 5.*** *(http://www.dec.state.ny.us/website/regs/part325.html)*

*References:* Harris, B.L. et. al. Reducing the Risk of Groundwater Contamination by Improving Pesticide Storage and Handling. Texas Agricultural Extension Service; Cornell Cooperative Extension Suffolk County Best Management Practices for Long Island Growers

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Container Disposal

What is done with unwanted or banned pesticides?

# Proper Disposal of Unused and Banned Pesticides

***These basic guidelines can help minimize excess pesticides and prevent groundwater contamination.***

## Prior to purchase:

- ☑ Estimate your pesticide needs

## At time of purchase:

- ☑ Buy only what you need
- ☑ Buy products in returnable containers

## After you purchase:

- ☑ Mix only enough product for the job at hand, to help reduce container and chemical cleanup and disposal needs.
- ☑ Maintain an inventory of all stored pesticides. Mark containers with date of purchase.

Pesticides must be disposed of in accordance with the laws and regulations of NY State.

## Points to Remember:

- → Pesticides which are still factory sealed may be returned to the dealer/distributor. Check with the company to see if they will take your surplus back.
- → Consider transferring your excess DEC labeled non-restricted use pesticides to another certified applicator who is able to use the pesticide to control a similar pest problem.
- → Banned pesticides should be set aside until the next Clean Sweep event and labeled as "not for use". (The NYS DEC holds these events periodically to properly discard of hazardous materials and waste.) Call DEC's Central Headquarters in Albany at 518-402-8788 for more information or visit: www.cleansweepny.org
- → Alternatively, you can arrange for a licensed hazardous waste disposal company to pick up and dispose of any unwanted pesticides.
- → Any pesticide in a damaged container or at risk of leaking should be placed in secondary containment and disposed of as soon as possible.
- → Contact your local waste management facility for information on what you can dispose of at their location.

*References:* Core Manual Pesticide Safety Education; Cornell Cooperative Extension Suffolk County Best Management Practices for Long Island Growers; AEM Tier II Pesticide Management worksheets, Long Island Stewardship Program

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Is the sprayer properly maintained and regularly calibrated?

# Sprayer Maintenance Recommendation

**All pesticide application equipment should be properly maintained and calibrated on a regular basis.** The sprayer must put out the correct gallonage per acre and each nozzle must deliver an equal share of that amount.

## Equipment Maintenance Includes

- ☑ Regular maintenance of nozzles. (This is essential for accurate pesticide application; accurate application can never be achieved with improper or worn nozzles.)
- ☑ Protect nozzles from grit and dirt by adequate screens.
- ☑ Sprayers should be thoroughly rinsed between applications of different pesticides. Clogged tips should be cleaned with a soft, bristled brush only, never use a metal object. *Use extreme care with soft tip materials such as plastic and brass.*

## When to Calibrate Equipment

- ☑ Prior to the application of pesticides
- ☑ Prior to each season of application (at a minimum)
- ☑ When a change in pesticide application is made

## Why it is Important to Calibrate Equipment

- ☑ To prevent an ineffective application.
- ☑ Over application will result in a more costly operation.
- ☑ Over application will likely cause off-target environmental contamination.
- ☑ Under application of materials may result in poor control.
- ☑ Under application could require repeated applications, which will be more costly.
- ☑ It is illegal to apply pesticides at a rate higher than the rate listed on the label.

*References:* Core Manual Pesticide Safety Education; Southern Nurserymen's Association. 1997. Best Management Practices, Guide for Producing Container-Grown Plants.; Cornell Cooperative Extension Suffolk County Best Management Practices for Long Island Growers

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What is the distance of spray application from water bodies?

## Spray Application Recommendations

- Pesticides must be used in an appropriate manner to prevent contamination of environmentally sensitive areas such as wetlands, wells and surface waters. This includes paying attention to weather conditions, such as wind and rain, which can cause off-target movement of product and can impact the efficacy of the application.
- Follow the label restrictions regarding the appropriate distance of spray application from surface water bodies, ponds, wetlands, streams, rivers.
- If there are no specifications given on the label, spray should be applied at least 35 feet from open water sources.

*References:* NY State DEC Rules and Regulations, Environmental Conservation Law Part 325 Application of Pesticides; Cornell Cooperative Extension Suffolk County Best Management Practices for Long Island Growers; AEM Tier 2 Worksheets for Pest Management



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Are runoff and leaching potential considered in pesticide selection?

## Leaching Potential

Runoff & leaching potential should be a primary consideration in selecting a pesticide.

*Most land on Long Island has highly permeable, coarse soils underlain by groundwater that is near the surface. As a result, there is an increased potential for groundwater contamination.*

*Pesticide application methods affect the amount of pesticides subject to leaching. If pesticides are applied directly to the soil, there is a greater probability that more of the product will leach than if applied to the foliage.*

### Factors that Contribute to Pesticide Leaching Potential

### 1. Pesticide Properties

**Low adsorptivity** – the pesticide is weakly bound to the soil particle and therefore more likely to move through the soil with percolating water rather than staying in the root zone.

**Slow degradation rate** – the more time required before a pesticide breaks down, the greater the chance of the chemical leaching into the groundwater.

**High solubility** – the pesticide dissolves easily in water and may be dissolved in percolating groundwater and carried to groundwater.

### 2. Soil Characteristics

- High sand and gravel content
- Low organic matter content

### 3. Site Conditions

- Shallow depth to groundwater
- High rainfall or frequent, excessive irrigation

### To Reduce the Likelihood of Environmental Contamination:

1. Select the pesticide with lowest leaching potential
2. Use the lowest recommended rates
3. Consider alternative pest control practices

*For more information on the leachability of a pesticide, consult the technical representative or dealer and the label.*

*References:* Cornell Cooperative Extension Suffolk County Best Management Practices for Long Island Growers; Pesticides and Groundwater, A Guide for the Pesticide User; Northeast Regional Agricultural Engineering Service Cooperative Extension. 1995

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Pesticide Use

Is application equipment selected to minimize drift?

# Pesticide Application ~ Minimizing Drift

Through careful planning and preparation *"drift can be minimized. Implementing just one of these methods* [listed below] *will greatly reduce the effects of drift and will improve efficiency of spray application saving you time, money and future problems."* *- Andrew Landers, PhD, Cornell University*

## Before Spraying:

- ★ Train the operator to use the sprayer correctly on your farm under your conditions.
- ★ Plan the spraying operation.
- ★ Read and follow the pesticide label.
- ★ Select the correct nozzle for the target. Adjust the size, position, and orientation of nozzles to achieve correct distribution within the canopy, particularly as the growing season progresses.
- ★ Consider the use of sprayers which direct the spray to the target such as towers and tunnels. Check that air deflectors are set properly to confine disturbance to the target.
- ★ Use spray additives to reduce drift only if they are independently proven to work.
- ★ Improve spraying logistics to ensure adequate time to spray within 'ideal' conditions.
- ★ Calibrate the sprayer with water to ensure that everything is working correctly.

## During Spraying:

- ★ **Stay Alert ~** Ensure the spray is not allowed to drift on to non-target areas. Watch for changes in wind speed and direction.
- ★ **Keep spray pressure as low as possible ~** Ensure an accurate gauge is used.
- ★ **Maintain a constant speed and pressure ~** If an automatic regulator is fitted, remember: small increases in speed result in large increases in pressure. The delivered air and spray must be given time to penetrate the canopy.
- ★ **Avoid spraying near sensitive crops or water courses ~** Use a 50 - 100 feet buffer zone.

Deposition and drift are both determined by a nozzle's droplet size spectrum. The smaller the particle size, the greater the drift potential.

Droplet size is grouped into 3 categories:
*Fine* (119-216 µm), *Medium* (217-353 µm), *Coarse* (354-464 µm ) (One micron (µm) = 1/25,000 inch)

**Fine sprays are prone to drift**. Do not use a fine spray for pesticides labeled toxic.
**Medium Sprays** should be used unless another spray quality is indicated. Medium droplets are ideal when foliage is the target.
**Coarse Sprays** have a low risk of drift but should only be used where recommended.

*References:* Landers, A. Cornell University. "*Minimizing Drift*" and "Facts on Droplet Size and Drift" <http://www.nysaes.cornell.edu/ent/faculty/landers/estapp>

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# Consider the Weather Before Applying Pesticides and Increase the Effectiveness of Pesticide Application

## Weather Tips to Save Time, Money and Reduce Environmental Risks

### ➜ Avoid high temperature and low humidity conditions

Under these conditions, the rate of evaporation is greatly increased. Small droplets that completely evaporate result in pesticide particles that can be carried through the air for several miles (aka vapor drift).

### ➜ Avoid windy days

High winds increase drift and result in pesticides being carried away from the treated area. To be safe, never apply pesticides at wind speeds of greater than 10 mph. Remember: **it is illegal** for pesticides to drift onto non-target areas.

### ➜ Do not apply pesticides just before a rain

Rains cause runoff and tend to wash pesticides away from the target area, leaving the pests untreated. Runoff can lead to surface waters and sensitive areas causing unanticipated environmental damage.

### ➜ Consider early morning or evening applications

At these times, wind speed is usually lowest and humidity is highest, thus the risk of drift is greatly reduced. Furthermore, by avoiding full daylight hours the contact danger to wildlife, such as birds and pollinators, is reduced.

*References:* Andrew Landers Cornell University: http://www.nysaes.cornell.edu/ent/faculty/landers/pestapp; CORE manual



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Integrated Crop Management

Are all appropriate methods of control used?

# Components of an IPM Approach:

## Preventative Measures

- **Cultural Controls ~** to disrupt the environment of the pest. Examples include crop rotation, plowing, and removal of infected plant material.
- **Biological Controls ~** using natural enemies to keep pest levels at a minimum before the problem gets out of hand.
- **Pheromones ~** the use of natural insect scents usually emitted by the female insect can confuse the male and prevent mating and therefore future generations.
- **Pest-Resistant Varieties ~** using crop varieties that are less susceptible to certain insects and diseases.

## Assess the Economic Threshold

The process of determining economic threshold or an intolerable level includes:

- Forecasting to help determine if weather conditions will be favorable for the development of diseases and insect pests.
- Keeping records from previous years will help to predict and prevent an out break.
- Monitoring/Scouting - the regular, systematic checking of an area can lead to early detection of pests, allowing you to make pest management decisions before the problem is out-of-control.
- Proper pest identification - A misdiagnosis of the problem can lead to improper treatment.

### Economic Thresholds:

**Levels that mark the highest point a pest population can reach without risk of economic loss.**

**Above these established levels, populations can reach the economic injury level where they can cause enough damage for the grower to lose money.**

*By knowing and observing thresholds, a grower can avoid spraying if the pest is not at a level that will cause economic loss.*

## Action or Control Measures

**Once a pest has reached the economic threshold, action should be taken. *The type of action taken depends on the pest and the severity of the situation.* The action taken could be cultural, such as harvesting early to avoid pest problems and to prevent crop loss, or the action could be the decision to use pesticides. Pesticides should be used when no other strategies will bring the population below the economic threshold level.**

*References:* Core Manual Pesticide Safety Education; Conservation Technology Information Center, Core 4 Conservation IPM Resources <http://www.conservationinformation.org/?action=learningcenter_core4_whatscore4>

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Recommendations



Does grower have knowledge and skills relating to IPM?

# Recommendations for Integrated Crop & Pest Management

## Knowledge & Skills Relating to Integrated Pest Management

Effective pest control requires an understanding of the cultural, biological, chemical, and field management procedures used in an integrated pest management (IPM) approach.

By practicing IPM, pesticide use can be greatly reduced, saving both time and money, while preserving beneficial organisms and ultimately reducing the risk to surface water and groundwater.

## Learn to:

- ☑ Recognize the common pests that you work with and their hosts.
- ☑ Properly identify a pest and know its life cycle.
- ☑ Know the best time to control the pest.
- ☑ Choose the proper pesticide and learn when you can use the lowest recommended rate.
- ☑ Avoid injury to the host.
- ☑ Avoid injury to non-target areas.
- ☑ Incorporate scouting into crop management activities to help determine when a pest has reached its economic threshold level.

Reference: Core Manual Pesticide Safety Education

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Integrated Crop Management

What type of pest management is used?

## Top 10 Management Tips

**Soil Management:**
Providing sufficient amounts of crop residue on the soil surface increases organic matter of the soil. Soil testing and applying proper amounts of macro and micronutrients provides for the optimum growing environment.

**Cultural Practices:**
The pest's environment is disrupted by rotating crops, and timely harvesting of crops. Planting cover crops can suppress weed pressure and provide nitrogen and better soil tilth.

**Planting:**
Plant crops that have good vigor and that can tolerate or resist common problems. The timing of planting should coincide within the optimum planting dates recommended. Row spacing, intercropping, trap crops and other alternative strategies can be looked at to discourage or detract pests.

**Pest Trapping:**
Traps that attract insects are placed near target crops. This can be done in conjunction with a larger network within state or multi-state areas to track infestations of some insects. This information can be utilized later when populations reach a critical point.

**Monitoring:**
Growers or scouts should use a systematic approach to regularly inspect representative areas of the fields to determine if pests are approaching a damaging level.

**Forecasting:**
Site specific or local weather data is consulted to predict if and when pest outbreaks will occur. Treatments can then be properly timed, preventing crop damage and saving spray applications.

**Biological Controls:**
Growers should promote and attract many natural enemies that can inhibit pest populations. Import and use additional biologicals where cost effective.

**Thresholds:**
Before treating, the pest population should reach a level that could cause economic damage. Until that threshold is reached, the cost of yield and quality will be far less than the cost for control.

**Chemical Controls:**
Growers select the most effective and appropriate pesticide and properly calibrate sprayer. Weather conditions are checked prior to spraying to assure proper coverage and minimum drift.

**Record Keeping:**
Records of soil management, planting dates, weather data, treatments and other appropriate information are kept for future weed and pest management decisions.

*References:* Conservation Technology Information Center, Core 4 Conservation IPM Resource <http://www2.ctic.purdue.edu/Core4/ipm/Top10.html>

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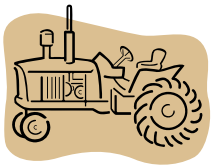
Are pest resistant crops grown?

Are cover crops grown to minimize nutrient and pesticide leaching and runoff?

# Benefits of Pest Resistant Crops and Cover Crops

- ★ The use of pest-resistant crop varieties is recommended when available.
- ★ Pest-resistant varieties are less susceptible to certain insects and diseases than other varieties and they reduce growers' need to apply pesticides.

## Cover Crops Minimize Nutrient & Pesticide Leaching and Runoff



Bare soil is susceptible to wind and water erosion, and to drying and crusting.

**A cover crop is a crop grown to cover the soil.** It may either be tilled into the soil as a "**green manure**" or used as a living or dead **mulch** on the soil surface. A cover crop may, or may not, be harvested. A cover crop can be any type of plants, but are generally grasses (including cereal grains), legumes, or grass/legume mixtures. Some non-legume broad-leaved plants are also used.

**Cover crops improve the physical, chemical, and biological quality of soil.** They do this by covering the soil surface, penetrating the soil (roots), adding organic matter to the soil, and by being involved in the soil nutrient cycle. They can also help in managing insects and disease.

**Cover crops reduce erosion and runoff by increasing infiltration.** Cover crops, especially **grasses**, may also slow down runoff by physically blocking water flow. This gives the water more time to soak into the ground than would happen with bare ground. Cover crops also reduce soil water levels more than a bare soil would, leaving more room for water in the soil profile and decreasing runoff and erosion in the case where rainfall would saturate a bare soil.

**Cover crops help suppress weeds.** While the cover crop is growing, it will suppress the germination and growth of fall and early spring weeds through competition and shading. When killed and left on the surface as mulch, cover crops continue to suppress weeds, primarily by blocking out light.

*References:* Washington State University, Grant and Adams Cooperative Extension <http://grant-adams.wsu.edu/agriculture/covercrops/benefits>; NRCS-USDA <http://www.nrcs.usda.gov/feature/outlook/Soil%20Quality.pdf>; Core Manual Pesticide Safety Education

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# Appendix 9
# NYSDEC LI Pesticide Strategy

# LONG ISLAND PESTICIDE POLLUTION PREVENTION STRATEGY

New York State
Department of Environmental Conservation
July 11, 2014

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# EXECUTIVE SUMMARY

## INTRODUCTION

Pest management plays an integral role in the health and economic vitality of New York State. At the same time, improperly used pesticides have the potential to impact environmental quality. This draft Long Island Pesticide Pollution Prevention Strategy (Strategy) was developed in response to concerns over detection of pesticide-related constituents in the groundwater over time at various locations on Long Island and recognition of the importance of protecting the environment while meeting critical pest management needs.

The New York State Department of Environmental Conservation (DEC) regulates the registration, commercial use, purchase and custom application of pesticides. The Environmental Conservation Law (ECL) sets forth the state's policy regarding pesticide usage. ECL 33-0301. According to the ECL, pesticides, when properly used, are "valuable, important and necessary to the welfare, health, economic well-being and productive and industrial capabilities of the people of this state." ECL 33-0301. However, pesticides also present potential dangers to health, property and the environment if improperly used. ECL 33-0301.

DEC exercises its broad regulatory responsibilities in consultation with the Departments of Health (DOH) and Agriculture and Markets (DAM) in order to protect public health and the environment while ensuring that pesticides proposed for use in New York State are properly registered and applied for the benefit of agricultural and other economic enterprises that rely on pesticide usage. In the interests of providing further protection to Long Island's precious groundwater resources, DEC engaged the public, municipalities, agricultural and other regulated communities in a discussion on how to further protect Long Island's groundwater resources. As a result, DEC developed the draft Long Island Pesticide Pollution Prevention Strategy. Implementation of the Strategy will enhance DEC's existing regulatory program using principles of pollution prevention. The Strategy presents a blueprint for DEC, in consultation with stakeholders, to evaluate pesticide usage on Long Island, identify pesticides that have the greatest potential to cause adverse impacts and work with partners to reduce or eliminate such usage or find alternatives that do not present such impacts. This approach will both protect Long Island's water resources from pesticide impacts and encourage effective methods of pest management.

## ES.1 THE CHALLENGE OF PESTICIDE USE AND GROUNDWATER ON LONG ISLAND

### ES.1.A. Critical Natural Resource and Essential Pest Management

Almost three million people in Nassau and Suffolk Counties rely on clean drinking water from Long Island's sole source aquifer, a unique and critical resource in the State. The heavy reliance on the sole source aquifer plus the nature of the aquifer system itself (e.g., shallow depth of groundwater, sandy and permeable soils overlying it), which is a factor in its vulnerability to contaminants, underscores the critical need to protect the quality of the groundwater before it becomes impaired for such usage. Pesticides play an important and beneficial role in managing

pests on Long Island. This includes regional pests which threaten public health, agricultural and horticultural productivity, structural integrity of public and private infrastructure (e.g., termite/carpenter ant control), quality of stored and marketed goods, and the condition of the environment. Annual regional pesticide use by many entities (e.g., agriculture, businesses, institutions and homeowners) averages in the millions of pounds and hundreds of thousands of gallons.[1]

### ES.1.B. Pesticide Detections in Long Island Groundwater

Water quality monitoring by Suffolk County and other entities shows that pesticides are among a number of contaminants detected in Long Island groundwater as a result of a wide range of human activities (e.g., nitrates, volatile organic compounds, pharmaceuticals and personal use products). The water quality monitoring data presented in this document, as well as the water quality monitoring data summary tables, are available at ftp://ftp.dec.ny.gov/dshm/pesticid/liwaterqualitydata.docx Data obtained from Suffolk County indicates that 117 pesticide-related chemicals were detected in the groundwater at a number of locations on Long Island at various points in time since 1997.[2] Approximately half of these are legacy compounds (from pesticides no longer or never registered for use on Long Island or in New York State), which have not been used in many years. Although the samples demonstrate that pesticides can persist in the Long Island aquifer, most detections were at low or trace levels. Some pesticide-related compounds were detected (mostly at low levels) at multiple locations, distributed broadly over Long Island. Primary examples include the active ingredients imidacloprid (insecticide), metalaxyl (fungicide), and atrazine (herbicide).[3]

### ES.1.C Drinking Water Quality

It is important to note that much of the water quality monitoring data presented in this document does not represent what the majority of residents of Long Island are using for drinking and other household purposes. Few detections of individual pesticide-related contaminants exceeded applicable standards. The Suffolk County Water Authority ensures that finished water (treated water) that they supply to their customers exceeds expectations for quality set by New York State drinking water standards.[4] Public water supplies are subject to regulation by the NYSDOH through the Suffolk County Department of Health Services (SCDHS) under New York Codes Rules and Regulation (NYCRR) Subpart 5-1.[5] The regulations establish water quality standards known as maximum contaminant levels (MCLs), and require routine water quality monitoring. If finished drinking water is found to contravene a standard, corrective action is required. Private wells are not regulated by NYSDOH, but SCDHS has a program to test private wells for pesticides and other contaminants. Through their work, if contaminants are found in a private well that exceeds standards then the homeowner is advised to not drink that water, and to either

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[1] NYS Department of Environmental Conservation, Final Annual Report for New York State Pesticide Sales and Applications 2005. http://www.dec.ny.gov/chemical/37825.html

[2] See Appendices A and B of the Strategy for a summary of results of Long Island water quality monitoring conducted by the Suffolk County (SC) Department of Health Services, SC Water Authority, and U.S. Geological Survey. See additional monitoring data at http://www.dec.ny.gov/.

[3] DEC data analysis regarding these active ingredients (AIs) is contained in Appendix B of this Strategy.

[4] 2012 Annual Drinking Water Quality Report, Suffolk County www.scwa.com.

[5] Title 10. Department of Health Chapter I. State Sanitary Code Part5. Drinking Water Supplies Subpart 5-1. Public Water Systems.

find an alternative source or to invest in treatment to achieve compliance with drinking water standards.

### ES.1.D. Significance of NYSDEC Pesticide Product Registration

DEC's pesticide product registration process forms an integral component of a comprehensive pest management program. The product registration program acts as a gatekeeper to control the universe of pesticide products in New York State that may be made available consistent with public health and environmental protection. The current in-depth pesticide product review process did not exist prior to the early 1990s. Older pesticides, registered before that time, have often not received a comprehensive DEC review, or received only a very limited review of a subset of products. The data demonstrate that DEC's existing pest management regulatory program has proven effective at preventing products which pose unreasonable adverse effects from being registered and used in the State. DEC's enhanced pesticide registration program relies on the New Active Ingredient (NAI) and Major Change in Labeling (MCL) review process. During this process pesticide registrants work with DEC to implement a feasible and effective resolution of any environmental concerns identified during DEC's review. For example, some pesticides may be registered for use in New York State with restrictions that prohibit or modify use on Long Island if the chemical or product use pattern poses a leaching risk for Long Island's vulnerable groundwater system. In this way, the current regulatory process effectively provides pesticide products needed by the user community while ensuring groundwater protection.

## ES.2 PESTICIDE POLLUTION PREVENTION GOAL

In general, once a contaminant that has the potential to adversely impact public health or the environment is found in groundwater, technological and fiscal constraints severely limit remedial options, and accurate assessments of public health and environmental quality implications are challenging. Therefore, it is essential to prevent contamination in the first instance, to the extent practicable, while still allowing for needed pest management.

DEC developed this Strategy as an approach for managing the ongoing need to prevent potential pesticide impacts to water resources while continuing to meet critical pest management needs on Long Island. In general terms, pollution prevention means reducing or eliminating the creation of pollutants at the source. In the context of pesticides on Long Island, pollution prevention may mean modifying pest management processes, promoting the use of alternative pest management practices, and utilizing effective, less-toxic products when available.

**GOAL OF STRATEGY**

***Prevent adverse effects on human health and the environment by protecting Long Island's groundwater and surface water resources from pesticide-related contamination, while continuing to meet the pest management needs of agricultural, residential, commercial, industrial, and institutional sectors.***

## ES.3 PESTICIDE POLLUTION PREVENTION (P2) BLUEPRINT

DEC's strategy to meet this goal of protecting water quality while meeting pest management needs is based on a blueprint of actions to further pesticide pollution prevention on Long Island. The greatest benefits can be gained from prevention when it is implemented through collaboration with involved entities. Therefore, the pesticide pollution prevention (P2) blueprint includes components to be acted on by DEC, in conjunction with various partners and Long Island stakeholders. In brief, the blueprint forms an approach for moving forward by supplementing the existing protective measures of the product registration, compliance and outreach components of DEC's pesticide regulatory program with P2 measures.

There are five main components in the pesticides P2 blueprint. The blueprint calls for actions essential to effective implementation of pesticide P2 in Long Island and, without which the Strategy cannot be meaningfully implemented. The blueprint is summarized below. Most of its components are based on multi-party actions needed to bring pesticide P2 to fruition. The actions must be feasible and carried out with available resources of DEC and its partners.

| PESTICIDE P2 BLUEPRINT SUMMARY |
|---|
| ***DEC Conducts Initial Assessments of Specific Active Ingredients (AIs) and Related Pesticide P2 Needs*** |
| ***DEC Forms, Convenes and Chairs Pesticide P2 Workgroups; Workgroups Consider Various Matters Regarding Specified AIs and Related P2 and Advise DEC*** |
| ***DEC Identifies and Prioritizes Pesticide P2 Measures and Partners Collaborate to Implement P2 Measures*** |
| ***DEC Tracks Pesticide P2 Results and Assesses Need for P2 Modifications*** |
| ***DEC Maximizes Department Use of Water Quality Monitoring for Pesticides (Monitoring underlies implementation of the entire blueprint.)*** |

These interrelated blueprint components follow a sequence which starts with assessing certain pesticide active ingredients detected in Long Island groundwater, then evaluating the type of P2 needed and implementing it, followed by tracking P2 results and modifying P2 if needed. Maximizing DEC use of water quality monitoring for pesticides involves actions which will provide an important part of the foundation for implementing P2 throughout the blueprint.

A number of action steps are needed to implement each component of the blueprint. These are shown in the full P2 blueprint on the following pages. Implementation of each component is designed to yield benefits which facilitate carrying out subsequent components and steps in the P2 process. Further detail on the blueprint is contained in chapter 3.

## ***BLUEPRINT for LONG ISLAND PESTICIDE POLLUTION PREVENTION***

### ***NYSDEC Conducts Initial Assessments of Active Ingredients (AIs) and Related Pesticide P2 Needs***

Review water quality monitoring results for Long Island groundwater; identify AIs detected as well as factors such as location, number, frequency and concentration of detections and potential for human exposure and associated health risks.

- Review AI-related standards, use and product information and water quality standards and benchmarks
- Identify AIs for which P2 measures potentially need to be taken
- Identify types of additional information needed to consider potential pesticide P2 needs and plan for AIs.

Note: DEC anticipates that the first group of AIs to be considered for assessment will be metalaxyl (fungicide), atrazine (herbicide) and imidacloprid (insecticide). These AIs have been detected by Suffolk County at multiple groundwater monitoring locations.

### ***DEC Forms, Convenes and Chairs Pesticide P2 Workgroups; Workgroups Consider Various Matters Regarding AIs and P2***

NYSDEC forms, convenes and chairs workgroups:

- A Technical Review and Advisory Committee (TRAC) which, at the request of DEC, considers AIs specified by the Department and advises on factors such as AI use and critical needs, potential for human exposure, human health risks, effective alternatives for AI, aquifer vulnerability, potential pesticide P2 measures (see below), P2 implementation partners, and other considerations to provide DEC with background information to support Department decisions regarding AIs and related P2 actions and implementation. (For further information on the TRAC, see Box ES-3 at close of the Executive Summary.)
- Additional workgroups, to ensure broad representation of involved entities in consideration of AIs and P2 measures (e.g., entities with direct involvement in pest management, pesticide use, and water quality on Long Island as well as academia). These workgroups may also consider AIs specified by NYSDEC, provide NYSDEC with requested information on particular subject areas (e.g., human health implications, water quality concerns, effective alternatives), and suggest feasible P2 measures and implementation partners.

### ***NYSDEC Identifies and Prioritizes Pesticide P2 Measures and Partners Collaborate to Implement P2 Measures***

NYSDEC considers workgroups' information and determines, the scope and priority of pesticide P2 measures appropriate for each AI to be addressed.

- NYSDEC will identify and prioritize P2 measures from among this overall scope of primary P2 measures:
  - Develop and disseminate best management practices and track their use.

## ***BLUEPRINT for LONG ISLAND PESTICIDE POLLUTION PREVENTION***

### ***DEC Identifies and Prioritizes Pesticide P2 Measures and Partners Collaborate to Implement P2 Measures, cont'd.***

- Research alternative products and practices, including organic practices, and provide related outreach and education to implement
- Conduct outreach and education on use pattern-specific integrated pest management
- Encourage voluntary label revisions (through registrant and USEPA process)
- Restrict products to certified applicator use.

- DEC will identify partners to collaborate with the Department to implement pesticide P2 measures (e.g., product registrants, user groups, academic entities, State and local agencies) and, as needed, convene P2 implementation workgroups.
- DEC and partners will collaborate to implement P2 within available resources.
- DEC may strengthen existing outreach partnerships with Cornell University and other entities, forge new partnerships and maximize Internet resources.
- DEC and partners will identify stakeholders and build P2 implementation support.

### ***DEC Tracks Pesticide P2 Results and Assesses Need for P2 Modifications or Regulatory Measures***

- DEC, with, as needed, assistance of pesticide P2 partners, monitors results of P2 implementation and determines additional monitoring and measures, if any, for effective pest management and water quality protection.
- DEC may consider certain regulatory measures to manage use of a specific AI, if P2 actions prove insufficient and if DEC and NYSDOH determine that detections of a pesticide-related chemical in water quality monitoring data indicate significant public health or environmental impacts may occur. Under such circumstances, DEC may reassess the registration status of products containing the target AI by reviewing the product registrations associated with the AI and, if necessary, take regulatory action to prohibit use on Long Island.

### ***DEC Maximizes Department Use of Water Quality Monitoring for Pesticides***

**NOTE:** This underlies all actions under the blueprint, in that water quality monitoring results are essential to conducting the work under each component (e.g., determining AIs to be considered, specifying P2 needed, etc.)

- Adjust emphasis of monitoring, as needed and within available resources and flexibility, to meet DEC information needs for Long Island (e.g., focus on specific AIs to capture information and discern trends and new detections in particular pesticide use settings, such as greenhouses, turf, vineyards) as well as to monitor P2 results, if applicable.
- Focus water quality monitoring, including the acquisition of finished drinking water monitoring results, conducted under available resources by Suffolk County and Cornell University or others, on AIs of concern to determine trends and changes in detection levels and frequency.

***TECHNICAL REVIEW AND ADVISORY COMMITTEE (TRAC) - SUMMARY DESCRIPTION***

**Composition**: DEC will convene, approximately six months after this Strategy is finalized, a TRAC to pool expertise of State and local government agencies as well as statewide and local public service and academic entities closely involved with pesticide regulation and water quality monitoring for Long Island:

- New York State: DEC (Chair), Department of Health, Department of Agriculture and Markets; Cornell University Department of Agriculture and Life Sciences.
- Local Entities: Suffolk County Department of Health Services, Water Authority, and Soil and Water Conservation District; Nassau County Health Department; Cornell Cooperative Extension of Suffolk County

After 5 years, Department and involved participants assess ongoing need for TRAC.

**Primary purposes**:

- Assist DEC in investigation and assessment of active ingredients (AIs), identified and ranked by the Department (potential contaminants detected in Long Island groundwater)
- Consider factors such as groundwater monitoring data, exceedances of chemical-specific water quality standards, potential for human exposure, public health risks, existing needs for pest management, and pest management alternatives
- Advise DEC regarding potential and feasible response actions to prevent further pesticide-related impacts to the Long Island aquifer while recognizing pest management needs. (Scope of response actions - see P2 measures in Information Box ES-1.)

## ES.4 SUMMARY OF LONG ISLAND PESTICIDE P2 STRATEGY CONTENTS

A summary of the contents of each chapter in the Strategy is contained in Table ES-1.

| **Table ES-1: EXECUTIVE SUMMARY OF CHAPTERS AND APPENDICES**<br>***LONG ISLAND PESTICIDE POLLUTION PREVENTION STRATEGY*** | |
|---|---|
| | **Summary of Chapters and Appendices** |
| ***1. Goal, Philosophy, and Purpose*** | ***Goal:*** Given that groundwater, pest management and pesticide use are vital to public and economic welfare on Long Island, the overall goal of this Strategy is to:<br>Prevent adverse effects to human health and the environment by protecting Long Island's groundwater and surface water resources from pesticide-related contamination, while continuing to meet the pest management needs of agricultural, residential, commercial, industrial, and institutional sectors.<br><br>***Philosophy:*** The goal of enhancing water quality protection from pesticide impacts and maintaining needed pest management on Long Island can be effectively achieved through a strong pollution prevention approach that recognizes the importance of both and incorporates the involvement and cooperation of various stakeholders. Preventive measures can be taken to both minimize further pesticide contamination after a pesticide has been detected and to prevent contamination before a pesticide is detected in water resources.<br><br>***Purpose:*** Establish a long-term pesticide pollution prevention blueprint to meet the goal of the Strategy and to outline enhanced DEC partnerships with involved entities that are essential to success. This blueprint should serve to enhance use of pest management methods on Long Island that incorporate pollution prevention techniques and protect Long Island water resources from pesticide-related contamination. |
| ***2. Overview: Groundwater and Pesticide Use on Long Island*** | ▪ ***Importance of Long Island sole source aquifer and its protection.***<br>▪ ***Aquifer structure and multiple uses by approx. 3 million people make it a critical resource.***<br>▪ ***Pesticide-related statistics for Long Island*:**<br>• Of the 13,688 pesticides registered in the State, 361 are prohibited from use and 145 are registered for use on Long Island only when certain conditions are met (June 2012);<br>• 4,733 certified pesticide applicators and technicians on Long Island (2012);<br>• 5.3 million pounds and 407,000 gallons of pesticides applied on Long Island (2005).<br>▪ ***Pesticide use yielded substantial benefits***, including Suffolk County's statewide lead in sales of horticultural, agricultural and vineyard products.<br>▪ ***The signs of pesticide use are showing up in Long Island's groundwater.*** 117 pesticide-related chemicals detected in the aquifer at various locations since 1997; approximately half are legacy compounds (no longer or never registered in NYS). Some detections at multiple locations and multiple compounds detected at individual wells.<br>▪ ***Most pesticide-related detections are much lower than water quality criteria.*** Seven types of State and federal water quality criteria are summarized. |

**Table ES-1: EXECUTIVE SUMMARY OF CHAPTERS and APPENDICES, cont'd.**
***LONG ISLAND PESTICIDE POLLUTION PREVENTION STRATEGY***

| Chapter | Summary of Chapters and Appendices |
|---|---|
| ***3. Action Plan to Implement Pesticide Pollution Prevention Strategy*** | ▪ ***Pollution prevention can prevent water quality impacts while continuing to meet critical pest management needs.***<br>▪ ***DEC Pesticide P2 Process Steps:***<br>• Conduct Initial P2 Needs Assessment<br>• Determine Scope of Applicable P2 Measures<br>• Convene P2 Working Groups<br>• Review Information from P2 Working Groups as Basis for P2 Assessment<br>• Identify and Prioritize Active Ingredients and P2 Measures<br>• Collaborate with Partners to Implement P2 Measures and Build Stakeholder Support<br>• Monitor Results of P2 Actions and Determine if Further/Modified Action Needed Based on Success Criteria |
| ***4. Pesticide Registration in New York State*** | ▪ ***History and evolution of New York State pesticide registration process***<br>▪ ***Current NYS registration process***<br>▪ ***NYS product review process for potential groundwater impacts*** - Safeguards against groundwater pollution built-into process<br>▪ ***Factors considered during registration,*** include land and groundwater characteristics<br>▪ ***Overview of leachate assessment and modeling*** of new active ingredients<br>▪ ***Current Pesticide Use Statistics in NYS:*** Approximately 13,688 registered products, and 1,700 restricted pesticides , 361 of which are prohibited from use on Long Island |
| ***5. Existing Pollution Prevention Programs and Activities*** | ▪ ***Summary of existing non-regulatory and regulatory measures to prevent or reduce potential impacts of pesticide use.*** Examples of non-regulatory: outreach, education, best management practices, integrated pest management, environmental benefit projects, agricultural environmental management. Examples of regulatory preventive measures: pesticide product registration, mixing and loading requirements, toxic and hazardous materials storage, and local pesticide phase-outs.<br>Measures conducted by State and local governments, academia, pesticide users, interest groups and others. |
| ***6. Legal Authority and Enforcement*** | ▪ ***Summary of existing DEC statutory and regulatory authority over pesticides*** registration, sales, use, storage and disposal as well as certain water quality requirements, primarily under the Environmental Conservation Law and related regulations.<br>▪ ***Comparison of DEC and USEPA authorities***<br>▪ ***Summary of DEC enforcement mechanisms related to pesticides***<br>▪ ***Summary of statutory authorities of other State agencies*** to conduct pesticide-related work, such as water quality and pesticide management-related functions under the authority of State laws. |
| ***Appendices*** | ▪ *Appendix A* Pesticide-Related Chemicals Detected In Long Island Groundwater 1996-2010<br>▪ *Appendix B* DEC Summaries of Long Island Water Quality Monitoring Data<br>▪ *Appendix C TRAC Description and Ongoing Pest Management Education and Outreach Efforts* |

# Chapter 1. GOAL, PHILOSOPHY AND PURPOSE

The New York State Department of Environmental Conservation's (DEC's) goal and philosophy, which are summarized here, go hand-in-hand as the core concepts underlying the purpose and details of this Strategy.

## GOAL OF STRATEGY

Given that groundwater, pest management and pesticide use are vital to the public and economic welfare on Long Island, the overall goal of this Strategy is to:
***Prevent adverse effects on human health and the environment by protecting Long Island's groundwater and surface water resources from pesticide-related contamination, while continuing to meet the pest management needs of the agricultural, residential, commercial, industrial, and institutional sectors.***

## PESTICIDE POLLUTION PREVENTION PHILOSOPHY

The primary philosophy underlying the goal of this Strategy is:
***The goal of enhancing water quality protection from pesticide impacts and maintaining necessary pest management on Long Island can be effectively achieved through a strong pollution prevention approach that recognizes the importance of both and incorporates the involvement and cooperation of various stakeholders.*** *Preventive measures can be taken to both prevent contamination before a pesticide is detected and minimize further pesticide contamination after a pesticide has been detected in water resources.*

## PURPOSE OF LONG ISLAND STRATEGY

The overarching purpose of this Strategy is to:
***Establish a long-term pesticide pollution prevention blueprint to meet the goal of the Strategy and to outline enhanced NYSDEC partnerships with involved entities that are essential to success.*** *This blueprint should serve to enhance use of pest management methods on Long Island that incorporate pollution prevention techniques and protect Long Island water resources from pesticide-related contamination.*

# Chapter 2. OVERVIEW: GROUNDWATER AND PESTICIDE USE ON LONG ISLAND

## 2.1 INTRODUCTION

U.S. Census Bureau population estimates for calendar year 2010 indicate that more than 1.3 million people reside in Nassau County and nearly 1.5 million reside in Suffolk County.[6] These 2.8 million people depend on underlying groundwater (see Figure 2.1)[7] as their principal source of clean, potable water. This water supply, containing approximately 90 trillion gallons of fresh water, is one of the nation's most critical sole-source aquifers.[8] More than 138 billion gallons are taken annually from this aquifer system for human use.[9]

## 2.2 GROUNDWATER AND THE IMPORTANCE OF PROTECTING IT

This Strategy centers on measures that can be taken to manage pesticide use to protect groundwater. To facilitate an understanding of this essential resource and the critical importance of protecting its quality to the maximum extent possible, this section summarizes the importance of the aquifer, contains a basic description of its structure and how it functions, provides an overview of the use and impact of pesticides on Long Island, and provides a brief description on various water quality criteria.

For Long Island, the key reason that protecting groundwater is so significant is that it is the sole source of fresh water for regional residential, agricultural, horticultural, commercial, industrial, institutional and other uses that include drinking, cooking, bathing, and irrigation. Groundwater is a source for municipal and private wells, and above-ground springs. The sandy soils of Long Island have, in part, enabled an abundant supply of groundwater to develop. However, those soils do little to shield this system of aquifers from contaminants and potential degradation associated with human activities, including pesticide use. A clean supply of groundwater is vital to those who live, work, and recreate on Long Island; therefore, it is critically important that this essential environmental resource be protected.

In recognizing the importance of conserving, protecting and managing the waters of the state, the New York State Legislature specially noted that the unique qualities of Long Island's unified aquifer system merit special attention, that this groundwater resource is sensitive to pollution, and that adequate supplies of good quality groundwater are essential to the health, safety and welfare of New Yorkers and the economic growth and prosperity of the State (ECL Article 15). In 1978, the U.S. Environmental Protection Agency (USEPA) determined that the aquifer system underlying Nassau and Suffolk counties is the principal source of drinking water for these

[6] U.S. Census Bureau, "State and County Quick Facts," http://quickfacts.census.gov/qfd/states/36/36059.html and http://quickfacts.census.gov/qfd/states/36/36103.html.
[7] Long Island Water Conference, http://www.liwc.org/pages/eduSource.htm.
[8] Long Island Water Conference; http://www.liwc.org/pages/aboutUs.htm.
[9] City of New York Department of Design and Construction, "Geothermal Heat Pump Manual," Ch. 5, p. 6, August 2002; http://www.nyc.gov/html/ddc/downloads/pdf/geotherm.pdf.

counties and that if the aquifer system was contaminated, it would create a significant hazard to public health.

## 2.2 A. Structure and Operation of the Aquifer

The aquifers underlying Long Island are among the most prolific in the country. Almost all of Long Island's drinking water is from groundwater, while surface water is an insignificant contributor. According to the *USGS Estimated Use of Water in the United States in 2000*, Nassau and Suffolk counties utilized more than 375 million gallons of groundwater per day for public, domestic, industrial, and irrigation uses. The three most important Long Island aquifers are the Upper Glacial Aquifer, the Magothy Aquifer, and the Lloyd Sands Aquifer, and are depicted in Figure 2.1.[10]

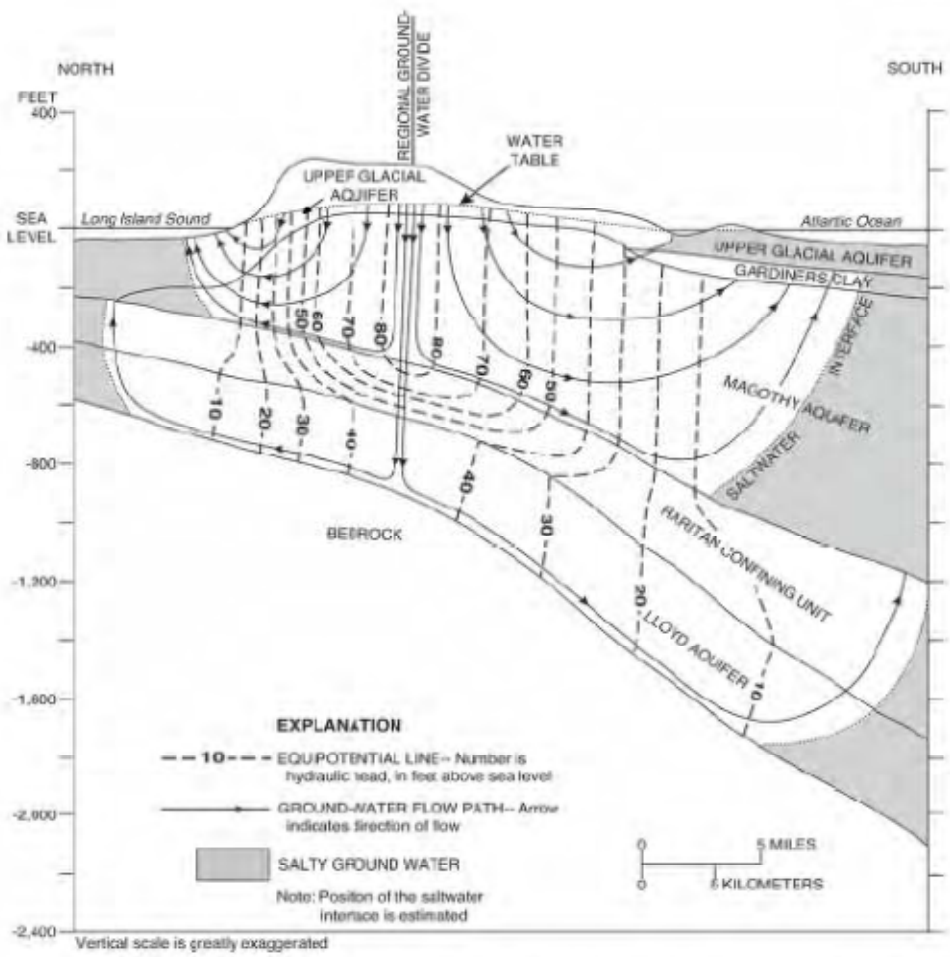
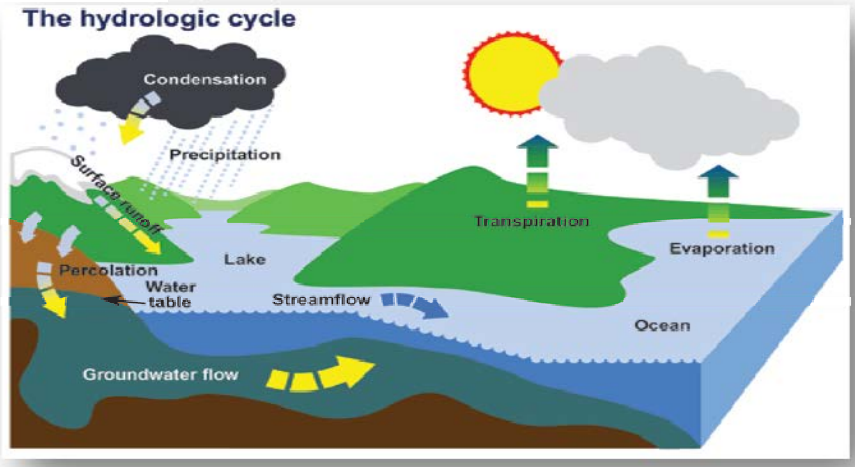



**Figure 2.1: Long Island's Aquifers** Generalized flow lines in the groundwater system of Long Island, N.Y., under natural (predevelopment) conditions. (Modified from a figure from Franko and Cohen, 1972).

[10] Water-Table and Potentiometric-Surface Altitudes of the Upper Glacial, Magothy, and Lloyd Aquifers on Long Island, New York, in March-April 2000, with a Summary of Hydrogeologic Conditions, by Ronald Busciolano, U.S. Geological Survey Water-Resources Investigations Report 01-4165.

About half of Suffolk County derives its drinking water from the Upper Glacial Aquifer, an unconfined aquifer directly underlying the surface of the ground. The Magothy Aquifer is the largest of Long Island's aquifers and is the source of water for most of Nassau County and about half of Suffolk County. The Raritan Clay Formation underlies the Magothy. The Lloyd Sands Aquifer is the deepest and oldest of Long Island's aquifers. It is a sand and gravel formation ranging in vertical thickness from zero to five hundred feet. At its deepest point beneath Long Island, the bottom of this aquifer is 1,800 feet below the surface of the ground. Not many wells tap this formation and ECL 15-1528 establishes a moratorium on the use of water from this formation in order to maintain it for future generations.

**Figure 2.2.**




On Long Island, groundwater is recharged by approximately 44 inches of precipitation that falls annually, half of which percolates into the ground and recharges the groundwater system.[11] As shown in Figure 2.2, during the hydrologic cycle, precipitation percolates downward through the soil to the water table where it is considered groundwater and where it follows the contours of the aquifer system. Eventually, groundwater may resurface, particularly shallow groundwater, and discharge to the atmosphere via evapotranspiration or feed into streams or other surface waters, some of which may be ecologically sensitive, such as the Peconic Estuary, the Long Island Sound South Shore Estuary, and the Long Island Sound.

## 2.3 OVERVIEW OF PESTICIDE REGULATION AND USE ON LONG ISLAND

The New York State Department of Environmental Conservation (DEC) regulates the registration, commercial use, purchase and custom application of pesticides. The Environmental Conservation Law (ECL) sets forth the state's policy regarding pesticide usage. ECL 33-0301. DEC exercises its broad regulatory responsibilities in consultation with the Departments of Health (DOH) and the Agriculture and Markets (DAM) in order to protect public health and the environment while ensuring that pesticides proposed for use in New York State are properly registered and applied for the benefit of agricultural and other economic enterprises that rely on pesticide usage.

According to the ECL, pesticides, when properly used, are "valuable, important and necessary to the welfare, health, economic well-being and productive and industrial capabilities of the people

[11] City of New York Department of Design and Construction, "Geothermal Heat Pump Manual," Ch. 5, p. 5, August 2002; http://www.nyc.gov/html/ddc/downloads/pdf/geotherm.pdf.

of this state." ECL 33-0301. However, pesticides also present potential dangers to health, property and the environment if improperly used. ECL 33-0301.

Pesticides are used on Long Island to limit the potentially harmful effects of a wide range of pests that affect people, companion animals, wildlife, structures, agricultural crops and other plants. They are defined by Part 325.1(aw) of Title 6 of the New York Codes, Rules and Regulations (6 NYCRR) as follows:

> *Pesticide means: (1) Any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any insects, rodents, fungi, weeds, or other forms of plant or animal life or viruses, except viruses on or in living humans /or other animals, which the department shall declare to be a pest; and (2) any substance or mixture of substances intended as a plant regulator, defoliant or desiccant.*

However, broad use of relatively large volumes of pesticides may have unintended consequences where groundwater quality is concerned. Although they play an important role in managing pests, pesticides pose a threat to groundwater quality when they are misused in violation of pesticide laws, rules and regulations, including use in contravention of label directions (pesticide misuse). Pesticides may also pose a threat to groundwater even when they are lawfully used in accordance with label directions if they exhibit properties and characteristics associated with chemicals already detected in groundwater, or are known to leach through soil into groundwater under certain conditions. Note that "pesticide use" is defined by 6 NYCRR Part 325.1(ax) as follows:

> *Pesticide use means performance of the following pesticide-related activities: application; mixing; loading; transport, storage or handling after manufacturer's seal is broken; cleaning of pesticide application equipment; and any required preparation for container disposal.*

The illegal use of pesticides, including improper storage, handling, and application is an issue that could have a significant impact on the groundwater in Long Island. Through the routine evaluation of groundwater monitoring data and reporting data, and by conducting investigations and inspections, the Department is able to determine the source of many illegal applications and take appropriate actions associated with these applications. Routine inspections of facilities also provide an opportunity for the Department to ensure that the pesticide use practices at the facilities are in compliance with the Environmental Conservation Law and its regulations. In addition, the routine inspection of pesticide dealers will help keep pesticides that are not permitted to be sold in Long Island from being sold there.

## 2.3 A. Quantity of Pesticide Use on Long Island

In 2005,[12] 5.2 million pounds[13] and 397,000 gallons[14] of pesticides were applied in Nassau and Suffolk counties by commercial pesticide applicators and technicians and another 112,000[15] pounds and 10,700[16] gallons were sold to private applicators, for a total of about 5.3 million pounds and 407,000 gallons. This represents about 30 percent of the total number of pounds of pesticides applied by occupational users in New York State in 2005 (17.6 million pounds), and 14 percent of the total number of gallons used statewide (2.8 million gallons). Reported weights and volumes are the weights and volumes of all inert and active ingredients in the pesticide products applied not the weights and volumes of the active ingredients alone. Commercial applicators must report the total weight or volume of a pesticide product applied, not merely the active ingredient. This means that, if a commercial applicator applied 100 pounds or 100 gallons of a product that contained only 1 percent of active ingredients, the applicator must report the entire 100 pounds or 100 gallons applied, while the amount of active ingredients applied would be only 1 pound or 1 gallon. It should be noted that commercial applicators do not report the use of registration-exempt minimum risk pesticides, and homeowner use of pesticides is also not reported.

The Pesticide Reporting Law requires reporting of information about certain pesticide applications as well as sales of certain pesticides. DEC has identified many errors in this data, resulting from under-reporting, over-reporting, incorrect units of measure, incorrect location information, and many other reasons. Despite numerous data quality deficiencies, DEC can still identify active ingredients registered for use on Long Island, as well as products sold and applied and their relative or approximate quantities from the data and from inspections and interviews with pesticide users. This information can and will be used, albeit with caution, to help guide water quality monitoring efforts on Long Island. Changes in pesticide reporting requirements could potentially improve timeliness, accuracy, and availability of the data.

As shown in Figure 2.3, as of June 2012, 4,733 certified commercial pesticide applicators and technicians, certified private pesticide applicators (growers), and aquatic antifouling paint applicators in Nassau and Suffolk counties were certified to apply pesticides.

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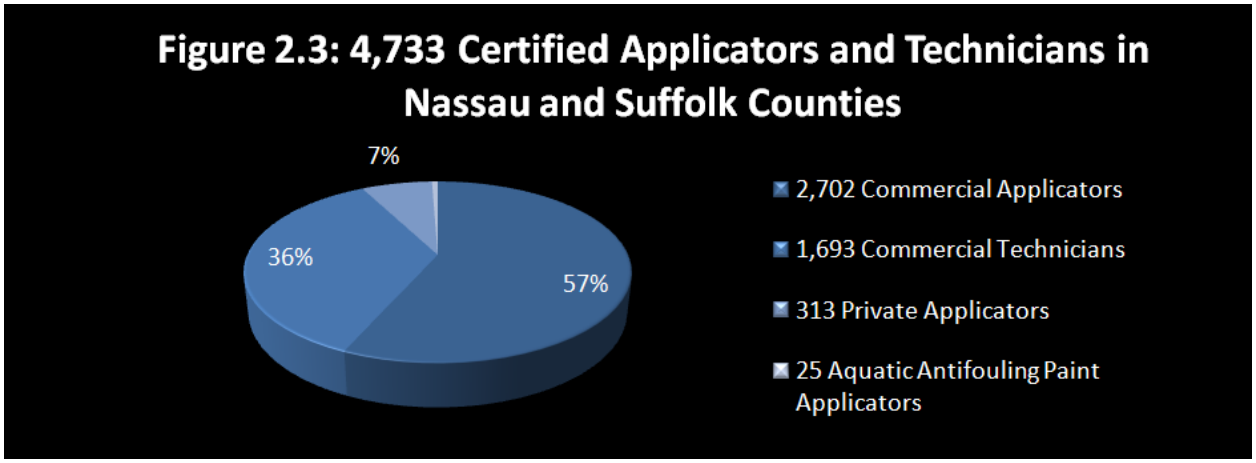
[12] Calendar year 2005 is the most recent year for which pesticide application data has been compiled from reports submitted by the occupational pesticide user community in accordance with the provisions of Title 12 of the New York State Environmental Conservation Law, known as the Pesticide Reporting Law.
[13] NYS Department of Environmental Conservation, Pesticide Reporting Law (ECL Art. 33, Title 12) statistics; http://www.dec.ny.gov/chemical/37855.html.
[14] NYS Department of Environmental Conservation; Pesticide Reporting Law (ECL Art. 33, Title 12) statistics; http://www.dec.ny.gov/chemical/37851.html.
[15] NYS Department of Environmental Conservation, Pesticide Reporting Law (ECL Art. 33, Title 12) statistics; http://www.dec.ny.gov/chemical/37847.html.
[16] NYS Department of Environmental Conservation, Pesticide Reporting Law (ECL Art. 33, Title 12) statistics; http://www.dec.ny.gov/chemical/37843.html.




There are approximately 12,700 certified commercial applicators, 6,500 certified technicians, 6,750 private applicators, and 50 Aquatic Antifouling Paint Applicators statewide. Long Island represents approximately 18% of the total number of applicators in the state. In order to become certified both certified applicators and technicians must pass a core exam and a category exam and meet the eligibility requirements to take the exams. The eligibility requirements vary between certified commercial applicators, certified technicians, private applicators and Aquatic Antifouling Paint Applicators; these requirements can be found in 6 NYCRR 325.8 and 9. Once certified commercial applicators and private applicators are certified they must recertify by attending Department approved courses during their recertification cycle. In addition, certified commercial applicators, certified technicians, Aquatic Antifouling Paint Applicators must report all commercial applications to the Department and keep records of the applications. Private applicators must maintain a record of restricted use pesticide applications.

The use of pesticides has produced substantial benefits to public health, agricultural production, and economic viability on Long Island. Consider the following statistics relating to Long Island.[17],[18],[19]

- Suffolk County has the highest amount of horticultural sales and service of any county in New York State,
- Suffolk County has the highest sales of agricultural products in New York State,
- Long Island's Nassau and Suffolk counties had agricultural sales of $258.7 million in calendar year 2007 – the highest of any two counties in New York State,
- Suffolk County, with 585 farms and 34,400 acres of farmland, accounted for 93 percent of the region's agricultural sales,
- Nassau and Suffolk County vineyards and wineries contributed significantly to New York State being the second-largest producer of wine in the Nation behind California in calendar year 2007,
- Suffolk County is New York's top producer of greenhouse and nursery flowers, plants, and sod,

[17] Long Island Wine Council, "Fast facts," http://www.liwines.com/default.ihtml?page=theregion&subpage=fastfacts.
[18] Cornell Cooperative Extension of Suffolk County, "Agriculture," http://ccesuffolk.org/agriculture/.
[19] State of New York Comptroller, "The Role of Agriculture in the New York State Economy," Report 21-1010, February 2010, http://www.osc.state.ny.us/reports/other/agriculture21-2010.pdf.

- Suffolk County is home to one-quarter of New York State's wineries, with 56 wineries and 60 vineyards ranging in size from 2.5 acres to 500 acres in size, and
- Suffolk County is New York State's top producer of aquaculture, which is the farming of freshwater and saltwater organisms such as mollusks, crustaceans, and aquatic plants.

## 2.4 PESTICIDE DETECTIONS IN GROUNDWATER ON LONG ISLAND

Groundwater is the source for municipal and private drinking water wells in Nassau and Suffolk Counties. For more than 30 years, federal, state, and county governments have periodically monitored such wells for the presence of pesticides. For example, from October 1997 through March 2002, over 4,000 wells (private domestic, public supply, and monitoring) were sampled in Nassau and Suffolk Counties. Results from this monitoring suggest that pesticide residues are common in groundwater in certain areas of Long Island (primarily the agricultural regions of the North and South Forks of eastern Suffolk County).

Water quality monitoring by Suffolk County and other entities has shown that pesticides are among a number of contaminants detected in Long Island groundwater as a result of a wide range of human activities (e.g., nitrates, volatile organic compounds, pharmaceuticals and personal care products). Long Island has the dubious distinction of being the location where a pesticide was first detected in groundwater in the United States. Aldicarb was first found in Suffolk County in 1979. A concise summary of this historical note is presented in the following portion of the abstract to an article that appeared in the *American Journal of Public Health*[20] - "Pesticides in Groundwater: The Aldicarb Story in Suffolk County, NY":

> *Aldicarb, a carbamate pesticide, was detected for the first time in groundwater in Suffolk County, New York, in August 1979. Although all laboratory and field studies indicated that the pesticide could not reach groundwater, a combination of circumstances allowed its residues not only to reach groundwater, but also to be ingested by humans. Inquiries in hospitals and poison control centers did not reveal any cases of carbamate poisoning.*
>
> *The extensive monitoring program, conducted by the County in cooperation with the federal and state agencies and the Union Carbide Corporation, showed that 1,121 (13.5 percent) of the 8,404 wells examined exceeded the state recommended guidelines of 7 ppb. Of the contaminated wells, 52 percent contained aldicarb between 8 and 30 ppb, 32 percent between 31 and 75 ppb, and 16 percent more than 75 ppb. Residents whose wells exceeded the guidelines were advised not to use the water for drinking or cooking purposes and to obtain an alternate source of potable water. The Union Carbide Corporation provided those residents with activated carbon filtration units.*

The DEC's response to the detections of aldicarb in Long Island groundwater well above the recommended guideline of 7 ppb at the time (the current New York State drinking water

[20] Mahfouz H. Zaki, M. D. (1982). Pesticides in Groundwater: The Aldicarb Story in Suffolk County, NY. *American Journal of Public Health* , Vol. 72, No. 12, 1391-1395.

standard is 3 ppb), was to issue an emergency ban in 1980 from use on potatoes. USEPA also revoked its approval of aldicarb use on Long Island in early 1980 at the manufacturer's request.[21]

Continued monitoring has shown that 117 pesticide-related chemicals have been detected in the groundwater at various locations since 1997.[22] Approximately half of these are legacy compounds (from pesticides no longer or never registered for use on Long Island or in New York State), which have not been used in many years, demonstrating that some pesticides can persist in the Long Island aquifer for considerable periods of time. While certain detections have exceeded water quality and public drinking water standards, most are at low or trace levels. Some have been detected at multiple locations, distributed broadly over Long Island. Moreover, multiple compounds have been detected in individual wells at a number of locations. Data summaries of the pesticides and their related degradates that have been detected in groundwater and surface water by Suffolk County and by the United States Geological Survey (USGS) are available at ftp://ftp.dec.ny.gov/dshm/pesticid/liwaterqualitydata.docx

Several active ingredients, most notably metalaxyl, imidacloprid, and atrazine, have been detected hundreds of times in certain well types since 1997, including hundreds of locations on Long Island. As mentioned above, the vast majority of these detections are at low concentrations that are slightly above or at laboratory detection levels, and fall well below drinking water standards and groundwater standards and guidance values. As stated in the blueprint at the beginning of this document, DEC anticipates that metalaxyl, atrazine and imidacloprid will be the first group of AIs to be considered for assessment based on the number of detections by Suffolk County at multiple groundwater monitoring locations. In addition, Appendix B includes maps showing the locations of these detections and charts showing the concentrations detected in groundwater and surface water samples over time. An overview of various water quality criteria is provided below to help explain the basis for their development and how they can be used in evaluating detections.

It is important to note that much of the water quality monitoring data presented in this document does not represent what the majority of residents of Long Island are using for drinking and other household purposes. Data from groundwater monitoring wells do not represent household supply water. Among other factors, public water suppliers generally provide treatment for their customers. Sampling results from certain private wells, however, may represent the individual water supplies for those locations that do not have access to public water. Overall, for all of these wells, few detections of individual pesticide-related contaminants exceeded applicable standards. The Suffolk County Water Authority ensures that finished water (treated water) that they supply to their customers exceeds expectations for quality set by New York State drinking water standards.[23] Public water supplies are subject to regulation by the NYSDOH through the Suffolk County Department of Health Services (SCDHS) under New York Codes Rules and Regulation (NYCRR) Subpart 5-1.[24] The regulations establish water quality standards known as

[21] Aldicarb-Pesticide Contamination of Groundwater in Eastern Suffolk County, Long Island, New York. US Geological Survey Water-Resources Investigations Report 84-4251,1984. pubs.usgs.gov/wri/1984/4251/report.pdf.
[22] See Appendix A – "Pesticide Active Ingredients and Degradates Detected in Long Island Groundwater Between 1996 and 2010."
[23] 2012 Annual Drinking Water Quality Report, Suffolk County www.scwa.com.
[24] Title 10. Department of Health Chapter I. State Sanitary Code Part 5. Drinking Water Supplies Subpart 5-1. Public Water Systems.

maximum contaminant levels (MCLs), and require routine water quality monitoring. If finished drinking water is found to contravene a standard, corrective action is required. Private wells are not regulated by NYSDOH, but SCDHS has a program to test private wells for pesticides and other contaminants. Through their work, if contaminants are found in a private well that exceeds standards then the homeowner is advised to not drink that water, and to either find an alternative source or to invest in treatment to achieve compliance with drinking water standards.

Pesticides have the potential to be carried downwards with recharge from precipitation or snowmelt or with irrigation water into aquifers, where groundwater conditions may act to preserve such contaminants. In some locations, groundwater may move only a few feet per month or even per year. Slow groundwater movement means that it may take years before a contaminant, which originated at the land surface, appears in a well. It is also possible that portions of the aquifer system will discharge pesticide contaminants into surrounding surface water resources, which may include ecologically sensitive seagrass beds and freshwater and tidal wetlands, but only after decades or longer. On the other hand, due to characteristics of the pesticide or soil, some pesticides can readily move from locations where they were applied, enter groundwater, and travel hundreds of feet in a year to degrade groundwater quality.

Because of the vulnerability of Long Island's groundwater, pollution prevention is the most effective approach to water quality protection. Once a contaminant is found in groundwater, technological and fiscal constraints limit remediation options and accurate assessment of public health and environmental quality implications is challenging. Co-occurrence of multiple contaminants at the same locations can heighten these challenges.

Note that, while this Strategy addresses most aspects of pesticide use on Long Island, it does not address potential surface water and groundwater impacts associated with aquatic pesticides, directly and lawfully applied to or over Long Island surface waters, to manage aquatic insects such as mosquito larvae and pupa, or mosquito adulticides. Such products can also target invasive plant and fish species. The application of aquatic pesticides and the application of mosquito adulticides via aerosol delivery over surface waters has been the subject to years of review and critical analysis involving many experts. The Suffolk County *Vector Control and Wetlands Management Long-Term Plan*, established a sustainable framework for protecting public health, reducing pesticide usage, and restoring marshes. Further explanation about why the Strategy does not address the use of mosquitocides and other aquatic pesticide use can be found in the Supplemental Information to the Strategy. Information on regulatory programs relating to aquatic pesticides, point source discharge permits and vector control can be found at DEC and Suffolk County online resources.[25]

[25] Information on NYSDEC's aquatic pesticide permit program can be found at http://www.dec.ny.gov/chemical/8530.html . Information on the State Pollutant Discharge Elimination System (SPDES) General Permit for point source discharges to surface waters from pesticide applications can be found at http://www.dec.ny.gov/chemical/70489.html. Information on mosquito control in Suffolk County is available at the Suffolk County Department of Public Works' Division of Vector Control web page at http://www.suffolkcountyny.gov/Departments/PublicWorks/VectorControl.aspx.

## 2.5 WATER QUALITY CRITERIA

Federal and New York State water quality standards provide a quantitative basis for the implementation of the pollution prevention elements of this Strategy. These standards have been used all along as our benchmarks in water quality monitoring to evaluate the level at which pesticide contamination has been detected and confirmed and are a factor in determining the type of response actions needed. These standards will continue to be used as the critical threshold calling for intervention and action under the Strategy. As noted, many of the pesticide residues referenced above have been detected at concentrations much lower than these critical thresholds, although some have exceeded those thresholds. The enhanced protections of the pollution prevention Strategy will detail a process by which assessments and mitigative pollution prevention measures may be initiated upon identification and verification of pesticides and their degradates in the groundwater, even at low concentrations.

Reference points in this Strategy include standards and guidance values. A *standard* is a value that has been promulgated and placed into state or federal regulation. A *guidance value* may be used where a standard for a substance or group of substances has not been promulgated into regulation. Both standards and guidance values are expressed as the maximum allowable concentration in units of micrograms per liter (and parts per billion) unless otherwise indicated.

For each pesticide active ingredient and each active ingredient associated with a degradate detected in surface water and groundwater, several reference points will be used to inform this enhanced Long Island pollution prevention Strategy in evaluating the need for preventive or corrective actions. The reference points are, in summary:

- DEC ambient groundwater quality standards for taste-, color- and odor-producing, toxic and other deleterious substances (6 NYCRR 703.5; includes the Principal Organic Contaminant (POC)[26] groundwater standard),
- DEC ambient groundwater guidance values where no water quality standard is assigned (6 NYCRR 702.15, DOW TOGS 1.1.1.),
- NYSDOH drinking water standards (10 NYCRR Part 5; includes POC and Unspecified Organic Contaminants ("UOCs") generic Maximum Contaminant Levels (MCLs)[27] as well as specific MCLs),
- Federal Drinking Water Maximum Contaminant Level Goals (MCLG) as guidance values for non-carcinogens,
- Federal Safe Drinking Water Act standards (MCLs), or
- USEPA Human Health Benchmarks for Pesticides.[28]

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[26] *Principal organic contaminant classes* defined in 6 NYCRR 700.1 means the following classes of organic chemicals: Halogenated alkanes, Halogenated ethers, Halobenzenes and substituted halobenzenes, Benzene and alkyl- or nitrogen-substituted benzenes, Substituted, unsaturated hydrocarbons, or Halogenated nonaromatic cyclic hydrocarbons.

[27] UOCs comprise any organic compound (including pesticides and their degradates) for which the POC designation does not apply, and for which a specific MCL has not been adopted. The UOC standard is 50 ppb for any individual substance in the class. There is also a standard of 100 ppb for "total POCs and UOCs." UOCs, which apply to public water supplies in New York State, are not directly adopted as ambient groundwater standards.

[28] USEPA Human Health Benchmarks for Pesticides, April 2012. http://www.epa.gov/pesticides/hhbp.

Federal water quality criteria for pesticides include drinking water Maximum Contaminant Levels (MCLs),[29] which are considered to be regulatory standards.
New York State led the nation in 1978 by establishing ambient groundwater quality standards for approximately 50 pesticides. The standards, expressed in 6 NYCRR Parts 700-705,[30] are applicable to the groundwater resource itself. New York State has also established ambient groundwater guidance values using procedures identified in 6 NYCRR Part 702.[31] These guidance values are formally established in the DEC Division of Water Technical and Operations Guidance Series (TOGS) 1.1.1.[32] New York State also led the nation in 1989, by establishing a drinking water standard system which encompassed virtually all pesticides and their metabolites (if organic compounds) that were not already assigned specific MCLs (10 NYCRR Part 5).[33] The DEC has incorporated some of these default drinking water standards as groundwater standards under 6 NYCRR Part 703.

The USEPA has developed guidance associated with Human Health Benchmarks for Pesticides. The guidance was created to set benchmarks for approximately 365 pesticides that are used on food crops, setting limits for acute exposure and chronic exposure. These benchmarks were developed to enable states to determine whether pesticide detections in drinking water or drinking water sources could be a potential health risk. The pesticides in the guidance are for pesticides for which USEPA has not set a drinking water health advisory or set an enforceable drinking water standard. Advanced testing methods now allow pesticides to be detected in water at very low levels The USEPA recognizes that small amounts of pesticides detected in drinking water or source water for drinking water do not necessarily indicate a health risk. However, the Department recognizes that potential long-term exposure to low levels of pesticide-related contaminants, and, in some cases, multiple contaminants, may be a concern that will be addressed through implementation of the action plan outlined in Chapter 3.

The water quality criteria for metalaxyl, imidacloprid, and atrazine are presented in Table 2.1 for illustration purposes.

[29] For information about MCLs, see http://water.epa.gov/drink/contaminants/index.cfm.
[30] To view 6 NYCRR Parts 700-705, see http://www.dec.ny.gov/regs/2485.html.
[31] To view 6 NYCRR Part 702, see http://www.dec.ny.gov/regs/2485.html.
[32] To view TOGS 1.1.1, see http://www.dec.ny.gov/regulations/2652.html.
[33] To view 10 NYCRR Part 5, subpart 5, see http://w3.health.state.ny.us/dbspace/NYCRR10.nsf/56cf2e25d626f9f785256538006c3ed7/8525652c00680c3e852565f6004a8705?OpenDocument.

**TABLE 2.1**
**WATER QUALITY CRITERIA FOR ATRAZINE, IMIDACLOPRID AND METALAXYL**
**(All units are in micrograms/liter)**

| Pesticide | DEC 6 NYCRR Part 703.5 | DEC DOW TOGS 1.1.1[34] | DOH 10 NYCRR Part 5 | USEPA Safe Drinking Water Act MCLs[35] | USEPA Human Health Benchmarks[36] |
|---|---|---|---|---|---|
| Atrazine | 7.5 | 7.5 | 3.0 | 3.0 | NF* |
| Imidacloprid | NF | NF | 50[5] | NF | 399 |
| Metalaxyl | NF | NF | 50[5] | NF | 519[37] |

*NF=Not found in reference

[34] NYSDEC Division of Water (DOW) Technical and Operational Guidance Series (TOGS) 1.1.1 Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations (PDF).
June 1998 Edition (464 kB). This is a standard for Class GA groundwater. Class GA waters are fresh groundwaters. The best usage of Class GA waters is as a source of potable water supply.
[35] MCL=Maximum contaminant level.
[36] USEPA Human Health Benchmarks for Pesticides, April 2012, publication EPA-822-F-12-001. http://www.epa.gov/pesticides/hhbp/HHBP-fact-sheet.pdf.
[37] This benchmark is for Mefanoxam, an isomer of Metalaxyl detected in the Long Island aquifer.

# Chapter 3. ACTION PLAN TO IMPLEMENT THE LONG ISLAND PESTICIDE POLLUTION PREVENTION STRATEGY

## 3.1 PESTICIDE POLLUTION PREVENTION: MEETING THE GOAL AND PURPOSE OF THE STRATEGY

A broad range of pesticide-related contaminants (and other contaminants) have been detected over a fairly wide area in the groundwater underlying Long Island. The concentrations of pesticide-related contaminants have generally been very low and do not indicate a significant public health threat, although historic data indicates that some contaminants have exceeded drinking water standards at some time. In addition, much of the water quality monitoring data included in this document do not represent finished water (water that has been treated), which is the water distributed by public water systems to the public for drinking and other household purposes. Thus, the current situation does not necessitate direct or immediate regulatory action. However, pollution prevention (P2) provides an ideal and effective approach to meet the goal of the Strategy over both the short- and long-terms. This means employing a pollution prevention approach to achieve the goal: preventing pesticide-related adverse impacts, while meeting pest management needs.

## 3.2 A PESTICIDE P2 BLUEPRINT

The purpose of this Long Island Strategy is to establish a blueprint for long-term pesticide pollution prevention on Long Island to meet the goal. Pollution prevention measures outlined in the blueprint serve as a framework for minimizing pesticide-related risks to Long Island's irreplaceable groundwater resources, while encouraging reliance on integrated pest management and sustainable pest management practices to maintain benefits derived from pesticide use. There is a need for a balanced and science-based approach that recognizes the important roles pesticides play in the economic and public welfare of Long Island and the importance of protecting human health and precious environmental resources from pesticide-related contamination.

**GOAL OF STRATEGY - Prevent adverse effects to human health and the environment by protecting Long Island's groundwater and surface water resources from pesticide-related contamination, while continuing to meet the pest management needs of agricultural, residential, commercial, industrial, and institutional sectors.**

This Strategy will involve the cooperation and expertise of a number of stakeholders: State and local government agencies; pesticide product registrants; commercial pesticide applicators; Cornell Cooperative Extension; and others. These stakeholders will assist the Department in an assessment of active ingredients of concern and associated products, focusing on top priority active ingredients, development and implementation of best management practices, and outreach and education to affected pesticide users. This pollution prevention initiative represents a significant effort by all involved partners during the short and long-term time frames. Pollution prevention measures must be feasible and carried out with available resources of DEC and its partners.

Chapter 5 identifies a number of preventive measures that are already being conducted on Long Island and across the State. Many of them are non-regulatory, pollution prevention activities and are conducted or managed not only by the Department, but also by local organizations and agencies. Others are State or local regulatory requirements that are also designed to prevent pesticide pollution. The pesticide product registration program is the State's main pesticide product regulatory process; that process also acts as an initial pesticide pollution prevention measure by limiting or precluding adverse environmental and human health impacts from pesticides through special registration conditions or denying registration for use on Long Island or in New York State in its entirety. This Strategy addresses pesticide-related contamination of groundwater associated with normal pesticide use patterns from currently registered pesticides, rather than those related to unlawful activities (addressed by the State's pesticide enforcement program). A program to address contaminants from past pesticide practices, particularly those related to pesticides that have not been registered for many years, is beyond the scope of this Strategy.

The primary components of the pesticide P2 process for Long Island are summarized below, followed by the full P2 blueprint of actions.

| **PESTICIDE P2 BLUEPRINT SUMMARY** |
|---|
| ***DEC Conducts Initial Assessments of Specific Active Ingredients (AIs) and Related Pesticide P2 Needs*** |
| ***DEC Forms, Convenes and Chairs Pesticide P2 Workgroups; Workgroups Consider Various Matters Regarding Specified AIs and Related P2 and Advise DEC*** |
| ***DEC Identifies and Prioritizes Pesticide P2 Measures and Partners Collaborate to Implement P2 Measures*** |
| ***DEC Tracks Pesticide P2 Results and Assesses Need for P2 Modifications*** |
| ***DEC Maximizes Department Use of Water Quality Monitoring for Pesticides (Monitoring underlies implementation of the entire.)*** |

## ***BLUEPRINT for LONG ISLAND PESTICIDE POLLUTION PREVENTION***

### ***NYSDEC Conducts Initial Assessments of Active Ingredients (AIs) and Related Pesticide P2 Needs***

Review water quality monitoring results for Long Island groundwater; identify AIs detected as well as factors such as location, number, frequency and concentration of detections and potential for human exposure and associated health risks.

- Review AI-related standards, use and product information and water quality standards and benchmarks
- Identify AIs for which P2 measures potentially need to be taken
- Identify types of additional information needed to consider potential pesticide P2 needs and plan for AIs.

Note: DEC anticipates that the first group of AIs to be considered for assessment will be metalaxyl (fungicide), atrazine (herbicide) and imidacloprid (insecticide). These AIs have been detected by Suffolk County at multiple groundwater monitoring locations.

### ***DEC Forms, Convenes and Chairs Pesticide P2 Workgroups; Workgroups Consider Various Matters Regarding AIs and P2***

NYSDEC forms, convenes and chairs workgroups:

- A Technical Review and Advisory Committee (TRAC) which, at the request of DEC, considers AIs specified by the Department and advises on factors such as AI use and critical needs, potential for human exposure, human health risks, effective alternatives for AI, aquifer vulnerability, potential pesticide P2 measures (see below), P2 implementation partners, and other considerations to provide DEC with background information to support Department decisions regarding AIs and related P2 actions and implementation. (For further information on the TRAC, see Box ES-3 at close of the Executive Summary.)
- Additional workgroups, to ensure broad representation of involved entities in consideration of AIs and P2 measures (e.g., entities with direct involvement in pest management, pesticide use, and water quality on Long Island as well as academia). These workgroups may also consider AIs specified by NYSDEC, provide NYSDEC with requested information on particular subject areas (e.g., human health implications, water quality concerns, effective alternatives), and suggest feasible P2 measures and implementation partners.

### ***NYSDEC Identifies and Prioritizes Pesticide P2 Measures and Partners Collaborate to Implement P2 Measures***

NYSDEC considers workgroups' information and determines the scope and priority of pesticide P2 measures appropriate for each AI to be addressed.

- NYSDEC will identify and prioritize P2 measures from among this overall scope of primary P2 measures:
  - Develop and disseminate best management practices and track their use.

## ***BLUEPRINT for LONG ISLAND PESTICIDE POLLUTION PREVENTION***

### ***DEC Identifies and Prioritizes Pesticide P2 Measures and Partners Collaborate to Implement P2 Measures, cont'd.***

- Research alternative products and practices, including organic practices, and provide related outreach and education to implement
- Conduct outreach and education on use pattern-specific integrated pest management
- Encourage voluntary label revisions (through registrant and USEPA process)
- Restrict products to certified applicator use.

- DEC will identify partners to collaborate with the Department to implement pesticide P2 measures (e.g., product registrants, user groups, academic entities, State and local agencies) and, as needed, convene P2 implementation workgroups.
- DEC and partners will collaborate to implement P2 within available resources.
- DEC may strengthen existing outreach partnerships with Cornell University and other entities, forge new partnerships and maximize Internet resources.
- DEC and partners will identify stakeholders and build P2 implementation support.

### ***DEC Tracks Pesticide P2 Results and Assesses Need for P2 Modifications or Regulatory Measures***

- DEC, with, as needed, assistance of pesticide P2 partners, monitors results of P2 implementation and determines additional monitoring and measures, if any, for effective pest management and water quality protection.
- DEC may consider certain regulatory measures to manage use of a specific AI, if P2 actions prove insufficient and if DEC and NYSDOH determine that detections of a pesticide-related chemical in water quality monitoring data indicate significant public health or environmental impacts may occur. Under such circumstances, DEC may reassess the registration status of products containing the target AI by reviewing the product registrations associated with the AI and, if necessary, take regulatory action to prohibit use on Long Island.

### ***DEC Maximizes Department Use of Water Quality Monitoring for Pesticides***

**NOTE:** This underlies all actions under the blueprint, in that water quality monitoring results are essential to conducting the work under each component (e.g., determining AIs to be considered, specifying P2 needed, etc.)

- Adjust emphasis of monitoring, as needed and within available resources and flexibility, to meet DEC information needs for Long Island (e.g., focus on specific AIs to capture information and discern trends and new detections in particular pesticide use settings, such as greenhouses, turf, vineyards) as well as to monitor P2 results, if applicable.
- Focus water quality monitoring, including the acquisition of finished drinking water monitoring results, conducted under available resources by Suffolk County and Cornell University or others, on AIs of concern to determine trends and changes in detection levels and frequency.

## 3.3 CONDUCT INITIAL ASSESSMENTS OF SPECIFIC ACTIVE INGREDIENTS AND PESTICIDE P2 NEEDS

DEC will review, based on past water quality monitoring results, groups of active ingredients (AIs) detected in Long Island groundwater and currently registered pesticide products containing those active ingredients. The P2 needs assessment will be based on active ingredients and product use patterns in order to capture all of the products that might contribute to the overall exposure picture for a particular active ingredient. It will be imperative to focus initial assessments on active ingredients that have not been previously reviewed by the Department or for which additional information is available for review.

The P2 needs assessment would begin with an evaluation of water quality or other environmental monitoring data and information, as described below, to systematically screen active ingredients in currently registered pesticides to define the environmental and human health impacts of those active ingredients. The active ingredients will be prioritized with respect to the need for pollution prevention measures based on the P2 needs assessment and comparison with other active ingredients. The initial list of active ingredients to prioritize will be based on the currently registered active ingredients identified in Appendix A. Potential criteria for prioritizing these active ingredients include:

- Detection (concentrations, number of detections, locations, frequency, co-occurrence of contaminants, etc.) in groundwater and surface water monitoring data,
- Never reviewed by New York State, only a subset of product types reviewed, or more than 10 years since review,
- Major data gaps in the face of concerns (outstanding required studies, data call-ins, etc.) identified by either New York State or USEPA,
- Major hazards prominent in the scientific literature,
- Major action (regulatory change, reassessment, reclassification based on hazard) by another regulatory entity,
    - Under Special Review at EPA (for example, products containing neonicitinoids)
    - Under reassessment by California
    - Regulatory/legal action by other entities (other states, Canada, European Union), and

  In the same chemical class, or related to, another pesticide of concern. For example, it may be worthwhile to assess classes of pesticides (e.g., fungicides, triazines, etc.) at one time rather than individual active ingredients. Suitable alternatives or pollution prevention measures identified during the evaluation of one fungicide may also be suitable for other fungicidal active ingredients. Similarly, DEC and the TRAC may find it beneficial to review active ingredients from a similar chemical class, such as triazines, at the same time due to similarities in environmental fate, human exposure or toxicity.

Within the top priority group identified using the criteria above, active ingredients would be further prioritized based on:

- Amount of reported use and/or sales in New York State,
- Exposure potential (e.g., frequent agricultural reapplications, residential use, aerial application, interior use, sensitive or vulnerable populations),
- Number and type of products containing the active ingredient,
- Availability of effective and lower-risk alternatives, and

- Critical need or necessity of these pesticides to meet the pest management needs of agriculture, industry, residents, agencies and institutions.

The following examples show some of the criteria mentioned above that might be applied in evaluating a couple of active ingredients:

- Metalaxyl: Concerns have been identified regarding numerous low- level groundwater detections in Nassau and Suffolk Counties, and lack of prior New York State review. Currently, there are approximately 40 products containing metalaxyl registered in New York State.

- Chlorothalonil: Concerns have been identified due to the amount of use, hazard characterization and lack of prior New York State review. EPA has completed a Re-registration Eligibility Decision (RED) and concerns were identified for the use of chlorothalonil in residential settings. Chlorothalonil was first registered in the United States in 1966. There are currently 114 products registered in New York State which contain chlorothalonil.

DEC will:

- consider whether P2 measures are needed to address active ingredients that are identified by applying the above criteria,
- assess whether sufficient information exists to make a final determination on appropriate P2 measures to implement,
- identify, based on that review, active ingredients that are most suitable for applying P2 measures associated with their use on Long Island and the type of information needed to design a P2 action plan for those active ingredients, and
- review, periodically, additional active ingredients or groups of active ingredients and go through the same process.

DEC will not pursue pollution prevention measures, registration changes or the removal of any pesticides simply based on the fact that they contain a particular active ingredient. Assessments and subsequent actions related to active ingredients will be based on the criteria noted in section 3.7.B relating to their detection in the groundwater and surface water and their use patterns. There are many pesticide products which are currently registered with very limited use patterns, such as indoor baits and gels and outdoor spot treatment that have little or no potential to impact the environment. DEC, with the help of the TRAC and other workgroups, will attempt to identify problematic use patterns and applications of products containing active ingredients of concern which may have a negative effect on water resources.

## 3.4 MAXIMIZE USE OF WATER QUALITY MONITORING FOR PESTICIDES

NYSDEC contracts with the Suffolk County Department of Health Services (SCDHS) to monitor and report to DEC on groundwater quality on Long Island. Under these contracts, the Department will focus ongoing water quality monitoring conducted by SCDHS, to help answer questions or respond to needs identified in the P2 assessment process. Annual scopes of services

with SCDHS, and potential arrangements with other entities, are intended and will be designed to ensure that a comprehensive monitoring program is developed over time which is sufficient to identify the nature and extent of pesticide-related contaminants in the groundwater and surface water. The monitoring program will be modified over time to improve monitoring related to specific active ingredients, use patterns and locations, and to incorporate newly registered and other active ingredients, when necessary, that have not been included in the monitoring program to date based on factors such as their toxicity, leachability, and physical characteristics. Comprehensive evaluations of contaminants in groundwater and surface water are needed to understand their nature and extent and to more clearly identify potential exposure and risks and feasible pollution prevention measures. The Department will use its limited resources to target identified areas of concern. Areas where pesticides have been detected in groundwater at higher levels than elsewhere on Long Island and where there is an identified potential for these detected pesticides to pose an increased risk to human health through consumption of drinking water or to the environment will be given special attention. Information collected from these tasks will assist NYSDEC in focusing attention and prioritizing efforts in the registration program to minimize the environmental and potential human health impact from the use of pesticides. Examples of other tasks which the Department may contract with SCDHS to conduct are:

- implement a task to monitor wells down gradient of existing green-houses all over Long Island to determine the quality of groundwater in those areas,
- evaluate crops and application methods used to apply certain active ingredients to determine if particular crop/application method combinations are potentially causing an impact to water quality, and
- implement a task to monitor and report on finished drinking water samples to assess the potential human health exposure and risks.

Targeted and maximized use of water quality monitoring results will be important to all phases of pesticide pollution prevention on Long Island, from initial assessment to implementation of P2 measures.

## 3.5 ESTABLISH, CONVENE AND CHAIR PESTICIDE P2 WORKGROUPS

The Department will determine whether additional information is required to complete a P2 needs assessment for a specific active ingredient; however, DEC does not have the resources to obtain exhaustive information relating to multiple P2 scenarios for an active ingredient. Therefore, it is likely that advisement from entities with expertise will be needed regarding many active ingredients. Overall, the intention is for workgroups to collaborate on ways to evaluate and improve pesticide use, pest management and water quality protection to implement pesticide P2 on Long Island.

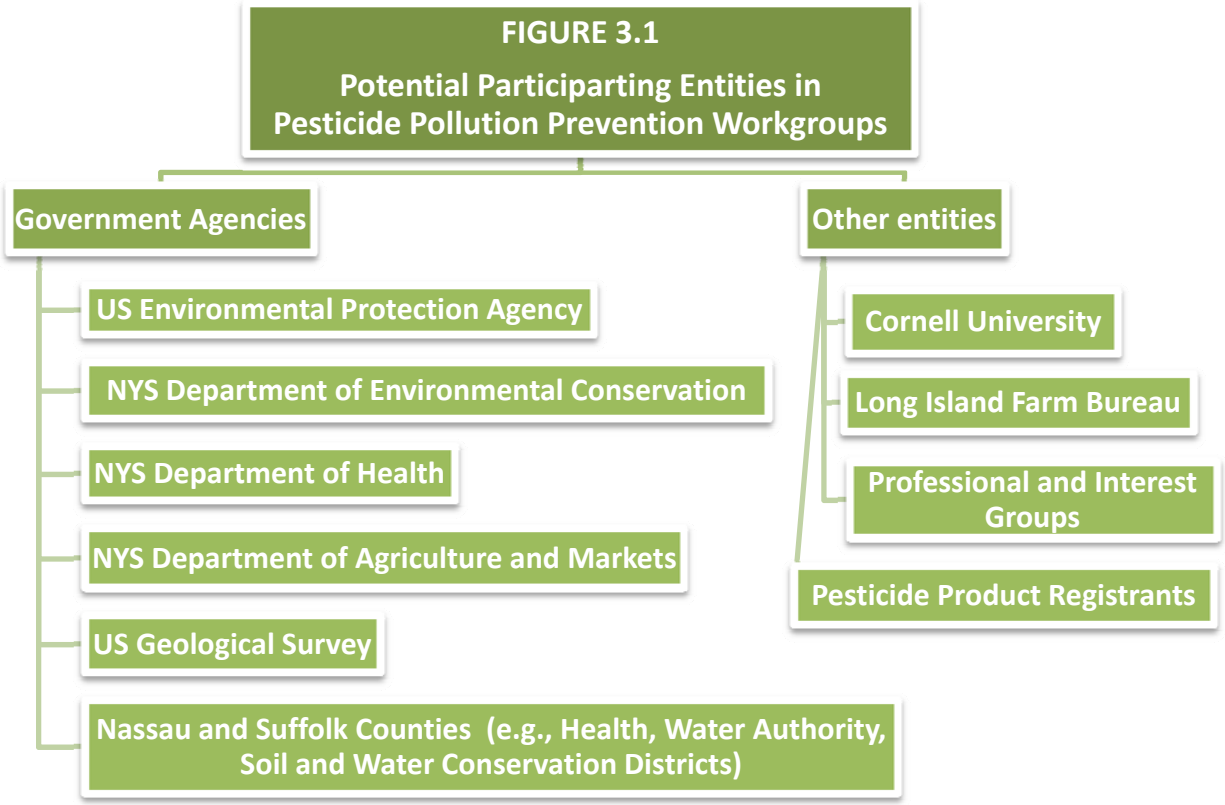
### 3.5 A. Purposes of P2 Workgroups

Workgroups will be needed to advise DEC and provide background information regarding specific active ingredients and feasibility of potential related P2 actions. DEC will form and convene several workgroups, representing a cross-section of entities with expertise and direct involvement in pest management, pesticide use, and water quality on Long Island. DEC will compile available information and request their consideration of certain active ingredients. The primary purposes of these groups will be to:

- *Provide information and advice to DEC based on their expertise and constituent base interests*.
- *Expand Knowledge Base to Support DEC P2 Decisions* - Such information would serve to expand the knowledge base supporting DEC pollution prevention measures for Long Island regarding specific active ingredients or use patterns. Over time, work groups would be phased-out once the original purpose(s) for which they were convened have been met.
- *Partner with DEC on P2 Implementation* – DEC will need the expertise and resources of certain entities to implement certain P2 measures, depending upon the nature of the measures to be taken. Entities on the workgroups with the most relevant expertise would be asked to collaborate with DEC to develop and disseminate information about these measures.

### 3.5 B. Types of P2 Workgroups and Participants

Several workgroups will be formed and convened, depending upon expertise and collaboration resources needed to implement pesticide P2. They would include representatives from involved State and local government agencies, pesticide user groups (e.g., agriculture, lawn care, etc.), product registrants, academic institutions, public interest groups, and others, all of whom are involved in some way in the registration, regulation or use of pesticides as well as water quality management on Long Island. The government agencies and other entities are illustrated in Figure 3.1.



The following workgroups are envisioned to implement the Strategy:

**Technical Review and Advisory Committee**
A Technical Review and Advisory Committee (TRAC) will be formed. At the request of NYSDEC, the TRAC will consider AIs identified by the Department and will advise on factors such as AI use and critical needs, potential for human exposure, human health risks, effective and lower-risk alternatives for the AI, aquifer vulnerability, potential pesticide P2 measures (see below), P2 implementation partners, and other considerations to provide DEC with background information to support Department decisions regarding AIs and related P2 actions and implementation. TRAC composition and purposes are summarized below.

The NYSDEC will coordinate the activities of the TRAC. Each entity and its representatives will participate in the TRAC in a manner that is consistent with its specific mission, purpose, resource capabilities and constraints, and priorities.

***TECHNICAL REVIEW AND ADVISORY COMMITTEE (TRAC) - SUMMARY DESCRIPTION***

**Composition**: NYSDEC will convene, approximately six months after this Strategy is finalized, a TRAC to pool expertise of State and local government agencies as well as statewide and local public service and academic entities closely involved with pesticide regulation and water quality monitoring for Long Island:

- New York State: DEC (Chair), Department of Health, Department of Agriculture and Markets; Cornell University
- Local Entities: Suffolk County Department of Health Services, Water Authority, and Soil and Water Conservation District; Nassau County Health Department and Soil and Water Conservation District; Cornell Cooperative Extension of Suffolk County

After 5 years, Department and involved participants assess ongoing need for TRAC.

**Primary purposes**:

- Assist NYSDEC in investigation and assessment of active ingredients (AIs), identified and ranked by the Department (potential contaminants detected in Long Island groundwater)
- Consider factors such as groundwater monitoring data, exceedances of chemical-specific water quality standards, potential for human exposure, human health risks, existing needs for pest management, and effective and lower-risk pest management alternatives
- Advise NYSDEC regarding potential and feasible response actions to prevent further pesticide-related impacts to the Long Island aquifer while recognizing pest management needs. (Scope of response actions - see P2 measures in Information Box ES-1.)

*Further information on the TRAC is contained in Appendix C.*

The mission of the proposed TRAC is to make recommendations to the Department, but it will not have a regulatory role. Jurisdiction in all matters pertaining to the distribution, sale, use and

transportation of pesticides, is vested exclusively in the Commissioner and EPA. DEC cannot shift any of its authority to the TRAC or any other entity. The TRAC is not an advisory committee as described in §33-0715 of the ECL, which is formed at the request of the Commissioner or a registrant and which is limited to recommending registration changes to the Commissioner. The TRAC's purpose will include evaluating the use, impacts, risks, alternatives, and potential pollution prevention measures related to the pesticides identified in implementing the Strategy and providing information to support the scientific approach for pesticide product registration. The TRAC will assist in investigation and assessment of active ingredients identified by DEC, evaluate existing information related to the active ingredients, such as monitoring data, potential human health risks, existing pest management needs, and effective alternatives, and it will advise DEC regarding potential response actions to prevent further pesticide-related impacts. DEC will work with county agencies and other members of the proposed TRAC to identify effective alternatives to particular active ingredients. It is also recognized that the other stakeholders have much of the expertise for identifying safer alternatives; notable in this regard are Cornell, certified applicators and their associations, product registrants, and public interest groups. Their participation in various workgroups will therefore be sought. When appropriate, they will also be invited to participate in TRAC meetings to offer technical advice. DEC and the TRAC may also consult with specialists when necessary for technical or other advice.

**Pesticide Product Registrants**
The Department will seek to work with pesticide product registrants and their industry associations to assess the environmental and human health impacts of their products and mitigate adverse impacts through measures such as voluntary changes in labels or use patterns, and development and dissemination of best management practices.

**Pesticide Applicators (**Pesticide Applicator Associations, Long Island Farm Bureau and New York Farm Bureau)

The Department will seek to develop partnerships with associations and entities representing a variety of pesticide applicators on Long Island to:

- Promote sustainable pest management and appropriate pesticide use to prevent groundwater impacts,
- Sponsor training courses that promote these practices and principles, and
- Gain feedback and gather information on pesticide use on Long Island.

**Cornell University**

- Support from the Cornell NYS Integrated Pest Management Program and Pesticide Management Education Program will be sought to:
  - Identify sustainable, cost-effective pest management methods with minimal risks to human health and the environment,
  - Promote agricultural & community IPM education and outreach on Long Island,
  - Provide IPM use recommendations.
  - Incorporate more information on Long Island groundwater protection in pesticide applicator certification and recertification training, and additional education activities for professional applicators and others,

- Provide leadership and training resources for statewide training of pesticide applicators,
- Provide guidelines on integrated crop management, organic production, and turfgrass pest management, and
- Perform pesticide impact assessments.

**Cornell Cooperative Extension of Suffolk County**
Support from Cornell Cooperative Extension of Suffolk County will be sought to:

- Identify sustainable and cost-effective alternatives to pesticides with the potential to leach.
- Conduct agricultural and horticultural pest management educational programs.
- Develop and provide best management practices for all crops and landscapes.
- Provide groundwater protection information in pesticide applicator certification and re-certification training.
- Develop pesticide use profiles/pesticide impact assessments.
- Disseminate pesticide use/groundwater protection information through emails, website, monthly magazines and newsletters.

**Public Interest Groups**
The Department will seek input from public interest groups regarding concerns about the environmental and human health impacts of pesticides and recommendations to mitigate such impacts. Public interest groups may also be able to assist with dissemination of information on pesticides, alternatives, and best management practices.

**NYSDEC**
DEC staff from the Divisions of Materials Management (DMM), Water (DOW), and Office of General Counsel (OGC) in the Central Office and Region 1 will be on the Department's team to implement the Strategy, headed by DMM Central Office staff. DEC will establish the administrative details of P2 workgroups (timing and frequency of meetings, etc.), when the Department implements this Strategy.

**Technical Advisory Committee**
A 25-member Technical Advisory Committee (TAC) representing a broad spectrum of interested stakeholders was established to assist with development of the Strategy. DEC will convene the TAC at least annually, to report on progress to the TAC and receive their input and recommendations.

## 3.6 P2 WORKGROUPS CONSIDER SPECIFIED ACTIVE INGREDIENTS AND RELATED P2

Workgroups will be asked to provide information and advice, in keeping with their area of expertise, for DEC consideration regarding specific active ingredients under consideration and degradates formed from the parent active ingredients, as well as any DEC research on subjects such as:

- Product use patterns,
- Primary users of the active ingredient and pest management purpose,
- Critical pesticide use and pest management needs and related economic factors,

- Additional scientific data from product registrants,
- Existing monitoring results and related water quality impacts,
- Results of focused new monitoring for active ingredients under consideration,
- Existing groundwater vulnerability assessments and groundwater/pesticides research from peer reviewed government or academic entities,
- Assessments of feasibility, practicality, cost-effectiveness, and efficacy (in terms of pest management) of potential P2 measures for specific active ingredients,
- Projection of degree of water resource protection to be achieved by potential P2 measures,
- Audiences to be affected by P2 measures,
- Potential exposure and risks to affected audiences,
- Evaluation of exposure potential and risk to human health, including potential additive or antagonistic effects of exposure to multiple contaminants,
- Partners to assist in conducting P2 measures and middlemen to spread P2 messages, including members of TRAC and external stakeholders,
- Additional entities, if necessary, to help support the assessment process, provide links to audiences and potentially contribute resources or services, including participating in P2 support efforts,
- Economic factors associated with pesticide use and the selection of pest management alternatives. These may include, among other things, the costs of treatment provided by water suppliers such as the Suffolk County Water Authority to address pesticide-related contaminants in drinking water, and agriculture industry financial benchmarking to identify the costs and risks associated with changing farming practices. DEC will work with these stakeholders to consider such economic factors,
- Potential opportunities for financial or marketing incentives, such as grants, insurance, or other programs that provide sources of funding or financial protections that help promote pursuit of certain P2 measures.

## 3.7 NYSDEC IDENTIFIES AND PRIORITIZES P2 MEASURES

### 3.7 A. Potential P2 Measures

Potential P2 measures could include a range of actions (e.g., technological, methodological, educational), such as:

- Develop and disseminate best management practices for currently used pesticides (e.g., pest problem identification, limit applications, buffer zones),
- Research and identify alternative pest management products and associated leachability and efficacy associated with those alternatives. Assess applicability of organic practices to specific Long Island pest management needs. Communicate alternatives to user groups through demonstration projects and outreach and education,
- Perform outreach and education on general pest management topics (in addition to outreach and education associated with best management practices (BMPs) and alternative pest management methods),
- Seek USEPA grant for organic land care education and outreach on Long Island
- Enhance or build upon existing DEC efforts, such as a permanent CleanSweepNY collection program, enhanced protection of seagrass, DEC's Be Green Organic Yards

NY program, or other initiatives the state may undertake to address broader Long Island water resource issues, and

- Product label and registration revisions:
    - NYSDEC restrict product to certified applicator use,
    - Registrants make voluntary label revisions through the USEPA label process.

Use of one or more of these measures would be dependent upon a number of factors regarding the background information on characteristics of the involved active ingredients, use patterns, economic impacts, resources needed for implementation of the measure, and other factors.

## 3.7 B. Potential Regulatory Preventive Measures

Changes in the NYS registration status of a product containing an active ingredient of concern, such as denying, cancelling or suspending registration or restricting product use through rulemaking, are potential actions available to the Department under existing regulations and statute, as discussed in Chapter 6 on Legal Authority and Enforcement. The regulations and statute allow for the Department to weigh the potential for human health and ecological risks against the potential benefits from using a pesticide product in making product registration decisions, which is an application of the goal of the Strategy. The Department may consider these regulatory preventive measures if P2 actions prove insufficient and if DEC and NYSDOH determine that detections of a pesticide-related chemical in water quality monitoring data indicate public health impacts may occur. The Department can also pursue enforcement actions with respect to product use even without pursuing pollution prevention steps, where necessary to protect public health or the environment. Appropriate courses of action, including additional regulatory measures, will be considered based on a variety of relevant factors applicable to the particular active ingredient, including:

--the magnitude of groundwater concentrations of the active ingredient;
--exceedances or near-exceedances of the applicable standard;
--temporal trend in the groundwater data;
--evidence of the leachability of the pesticide;
--usage of groundwater for drinking water near the areas of contamination;
--agricultural dependence on the active ingredient;
--availability of a less toxic alternative;
--efforts to use alternatives or to change application practices, and outcomes; and
--other relevant factors.

As part of the P2 Strategy for Long Island, NYSDEC would take several steps leading to implementation of P2 measures. Based on the review of the available information listed in Section 3.6, NYSDEC would:

- Prioritize the active ingredients to which P2 measures would be applied on Long Island.
- Identify the scope of P2 measures needed
- Determine P2 measures with the greatest potential for positive results, considering feasibility and effectiveness, and prioritize measures to be implemented
- Develop short and long-term P2 objectives and implementation schedules for each active ingredient.

## 3.8 NYSDEC AND PARTNERS COLLABORATE TO IMPLEMENT P2 MEASURES

Two key steps for a successful P2 program will be to collaborate with partners to implement P2 measures and build stakeholder support for implementing the measures. This is the most critical component of the P2 program as the culmination of all of the efforts outlined herein is the implementing of actions, not simply gathering and reviewing information. Appropriate stakeholders will be encouraged to implement or support P2 measures that are applicable to their business, association, or other functional roles as their available resources allow. In order to accomplish this, the Department will need to:

- Identify partners needed to implement priority P2 measures (e.g., product registrants, user groups, academic entities, State and local agencies).
- Convene partner groups and communicate, collaborate, and plan P2 implementation with them.
- Identify stakeholders and means to build support (meeting, web content, etc.).
- Utilize NYSDEC and partner websites to the greatest extent possible to implement P2 measures, monitor results, and communicate with stakeholders.
- Involve stakeholders at the state and local levels to help implement outreach and education to protect water quality and manage pesticide use and pests on Long Island. Outreach and education are longstanding core elements of pest management and water quality programs. A number of ongoing outreach and education efforts are described in Appendix C. They continue to be essential activities tied to promoting use of integrated pest management (IPM) and alternatives to pesticides, and proper pesticide use to decrease the risk of pesticide impacts to resources including groundwater, as well as for preventing misuse of pesticides.
- Work with partners and stakeholders to implement P2 measures.

## 3.9 NYSDEC MONITORS PESTICIDE P2 RESULTS AND ASSESSES NEED FOR P2 MODIFICATIONS

- NYSDEC, with TRAC and certain other partners, monitors results of P2 implementation and determines whether additional measures (P2 or otherwise) need to be taken,
- Monitor P2 results through environmental monitoring, inspections, user surveys and reporting, etc. and make adjustments as needed, and
- Collaborate with stakeholders on review of monitoring results and their application to other active ingredients.

The action plan outlined in this Chapter includes specific steps for each group of active ingredients under evaluation. However, they are not designed or intended to impede progress or preclude rapid implementation of obvious and appropriate pollution prevention measures, including the use of known and effective alternatives. The steps also do not have specified time frames. The process, and each step in the process, may take different amounts of time for different active ingredients. Each active ingredient will follow its own timeline as the characteristics, use patterns, monitoring results, pollution prevention measures and progress toward implementation and meeting pollution prevention and water quality goals will be different for each. Timelines for each active ingredient may be estimated as the action plan for

each is implemented. In addition, the process for the each successive group of active ingredients to be addressed will be triggered as soon as sufficient resources become available.

## 3.10 CRITERIA FOR MEASURING SUCCESS OF P2 MEASURES

Ongoing monitoring of the results of P2 implementation will be performed by DEC, along with the TRAC and certain other partners, to determine whether additional measures (P2 or otherwise) need to be taken. Monitoring will include not only environmental monitoring, but also inspections, user surveys and reporting, etc., so that adjustments can be made to specific P2 measures or to methods used to promote and explain those measures, or to determine if additional P2 measures are needed. Potential P2 measures could include a range of actions involving alternative products, practices, processes, and outreach; therefore, several types of criteria or evaluations are necessary to measure their success.

First, groundwater and surface water monitoring can demonstrate the eventual environmental results of implementing the Strategy. However, the success of the Strategy should also be measured in terms of disseminating information and implementing specific P2 measures. For example, DEC will collaborate with partners to develop and disseminate best management practices (BMPs) for currently used pesticides, and provide outreach and education on general pest management topics, BMPs and alternative pest management methods. Criteria for success may therefore be defined in terms of monitoring data, outreach and education, and implementation of P2 measures.

**Criteria based on Environmental Monitoring Data.**
Part of the overall goal of the Strategy is to prevent adverse effects on human health and the environment by protecting Long Island's groundwater and surface water resources from pesticide-related contamination. In some cases, water quality objectives or goals may be developed for specific pollution prevention measures implemented to address certain active ingredients. Development of such objectives should consider a variety of factors such as the characteristics of the active ingredient, site-specific hydrogeologic conditions, the P2 measures implemented, the rate of expected progress, and other factors. Success in achieving the overall goal of water quality protection would be assessed in terms of progress toward overall reduction of those contaminants as measured by parameters such as those listed below. Environmental monitoring data represents the most important means for measuring the success of the Strategy. It should be noted that these factors are interdependent and need to be evaluated together in order to get a complete picture of progress. Effective P2 measures should result in a decrease in each of these parameters.

- Number of detections – The overall number of detections should decrease if all other facets of a monitoring program remain the same. However, the number of detections needs to be evaluated with respect to the consistency of the monitoring program as well as of detection limits. The number of detections can increase or decrease simply by expanding or contracting the number of locations or the frequency of sampling within the monitoring network or by changing detection limits.
- Concentrations – The concentrations at each location and overall concentrations throughout the monitoring network should steadily decrease. If concentrations increase at any location, potential sources and causes of those increases need to be investigated.

- Frequency – The frequency of detections should steadily decrease. Again, this can be affected by the consistency of operating the monitoring program, as mentioned above, and needs to be evaluated in that context.
- Co-occurrence of contaminants – The detection of multiple pesticide-related contaminants should steadily decrease at each well and throughout the monitoring network in terms of all of the other parameters – number, concentration, frequency, etc. The number of contaminants could temporarily increase if degradates are formed as some pesticides degrade. But the detection of degradates should decrease over time as well.
- Locations – Detections should be observed at fewer locations. Again, this depends on and will be evaluated in the context of the consistency of operating the monitoring network. Consideration should also be given to whether the network is expanded or contracted in terms of the number of locations sampled or if locations are added (new wells installed or new surface water sampling locations) or reduced (wells taken out of service).

**Criteria based on Implementation of P2 Measures.**
The Strategy outlines a variety of P2 measures intended to reduce pesticide levels in groundwater. Some criteria for measuring the success of those efforts could include:

- Alternative pest management products – Identify products, research on those products, and how much they are used through inspections, user surveys or reports; introduce the alternative products.
- Best Management Practices – Identify BMPs and track the number and percentages of entities which implement them.
- Product label and registration revisions – Track all products for which registrants voluntarily agree to label changes.

**Criteria based on Modeling.**
The likelihood of alternative products entering groundwater can be predicted with leachability modeling. Results of such modeling could demonstrate the effectiveness of substitution of alternative products for those currently used and detected in groundwater. For example, if alternative product X has a significantly lower modeled leachability than a widely used active ingredient Y, the modeling data, coupled with information on the expanding use of product X, could point to progress of the Strategy.

**Criteria based on Outreach and Education.**
The Strategy outlines a variety of ways for DEC and stakeholders to reach out to pesticide users about P2 measures. Some criteria for measuring the success of those efforts could include:

- Training courses and programs – Identify training courses, programs, demonstration projects and sponsors (registrants, applicator associations, Cornell) that cover information on pesticide active ingredients of concern. This can also include the number of courses and the target audiences (professional applicators, consumers).
- Informational brochures, websites, etc. – Identify specific information about pesticides and alternatives that are developed or being developed and distributed to users.
- Training materials - Identify information on Long Island groundwater protection in pesticide applicator certification and recertification training.

# Chapter 4. PESTICIDE REGISTRATION IN NEW YORK STATE

## 4.1 INTRODUCTION

The NYSDEC Pesticide Product Registration process is an integral component of a comprehensive pest management program. The product registration program acts as a gatekeeper to control the universe of available pesticide products in New York State and operates within specified legislatively mandated timeframes. The current pesticide product review process did not exist prior to the early 1990s. Older pesticides, registered before that time, have often not received a comprehensive New York State review, or received only a very limited review of a subset of products. The New York State review, embodied in NYSDEC's existing pest management regulatory program, has proven effective at preventing products which pose unreasonable adverse effects from being registered and used in the State. DEC's enhanced pesticide registration program relies on the New Active Ingredient (NAI) and Major Change in Labeling (MCL) review process. During the process, pesticide registrants work with DEC to implement feasible and effective resolutions of any environmental concerns identified during NYSDEC's review. For example, some pesticides may be registered for use in New York State with restrictions for use on Long Island if the chemical poses a leaching risk for Long Island's vulnerable groundwater system. In this way, the current regulatory process effectively allows the availability of pesticide products needed by the user community.

## 4.2 USEPA PRODUCT REGISTRATION OVERVIEW

All pesticide products must be registered or exempted by the United States Environmental Protection Agency (USEPA) before they may be sold or distributed in the United States. A pesticide product is comprised of a distinct combination of active and inert ingredients and includes specific labeling instructions. During the registration process the USEPA examines the ingredients of a pesticide; the site or crop on which it is to be used; the amount, frequency and timing of its use; and storage and disposal practices. Every pesticide product is assigned a unique USEPA Registration Number which must appear on the product's label. Once registered, a pesticide may not legally be used unless the use is consistent with the approved directions for use on the pesticide's label or labeling. Pesticide products can only bear labeling that has been reviewed and approved by the USEPA and conform to the provisions set forth in the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

## 4.3 NEW YORK STATE PRODUCT REGISTRATION OVERVIEW

Registration of individual pesticide products is also required in every state. Every pesticide product which is distributed, sold, offered for sale or used in New York State must be registered by the NYSDEC.

There are two basic types of FIFRA Section 3 pesticide product registration applications in New York State; "routine" and "non-routine."

### 4.3. A. Scope of NYSDEC Product Registration Reviews

The NYSDEC reviews approximately 1,600 new product applications, 6,500 product renewals, and 2,600 revised label applications per year. The bulk of the NYSDEC's workload involves the review and registration of routine product applications. All New York State accepted labels are posted online via the Cornell University Cooperative Extension Pesticide Management Education Program (PMEP) Product, Ingredient, and Manufacturer System (PIMS) (http://pims.psur.cornell.edu/).

Routine pesticide products are those that contain active ingredients with labeled use patterns and application rates that are similar to currently registered pesticide products. Examples of routine pesticide product applications are those that are for new products containing active ingredients that are already in currently registered products along with renewals and revised labels for currently registered products. Routine applications are reviewed to ensure that their product labeling meets Federal and State labeling requirements. New York State is one of the only entities that conduct an extensive side-by-side label review of the USEPA stamped "ACCEPTED" labeling and the proposed final product container labeling. NYSDEC also conducts a comprehensive review of the appearance of the final product labeling. This includes, but is not limited to, the overall presentation and intent of the labeling, formatting of the labeling, legibility, graphics, labeling color, marketing statements, and product names. The USEPA and most states do not review final product container labeling. The NYSDEC is nationally recognized for the high level of label review expertise and ability to apply FIFRA and 40 CFR labeling requirements and standards to proposed final container labels.

Non-routine pesticide products contain new active ingredients (NAI) and/or represent major changes in labeling (MCL). An NAI is an active ingredient that has not been previously registered in New York State. MCL is the term given to a pesticide product which results in a major change in the use pattern for the active ingredient, increases the application rate, and/or any other change which significantly increases the potential exposure of any non-target organism or which increases the potential for a significant impact to humans, property or the environment, including water resources. NAI and MCL product applications undergo an extensive review and will be discussed in greater detail. In addition, there are several other types of non-routine product applications, FIFRA Section 24(c) Special Local Need, FIFRA Section 5 Experimental Use Permit and FIFRA Section 18 Emergency Exemption; however, only a few are received per year.

### 4.3. B. NYSDEC Product Registration and Renewals

Pesticide products are registered to a specific company, or registrant, that submits the application and maintains the registration in New York State. A registrant is assigned one expiration date on which all of their New York State registered products will expire, unless they are renewed. Currently, there are approximately 1,250 companies that maintain the registration of approximately 13,000 pesticide products in New York State. The registration period in New York State is two years, and within the two years, the Department has quarterly renewal cycles. The number of companies renewing products throughout the eight renewal cycles is divided equally, for the most part.

Expiration dates are randomly assigned and are based on when a company first registered a product in New York State. Since expiration dates are assigned to companies regardless of the type of product they register or the chemical composition of the individual products, similar products with identical active ingredients registered by different companies would have different expiration dates and would be renewed at different times.

According to 6NYCRR Part 326.24(a) applicants for renewal must file an application with the Department at least thirty days prior to the registration expiration date as shown on the registration certificate. If a complete renewal application is on file with the Department on or before the registration expiration date, the pesticide product registration will continue in effect until a registration renewal decision is issued and takes effect. Please see Chapter 6 and information regarding the State Administrative Procedures Act (SAPA).

## 4.4 NEW YORK STATE MANDATED TIMEFRAMES

All New York State product registration reviews are based on applications submitted to the Department. The legislatively mandated timeframes for all applications, reviews and registration decisions are depicted in the Table 4.1. Timeframes are based on the date an application is received by the Department.

Currently, pesticide product applications are classified broadly as new active ingredient or major change in labeling with no distinction as to the type of product being submitted for review and registration. The U.S. EPA has implemented a program which allows for expedited reviews for certain products which meet the criteria for Reduced Risk. Registrants prepare justifications for U.S. EPA consideration to classify a specific active ingredient and a specific use as being Reduced Risk. The U.S. EPA Reduced Risk classification indicates that the active ingredient and specific use is considered "reduced risk" when compared to a previous formulation or other existing products. A pesticide product classified as Reduced Risk by the U.S. EPA may still raise concerns for registration in New York State, such as potential to impact groundwater resources. However, a reduced risk program in New York State may be a way to provide an incentive to develop new, lower risk pesticide products.

**TABLE 4.1**
**NYSDEC PRODUCT REGISTRATION REVIEW – LEGISLATIVELY MANDATED TIMEFRAMES**

| Registration Type | Completeness Determination | Registration Decision* |
|---|---|---|
| New Active Ingredient (AI) | 60 days, written notice to applicant | 150 days + 30 days, if applicant requests decision |
| Major Change in Labeling (MCL) | 60 days, written notice to applicant | 150 days + 30 days, if applicant requests decision |
| AI already registered (New and Renewal) | 60 days, written notice to applicant | 90 days + 30 days, if applicant requests decision |
| Revised labeling, | 60 days, written notice to applicant | 30 days + 30 days, if applicant requests decision |

| | | |
|---|---|---|
| amendment | | |
| Revised labeling, notification | 30 days | Automatically deemed accepted on 31st day after receipt, unless determination is made that amendment application is required |
| Special Local Need Registration | 60 days, written notice to applicant | 60 days + 10 days, if applicant requests decision |
| Experimental Use Permit | 60 days, written notice to applicant | 60 days + 30 days, if applicant requests decision |
| Section 18 Emergency Exemption | Filed with NYSDEC at least 105 days before decision is needed. 30 days to determine completeness. | Files with EPA at least 60 days before decision is needed. |

## 4.5 NYSDEC REGISTRATION DECISION PROCESS FOR NAIS AND MCLS

### 4.5. A. Background on and Evolution of NYSDEC Product Registration Process

The State's Pesticide Product Registration Section was established on January 4, 1993 as a result of the 1992 pesticide fee bill (Chapter 67 of the Laws of 1992). Environmental Conservation Law Section 33-0701 requires that all pesticide products prior to sale, offer for sale, use or distribution must be registered with DEC. The 1992 fee bill also prescribed specific time frames for pesticide registration reviews and provided for the establishment of the Pesticide Product Registration Section. Prior to the 1992 fee bill, no new active ingredients or major changes in labeling were being registered for use, so no new chemistries or products could legally enter the state. A six-year backlog of applications existed before the Section was established.

The USEPA routinely registers new active ingredients that are appropriate for use in some, but not all, areas of the country. For example, they may register a pesticide product whose use is appropriate in areas with thick impermeable till soils, but is not appropriate in areas with permeable soils and near-surface aquifers. Thus, a federally registered product could cause serious contamination in some areas of the country. The USEPA, therefore, relies on states to be vigilant and innovative in identifying vulnerable areas and tailoring registration decisions to protect their own environmental resources while allowing for new, innovative and safer chemistries to be available to the pesticide users in the state.

In New York State, there is no attempt to duplicate the USEPA's review, but rather the NYSDEC reviewers expand upon USEPA's reviews and identify situations and circumstances where local conditions might not be protected by the broad criteria used by the federal government. New York State registrations are not based entirely on the results of the USEPA technical reviews, and some risks judged important in New York State are not considered in the USEPA review. The USEPA weighs the risks of using a particular pesticide against possible advantages in a cost-benefit analysis. The parameters that result in a favorable cost benefit on a

national scale may be unfavorable on a local scale. New York State evaluates each product for risks to human health, groundwater and non-target organisms. The advantages identified in a cost-benefit analysis are secondary to the protection of human health, groundwater and non-target organisms; however, the NYSDEC does consider the potential benefits of new, safer product chemistries to control pests as part of their registration review.

Throughout the years, as new scientific information and better assessment and analytical methods and models have become available, they have been incorporated into the State's registration review process. For new active ingredients in the same chemical families as previously registered products, reviewers evaluate information on human health, groundwater, and non-target organisms from use of previously registered products. For major changes in label where the registrant is adding a new use pattern or increasing the application rate, all available information from the previously registered product is again scrutinized. New York State requires that registrants submit copies of their Adverse Effects Reports required under FIFRA Section 6(a)(2). These reports are used to monitor for any negative impacts reported by users of pesticide products and are utilized in the reviews. The State's registration review process also utilizes the Internet as a tool for searching for additional information regarding an active ingredient that may not have been included in the registration application.

### 4.5.B. Current Product Registration Process

NYSDEC requires the submission of a complete data package in support of the application for registration of an NAI or MCL. A complete application includes all USEPA registration review documents prepared or solicited by the USEPA in its review, analysis and evaluation of an application to register a pesticide product, including all data evaluation record reports, branch reviews, comment and decision-making documents and correspondence with the registrant. The USEPA requires certain studies to be performed by the registrant, based on the product's use patterns. The USEPA reviews the studies, and develops a Data Evaluation Record report (DER) for each study. In addition, the USEPA produces an Environmental Fate and Effects Division Ecological Risk memo which summarizes all of the study results and discusses the data and data gaps, if any, for the active ingredient and/or end use product.

New York's product registration review is an intensive process involving cautious, conservative approaches in the evaluation of potential adverse effects to health, ecological resources, and water resources of the state. NYSDEC has 60 days to perform a completeness determination on a NAI or MCL application. If any information is missing, a letter is sent to the registrant requesting the information, or a justification as to why the information is missing or unavailable. The registrant has 45 days to respond to the NYSDEC. Once any additional information is received, it undergoes another completeness determination. Once an application is deemed complete, a letter is sent to the registrant and the NYSDEC has 150 days to issue a registration decision on the application.

During the 150 days, a technical review of the application is performed. Technical staff reviews each applicable DER, noting whether or not the USEPA found the study acceptable. If the study was unacceptable, they review the reasons; in most cases, it is a paperwork issue that was subsequently cleared up, and the data is valid for use.

The State's registration process also involves review by the Bureau of Toxic Substance Assessment of the New York State Department of Health (NYSDOH) Center for Environmental Health, which evaluates human health risks posed by the use of the product, and assists the Department in making decisions on pesticide registration. The intent of NYSDOH's review is to reduce risks to public health from the use of pesticides by assessing exposures and risks and recommending ways to reduce those risks. The goals of this review are to ensure that any pesticides registered in the State do not pose significant risks to public health from occupational and residential exposure or other sources, such as food, water, or air when used as labeled.

The Department's Division of Fish, Wildlife and Marine Resources' Bureau of Habitat (BOH) is also involved in the State's registration process. The BOH evaluates the potential effects of product use on non-target organisms and endangered species in New York State. They evaluate and identify the risks posed by use of the product and, if needed, recommend ways to reduce those risks.

The State's groundwater quality assessment review of the environmental fate data builds on the FIFRA Section 3 review by evaluating the potential impacts of product use on groundwater quality under New York State conditions, such as those that exist on Long Island. The environmental fate studies used to evaluate impacts to groundwater include:

- Hydrolysis
- Photodegradation in Water
- Photodegradation on Soil
- Aerobic Soil Metabolism
- Anaerobic Soil Metabolism
- Anaerobic Aquatic Metabolism
- Aerobic Aquatic Metabolism
- Adsorption/Desorption Mobility
- Column Leaching Mobility
- Field Dissipation Studies

This evaluation provides information that is used to assess and develop conditions for use of the product and treats all groundwaters as potential sources of drinking water. The groundwater assessment is designed to be conservative to ensure that potential water quality impacts are minimized to the maximum extent practicable and to clearly demonstrate that the proposed use of the product will not violate State or federal standards or guidance values for groundwater.

If it appears that the product's characteristics indicate that it might leach to groundwater, have an adverse impact to non-target organisms, or raise concerns regarding potential human health impacts, a technical issues letter is sent to the registrant. This letter advises the registrant of the issues found during the NYSDEC's technical review, and requests any additional information that would support a registration decision. The registrant may also request a meeting to discuss the technical issues with NYSDEC staff.

If any one of these three reviews determines that an unreasonable impact could occur to groundwater, human health or non-target organisms from the labeled use of the new active ingredient or major change in label, the NYSDEC has the right to deny the registration of the

product. However, if the three reviews determine that there is no unreasonable impact to groundwater, human health or non-target organisms, if the composition of the pesticide is such as to warrant the proposed claims for it, and if the pesticide and its labeling and other material required to be submitted comply with the requirements of Article 33 of the ECL, then the NYSDEC will register the product for use in New York State.

### 4.5. C. Review Process for Potential Groundwater Impacts

In order to understand how the pesticide pollution prevention Strategy will be used to enhance the protections of groundwater resources on Long Island, it is essential to understand what safeguards are already being used to protect groundwater as part of the State's registration program. This section of the Strategy provides a detailed overview of the State's current groundwater assessment process.

In addition to reviewing the environmental fate studies required by EPA, staff also reviews groundwater monitoring data, if available in the registration application, but it is rare to have groundwater monitoring data available for new active ingredients. (In those situations, the NYSDEC uses LEACHP computer modeling as an additional tool to help determine the potential impact of the use of the product in vulnerable areas.) While the Department has always used LEACHP worst-case modeling as a tool in the registration decision-making process, in more recent years, NYSDEC has used even more conservative criteria when evaluating potential use on Long Island due to increased concerns over potential detection of any active ingredient in the groundwater.

#### *4.5.C.1. LEACHP Modeling*

The NYSDEC always models "worst-case" parameters to ensure that the results are as conservative as possible. The model incorporates a soil profile based on the Riverhead sandy soil of Long Island and 10-year rainfall data set from JFK Airport. Chemical-specific parameters used in the model include:

- solubility of the product,
- maximum yearly application rate,
- half-life of the product as found in aerobic metabolism soil studies, and
- adsorption-desorption coefficient (a measure of how tightly the product binds to the organic carbon in the soil profile).

The half-life and the adsorption-desorption data are taken from the studies based on soils with a pH and percent of organic matter most similar to that of the Riverhead soil profile.

The pesticide is then modeled as a "bare-ground" application; the output is not corrected for foliar uptake, interception by thatch, or photolysis from the plant or soil. New York State assumes 100% of the applied product reaches the soil surface and is available to leach. The model projects the amount of leachate that moves through the soil column beneath the application area and is available to reach groundwater.

The same modeling process is applied to any degradates that were found at 10% or more of the application rate in the aerobic metabolism study.

A document is prepared which summarizes all of the studies and data results, and, if there was no groundwater data, computer modeling projections. Review staff sends this document to the project manager with a recommendation regarding whether or not the product has characteristics that would allow it to leach to groundwater when used as labeled.

New York State considers all groundwater on Long Island, which is a sole source drinking water aquifer system, as either a current or potential source of drinking water. This Strategy seeks to preserve the viability of all of Long Island's groundwater for that purpose. Factors used for pesticide product registration decisions of New Active Ingredients and Major Changes in Label are summarized in Figure 4.1.

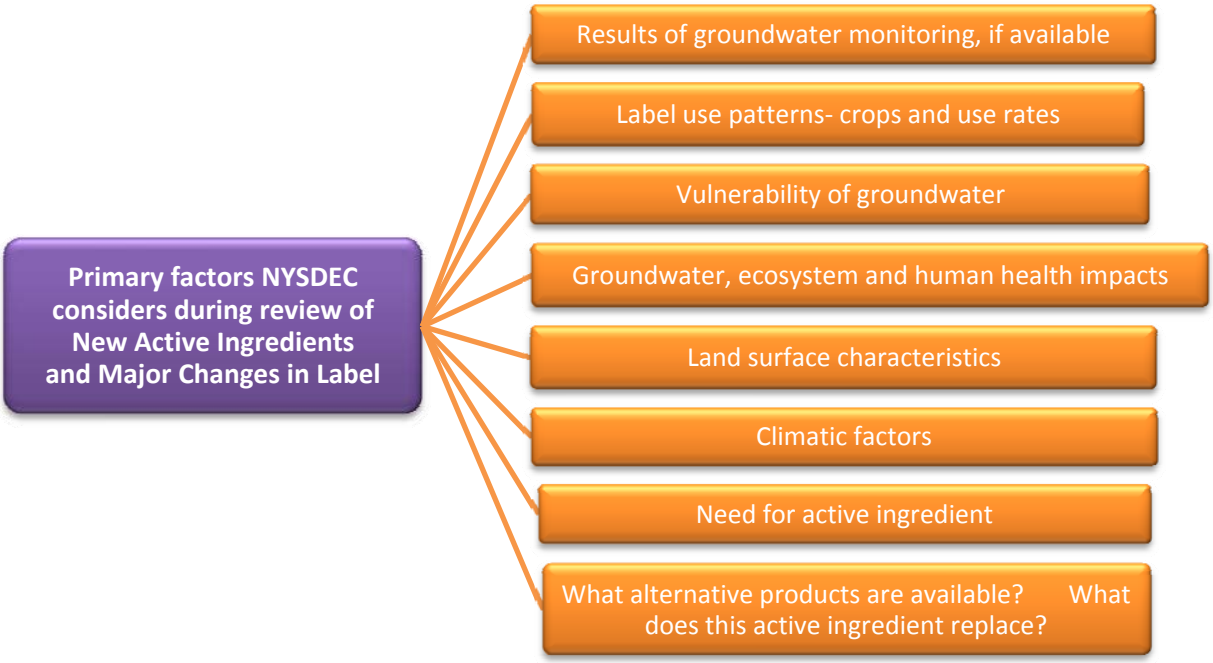



**Figure 4.1: Primary Factors NYSDEC Considers as Basis for the Registration of a New Active Ingredient or Major Change in Label**

## 4.5. D. Factors Considered During Product Registration

The NYSDEC reviews all information submitted in support of an application and determines whether the product, when used as labeled, is likely to result in adverse effects on the health of workers or the general public, the fish and wildlife resources, or the ground and surface water of New York State. If concerns are identified during the review process, the registrant is notified. If the concerns can be mitigated through revisions of the product labeling, the registrant has the option of pursuing those changes with the USEPA. For example, the addition of the statement: "Not for sale, use or distribution in Nassau and Suffolk Counties, New York" might address NYSDEC's concerns regarding potential impact on the groundwater resources of Long Island. The NYSDEC does not have the authority to require a registrant to change its product labeling in order for a product to be registered in New York State. However, the NYSDEC is not required

to register a product if the concerns identified in the registration review process are not mitigated. In such cases, NYSDEC will issue an unfavorable registration decision and deny the registration of the product in New York State. See Legal Authority and Enforcement in Chapter 6 for more information.

Based on issues raised during the technical review, the NYSDEC and the registrant may work together to agree on the following steps in order to mitigate concerns:

- Withdraw registration application,
- Deny registration,
- Reduce application rates,
- Reduce number of applications,
- Limit application methods,
- Add personal protective equipment,
- Add buffer zones,
- Limit sites of application,
- Require new studies, or
- Designate product as "NYS Restricted Use".

## 4.6 REGISTERED AND RESTRICTED PESTICIDE PRODUCTS IN NYS

The specific restrictions and prohibitions established in connection with the NYSDEC NAI and MCL registration review process are applied to all future products registered with the same active ingredient and/or use pattern. In part, registration actions are designed to protect the quality of surface water and groundwater on Long Island. As of June 2012, there were 13,688 pesticide products registered for use in New York State. In general, NYSDEC registration decisions are made on a statewide basis. About 1,700 products have New York State-specific language and/or use restrictions placed on them. Due to the high vulnerability of Long Island groundwater to contamination through its recharge zone, pesticides that could readily enter the Long Island aquifer system are prohibited from distribution or use in Nassau and Suffolk counties. Of the approximately 1,700 restricted pesticides, 361 are strictly prohibited from use in Nassau and Suffolk counties. Any registered pesticide product that is prohibited from distribution and use in Nassau and Suffolk counties will include a statement to that effect on the label. Another 145 are registered for use on Long Island only when used in accordance with specific label conditions. Based on the specific pesticide product characteristics or findings regarding these products, protective conditions such as the following are developed and enforced:

- Use for ornamentals in enclosed structures only,
- No use within 100 feet of coastal marshes,
- 25-foot buffer strip to coastal marsh,
- Use limited to onions and strawberries,
- No soil injection,
- No aerial application,
- No use on golf courses or sod farms,

- Reduced rates of application, and
- Maximum annual/seasonal quantity.

In response and as a result of the pollution prevention efforts of the Strategy, additional labeling modifications and reference to Best Management Plans will be explored.

### 4.6. A. Research to Support Pesticide Product Sale, Distribution and Use on Long Island

The Department currently uses very conservative parameters during the new active ingredient and major change in labeling extensive review process. As a result, many pesticide products containing new active ingredients or representing major changes in labeling are not registered for use on Long Island if there is an indication that there is a potential for leaching. If there is a specific need for such a product or if the registrant wants to amend the label to allow use on Long Island, "pilot trial" or research may be conducted in order to gather relevant, meaningful, real-world scientific data to support the use. Such "pilot trials" may be conducted in conjunction with Cornell University and/or Cornell Cooperative Extension, and the pesticide registrant, and with the appropriate Department approval.

# Chapter 5. EXISTING POLLUTION PREVENTION PROGRAMS AND ACTIVITIES

## 5.1 INTRODUCTION

The Strategy provides an overall structure for prevention and response efforts related to the impact of pesticides on the quality of surface water and groundwater on Long Island. Preventive actions are those which may directly or indirectly reduce the potential for pesticides to contaminate surface water and groundwater, regardless of whether a pesticide has been detected in Long Island's water resources.

This chapter describes a host of measures that have been or can be employed to prevent contamination of Long Island's water resources by currently used pesticides. Two broad categories of prevention measures are addressed in this chapter - regulatory and non-regulatory.

The actions proposed in the Strategy have been developed to potentially supplement some of the programs and measures summarized below. As the Strategy is implemented, it is expected that some of these programs and activities will indeed be utilized. As it becomes apparent what programs complement the Strategy's goal of protecting Long Island's groundwater and surface water resources from pesticide-related contamination while continuing to meet pest management needs, the Department may perform an assessment of these programs to further improve their overall contribution to the Strategy.

## 5.2 THE NATURE OF PREVENTIVE MEASURES

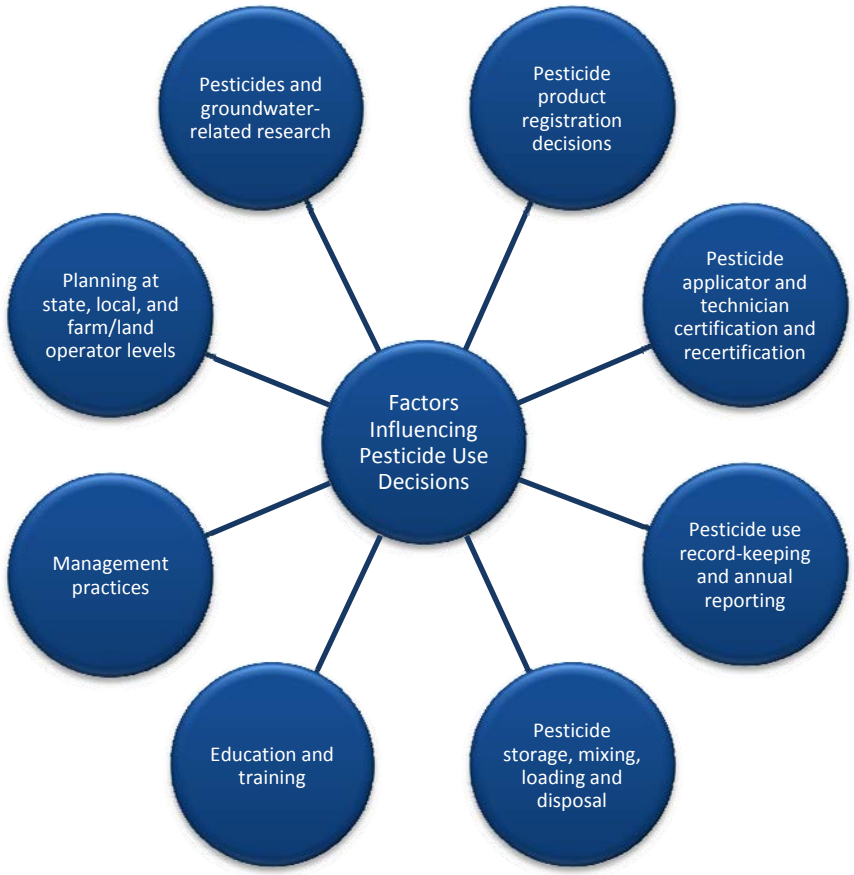
Preventive measures may be employed on a proactive basis to help prevent contamination or on a responsive basis, to reduce or eliminate further contamination from a pesticide already detected in the water resource. Best management practices can be utilized regardless of whether a pesticide has already been detected in water resources. New York's overall prevention effort includes activities which support the development, communication or implementation of preventive approaches (e.g., education, planning and coordination among involved entities).

The Strategy focuses on proactive preventive measures as the primary means to support improved pesticide use decisions all the way from the review of an application for New York State pesticide product registration, to the disposal of empty pesticide containers. Such decisions are made primarily by regulatory agencies, as well as occupational users and homeowners who use a pesticide to manage a pest problem. Improved decisions about pesticide use help protect water quality, by influencing what products and strategies are used to manage pests, ranging from the lawn dandelion to the farm field of cauliflower. The primary factors that can influence pesticide use decisions are summarized in Figure 5.1.

## 5.3 NON-REGULATORY POLLUTION PREVENTION MEASURES

There are a host of non-regulatory, pollution prevention actions that have been or can be utilized to prevent or reduce potential impacts of pesticide use, as shown in Figure 5.3.

**FIGURE 5.1 FACTORS INFLUENCING PESTICIDE USE DECISIONS**




### *5.3.1. Education and Training*

Education and training are an integral part of most pesticide and water quality management activities, and are critical to effectively preventing pesticide-related contamination of Long Island's surface water and groundwater. It is essential to understand and share information on matters such as the adverse impact of pesticides on water quality and pesticide and water quality management strategies in order to prevent such contamination and achieve proper management and protection of these water resources.

A range of public and private entities provide education and training relative to pesticides and water quality management, including the NYS Department of Environmental Conservation (NYSDEC), Cornell University, Cornell Cooperative Extension, and such private course sponsors as the Nassau-Suffolk Landscape Gardeners' Association, Inc., Professional Pesticide Applicators of Long Island, Inc., Long Island Pest Control Association, Inc., and regional pesticide distributors.

#### 5.3.A. New York State Department of Environmental Conservation Outreach

On Long Island, the Department's outreach efforts focus attention on the regional groundwater situation, and NYSDEC personnel work to inform the general public and regulated community

about the importance of preventing further pesticide-related contamination of that underground resource.

Since NYSDEC is the state agency responsible for regulating the distribution and use of pesticides, compliance assistance, public outreach activities, and enforcement of New York State's pesticide-related laws, rules and regulations, the Division of Materials Management, Bureau of Pest Management personnel engage in outreach activities that provide information to pesticide users by:

- making presentations to the professional pest management community, including those involved with the production of food crops, and other occupational pesticide users,
- participating in events where occupational pesticide users and others assemble for educational purposes (including such regional annual conferences and trade shows as those sponsored by Cornell Cooperative Extension of Suffolk County, Nassau-Suffolk Landscape Gardeners' Association, Inc., Long Island Pest Control Association, Inc., Professional Certified Applicators of Long Island, Inc., and Neighborhood Network, Inc.),
- developing informational brochures, fact sheets, and presentations on pest management, Integrated Pest Management (IPM), pesticide use, and best management practices (BMPs). This is sometimes done in conjunction with the NYSDOH, Cornell University, Cornell Cooperative Extension of Suffolk County, or pesticide product manufacturers, registrants, and sub-registrants, and distributing these as appropriate,
- maintaining current and useful information on the NYSDEC website, and
- assisting training course sponsors who develop and provide certification, recertification, and other training courses.

#### *5.3.A.2. Cornell University, PMEP and Cornell Cooperative Extension of Suffolk County*

Cornell University's Pesticide Management Education Program (PMEP) provides a gateway to resources on various topics related to pesticides management and surface water and groundwater protection strategies. The PMEP website[38] contains information on many pesticide use and regulatory requirements as well as links to other educational materials. Fact sheets on groundwater are also posted.[39]

PMEP also conducts statewide training for certification and recertification of pesticide applicators. PMEP has conducted a series of training sessions entitled "Groundwater and Pesticides Information" directed at Cooperative Extension staff, NYSDEC staff and others involved in pesticide applicator training.

Cornell Cooperative Extension of Suffolk County works closely with programs and departments at Cornell University. Cooperative Extension of Suffolk County, however, is the locally based component of Cornell University, which is actively conducting pollution prevention programs on Long Island. The Agriculture Program is dedicated to supporting the economic viability of agriculture while working to preserve and protect our water resources. A major emphasis of

[38] The PMEP website[38] http://pmep.cce.cornell.edu/ provides access to information on pesticide/groundwater/soil interaction, application techniques, pesticide issues, toxicology, pesticide certification information, pesticide active ingredient/New York State product registration data, pest management recommendations, and federal and New York State pesticide-related laws, rules and regulations, as well as links to other educational materials.
[39] PMEP posts groundwater fact sheets at http://pmep.cce.cornell.edu/facts-slides-self/Factsheets.aspx

Cooperative Extension's programming is devoted to research and educational extension of alternative strategies for pest management. Producers commonly adopt these best management practices once their effectiveness has been demonstrated, often shown with on-farm demonstrations.

Cornell Cooperative Extension publishes educational documents that relate to pesticides and water quality, available on their website or through their publications center, such as *Pesticides and Groundwater - A Guide for the Pesticide User*.[40]

#### *5.3.A.3. New York State Water Resources Institute*

The New York State Water Resources Institute (WRI) at Cornell University (http://wri.eas.cornell.edu) has developed educational computer tutorials for pesticide applicators and farmers. A joint effort by the WRI and NYSDEC produced a brochure in August 2004 entitled *Water Quality Protection Tips for Professional Applicators, Pesticide Application and Water Quality*. It contains water quality protection tips for professional applicators,[41] and a slide set and script for training pesticide applicators entitled *Protecting New York's Waters, Water Quality and Pesticides Training for Pesticide Applicators and Technicians*.[42]

#### *5.3.A.4. Private Course Sponsors*

Many private entities (trade organizations, pesticide businesses, pesticide distributors, individuals, and others) provide training and educational opportunities for pesticide applicators. Many courses are offered each year and, after approval by NYSDEC, these courses provide continuing education credits to applicators that successfully complete them.

#### *5.3.A.5. EXtension TOXicology NETwork (EXTOXNET)*

Information regarding pesticide toxicology can be accessed through the EXtension TOXicology NETwork (EXTOXNET) at the following website: http://extoxnet.orst.edu, or by telephoning the National Pesticide Information Center (800) 858- 7378. It is a source of objective, science-based information about pesticides that is developed by toxicologists and chemists within the Extension Service of Cornell University and a number of other land-grant universities.

### 5.3.B. Management Practices

Management practices for pesticide users can be pesticide-specific or general in nature. Their objective is to improve the manner in which pesticides are used and managed and thereby prevent or minimize the impact of pesticides on the environment. Education and outreach events

[40] Cornell Cooperative Extension publications are listed at http://www.cce.cornell.edu/store/customer/home.php. *Pesticides and Groundwater - A Guide for the Pesticide User* can be viewed at http://psep.cce.cornell.edu/facts-slides-self/facts/pest-gr-gud-grw89.aspx and *Pesticide Management for Water Quality - Principles and Practices* (Van Es and Trautmann, 1990) can be viewed at http://psep.cce.cornell.edu/facts-slides-self/facts/pestmgt-water-qual-90.aspx .

[41] The brochure, *Water Quality Protection Tips for Professional Applicators*, and other brochures are accessible through the NYSDEC website at http://www.dec.ny.gov/chemical/8531.html.

[42] NYS Water Resources Institute and the NYS Department of Environmental Conservation, *Protecting New York's Waters, Water Quality and Pesticides Training for Pesticide Applicators and Technicians*, December 2000, http://psep.cce.cornell.edu/Tutorials/Tutorials-Slides.aspx.

often provide excellent opportunities to disseminate and even implement best and alternative management practices.

### *5.3.B.1. Best Management Practices*

Pesticide-specific best management practices can be implemented by wide range of pesticide users, or in some cases by a particular set of pesticide users. Such practices are developed as the need arises, to serve as preventive measures in the absence of the detection of pesticide in water resources, or to prevent further contamination when a pesticide is detected. For example, in 2004, best management practices were developed by the NYSDEC, Cornell Cooperative Extension of Suffolk County, and Bayer CropScience for certain uses of the insecticide imidacloprid on Long Island.[43]

The New York State Nonpoint Source Management Practices Task Force was established by the NYSDEC to identify candidate management practices for all land uses contributing to nonpoint source pollution. Subsequently, management practice subcommittees, developed catalogues of management practices. One such catalogue, the *Agricultural Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State* (3rd rev. May 1996),[44] addresses pesticides relevant to groundwater concerns. It includes assessments of agricultural management practice effectiveness, advantages, disadvantages, cost, operation and maintenance issues, and other concerns.

### *5.3.B.2. Integrated Pest Management (IPM)*

Integrated Pest Management (IPM) is a systematic approach to managing pests which focuses on long-term prevention or suppression with minimal impact on human health, the environment and non-target organisms. IPM incorporates all reasonable measures to prevent pest problems by properly indentifying pests, monitoring population dynamics, and utilizing cultural, physical, biological or chemical pest population control methods to reduce pests to acceptable levels. The New York State IPM (NYSIPM) Program, which is implemented by the Cornell College of Agriculture and Life Sciences, provides education and facilitates implementation of IPM in four major commodity production areas: vegetables, dairy/field crops, fruit, and ornamentals, and in community IPM. New York State budget funds have been appropriated annually for the NYSIPM Program, and provided to Cornell under contracts or agreements with the NYSDEC and NYS Department of Agriculture and Markets. The mission of the NYSIPM Program is to develop sustainable ways to manage pests and helps people use methods that minimize environmental, health, and economic risks.

In general, IPM takes into account:

- current pest control practices and environmentally-preferable alternatives to those practices,
- pest priorities,
- socio-economic factors affecting IPM adoption, and
- strategies for IPM practices, education/technology transfer/outreach, and agricultural and urban pest management.

[43] The imidacloprid best management practice documents can be viewed at the following Cornell Cooperative Extension of Suffolk County website: http://ccesuffolk.org/best-management-practices-for-long-island-ny/.
[44] The Catalogue is accessible at http://www.nysl.nysed.gov/scandoclinks/ocm36966918.htm.

Examples of IPM activities which could contribute to Long Island groundwater protection include:

- continued coordination and facilitation of IPM activities through an IPM specialist on Long Island,
- continuation of the electronic communication system for growers (weather data, pest predictions, and management recommendations), through web-based resources such as the Network for Environmental and Weather Applications (NEWA), and
- conducting on-site IPM demonstration projects as resources allow.

#### *5.3.B.3. NYSDEC Environmental Benefit Projects*

An Environmental Benefit Project ("EBP"), is a project undertaken as part of a civil settlement of claims of violation of environmental laws or regulations that partially compensates for the environmental insult associated with an alleged violation, either at the offending facility or in the surrounding area. EBPs produce additional environmental and public health protection or improvements in the community where the insult occurred. An example is the *CleanSweepNY* pesticide collection and disposal EBP, which includes the construction and installation of pesticide handling facilities. EBPs are adopted in accordance with the NYSDEC's *CP-37 Environmental Benefit Projects Policy*, which can be found at:
http://www.dec.ny.gov/regulations/64596.html

#### *5.3.B.4. Long Island Agricultural Pesticide Handling Facilities Environmental Benefit Projects*

Long Island Agricultural Pesticide Handling Facilities Environmental Benefit Projects (LIAPHF EBPs) resulted in the construction of pesticide handling facilities at agricultural establishments engaged in the production of agricultural plants in Nassau and Suffolk Counties for the purpose of protecting Long Island's vulnerable sole source drinking water aquifer system from releases of pesticides associated with certain pesticide handling activities. These EBPs include the following activities:

- mixing pesticides, loading or filling pesticide containers, mixing equipment, loading equipment, or application equipment,
- transferring pesticides between containers, mixing equipment, loading equipment, and/or application equipment,
- rinsing (including triple-rinsing) or washing of pesticide containers, mixing equipment, or application equipment,
- disposing of pesticides or pesticide containers,
- handling opened containers of pesticides, and
- cleaning, adjusting, handling, or repairing the parts of mixing, loading, or application equipment that may contain pesticide residues.

Pesticide handling facilities are generally intended to contain and collect pesticide-related spills, rinsates, and washwaters, and allow for their lawful reuse (recycling) and/or disposal.

#### *5.3.B.5. CleanSweepNY – NYSDEC Environmental Benefit Project, Pesticide Collection and Disposal*

Pesticides which are obsolete and/or improperly packaged or handled pose a significant hazard to the surface waters, groundwater, and soils of New York State. Therefore, proper disposal of unwanted pesticides is an important management practice.

*CleanSweepNY* is an EBP that was initiated by the NYS Department of Environmental Conservation's Bureau of Pest Management. It is an effort to safely and economically dispose of

canceled, unwanted, unusable, or otherwise obsolete pesticides and other select chemicals from agricultural or non-agricultural business operations. *CleanSweepNY* also provides for the disposal of pesticides, cleaning products, and laboratory class chemicals, as well as elemental mercury, and mercury-containing devices such as thermometers and manometers from schools and other entities.

*CleanSweepNY* collection events do not target the general public since home and garden pesticides are accepted in Household Hazardous Waste (HHW) collection programs. Commercially applied or larger quantities of pesticides are usually excluded from local HHW collections. In New York State there is a backlog of demand for safe, lawful, and affordable disposal of obsolete pesticide products and other chemicals.

In almost every year since the first event took place on Long Island in calendar year 2002, *CleanSweepNY* events have been held in several areas of New York State. Under this program, as of the fall of calendar year 2013, statewide, more than 1.2 million pounds of unwanted pesticides and other hazardous chemicals have been collected and properly disposed and approximately 4,500 pesticide containers have been collected for recycling. For more information about *CleanSweepNY*, go to the following Internet website: http://www.cleansweepny.org.

Based on the success of the *CleanSweepNY* program and since its overall goal is consistent with the Strategy's goal, the Department is evaluating ways to expand the *CleanSweepNY* program. This could potentially involve regular scheduling of the pesticide collection events along with increased advertising to promote participation and the proper disposal of pesticides at these collection events.

### *5.3.B.6. Pesticide Plastics Recycling*

The first pesticide plastics recycling program in New York State was on Long Island. The Long Island Cauliflower Association (LICA) implements the plastic pesticide container recycling program on Long Island in conjunction with the Ag Container Recycling Council (ACRC). The ACRC is a voluntary industry funded product stewardship program that oversees the collection and recycling of pesticide containers nationwide. Farmers, nurseries, vineyards, and commercial applicators can drop off triple rinsed pesticide containers for free at the LICA facility in Riverhead. The program collects about 28,000 pounds of plastics annually. The collected plastic is crushed, baled and shipped primarily to a processing facility in Texas where it is used to produce field drain tile. For more information about ACRC and the recycling of pesticide containers, go to http://www.acrecycle.org/home.

**Figure 5.2: Empty pesticide containers stored at Long Island Cauliflower Association**

### *5.3.B.7. Be Green Organic Yards NY*

On June 7, 2010, NYSDEC announced the *Be Green Organic Yards NY* initiative. NYSDEC's *Be Green* program is designed to promote recognition of organic landscaping practices and organic service providers. Consumers will be able to find lawn and landscape businesses that provide organic services by looking for the *Be Green* logo. Qualified businesses can use the *Be Green* logo to advertise their organic services. NYSDEC will work with:

- qualified trainers to offer courses in *Be Green* organic principles,
- lawn companies, landscapers and arborists to be tested to verify their knowledge of organic practices, and
- eligible organic service providers and course providers to enter into Be Green Service Mark agreements to use the *Be Green* logo when advertising organic services.

The goal of *Be Green* is to help create an organically managed landscape for people, pets, wildlife and plants. The *Be Green* program recognizes that public demand for all types of organic landscaping services is on the rise as people continue to be concerned about the amounts and types of chemicals used in everyday tasks.

Consumers will be able to search a list of these *Be Green* Businesses on NYSDEC's website at http://www.dec.ny.gov/public/65071.html. Consumers will have assurance that a *Be Green* Business will not engage in practices or use products that are considered by NYSDEC to be inconsistent with organic principles.

#### *5.3.B.8. Neighborhood Network Organic Landscaper Certification Program*

The Neighborhood Network is a Long Island-based environmental organization that wrote and advocated for the 48-Hour Pesticide Notification Law, which was adopted in New York State in 2000, with opt-in provisions for counties. The 48-Hour Pesticide Notification Law requires commercial lawn pesticide applicators to supply written notice of the application to the occupants of neighboring properties. (For information on the Neighborhood Network, visit http://neighborhood-network.org/organization/about.htm.)

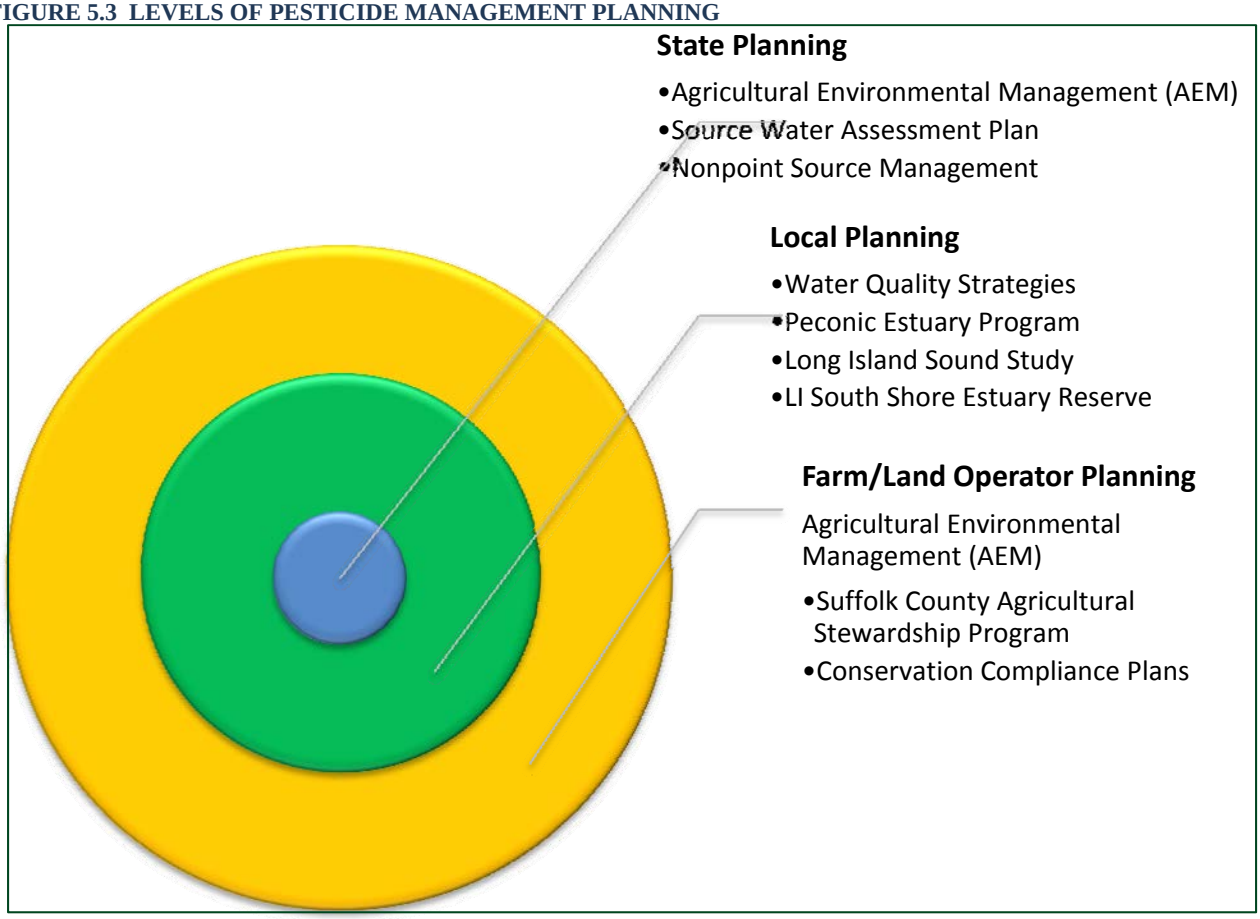
The organization holds an annual Organic Turf and Tree Show to promote businesses on Long Island that provide less-toxic services and to provide professionals with the latest information for establishing healthy turf without relying upon chemical pesticides.
The Neighborhood Network's Organic Landscaper Listing Program identifies pest management professionals who:

- meet specific education and training requirements in organic horticulture methods through the Organic Turf Trade Show, Nature Lyceum, Soil Food Web classes, or equivalent,
- demonstrate knowledge via a questionnaire/exam in the use of organic pest management methods,
- sign a contract to comply with the Neighborhood Network's standard for organic horticulture that includes lists of permitted and prohibited products and practices, and
- operates transparently by agreeing to the possibility of inspections to ensure compliance.

### *5.3.B.9. Planning at State, Local and Farm/Land Operator Levels*

Planning for proper pesticide use and water quality management is an important component of preventive action. Planning can take many forms and be conducted at several levels: state, local and entity-specific (e.g., farms, vineyards, golf courses). However, as shown in Figure 5.3, pesticide management planning is interconnected at all levels regardless of the level at which specific planning is initiated, and planning at each level affects planning and actions at the other levels. The more significant planning opportunities and efforts involving Long Island are highlighted in this section.

**FIGURE 5.3 LEVELS OF PESTICIDE MANAGEMENT PLANNING**




### *5.3.B.10. Agricultural Environmental Management (AEM)*

Agricultural Environmental Management (AEM) is a program developed by farmers, federal, state and local governments, and farm conservation professionals to enhance the protection and improvement of important environmental resources such as the New York State's groundwater resources, rivers, lakes, streams, freshwater wetlands, and tidal wetlands, while maintaining a healthy agricultural economy. Since its formal inception in 2000, the AEM program has grown to include nearly 8,000 farms statewide.

The essence of AEM is a five-step ("five-tiered") environmental assessment, planning and implementation process that farmers undertake voluntarily, with the help and support of a team of agricultural and environmental professionals from agricultural agencies and private industry. The AEM tiered approach takes place on the farm, with the farmer as the decision maker. Core members of the local working group - "the County Project Team" - work with the farmer to carry out the tiered approach. Qualified private consultants may also be used at appropriate points in the process.

The New York State Soil and Water Conservation Committee (NYSSWCC) is responsible for planning, coordinating and setting policy for the AEM program statewide. The Suffolk County Soil and Water Conservation District (SCSWCD) is tasked by the NYSSWCC with implementing the AEM tiered approach to Conservation Planning or Whole Farm Planning and is responsible for creating and implementing the County's AEM plans.

#### *5.3.B.11. Suffolk County Agricultural Stewardship Program*

The Suffolk County Agricultural Stewardship Program was established in response to growing concerns about nitrate levels and pesticide residues in Long Island's surface waters and groundwater. Cornell Cooperative Extension, the coordinating agency of the Stewardship Program, works together with Suffolk County Soil and Water Conservation District (SCSWCD) and USDA Natural Resource Conservation Service (USDA-NRCS) to protect the Long Island sole source aquifer system while at the same time preserving the region's viable and sustainable agricultural industry. By taking a proactive approach and helping growers evaluate their farm management practices, they are working to stay ahead of the curve and to prevent the need for future regulatory controls. Through a variety of services, the Stewardship Program works with local growers to incorporate better management practices that protect the quality of Long Island groundwater resources and maintain and improve crop production.

#### *5.3.B.12. Source Water Assessment Program (SWAP) Plan*

As stated on New York State Department of Health (NYSDOH) Source Water Assessment Program (SWAP) websites,[45] NYSDOH is responsible for developing New York's SWAP Plan and ensuring that assessments are completed for all public water systems. The Safe Drinking Water Act requires that each source of water used by a public water system be evaluated to identify possible contaminant threats to the source water quality. This evaluation is called a Source Water Assessment.[46] NYSDOH developed New York's SWAP Plan, which was approved by the USEPA in November 1999, and a detailed work plan was developed by the Long Island SWAP Steering Committee. Source Water Assessments were completed in New York State in 2003.

Source water assessments were performed for all public water supplies in Nassau and Suffolk Counties by a contracted engineering firm. The Long Island Source Water Assessment (LISWA) Report summarizes the results of the assessments for 938 community and 418 non-community wells serving public water supplies on Long Island. The report showed source water recharge areas, time of travel for these public water supply wells, and land uses within the source water

[45] The NYSDOH SWAP Plan is accessible at http://www.health.ny.gov/environmental/water/drinking/swapp.pdf. and a fact sheet on the program is available at http://www.health.ny.gov/environmental/water/drinking/li.htm.
[46] Personal communication from Lloyd R. Wilson, NYSDOH to Vincent A. Palmer, NYSDEC, 11-05-10.

recharge areas. It also assessed susceptibility of the wells to various contaminants associated with each type of land use. Pesticides comprised one of the four types of contamination assessed in the report. The other three were microbials, nitrates, and volatile organic compounds (VOCs).

The LISWA Report found that in Suffolk County, where significant tracts of agricultural land are farmed, approximately 10 percent of the public water supply wells were rated as medium-high or greater for susceptibility to pesticides. The high susceptibility rating is because it is known that pesticides are used in the recharge areas of the wells, and that many of these wells are relatively shallow meaning there is less of a barrier to protect groundwater. Most of these wells are located in agricultural areas in central Suffolk County, or on eastern Long Island's North Fork.[47] The public water suppliers are required to routinely monitor their finished water for the presence of pesticides. Should pesticides be found, water suppliers may need to consider not using the contaminated well or providing treatment.

#### *5.3.B.13. Conservation Compliance Plans*

The USDA (primarily the Natural Resources Conservation Services [NRCS]) has a lead responsibility, under provisions of the 1990 Farm Bill (Food, Agriculture, Conservation and Trade Act of 1990), to ensure conservation compliance by farmers who are eligible for USDA farm program benefits. The development and implementation of conservation plans for highly erodible crop land is required of farmers participating in most USDA programs. Soil erosion control practices may have indirect consequences on pesticide leaching to groundwater (increased infiltration, macropores as preferential flow channels, potential alterations in pesticide use). The New York State Nonpoint Source Management Program, with its Coordinating Committee, provides a forum for assessing these issues, exchanging information, and ensuring compatibility of the pesticide/groundwater strategy and the conservation planning process.

#### *5.3.B.14. Local and Regional Water Quality Strategies*

In general, many of the programs described in this chapter are implemented at the state level. However, regional and local scale programs are also important to the protection of Long Island's groundwater resources. For example, the Suffolk County Agricultural and Farmland Protection Board established the Pesticide/Groundwater Working Group to develop a Long Island Stewardship Program. Proposed objectives of that program include:

- design effective and practical Best Management Practice Guidelines for Long Island growers,
- promote efficient and environmentally responsible production,
- provide educational and cost sharing opportunities to improve stewardship of agricultural inputs that are specifically oriented to Long Island conditions and cultural practices, and
- develop and implement non-chemical pest management alternatives.

That initiative produced a Final Report "A Strategy to Develop and Implement the Suffolk County Agricultural Stewardship Program, A Report of the Agricultural Environmental Management Task Force for Nitrogen and Pesticide Load Reduction."[48]

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[47] Long Island Source Water Assessment Executive Summary. http://www.nassaucountyny.gov/agencies/health/Docs/PDF/LIEXEC.PDF.

[48] "A Strategy to Develop and Implement the Suffolk County Agricultural Stewardship Program, A Report of the Agricultural Environmental Management Task Force for Nitrogen and Pesticide Load Reduction", May 26, 2004. http://www.lifb.com/FARMINGONdd/Stewardship/tabid/72/Default.aspx).

### *5.3.B.15. Nonpoint Source Management and Related Initiatives (County Water Quality Strategies)*

The New York State Nonpoint Source Management Program, under the direction of NYSDEC, has initiated other efforts that contribute to the pesticide-related surface water and groundwater protection methods presented in this Strategy, in addition to development of the *Agricultural Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State* (3rd rev. May 1996).[49] A significant initiative under that program is the establishment of County Water Quality Coordinating Committees and development of County Water Quality Strategies. Agricultural issues are one of the major concerns of these strategies. Key participants in the committees generally include personnel from County Soil and Water Conservation Districts, Cornell Cooperative Extension, the USDA Natural Resources Conservation Service, and other entities. County water quality strategies may include consideration of comprehensive watershed planning and wellhead protection. Wellhead protection planning and implementation conducted by towns and municipalities may address pesticide issues through education and technical assistance efforts.

### *5.3.B.16. Peconic Estuary Program Comprehensive Conservation and Management Plan (CCMP)*

The Peconic Estuary is one of 28 designated "Estuaries of National Significance" under USEPA's National Estuary Program. Formally convened in 1993 at the request of the Governor of New York State, the goal of the Peconic Estuary Program (PEP) and its Management Conference was to seek to advance protection and restoration of the estuary system. The PEP, an innovative partnership of local, federal and New York State agencies, citizens, environmental user groups, businesses, industries and academic institutions, is presently in the process of implementing a watershed based Comprehensive Conservation and Management Plan (CCMP) that was approved by the USEPA Administrator with the concurrence of the Governor. Implementation of the Peconic CCMP requires the aforementioned stakeholders to work together to carry out nutrient, pathogen, and toxic management, habitat and living resource, and critical land protection initiatives.

**Figure 5.4 Map of Peconic Estuary (yellow line indicates estuary)**

The CCMP includes a variety of toxic management actions to address point and nonpoint discharges to the Peconic Estuary. As described in the CCMP, "the proposed actions call for remediation at specific sites, enforcement of existing and new regulations, pollution prevention programs, research, and monitoring." The CCMP also addresses educational programs to enhance public awareness of toxics issues. Pesticide-related management, monitoring and educational elements could be included as part of the Post-CCMP Management Actions.[50]

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[49] The Catalogue is accessible at http://www.nysl.nysed.gov/scandoclinks/ocm36966918.htm.
[50] The CCMP can be viewed through a link at http://www.peconicestuary.org/. For information about the estuary see http://www.dec.ny.gov/lands/31842.html.

### *5.3.B.17. New York State Seagrass Task Force*

Acknowledging the importance of seagrass and the necessity to protect and restore this valuable natural resource, Chapter 404 of the Laws of 2006, enacted on July 26, 2006, established a New York State Seagrass Task Force chaired by NYSDEC. Chapter 285 of the Laws of 2008 extended the life of the Task Force one additional year to January 1, 2010. The final report was released in December 2009.

With regard to pesticides, the task force recommended that the coastal watershed use of pesticides and herbicides proven to be toxic to seagrass and species dependent on seagrass resources, be banned or restricted to ensure the protection of New York State seagrass resources. They also recommend that pesticides and herbicides and the concentrations at which they are toxic or sublethal to seagrass and seagrass habitat be identified.

### *5.3.B.18. Pesticides and Groundwater Research*

New and ongoing research, on subjects such as pesticides, groundwater and soils, can contribute to the prevention of pesticide contamination of groundwater through the application of research results in the manufacture, registration and use of pesticides as well as in groundwater protection measures. Two areas of pesticide research that are especially important to groundwater protection are:

- pesticide efficacy - directed toward determining the minimum effective application rates, and
- pesticide degradation, migration through soils, persistence in different groundwater systems, and favored flow paths (macropores, channels).

Modeling predictions of pesticide movement and persistence can enhance groundwater vulnerability assessments. A key research need is investigation of variability with respect to pesticide residue levels over small changes in time, depth and lateral distance within groundwater. Regarding efficacy, product formulations and application methodologies need to be studied to determine the most efficient techniques to deliver the pesticide to target organisms, thus minimizing off target movement of the pesticide. When necessary, NYSDEC requests efficacy data from registrants, because it is useful to support decisions of the state's product registration program. Research in pesticides and related fields is provided by:

- Pesticide product registrants - a principal source of pesticide research in the nation. Registrants should place special emphasis on efficacy and environmental fate research and share the results of that research with institutions and federal and state agencies. A closer research partnership between registrants and federal and state agencies is necessary.
- New York State College of Agriculture and Life Sciences at Cornell University and its affiliated research stations (e.g., the Long Island Horticultural Research and Education Center).
- The Long Island Groundwater Research Institute[51] - a multi-disciplinary center which combines expertise and resources of the Department of Earth and Space Sciences, the

[51] For more information about the Long Island Groundwater Research Institute, see http://www.somas.stonybrook.edu/institutes/ligri.html.

Department of Applied Mathematics and Statistics, and the Marine Sciences Research Center of the University at Stony Brook, for improving understanding of groundwater hydrology and chemistry. The Institute coordinates and expands the potential for research by faculty, staff and students in groundwater hydrology. The Institute maintains communication with groundwater professionals in the government and private sector on Long Island.

## 5.4 REGULATORY PREVENTIVE MEASURES

### 5.4.A. Pesticide Product Registration Decisions

NYSDEC's pesticide product registration process is the principal existing regulatory effort that helps prevent or minimize potential pesticide contamination. The product registration process is more fully described in Chapter 4.

As previously mentioned, as of June 2012, there were 13,688 pesticide products registered for use in New York State, 361 of which are strictly prohibited from any use in Nassau and Suffolk Counties and another 145 of which are conditionally permitted for use on Long Island only when they are used in compliance with specific conditions. These actions help protect water quality on Long Island. Any use of these pesticides in contravention of such unique label directions would constitute an unlawful act, subject to administrative, civil, and criminal sanctions depending on the circumstances involved.

### 5.4.B. Applicator and Technician Certification, Recertification and Recordkeeping

Pesticide applicator and technician certification, recertification, training, recordkeeping, and annual pesticide use reporting requirements (and relevant exceptions) are described in ECL Article 33 and 6 NYCRR Part 325.[52] Certification is required for the commercial application of pesticides including commercial applicators and technicians using restricted use, general use, and unclassified pesticides, and for private applicators, who apply restricted use pesticides for the purpose of producing an agricultural commodity. The categories and subcategories of certification used in New York State are specified in 6 NYCRR 325.16.[53]

In New York State, individuals may qualify for certification examination through verifiable pesticide application experience, or by successfully completing certification preparatory coursework. Certain requirements must be met for certification including training in various aspects of pesticide use and handling, and successful completion of at least two examinations designed to verify one's competence in the safe, lawful, and effective use of pesticides. Once certified, applicators must be recertified in each pesticide category or subcategory generally every three years, which can be achieved by accumulating the specific number of continuing education credits assigned to each category/subcategory of certification or by successfully passing a recertification exam for each category or subcategory. With regard to education and training designed to meet certification and recertification education requirements, New York State regulations (6 NYCRR 325.18) require that pesticide training courses be approved by the NYSDEC prior to the course being offered. In addition, individuals conducting certification and

[52] For additional information about statutory and regulatory certification requirements, see http://www.dec.ny.gov/chemical/298.html.
[53] 6 NYCRR 325 can be found at http://www.dec.ny.gov/regs/4424.html#14549 and 325.17 (which can be found at http://www.dec.ny.gov/regs/4424.html#14548).

recertification training courses must possess appropriate credentials recognized by the NYSDEC, or have at least three years of verifiable experience as a certified pesticide applicator. Approved recertification training courses are assigned credit hours by NYSDEC toward pesticide applicator certification and recertification.[54]

New and updated training manuals prepared by Cornell University Pesticide Management Education Program in cooperation with NYSDEC staff include a component on water quality protection when using and handling pesticides. Questions on groundwater information are included in updated certification exams. NYSDEC pesticide program staff conducts outreach programs, presentations and other efforts at numerous pesticide applicator training programs throughout the year. Recordkeeping and annual reporting requirements regarding commercial and private application of pesticides are contained in ECL 33-0905.4 and 33-1205.1 and 325.25.[55]

### 5.4.C. Pesticide Storage, Mixing, Loading and Disposal

NYSDEC regulations and policies which address pesticide storage, mixing/loading, and disposal, are summarized in Table 5.1.

**Table 5.1 NYSDEC Regulations and Policies Relating to Pesticide Storage, Mixing, Loading, and Disposal[56]**

| Subject of Regulation or Policy | Regulation | Policy |
|---|---|---|
| *Pesticide storage* - Covered in general in regulation and the policy provides pesticide storage guidelines for registered businesses, commercial permit holders, wholesalers and distributors, private pesticide applicators and others. | 6 NYCRR Part 326 Registration and Classification of Pesticides | *PES 05 03 Pesticide Storage Guidelines* |
| *Pesticide bulk storage and mixing.* Storage of larger quantities of pesticides is covered in the regulations. The policy provides guidelines for business commercial permit holders, restricted use wholesalers, and pesticide applicators. | 6 NYCRR Parts 595-599 Hazardous Substances/Water | *PES 05 03 Pesticide Storage Guidelines* |
| *Pesticide mixing areas* Covered in regulation; the policy on storage also addresses mixing/loading. | 6 NYCRR Part 325 Application of Pesticides | *PES 05 03 Pesticide Storage Guidelines* |
| *Anti-siphon devices* - The regulation contains a definition of anti-siphoning devices and a requirement that all equipment containing pesticides and drawing water from any water source have an effective anti-siphon device to help contain pesticides, and prevent their backflow into and contamination of the water supply. The policy provides guidelines on such devices. | 6 NYCRR Part 325 Application of Pesticides | PES-05-07 Backflow Prevention Devices |

[54] The NYSDEC posts a listing of approved training courses in a searchable database at the following website: http://coursecalendar.psur.cornell.edu/
[55] Recordkeeping and annual reporting requirements in ECL 33-0905.4 and 33-1205.1 and 325.25 can be found at http://www.dec.ny.gov/regs/4424.html#14540).
[56] Regulations and policies referenced in Table 10 can be accessed at http://www.dec.ny.gov/regulations/regulations.html.

| | | |
|---|---|---|
| *Disposal of pesticides and pesticide containers.* Regulations provide requirements for disposal of such materials. | 6 NYCRR Parts 325, 360, 364, 371-373 (Various Solid Wastes and Hazardous Wastes) | |

### 5.4.D. Nassau County Toxic and Hazardous Materials Storage, Handling and Control

Article 11 of the Nassau County public health code, captioned *Toxic and Hazardous Materials Storage, Handling and Control*,[57] also requires county registration of storage tanks, both above and underground, drum storage areas or other storage vessels that contain chemical substances that can contaminate groundwater.

### 5.4.E. Suffolk County Toxic and Hazardous Materials Storage and Handling Controls

Article 12 of the Suffolk County sanitary code, captioned *Toxic and Hazardous Materials Storage and Handling Controls*,[58] requires toxic and hazardous material storage facilities to be registered with the County Department of Health Services. Registration is a process of informing the county of the existence of storage tanks, both above and underground, drum storage areas or other storage vessels that contain chemical substances that can contaminate groundwater. (Note: Storage of pesticides not intended for resale is not covered under Article 12.)

### 5.4.F. Suffolk County Pesticide Phase-Out Law

The Suffolk County Code Chapter 647 - Pest Control, passed in 1999, became effective on January 1, 2000. This Suffolk County Pesticide Phase-Out Law was designed to phase out the use of pesticides on County-owned properties and in County buildings by July 1, 2003. The law prohibits any Suffolk County department or agency, or any pesticide applicator employed by a Suffolk County or agency as a contractor or subcontractor for pest control purposes, from applying the following pesticides on Suffolk County property (as owner or tenant):

- any pesticide classified as Toxicity Category I by the United States Environmental Protection Agency,
- any pesticide classified as a known, likely, or possible carcinogen by the United States Environmental Protection Agency, except as provided for in Section 380-3 of the Suffolk County Pesticide Phase-Out Law,
- any pesticide classified as Toxicity Category II by the United States Environmental Protection Agency,
- any pesticide classified as restricted use by the United States Environmental Protection Agency or the New York State Department of Environmental Conservation, except as provided for in Section 380-3 of the Suffolk County Pesticide Phase-Out Law, or
- any pesticide on County property (as owner or tenant), except as provided for in Sections 380-3 of the Suffolk County Pesticide Phase-Out Law.

[57] See http://www.nassaucountyny.gov/agencies/Health/Docs/PDF/Ordinance.pdf.
[58] See http://www.suffolkcountyny.gov/health/eq_article12.pdf and http://www.co.suffolk.ny.us/departments/healthservices/environmentalquality/pollutioncontrol/Registration%20of%20Toxic%20and%20Hazardous%20Materials.aspx.

### 5.4.G. Town of Islip Pesticide Ban

In August of 2010, the Town of Islip banned the use of pesticides on all town property, including its 106 parks, and facilities that the public uses on a daily basis. The town law requires the use of specific groundskeeping products on all of its properties except in those instances in which a golf course is involved or instances in which the town parks, recreation and cultural affairs commissioner declares an emergency. Just as the Suffolk County Pesticide Phase-Out Law relates to county-owned properties only, the Town of Islip ban on pesticide use relates to town-owned properties only.[59]

## 5.5 RELATIONSHIP OF PREVENTION MEASURES TO EXISTING PROGRAMS AND ACTIVITIES

The preventive measures in the Strategy are intertwined with groundwater and pesticides management approaches and policies of other programs and activities, which are summarized in Figure 5.5.

**FIGURE 5.5 Other Elements Related to Prevention Measures**

**NYS Water Quality Policies**

- Protect and conserve groundwater
- Emphasize pollution prevention
- Emphasize protection of high-yield aquifer systems
- Foster state and local partnerships

**NYSDEC Groundwater Program Elements**

- Wellhead Protection Program
- Source Water Assessment Program (SWAP) Plan
- Pine Barrens protection
- Farmland preservation

**Coordination with Related Programs**

- Groundwater vulnerability assessments
- Pesticide use data
- Education, prevention and response

### 5.5.A. New York State Groundwater Management Program

This Strategy is consistent with major policies of the State Groundwater Management Program, which recommended key policies and program initiatives endorsing geographic targeting and critical protection areas on Long Island (1986) and Upstate New York (1987). Principal and primary aquifers were defined and mapped, through a cooperative program with the United States Geological Survey. These concepts were forerunners of the Safe Drinking Water Act's

[59] Town of Islip Town Code, Ch. 7, adopted August 17, 2010, http://www.townofislip-ny.gov/e-services/town-code.

Wellhead Protection Program, which is a pollution prevention program designed to protect groundwater sources which are relied upon by public drinking water systems.

The Strategy reflects the NYSDEC Groundwater Management Program's basic water quality policies, which:

- Protect and conserve groundwater for a best usage as drinking water supply.
- Emphasize pollution prevention.
- Emphasize protection of critical high yielding aquifer systems.
- Foster a state and local partnership.

Other elements of New York State's groundwater program will be coordinated through efforts such as:

- Wellhead Protection Program efforts which address pesticide use will focus primarily on management practices, agricultural environmental management, Integrated Pest Management, whole farm planning and related individual farm approaches, education, and related efforts.
- The Final SWAP Plan (discussed earlier in this chapter) and the Long Island Source Water Assessment Report, which summarize the results of the assessments for over 1,000 wells serving public water supplies on Long Island.
- Clean Water State Revolving Fund has supported the acquisition of pine barrens to protect groundwater recharge areas (Pine Barrens Wilderness and Water Protection Preserve).

#### *5.5.A.1. Groundwater Vulnerability Assessments*

Groundwater vulnerability assessments include both regional-scale and landscape-scale approaches. The application of these vulnerability assessments to different elements of the Strategy (prevention, response, monitoring) will depend on the nature of the activity. In general, regional-scale assessments could potentially be applied to Long Island-wide management concerns, and the landscape-scale assessments could be applied to site-specific (individual farm or pesticide user) management concerns.

The greatest potential uses of the vulnerability assessments would be in programs and activities related to nonpoint source management (management practices, whole farm planning, local water quality strategies, etc.), integrated pest management, and other comparable elements. Regional vulnerability assessments could have potential applications in setting priorities for several management elements described in this chapter (e.g., education, management practice promotion and assessment, Integrated Pest Management [IPM], and county water quality strategies). The most direct application of vulnerability assessments will be at the site-specific, pesticide user level. Landscape-scale assessment should be employed in the preparation of whole farm plans, farmstead assessments, integrated crop management planning and in IPM planning at the farm level. They may also be employed in the development of county water quality strategies or local wellhead protection plans. Vulnerability assessments could also potentially be used to interpret results of monitoring (evaluating validity of the vulnerability map) and to consider potential responses or the need for investigation of comparable areas.

The SWAP, discussed earlier in this chapter, designates the recharge areas associated with public water supply wells. The program includes a review of factors such as travel time and land use to estimate relative susceptibility of each public well system to pesticide contamination. The understanding gained under the SWAP will allow managers to better target areas of specific pesticide use (residential, agricultural, recreational, commercial, industrial, institutional, rights-of-way) for educational and voluntary management approaches. Also, the groundwater models developed under the program can be useful for tracking the source of contamination. Information developed under the SWAP could be used to geographically target specific areas for particular protection activities.

If feasible and if appropriate, groundwater vulnerability assessments could be utilized in training and education programs associated with the pesticides regulatory program (e.g., applicator training), in workshops (e.g., train-the-trainer sessions, etc.), and as part of other information dissemination processes. The principal uses would be to convey methods for assessing groundwater vulnerability within individual farms or specific areas, and to describe the important factors affecting pesticide leaching and groundwater impacts.

#### *5.5.A.2. Pesticide Use Data*

Pursuant to ECL 33-1205 and 6 NYCRR 325.25, commercial pesticide applicators and technicians, and private pesticide applicators are required to maintain specific records of pesticide use. In addition, commercial applicators must file certain use records with the Department. Data management systems for commercial applicator pesticide records derived from Pesticide Reporting Law requirements (ECL Article 33, Title 12 – Pesticide Sales and Use Data Base and Recordkeeping and Reporting) are currently maintained by NYSDEC.[60]

Pesticide use information can be utilized in a comparable manner to vulnerability assessments. Pesticide use assessments may also include those based on surveys of selected pesticide users and statistical interpretation of results, and information about land use associated with certain pesticides. Land use information may be derived from agricultural census and statistical data, aerial photography interpretation, or other sources. Site specific pesticide management elements at the farm or pesticide-user level may rely on those use records already required to be maintained, supplemented by other information retained by the user or landowner.

Cornell's Pesticide Management Education Program (PMEP) has developed a series of detailed pesticide use assessments for New York, with support from the USDA National Agricultural Pesticide Impact Assessment Program (NAPIAP). This program is designed to develop information and analyze pesticide use and impacts of pesticide regulations on agricultural products, product prices, and environmental issues. In recent years, the program focus has changed from a conventional pesticide orientation to an increased emphasis on non-chemical alternatives and integrated pest management methodologies. Examples of pesticide use assessments for New York State include dairy, field and forage production systems, cabbage, and vegetables.

[60] Information about the Pesticide Reporting Law and the data submitted in connection with that law is available at the following website: http://www.dec.ny.gov/chemical/27506.html.

# Chapter 6. LEGAL AUTHORITY AND ENFORCEMENT

## 6.1 INTRODUCTION

This Chapter briefly summarizes:

- NYSDEC statutory and regulatory authority, the registration of pesticides, and the overall authority of other state agencies; and
- NYSDEC enforcement of New York State's pesticide-related laws, rules and regulations.

## 6.2 STATUTORY AND REGULATORY AUTHORITY

Overall authority is provided to the NYSDEC under Article 3 of the Environmental Conservation Law (ECL) (General Functions, Powers, Duties, and Jurisdiction), for general functions, several of which are related to the Strategy, including:

- water resource protection,
- prevention of pollution through the regulation of storage, handling, transport and disposal of substances which may cause or contribute to pollution,
- regulation of the use, storage and disposal of pesticides,
- inspections and investigations,
- undertaking studies or analyses with the cooperation of public and private agencies,
- adoption of rules, regulations, policies and procedures, and
- coordination with other federal and state agencies.

Specific authority for the regulation of pesticides is found at Article 33 of the ECL.

The primary rules and regulations relating to pesticides include Parts 320-329 of Title 6 of the New York Codes, Rules and Regulations (6 NYCRR).[61] Those regulations cover such subjects as application of pesticides; classification of pesticides (restricted use v. general use); registration of pesticides; certification of occupational pesticide users; collection of pesticide sales and use data; and aquatic insect, vegetation, and undesirable-fish control.

## 6.3 REGISTRATION OF PESTICIDES

This Strategy focuses on pollution prevention approaches to reducing the use of pesticides and protecting water quality on Long Island. The registration of pesticides is a regulatory action, but it is also recognized as a key pollution prevention measure, particularly at the point of initial registration. The NYSDEC's general authority to register pesticides is found at ECL Article 33, Title 7 and 6 NYCRR Part 326.

ECL §33-0303(3)(d) allows the Commissioner, after a hearing, to promulgate a list of restricted use pesticides and permitted uses subject to appropriate conditions to fully protect the public interest. ECL §33-0303(3)(e) allows the Commissioner, after a hearing, to adopt regulations related to the time, place, manner and method of application of pesticides, which encompass all reasonable factors necessary to prevent damage or injury to health, property and wildlife.

[61] Text of 6 NYCRR Parts 320-329 pesticides regulations can be accessed at http://www.dec.ny.gov/regs/2491.html.

Related regulatory authority is found at 6 NYCRR 326.23(e), stating the NYSDEC has the authority to place any conditions on the registration of any product that are deemed necessary to prevent damage or injury to health, property or wildlife. Conditions may include, but are not limited to: (1) the submission of additional data; (2) classification of restricted use; (3) recordkeeping or reporting requirements; and (4) any other use conditions deemed necessary. Examples of restricted use pesticides and types of conditions placed on pesticides can be found at 6 NYCRR 326.2. Compliance with the conditions of the registration is required for the continued registration of the pesticide 6 NYCRR 326.23(f).

The denial of a registration is governed by ECL §33-0711. If a pesticide does not warrant the proposed claims or if the label does not comply with the provisions in ECL Article 33, the registrant shall be notified of such deficiency. If the necessary corrections are not made by the registrant and the application is refused, the registrant may file a petition requesting that the matter be referred to an advisory committee or file objections and request a public hearing in accordance with ECL §33-0717. For the denial of an initial application to register a pesticide, the applicant has the burden of proof, which is a preponderance of evidence, to demonstrate that its proposal will be in compliance with applicable laws and regulations.

Pesticides have a two year registration cycle. The renewal of a pesticide registration is governed by 6 NYCRR 326.24. In accordance with SAPA §401(2), if a complete application for pesticide product registration renewal is on file with the Department on or before the expiration date, the pesticide product registration will continue until a registration renewal decision is issued and takes effect. In addition to the general requirements for renewal, the NYSDEC has the authority at 6 NYCRR 326.14(h) to request information at any time which is deemed necessary to support the continued registration of any pesticide product. Examples of such information include but are not limited to: product effectiveness data, indoor air residues, and surface residues. Making changes to a registered product at the time of renewal was also contemplated by the *Final Programmatic Environmental Impact Statement* (FPEIS) *on Pesticide Registration and Classification Program of the New York State Department of Environmental Conservation* which was released on December 8, 1982. The FPEIS states the Commissioner has the same authority and scope of review upon renewal as it does upon initial registration, which clearly allows the NYSDEC to modify a registration as needed. For denial of an application to renew a pesticide registration, the permittee still has the burden of proof to demonstrate that the permitted activity is in compliance with all applicable laws and regulations. However, a demonstration by the permittee, that there is no change in permitted activity, environmental conditions or applicable law and regulations constitutes a prima facie case for the permittee (6 NYCRR 624.9(b)(3)). The NYSDEC has existing authority to take action on a currently registered pesticide at any point during the registration cycle through cancellation, suspension and emergency rulemaking. ECL §33-0713 governs the cancellation of a registration. The Commissioner may cancel the registration of a pesticide whenever it does not appear that the article or its labeling or other material required to be submitted complies with Article 33. Notice must be provided to the registrant and the cancellation will become effective 30 days after service of the notice unless the registrant: makes the necessary corrections; files a petition for the matter to go before an advisory committee; or files objections and requests a public hearing. A cancellation may be initiated at any time during the registration cycle.

Active ingredients may be present in a dozen to several hundred products with different renewal dates. If there is concern with an active ingredient, attempts to address those concerns during the time of renewal for each product would allow some products to remain in commerce while other products were being phased out. To address the matter most efficiently with all affected parties, the NYSDEC would contact all affected registrants to discuss the NYSDEC's concerns with the active ingredient and attempt to remedy the problem either through conditions placed on the products or by a voluntary change in label language.

ECL §33-0719 governs the suspension of a pesticide registration. The Commissioner may, by Order, suspend the registration of a pesticide immediately when he finds that such action is necessary to prevent an imminent hazard to the public or any other non-target organism. The registrant will receive prompt notice and have the opportunity to have the matter go before an advisory committee or to an expedited hearing.

ECL §33-1301.1a provides the Department with the ability to stop the sale or use of a pesticide if the characteristics associated with it differ from the conditions under which it was registered. This provision may be enforced at the point of sale or use of the pesticide. The use of this provision will not immediately impact the State registration status of the pesticide, but would make its sale or use illegal.

SAPA §202(6) gives NYSDEC the authority to immediately adopt a rule, without going through all the necessary steps for a standard rulemaking, when the rule is necessary to preserve public health, safety or general welfare and if a standard notice of rulemaking would be contrary to public interest. The rule is only valid for 90 days and each re-adoption will be in effect for 60 days. The emergency rule allows immediate action while giving the NYSDEC time to do a full rulemaking.

Before the NYSDEC makes a decision to cancel or suspend a registration, or undergoes an emergency rulemaking, proper sampling, studies, and documentation should already be in place to support that decision. Any cancellation or suspension of a product will be in effect for all of New York State, not just Suffolk and Nassau counties. If a specific active ingredient is targeted, each product that contains that active ingredient will need to be addressed. As mentioned previously, it would be most efficient and fair to address them together. However, a denial, cancellation or suspension affords each registrant a right to request a hearing or request the matter be referred to an advisory committee.

Table 6.1 summarizes the New York State and federal authorities related to registration of pesticides.

| **Table 6.1**<br>**NYSDEC AND USEPA PESTICIDE REGISTRATION AUTHORITIES** | |
|---|---|
| **NYSDEC Authority** | **USEPA Authority** |
| 6 NYCRR 326.14(h)<br>The Department may request, at any time, information deemed necessary to support the continued registration of any pesticide product.<br>▪ The Department can request information from one product or several products if an active ingredient is the concern.<br>▪ This request can be made at any time during the 2 year registration cycle or at the time of renewal.<br>▪ The Department can use the findings from an evaluation of such information to initiate a cancellation proceeding. | FIFRA §3(c)(2)(B) & 40 CFR 155.48<br><br>If the Administrator determined that additional data are required to maintain in effect an existing registration of a pesticide, the Administrator shall notify the existing registrants of the pesticide to which the determination relates and provide a list of such registrants to any interested party. |
| 6 NYCRR 326.23(c)<br>When a pesticide registration application is complete, the Department will review submitted data to evaluate the potential for adverse impacts to human health and the environment when the product is used according to label directions. The commissioner will weigh the potential for human health and ecological risks against the potential benefits that could accrue from the use of the product when making a decision whether or not to approve a registration. | FIFRA §3<br>40 CFR 152.112<br><br>EPA will register pesticides and make it unlawful to distribute, sell, or use unregistered pesticides in order to prevent unreasonable adverse effects on the environment.<br><br>EPA must determine, among other items, whether the product will perform its intended function without unreasonable adverse effects on the environment and when used in accordance with common practice, will not generally cause unreasonable adverse effects on the environment. |
| 6 NYCRR 326.23(e)<br>The Commissioner may place any conditions on the registration of any product that are deemed necessary to prevent damage or injury to health, property and wildlife.<br>▪ Submission of additional data<br>▪ Classifying the pesticide as Restricted Use<br>▪ Recordkeeping and reporting requirements<br>▪ Other conditions deemed necessary<br>▪ If a condition is related to pesticide use, it will require a change to the pesticide label. Since the Department is preempted by | 40 CFR 152.115(c)<br><br>The Agency may establish, on a case-by-case basis, other conditions applicable to registrations issued under FIFRA §3(c)(7)-New Active Ingredient |

| **Table 6.1**<br>**NYSDEC AND USEPA PESTICIDE REGISTRATION AUTHORITIES** | |
|---|---|
| **NYSDEC Authority** | **USEPA Authority** |
| FIFRA §24(b) from requiring any changes to an EPA approved label, either the registrant must voluntarily agree to change their label or the registration must be denied or cancelled. | |
| ECL 33-0301. *Declaration of Policy and Purpose*<br>The purpose of Article 33 is to create a balance between the use of pesticides, which are valuable, important and necessary to welfare, health and economic well-being of the people of the State and ensuring properly used pesticides will prevent injury to health, property and wildlife. | |
| ECL 33-0303(3). *Powers and Duties*<br>The Commissioner, after a hearing, is authorized to promulgate a list of pesticides highly toxic to man; promulgate a list of restricted use pesticides and permitted usages; and promulgate regulations that detail the methods to be used in the application of pesticides.<br>▪ The Commissioner can ban highly toxic pesticides via rulemaking.<br>▪ Pesticides can be classified as restricted use via rulemaking.<br>▪ Methods of pesticide application can be promulgated via regulation. | FIFRA§3(d)<br><br>As part of the registration process, EPA can classify a pesticide as general use or restricted use. |

**Table 6.1**
**NYSDEC AND USEPA PESTICIDE REGISTRATION AUTHORITIES**

| NYSDEC Authority | USEPA Authority |
|---|---|
| ECL 33-0711. *Denial*<br>The Commissioner may deny a registration if the pesticide does not warrant the proposed claims for it or if the pesticide and its labeling and other material required to be submitted do not comply with provisions of Article 33.<br>▪ This process can be used at the time of initial registration or upon renewal of a pesticide product.<br>▪ Denial can be based upon any of the following:<br>• False claims are being made;<br>• There are issues with the label such as misbranding or the label submitted to the Department does not match the label filed with EPA; or<br>• The pesticide or the submitted material does not comply with Article 33, which is intended to create a balance between the use of pesticides and the prevention of injury to health, property and wildlife. | FIFRA §3(c)(6)<br>40 CFR 152.118<br><br>Factors for Denial:<br>▪ Composition does not warrant the proposed claims.<br>▪ Label or other material submitted doesn't comply with FIFRA.<br>▪ Unreasonable adverse impacts on the environment when performing intended function or when used in accordance with widespread and commonly recognized practice. |
| ECL 33-0713. *Cancellation*<br>The Commissioner may cancel a product registration whenever it does not appear that the article or its labeling or other materials required to be submitted complies with Article 33.<br>▪ This process can be used at any time during the 2 year registration cycle of a pesticide product.<br>▪ Action is taken on a pesticide product, not an active ingredient.<br>▪ A proceeding can be initiated if:<br>• False claims are being made; or<br>• There are issues with the label such as misbranding or the label submitted to the Department does not match the label filed with EPA; or<br>• The pesticide or the submitted material does not comply with Article 33. | FIFRA §6(b)<br><br>Factors for Cancellation:<br>▪ Pesticide, labeling or other material required to be submitted does not comply with the provisions of FIFRA.<br>▪ When the pesticide is used in accordance with widespread and commonly recognized practice, it generally causes unreasonable adverse impacts on the environment |

| **Table 6.1**<br>**NYSDEC AND USEPA PESTICIDE REGISTRATION AUTHORITIES** | |
|---|---|
| **NYSDEC Authority** | **USEPA Authority** |
| ECL 33-0714. *Water Quality Monitoring*<br>The Department, in coordination with other parties, shall conduct a water quality monitoring program on Long Island to understand health and environmental impacts of pesticide use in the State. The data is used in making registration decisions, reviewing suspensions and cancellations and assessing the status, trends, and health impacts of any pesticide contamination of ground and surface waters on LI and throughout the State. | |
| ECL 33-0719. *Suspension*<br>The Commissioner may, by Order, suspend the registration of a pesticide immediately when he finds that such is necessary to prevent an imminent hazard to the public or any other non-target organism.<br>▪ This process can be used at any time during the 2 year registration cycle of a pesticide product.<br>▪ An imminent hazard to the public must be present- DOH would need to make such determination.<br>▪ An imminent hazard to a non-target organism must be present. | FIFRA §6(c)<br><br>Factor for Suspension:<br>Action is necessary to prevent an imminent hazard during the time required for cancellation or change in classification proceedings. |
| SAPA 202(6) *Emergency Rulemaking*<br>The Department must determine that immediate adoption of a rule is necessary for the preservation of the public health, safety or general welfare and that compliance with normal rulemaking procedures would be contrary to the public interest.<br>The Department has used this rulemaking power to cancel pesticide product registrations. | |

## 6.4 SUMMARY OF PRIMARY ENFORCEMENT MECHANISMS

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)[62] authorizes several roles for the states (under conditions set by that law), such as primary enforcement responsibility for pesticide use violations, regulation of the distribution and use of federally registered pesticides, and state registration for additional uses of federally registered pesticides to meet special local needs. Several other federal environmental protection acts contain provisions relevant to elements of the Long Island Strategy (e.g., Clean Water Act, Safe Drinking Water Act). NYSDEC is the New York State agency assigned primary responsibility for enforcing certain elements of FIFRA and many other related Federal environmental laws. The NYS Department of Health (NYSDOH) is assigned primary responsibility for enforcing certain elements of the Safe Drinking Water Act.

Enforcement of New York State's pesticide-related laws, rules and regulations, as well as water quality standards, is an important component of managing pesticide use on Long Island and protecting surface waters and groundwater from potential pesticides contamination. NYSDEC enforcement actions related to pesticides and the Strategy would be conducted within the Department's existing pesticide enforcement framework, resources, and capabilities. A summary of NYSDEC's primary pesticides enforcement mechanisms is presented below.[63]

Article 71 ("Enforcement") of the ECL provides NYSDEC with the authority to enforce many aspects of pesticides management, such as pesticide distribution and use, and water quality-related matters. Enforcement of 6 NYCRR Parts 320-329 occurs under the framework of Article 71 of the ECL and other NYSDEC documents, which establish related policies and procedures.[64] Enforcement of pesticide product use restrictions or prohibitions is essential to water quality protection. New York State registration of pesticides is conducted under the authority of Title 7 of Article 33 of the ECL and 6 NYCRR Part 326. NYSDEC's pesticide product registration process is critical to management of pesticide use and is a major proactive step in water quality protection on Long Island. It is only through this process that the state can ultimately restrict or prohibit use of pesticide products that might degrade surface water and groundwater quality on Long Island or other areas of New York State. Necessary revisions of pesticide product labels are made through the USEPA label amendment process.

As mentioned in Chapter 4, as of June 2012, there were 13,688 pesticide products registered for use in New York State. Enforceable restrictions and prohibitions are established in connection with the NYSDEC pesticide product registration process. About 1,700 products have New York State-specific language and/or use restrictions placed on them. Of the approximately 1,700 restricted pesticides, 361 are strictly prohibited from use in Nassau and Suffolk counties.

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[62] FIFRA can be accessed at http://www.epa.gov/pesticides/regulating/laws.htm.

[63] Although each of the major NYS programs involved in elements of the LI Strategy include enforcement mechanisms, an exhaustive description of enforcement regarding pesticides management, public water supplies, and prevention of water pollution is beyond the scope of this report.

[64] [4]The NYSDEC Pesticide Enforcement Guidance Memorandum can be viewed at the following website: http://www.dec.ny.gov/regulations/25241.html. Information about the NYSDEC Civil Penalty Policy and other enforcement-related documents can be viewed at the following website: http://www.dec.ny.gov/regulations/2379.html. Other State entities would need to be contacted directly for information regarding associated enforcement mechanisms if that information is not available on their websites.

Another 145 are registered for use on Long Island only when used in accordance with specific label conditions. These pesticide product registration decisions are designed to protect the quality of surface water and groundwater on Long Island. Since the NYSDEC does not have the ability to require a change to an EPA-approved label, adding any restrictive or prohibiting language is only accomplished through a process involving negotiations with the pesticide product registrants to assure that the NYSDEC's concerns are addressed on the label.

**Table 6.2: Summary of NYSDEC Statutory Authority Pertinent to Elements of the LI Strategy under the Environmental Conservation Law of New York State[65]**

| **Article 15 Water Resources** | **Article 17 Water Pollution Control** | **Article 27 Collection, Treatment and Disposal of Refuse and Other Solid Waste** | **Article 33 Pesticides** | **Article 37 Substances Hazardous to the Environment**<br><br>**Article 40 Hazardous Substances Bulk Storage Act** | **Article 71 Enforcement** |
|---|---|---|---|---|---|
| Authority to conserve waters for public beneficial uses, establish reasonable standards of purity and quality for such waters and require use of all known available and reasonable methods to prevent and control pollution, and undertake comprehensive planning for the protection of water resources. Authorizes DEC Commissioner to require, by a rule, a permit for the application or introduction of a pesticide directly to surface waters of the State. | Authority to prevent and control pollution of waters (including groundwater) of the state, including point source and nonpoint sources. | Authority to regulate storage, transport, treatment and disposal of solid and hazardous wastes, including disposal of pesticides and pesticide containers. | Authority to regulate distribution, sale, use, and transportation of pesticides. Jurisdiction in these matters vested exclusively in the DEC Commissioner. Authority to promulgate rules pertaining to pesticides, including reporting regulated pesticide activities and conducting pesticide monitoring on Long Island. | Authority to promulgate a list of substances hazardous to the environment and to regulate the storage and discharge of such substances.<br><br>Authority regarding such bulk storage. | Authority for enforcement relevant to ECL Articles 33, 15, 27, 37, and 40. Allows for DEC actions, such as investigations, and civil and criminal sanctions. |

[65] Table 6.2 provides a brief statement of the statutory authority in certain Articles of the ECL pertinent to elements of the LI Strategy. Specific language of Articles 15, 33 and 71 pertinent to the pesticides program, can be viewed at the following website: http://www.dec.ny.gov/regulations/40195.html. http://public.leginfo.state.ny.us/menuf.cgi.

## 6.5 OTHER STATUTORY AUTHORITIES OF THE DEPARTMENT AND OTHER AGENCIES

Several other articles of the ECL provide more specific authority for certain activities addressed in the Strategy. A very brief summary of those authorities is included in Table 6.2. A number of New York State laws relate to the roles of other state agencies and institutions reflected in the Long Island Strategy. Their statutory authority is summarized in Table 6.3.

**Table 6.3: Summary of Statutory Authority of Other Involved New York State Agencies Pertinent to Elements of the LI Strategy[66]**

| ***NYS Public Health Law Articles 11 and 2*** | ***NYS Agriculture and Markets Law Articles 2 and 11*** | ***NYS Soil and Water Conservation Districts Law*** |
|---|---|---|
| Article 11 provides authority to the NYS Department of Health (DOH) to make rules and regulations for protection from contamination of any or all public water supplies. Article 2 provides for the functions, powers and duties of the DOH, including regulation of the sanitary aspects of water supplies (drinking water quality standards). | Article 2 provides for general powers and duties of the Department of Agriculture and Markets including aid in the promotion and development of the state's agricultural resources, collection and dissemination of agricultural data and statistics, provision for operation of the NYS Soil and Water Conservation Committee, and establishment and implementation of a program for integrated pest management (IPM). Article 11 provides more specific authority for establishment of an IPM program. | The Soil and Water Conservation District (SWCD) Law establishes the NYS Soil and Water Conservation Committee and provides authority to approve and coordinate the programs of NYS's Soil and Water Conservation Districts. |

[66] Table 8 provides a brief statement of the statutory authority expressed in NYS statutes pertinent to elements of the LI Strategy. Language of the statutes referenced in the Table 7 can be accessed at the following website: http://public.leginfo.state.ny.us/menuf.cgi.

# APPENDIX A

# PESTICIDE-RELATED CHEMICALS DETECTED IN LONG ISLAND GROUNDWATER 1996-2010

## Results of Water Quality Monitoring by United States Geological Survey (USGS), Suffolk County Department of Health Services (SCDHS), and Suffolk County Water Authority (SCWA)

# APPENDIX A PESTICIDE-RELATED CHEMICALS DETECTED IN LONG ISLAND GROUNDWATER 1996-2010 BY USGS, SCDHS, AND SCWA

The two tables in this Appendix identify 117 pesticide-related chemicals detected in Long Island's sole source drinking water aquifer system by the Suffolk County Department of Health Services (SCDHS), Suffolk County Water Authority (SCWA), and United States Geological Survey (USGS) between the years 1996 and 2010.

- The first table identifies 61 pesticide-related chemicals associated with 47 active ingredients currently registered for distribution and use in Nassau and Suffolk counties, New York, while the second table identifies 56 chemicals associated with 35 active ingredients that are not currently registered for such Long Island distribution and use.
- The left column presents a sequential numbering of chemicals. A total of 117 chemicals are represented by 61 identified in the first table combined with 56 identified in the second table. Green shading is used in cells in the left column to identify 11 chemicals that have been detected only by the USGS.
- The center column identifies 82 parent active ingredients, 47 of which are currently registered for distribution and use in Nassau and Suffolk counties, New York, and 35 of which are not.
- The right column identifies 35 pesticide-related chemicals in the form of degradates (breakdown products), a carrier, and an impurity, 14 of which are associated with active ingredients currently registered for distribution and use in Nassau and Suffolk counties, New York, and 21 of which are associated with active ingredients which are not.
- Please note that common chemical trade names shown and are included for informational purposes only.
- Long Island water quality monitoring is addressed in Chapter 3.
- Detailed water quality monitoring data, from monitoring conducted by Suffolk County and the U.S. Geological Survey, are available at ftp://ftp.dec.ny.gov/dshm/pesticid/liwaterqualitydata.docx. Datasets in that document indicate minimum, maximum and median concentration levels of pesticides and degradates detected from about 1997 to 2011.

| **Identification of 61 Pesticide-Related Chemicals Detected in Long Island Groundwater Between 1996 and 2010 and Associated with 47 Parent Active Ingredients Currently Registered for Distribution and Use in Nassau and Suffolk Counties, New York** | | |
|---|---|---|
| | **Parent Active Ingredient** | **Degradate, Carrier, Impurity** |
| 1 | **Arsenic**<br>Inorganic arsenicals such as chromate copper arsenate (CCA), ammoniacal copper arsenate (ACA), and ammoniacal copper zinc arsenate (ACZA) are used as wood preservatives, herbicides, soil sterilants, insecticides, fungicides, and rodenticides.<br>Organic arsenicals such as monosodium methanearsonate (MSMA), disodium methanearsonate (DSMA), calcium acid methanearsonate (CAMA), and cacodylic acid and its sodium salt are used as herbicides, insecticides, defoliants, and soil sterilants on agricultural crops, in forestry, on residential and other lawns and turf, and in non-crop areas such as rights of way, drainage ditch banks, fence rows, and storage yards. | |
| 2 | **Atrazine (*AAtrex*, *Atrazine*)**<br>(CAS Reg. No. 1912-24-9)<br>Triazine herbicide used to control broadleaf and grassy weeds in agricultural crops, including corn, sorghum, and turf grass sod. Used for selective weed control in Christmas tree farms as well as for nonselective control of vegetation in noncrop land. | |
| 3 | ↘ Atrazine Degradates → | **Deethylatrazine a.k.a. 2-Chloro-4-isopropylamino-6-amino-S-triazine (CIAT)**<br>(CAS Reg. No. 6190-65-4) |
| 4 | Deisopropylatrazine may also be a degradate of Simazine listed below. | **Deisopropylatrazine a.k.a. 2-chloro-6-ethylamino-4-amino-s-triazine (CEAT)**<br>(CAS Reg. No. 1007-28-9) |
| 5 | | **Didealkylatrazine**<br>(No CAS Reg. No.) |
| 6 | | **Hydroxyatrazine a.k.a. 2-Hydroxy-4-isopropylamino-6-ethylamino-s-triazine (OIET)**<br>(CAS Reg. No. 2163-68-0) |
| 7 | **Azoxystrobin (*Heritage*, *Quadris*)**<br>(CAS Reg. No. 131860-33-8)<br>Preventive and curative systemic fungicide used for several diseases on many agricultural crops and ornamental plants. | |
| 8 | **Bentazon (*Basagran*)** (CAS Reg. No. 25057-89-0)<br>Herbicide for postemergent control of selected broadleaf weeds and sedges in agricultural crops, including beans, clover grown for seed, corn, peas, peppermint, and spearmint. | |

| | Parent Active Ingredient | Degradate, Carrier, Impurity |
|---|---|---|
| 9 | | **Bis(2-ethylhexyl) phthalate (DEHP)**<br>(CAS Reg. No. 117-81-7)<br>DEHP is used as a pesticide carrier. It is also widely used as a plasticizer for polyvinyl chloride (PVC) and other polymers including rubber, cellulose, and styrene. |
| 10 | **Bromacil (*Hyvar, X, XL*)**<br>(CAS Reg. No. 314-40-9)<br>Herbicide for general weed or brush control in noncrop areas; particularly useful against perennial grasses. | |
| 11 | **Bromoxynil (phenol) (*Brominal, Buctril*)**<br>(CAS Reg. No. 1689-84-5)<br>Nitrile herbicide used for postemergent control of annual broadleaved weeds. Especially effective in the control of weeds in cereal, corn, onions, mint, turf, on non-cropland, and non-residential turf. | |
| 12 | **Carbaryl (*Sevin*)**<br>(CAS Reg. No. 63-25-2)<br>Carbamate insecticide used on citrus, pome, stone and berry fruits, forage, field and vegetable crops, nuts, lawns, ornamental plants, shade trees, poultry and pets, indoor use. | |
| 13 | **Chlorothalonil (*Bravo*)**<br>(CAS Reg. No. 1897-45-6)<br>Broad spectrum organochlorine (chlorinated isophthalic acid derivative) fungicide used to control a wide variety of fungal diseases on agricultural crops and noncrop plants. | |
| 14 | **Chloroxylenol**<br>(CAS Reg. No. 88-04-0)<br>Antimicrobial agent used to control bacteria, algae and fungi in adhesives, emulsions, paints and wash tanks, and to sanitize bathroom premises, diaper pails, laundry equipment, human bedding and pet living quarters in households, hospitals and other institutions. | |
| 15 | **2,4-D (2,4-Dichlorophenoxyacetic acid)**<br>(CAS Reg. No. 94-75-7)<br>Chlorinated phenoxy herbicide and plant growth regulator (includes parent acid as well as salt, amine and ester derivatives) used for postemergent weed control in agricultural crops, primarily corn, and in noncrop settings including turf. | |
| 16 | **Diazinon (*Spectracide, AG500*)**<br>(CAS Reg. No. 333-41-5)<br>Organophosphate insecticide used on many agricultural crops, including field, fruit, and vegetable (including seed treatment), and nonfood crops (ornamentals); forestry (including Christmas tree farms); greenhouse food crops (vegetable bedding plants and ornamentals); animal premises; lawns and turf; domestic outdoor and indoor, (household); commercial indoor (including food handling establishments and processing plants) | |

| | Parent Active Ingredient | Degradate, Carrier, Impurity |
|---|---|---|
| 17 | **Dicamba (*Banvel*)**<br>(CAS Reg. No. 1918-00-9)<br>Benzoic acid herbicide used on agricultural crops, including corn, asparagus, and agricultural seed crops. Noncrop sites, forest lands, lawns and ornamental turf. | |
| 18 | **Dichlobenil (*Casoron*)**<br>(CAS Reg. No. 1194-65-6)<br>Selective benzonitrile herbicide used to control weeds in ornamentals, nurseries, fruit orchards, vineyards, forest plantations, public green areas, and for total weed control (industrial sites, railway lines, etc. under asphalt). | |
| 19 | ↘ Dichlobenil Degradate → | **2,6-Dichlorobenzamide**<br>(CAS Reg. No. 2008-58-4) |
| 20 | **Dichlorvos (*DDVP, Dichlorvos, Vapona*)**<br>(CAS Reg. No. 62-73-3)<br>Organophosphate insecticide. A contact and stomach poison that also acts as a fumigant for control of household and public health pests, stored product insects, mosquitoes, mushroom flies, aphids, spider mites, caterpillars, thrips, white flies in greenhouse crops, and outdoor fruit and vegetables. | |
| 21 | **Diethyltoluamide (*DEET*)**<br>(CAS Reg. No. 134-62-3)<br>Multipurpose insect repellent registered for direct application to human skin, clothing, household pets, tents and bedrolls and screens. | |
| 22 | **Dimethazone a.k.a. Clomazone (*Strategy, Command*)**<br>(CAS Reg. No. 81777-89-1)<br>Herbicide used to control weeds on agricultural crops, including beans, cabbage, cucumbers, melons, mint, peas, peppers, soybeans, squash, and sweet potatoes. | |
| 23 | **Diuron (*Karmex*)**<br>(CAS Reg. No. 330-54-1)<br>Urea herbicide used to control a wide variety of annual and perennial broadleaf and grassy weeds on numerous agricultural crops including vegetables and ornamental crops, and in noncrop sites including industrial sites, rights-of-way, and around farm buildings. | |
| 24 | ↘ Diuron and Propanil Degradate → | **3,4-Dichloroaniline (DCA)**<br>(No CAS Reg. No.) |
| 25 | **Endosulfan**<br>(CAS Reg. No. 115-29-7)<br>Chlorinated hydrocarbon (organochlorine) insecticide and acaricide of the cyclodiene subgroup which acts as a contact poison in a wide variety of insects and mites on agricultural crops. Also used as a wood preservative. | |

| | Parent Active Ingredient | Degradate, Carrier, Impurity |
|---|---|---|
| 26 | Endosulfan (*Thiodan*) Degradate ⟶ | **Endosulfan Sulfate**<br>(CAS Reg. No. 1031-07-8)<br>ENDOSULFAN NOTE:<br>Technical-grade endosulfan contains at least 94% of two pure isomers, α- and β-endosulfan. The α- ("I") and β-isomers ("II") of endosulfan are present in the ratio of 7:3, respectively. Endosulfan sulfate is a reaction product found in technical endosulfan; it is also found in the environment due to photolysis and in organisms as a result of oxidation by biotransformation. |
| 27 | **Ethofumesate (*Poaconstrictor, Prograss, Thrasher*)**<br>(CAS Reg. No. 26225-79-6)<br>Herbicide used on ornamental turf such as golf courses, sod farms, parks, cemeteries and residential or commercial lawns, and after overseeding specific grasses for the control and/or suppression of annual grasses and broadleaf weeds. Has both preemergent and early (two-leaf stage) postemergent activity. | |
| 28 | **Fenarimol (*Rubigan*)**<br>(CAS Reg. No. 60168-88-9)<br>Pyrimidine fungicide used on turf grasses, ornamentals, and fruit crops. | |
| 29 | **Fipronil**<br>(CAS Reg. No. 120068-37-3)<br>Broad-spectrum phenylpyrazole insecticide used in agricultural and non-agricultural settings. | |
| 30 | ↘ Fipronil Degradate ⟶ | **Fipronil sulfide**<br>(CAS Reg. No. 120067-83-6) |
| 31 | **Fluoride**<br>(CAS Reg. No. 7681-49-4)<br>Potential sources include insecticidal fluorine compounds such as sodium fluoaluminate or sodium aluminofluoride (*Kryocide*) used on food crops and ornamentals, including potatoes to control Colorado potato beetle under a FIFRA Sec. 18 exemption. Also sodium fluoride used as a wood preservative. Also present in toothpaste, mouthwash and water. | |
| 32 | **Hexazinone**<br>(CAS Reg. No. 51235-04-2)<br>Triazine herbicide used in agricultural and non-agricultural areas to control a broad spectrum of weeds on ornamental plants, forest trees and other non-crop areas. Used for pre-emergent, postemergence, layby, directed spray and basal soil applications. | |

| | Parent Active Ingredient | Degradate, Carrier, Impurity |
|---|---|---|
| 33 | **Imidacloprid (*Admire, Merit, Provado*)**<br>(CAS Reg. No. 138261-41-3)<br>Systemic neonicotinoid insecticide with soil, foliar and seed uses to control sucking insects, some chewing insects including aphids, thrips, whiteflies, termites, turf insects, soil insects, some beetles, and as a topical treatment to control fleas on pets. May be applied to structures, crops, soil, and as a seed treatment. Most commonly used on maize, potatoes, vegetables, sugar beets, fruit, and turf, and is especially systemic when used as a seed or soil treatment. Used to control Asian longhorned beetle (*Anoplophora glabripennis*). | |
| 34 | ↘ Imidacloprid Degradate ⟶ | **Imidacloprid Urea**<br>(CAS Reg. No. not assigned) |
| 35 | **Iprodione (*Chipco 26019*)**<br>(CAS Reg. No. 36734-19-7)<br>Dicarboximide contact fungicide used to control a wide variety of crop diseases on vegetables, ornamentals, pome and stone fruit, root crops, and sunflowers. Used as a post-harvest fungicide and seed treatment. | |
| 36 | ↘ Iprodione Degradate ⟶ | **3,5-Dichloroaniline**<br>(CAS Reg. No. 626-43-7) |
| 37 | **Malathion**<br>(CAS Reg. No. 121-75-5)<br>Non-systemic, wide spectrum insecticide used to control sucking and chewing insects on fruits and vegetables. Used to control mosquitoes, flies, household insects, animal parasites (ectoparasites), and head and body lice. | |
| 38 | ↘ Malathion Degradate ⟶ | **Malaoxon**<br>(CAS Reg. No. 1634-78-2) |
| 39 | **Mecoprop (MCPP)**<br>(CAS Reg. No. 93-65-2)<br>Selective hormone-type phenoxy herbicide applied postemergence on ornamentals and turf to control surface creeping broadleaf weeds. | |
| 40 | ↘ MCPA Degradate ⟶ | **4-Chloro-2-methylphenol**<br>(No CAS Reg. No.) |
| 41 | **Metalaxyl (Ridomil)**<br>(CAS Reg. No. 57837-19-1)<br>Systemic, benzenoid fungicide used as a foliar spray for crops, as a soil treatment to control soil-borne pathogens, and as a seed treatment to control downy mildews. | |
| 42 | **Methiocarb (*Mesurol*)**<br>(CAS Reg. No. 2032-65-7)<br>Insecticide, acaricide and molluscicide used to control snails, slugs, spider mites and insects on lawns, turf and ornamentals, around building foundations, and in gardens. | |

| | Parent Active Ingredient | Degradate, Carrier, Impurity |
|---|---|---|
| 43 | **Methomyl (*Lannate*)**<br>(CAS Reg. No. 16752-77-5)<br>N-methyl carbamate insecticide used on field, vegetable, orchard crops, and sod farms. | |
| 44 | **Metribuzin (*Sencor*)**<br>(CAS Reg. No. 21087-64-9)<br>Selective triazinone herbicide used to control broadleaf weeds and grassy weed species on a wide range of sites including vegetable and field crops, turf grasses (recreational areas), and non-crop areas. | |
| 45 | **Napropamide (*Devrinol*)**<br>(CAS Reg. No. 15299-99-7)<br>Selective systemic amide herbicide applied to soils to control a number of annual grasses and broad-leaved weeds where vegetables, fruit trees and bushes, vines, strawberries, sunflowers, and mint or other crops are grown. | |
| 46 | **Oxadiazon (*Ronstar*) ()**<br>(CAS Reg. No. 19666-30-9)<br>Oxadiazole herbicide used for preemergent control of grasses, broadleaves, vines, brambles, brush, and trees. | |
| 47 | **Pentachloronitrobenzene (*Quintozene, PCNB*)**<br>(CAS Reg. No. 82-68-8)<br>Organochlorine fungicide used as a seed dressing or soil treatment to control a wide range of fungi species in such crops as potatoes, onions, lettuce, tomatoes, tulips, garlic, and others. | |
| 48 | ↘ Pentachloronitrobenzene Impurity ⟶<br>Depending on the producer and the manufacturing procedure, PCNB impurities can include hexachlorobenzene, pentachlorobenzene, and tetrachloronitrobenzene. | **Pentachlorobenzene**<br>(CAS Reg. No. 608-93-5) |
| 49 | **Piperonyl butoxide (PBO)**<br>(CAS Reg. No. 51-03-6)<br>Piperonyl butoxide is a synergist added to a wide variety of more than 1,500 pesticide products used to control many different types of flying and crawling insects and arthropods, although there are no products that contain only PBO. It lacks pesticidal effects on its own, but is added to other pesticides to enhance the pesticidal properties of those other pesticides, including pyrethrins, pyrethroids, rotenone, and carbamates. | |
| 50 | **Prometon (*Pramitol*)**<br>(CAS Reg. No. 1610-18-0)<br>Triazine herbicide used to control the emergence of most annual and many perennial broadleaf weed and grasses in non-agricultural areas. | |
| 51 | **Propamocarb hydrochloride (*Banol, Previcur*)**<br>(CAS Reg. No. 25606-41-1)<br>Fungicide used to control *Pythium* spp. and *Phytophthora* spp. on turf, outdoor woody and herbaceous ornamentals. | |

| | | |
|---|---|---|
| | | |
| | **Parent Active Ingredient** | **Degradate, Carrier, Impurity** |
| 52 | **Propiconazole (*Banner, Banner Maxx*)**<br>(CAS Reg. No. 60207-90-1)<br>Triazole systemic foliar fungicide with a broad range of activity that is used on grasses grown for seed, corn, and fruit crops. | |
| 53 | **Propoxur (*Baygon*)**<br>(CAS Reg. No. 114-26-1)<br>Carbamate insecticide used in fruit, maize, vegetables, ornamentals, and to control ants, roaches and hornets in and around residences and commercial food handling establishments. | |
| | | |
| 54 | **Siduron (*Tupersan*)**<br>(CAS Reg. No. 1982-49-6)<br>Phenylurea herbicide used to control annual grasses, annual weeds, barnyardgrass, bermudagrass, crabgrass, and foxtail on golf courses, sod farms, and residential turf. | |
| 55 | **Simazine (*Princep*)**<br>(CAS Reg. No. 122-34-9)<br>Selective chlorinated triazine systemic herbicide applied to soil to control most annual grasses and broadleaf weeds before they emerge or after removal of weed growth. | |
| 56 | **Terbacil (*Sinbar*)**<br>(CAS Reg. No. 5902-51-2)<br>Selective uracil herbicide used to control broadleaf weeds in agricultural crops. | |
| 57 | **Triadimefon (*Bayleton*)**<br>(CAS Reg. No. 43121-43-3)<br>Triazole fungicide used to control powdery mildews, rusts and other fungal pests on cereals, fruits, vegetables, turf, shrubs and trees. | |
| 58 | **Triadimenol (*Baytan*)**<br>(CAS Reg. No. 55219-65-3)<br>Fungicide/seed treatment/protectant used to control seed- and soil-borne diseases and to provide early season control of foliar diseases. | |
| 59 | **Trichlorfon (*Dylox*)**<br>(CAS Reg. No. 52-68-6)<br>Systemic insecticide used on golf course turf, home lawns, ornamental shrubs and plants, and ornamental and bait fish ponds to control insects. | |

| | Parent Active Ingredient | Degradate, Carrier, Impurity |
|---|---|---|
| 60 | **Triclosan**<br>(CAS Reg. No. 3380-34-5)<br>Antimicrobial agent (pesticide) used to control the growth of bacteria fungi, and mildew in commercial applications and textile manufacturing. Also contained in consumer products (i.e., over-the-counter drugs such as antibacterial soap and some toothpaste) regulated by the Food and Drug Administration (FDA) under the Federal Food, Drug, and Cosmetic Act (FFDCA). | |
| 61 | **Vinclozolin (*Touche, Curalan*)**<br>(CAS Reg. No. 50471-44-8)<br>Dicarboximide non-systemic pesticide used to control several species of fungi in vines (such as grapes), strawberries, vegetables, fruit and ornamentals. Also used on turf grass. | |

| **Identification of 56 Pesticide-Related Chemicals Detected in Long Island Groundwater Between 1996 and 2010 and Associated with 35 Active Ingredients Not Currently Registered for Use In Nassau and Suffolk Counties, New York** | | |
|---|---|---|
| | **Parent Active Ingredient** | **Degradate, Inert, Impurity** |
| 1 | **Acetochlor (*Harness*)**<br>(CAS Reg. No. 34256-82-1)<br>Chloroacetanilide herbicide used for control of most annual grasses and certain broadleaf weeds and yellow nutsedge in agricultural crops, including corn and potatoes. | |
| 2 | **Alachlor (*Lasso*)**<br>(CAS Reg. No. 15972-60-8)<br>Chloroacetanilide herbicide used for control of many annual grasses and certain broadleaf weeds in agricultural crops, including soybeans, corn, dry beans, and sunflowers. | |
| 3 | ↘ Alachlor Degradates → | **Alachlor ethanesulfonic acid (ESA)**<br>(No CAS Reg. No. assigned) |
| 4 | | **Alachlor oxanilic acid (OA)**<br>(No CAS Reg. No. assigned) |
| 5 | **Aldicarb (*Temik*)**<br>(CAS Reg. No. 116-06-3)<br>Carbamate insecticide used to control a variety of pests on agricultural crops. Long Island potato growers targeted the Colorado potato beetle (*Leptinotarsa decemlineata*) and golden nematode (*Globodera rostochiensis*). | |
| 6 | ↘ Aldicarb Degradates → | **Aldicarb sulfone a.k.a. Aldoxycarb**<br>(CAS Reg. No. 1646-88-4) |
| 7 | | **Aldicarb sulfoxide**<br>(CAS Reg. No. 1646-87-3) |
| 8 | Pesticide/antioxidant inert ingredient in pesticide formulas → | **Butylated hydroxytoluene** (BHT)<br>(CAS Reg. No. 128-37-0) |
| 9 | **Cadmium (*CADDY*)**<br>Heavy metal fungicide used on golf course tees and greens. | |
| 10 | Questionable pesticidal relation → | **Caffeine**<br>(CAS Reg. No. 58-08-2) |
| 11 | **Carbofuran**<br>(CAS Reg. No. 1563-66-2)<br>Carbamate systemic insecticide/nematicide used on a wide variety of fruit and field crops, including potatoes, corn and soybeans, and ornamentals. | |
| 12 | ↘ Carbofuran Degradate → | **3-Hydroxycarbofuran**<br>(CAS Reg. No. 16655-82-6) |

| | Parent Active Ingredient | Degradate, Inert, Impurity |
|---|---|---|
| 13 | **Carbon Disulfide (*Vertifume*)**<br>(CAS Reg. No. 75-15-0)<br>Insecticide, nematicide and fungicide used as a fumigant soil disinfectant. | |
| 14 | **Chlordane (*Gold Crest C-100*)**<br>(CAS Reg. No. 57-74-9)<br>Chlorinated cyclodiene termiticide used subsurfacely for termite control, and above ground structural application for control of termites and other wood-destroying insects. | |
| 15 | **Chlorfenvinphos**<br>(CAS Reg. No. 470-90-6)<br>Organophosphate insecticide and acaricide/miticide used on agricultural crops. | |
| 16 | **Cyanazine (*Bladex*)**<br>(CAS Reg. No. 21725-46-2)<br>Triazine herbicide used as a preemergent and postemergent to control annual grasses and broadleaf weeds, primarily on corn. | |
| 17 | **Dacthal (DCPA, Dimethyl tetrachloroterephthalate)**<br>(CAS Reg. No. 1861-32-1)<br>Phthalate/chlorinated benzoic acid preemergent herbicide used to control annual grasses and certain annual broadleaf weed species in a wide range of vegetable crops. | |
| 18 | ↘ Dacthal Degradate ⟶ | **Tetrachloroterephthalic acid (TCPA)**<br>(CAS Reg. No. 2136-79-0) |
| 19 | **1,2-Dibromo-3-chloropropane (DBCP)**<br>(CAS Reg. No. 96-12-8)<br>Halogenated organic soil fumigant (nematicide) registered for use on more than 40 agricultural crops. | |
| 20 | **1,2-Dibromoethane a.k.a. Ethylene dibromide (EDB) (*Dowfume*)**<br>(CAS Reg. No. 106-93-4)<br>Halogenated organic liquid soil fumigant (insecticide, nematicide) used as a soil and post-harvest fumigant for agricultural crops. | |
| 21 | **1,2-Dichlorobenzene (o) (*DowTherm E*)**<br>(CAS Reg. No. 95-50-1)<br>Halogenated organic insecticide and fumigant, and used to manufacture herbicides. | |
| 22 | **1,4-Dichlorobenzene (p) a.k.a. Paradichlorobenzene**<br>(CAS Reg. No. 106-46-7)<br>Halogenated organic solid insecticide used for moth and carpet beetle control inside of airtight spaces (closets, chests, and garment bags) in homes, to kill lice and mites on birds in cages, to repel commensal rodents. | |

| | Parent Active Ingredient | Degradate, Inert, Impurity |
|---|---|---|
| 23 | **1,2-Dichloroethane a.k.a. Ethylene dichloride (*Dowfume*)**<br>(CAS Reg. No. 107-06-2)<br>Halogenated organic liquid insecticide fumigant used on agricultural crops. | |
| 24 | **1,2-Dichloropropane**<br>(CAS Reg. No. 78-87-5)<br>Halogenated organic liquid soil fumigant, nematicide, and impurity. | |
| 25 | **cis-1,3-Dichloropropene (*Telone*)**<br>(CAS Reg. No. 542-75-6)<br>Halogenated organic liquid fumigant for preplant treatment of soil to control plant parasitic nematodes, including golden nematode (*Globodera rostochiensis*) and symphlans, and to manage soil-borne diseases in agricultural cropland. Typically applied to soils prior to planting by underground injection at a depth of 12–18 inches. | |
| 26 | ↘ cis-1,3-Dichloropropane Degradate ⟶ | **1,1-Dichloropropene**<br>(CAS Reg. No. 563-58-6) |
| 27 | **Dieldrin**<br>(CAS Reg. No. 60-57-1)<br>Organochlorine insecticide used as a contact and stomach poison to control soil insects, public health insects, termites, and many other pests. | |
| 28 | **Dimethyl disulfide**<br>(CAS Reg. No. 624-92-0)<br>Soil fumigant. | |
| 29 | **Dinoseb (*Premerge, Dinitro*)**<br>(CAS Reg. No. 88-85-7)<br>Nitrophenolic herbicide. The phenol form is used as a general contact herbicide in orchards, vineyards, forage legumes, and for killing potato vines and desiccating seed crops to facilitate harvest. The ammonium salt is used as a selective contact herbicide in alfalfa, clover, birdsfoot trefoil, onions, garlic, peas, and small grains. Alkanolamine salts are applied to kill germinating seeds contained in the upper soil surface layers in preemergence treatments, and in early postemergence and directed sprays in numerous agricultural crops. | |
| 30 | **Diphenamid (*Dymid, Enide*)**<br>(CAS Reg. No. 957-51-7)<br>Amide herbicide for control of annual grasses and broadleaf weeds in tomatoes, peppers, potatoes, soybeans, strawberries, blackberry and raspberry (nonbearing), apple and peach trees, cherry trees (nonbearing), and ornamental plants. | |
| 31 | Disulfoton (*Di-Syston*) Degradate ⟶ | **Disulfoton sulfone**<br>(CAS Reg. No. 2497-06-5) |

| | Parent Active Ingredient | Degradate, Inert, Impurity |
|---|---|---|
| 32 | **Ethyl dipropylthiocarbamate (EPTC) (*Eptam*)**<br>(CAS Reg. No. 759-94-4)<br>Selective thiocarbamate herbicide used in preemergent control of certain annual grasses, broadleaf weeds and perennial weeds on field, vegetable, orchard, ornamental, and noncrop sites. | |
| 33 | **Fenuron**<br>(CAS Reg. No. 101-42-8) | |
| 34 | **Gamma-BHC (Lindane, gamma-hexachlorocyclohexane) (*Lindane*)**<br>(CAS Reg. No. 58-89-9)<br>Organochlorine insecticide used on ornamentals and trees (especially borers), seed treatments, and livestock pests. | |
| 35 | Heptachlor Degradate ⟶<br>Technical-grade heptachlor was the form of heptachlor used most often as a pesticide. Heptachlor epoxide is a by-product of heptachlor, and was not manufactured and was not used as an insecticide like heptachlor. Approximately 20 percent of heptachlor is changed within hours into heptachlor epoxide in the environment. | **Heptachlor epoxide**<br>(CAS Reg. No. 1024-57-3) |
| 36 | **Hexachlorobutadiene**<br>(CAS Reg. No. 87-68-3)<br>Hexachlorobutadiene is used as a pesticide, insecticide, herbicide, algicide and chemical intermediate The primary source of hexachlorobutadiene is inadvertent production as a waste by-product of the manufacture of certain chlorinated hydrocarbons, such as tetrachloroethylene, trichloroethylene, and carbon tetrachloride. | |
| 37 | **Isofenphos (*Oftanol*)**<br>(CAS Reg. No. 25311-71-1)<br>Organophosphate insecticide used on turf and ornamental trees and shrubs to control white grubs, mole crickets, and other insects (mostly subterranean species). | |
| 38 | **Kelthane (*Dicofol*)**<br>(CAS Reg. No. 115-32-2)<br>Acaricide/miticide used as a foliar spray on agricultural crops and ornamentals, and in or around agricultural and domestic buildings for mite control. | |
| 39 | **Methoxychlor**<br>(CAS Reg. No. 72-43-5)<br>Organochlorine insecticide used to control many species of insects on fruit and shade trees, vegetables, home gardens, and around farm buildings | |
| 40 | Fumigant Degradate ⟶ | **Methyl sulfide a.k.a dimethyl sulfide**<br>(CAS Reg. No. 75-18-3) |

| | Parent Active Ingredient | Degradate, Inert, Impurity |
|---|---|---|
| 41 | **Metolachlor (*Dual, Pennant, Bicep*)**<br>(CAS Reg. No. 51218-45-2)<br>Chloroacetamide broad spectrum herbicide used for general weed control in many agricultural food and feed crops, and on lawns and turf, ornamental plants, trees, shrubs and vines, rights of way, fencerows and hedgerows, and in forestry. | |
| 42 | ↘ Metolachlor Degradates → | **Metolachlor ESA (CGA-354743)**<br>(CAS Reg. No. 171118-09-5) |
| 43 | | **Metolachlor metabolite (CGA-37735)**<br>(CAS Reg. No. 97055-05-5) |
| 44 | | **Metolachlor metabolite (CGA-40172)**<br>(CAS Reg. No. 131068-72-9) |
| 45 | | **Metolachlor metabolite (CGA-41638)**<br>(CAS Reg. No. 65513-61-3) |
| 46 | | **Metolachlor metabolite (CGA-67125)**<br>(No CAS Reg. No.) |
| 47 | | **Metolachlor OA (CGA-51202)**<br>(CAS Reg. No. 152019-73-3) |
| 48 | Methyl Parathion Degradate → | **4-Nitrophenol**<br>(CAS Reg. No. 100-02-7) |
| 49 | **Norflurazon (*Solicam*)**<br>(CAS Reg. No. 27314-13-2)<br>Selective pyridazinone preemergent herbicide used to control germinating annual grasses and broadleaf weeds in fruits, vegetables, other crops, and various nonagricultural and industrial areas. | |
| 50 | **Oxamyl (*Vydate*)**<br>(CAS Reg. No. 23135-22-0)<br>Carbamate systemic and contact insecticide/acaricide and nematicide used on many agricultural crops, including cucumbers, eggplants, garlic, muskmelon (including cantaloupe and honeydew melon), onion (dry bulb), pears, peppers, peppermint, potatoes, pumpkins, spearmint, squash, sweet potatoes, tomatoes, watermelons. | |
| 51 | **Pentachlorophenol**<br>(CAS Reg. No. 87-86-5)<br>Biocide used to control microorganisms, and as a wood preservative to protect wood from decay and insect attack. | |
| 52 | Questionable Degradate → | **Perchlorate**<br>(CAS Reg. No. 14797-73-0) |
| 53 | **Prometryn (*Caparol*)**<br>(CAS Reg. No. 7287-19-6)<br>Substituted thiomethly triazine herbicide used to control annual grasses and broadleaf weeds in food and feed crops. | |

| | Parent Active Ingredient | Degradate, Inert, Impurity |
|---|---|---|
| 54 | **Propachlor (*Ramrod*)**<br>(CAS Reg. No. 1918-16-7)<br>Herbicide used to control grasses and broadleaf weeds. | |
| 55 | **Tebuthiuron (*Spike*)**<br>(CAS Reg. No. 34014-18-1)<br>Nonselective, soil-activated herbicide used to control broadleaf and woody weeds, grasses and brush on feed crop sites (pasture and rangeland) and a variety of non-food crop sites including airports and landing fields, outdoor industrial areas, non-agricultural rights-of-way, fencerows, hedgerows, uncultivated areas/soils, and under paved roads and sidewalks in areas where no future landscaping is planned. | |
| 56 | Soil Fumigant/Nematicide Impurity ⟶<br>TCP has been used in the production of pesticides, and as an industrial solvent and cleaning and degreasing agent. | **1,2,3-Trichloropropane (TCP)**<br>(CAS Reg. No. 96-18-4) |

# APPENDIX B

# SUMMARIES OF LONG ISLAND WATER QUALITY MONITORING DATA FOR METALAXYL, IMIDACLOPRID, AND ATRAZINE

Maps Provided by the Suffolk County Department of Health Services (SCDHS) and Charts Based on Data Provided by SCDHS of Water Quality Monitoring Conducted by SCDHS 2001-2010

**The following charts present a summary of data supplied by the Suffolk County Department of Health Services based on monitoring SCDHS conducted. The graphical representations of the detections of each active ingredient correspond with each map and with the water quality monitoring data tables available at ftp://ftp.dec.ny.gov/dshm/pesticid/liwaterqualitydata.docx.**

**The categories of graphical representations include:**
**Private water supplies,**
**Public water supplies, and**
**Groundwater supplies.**

**Applicable Unidentified Organic Contaminants (UOC) or Maximum Contaminant Level (MCL) associated with certain types of monitoring and pesticides are indicated.**

# NYSDEC SUMMARIES OF LONG ISLAND WATER QUALITY MONITORING DATA 2001-2010

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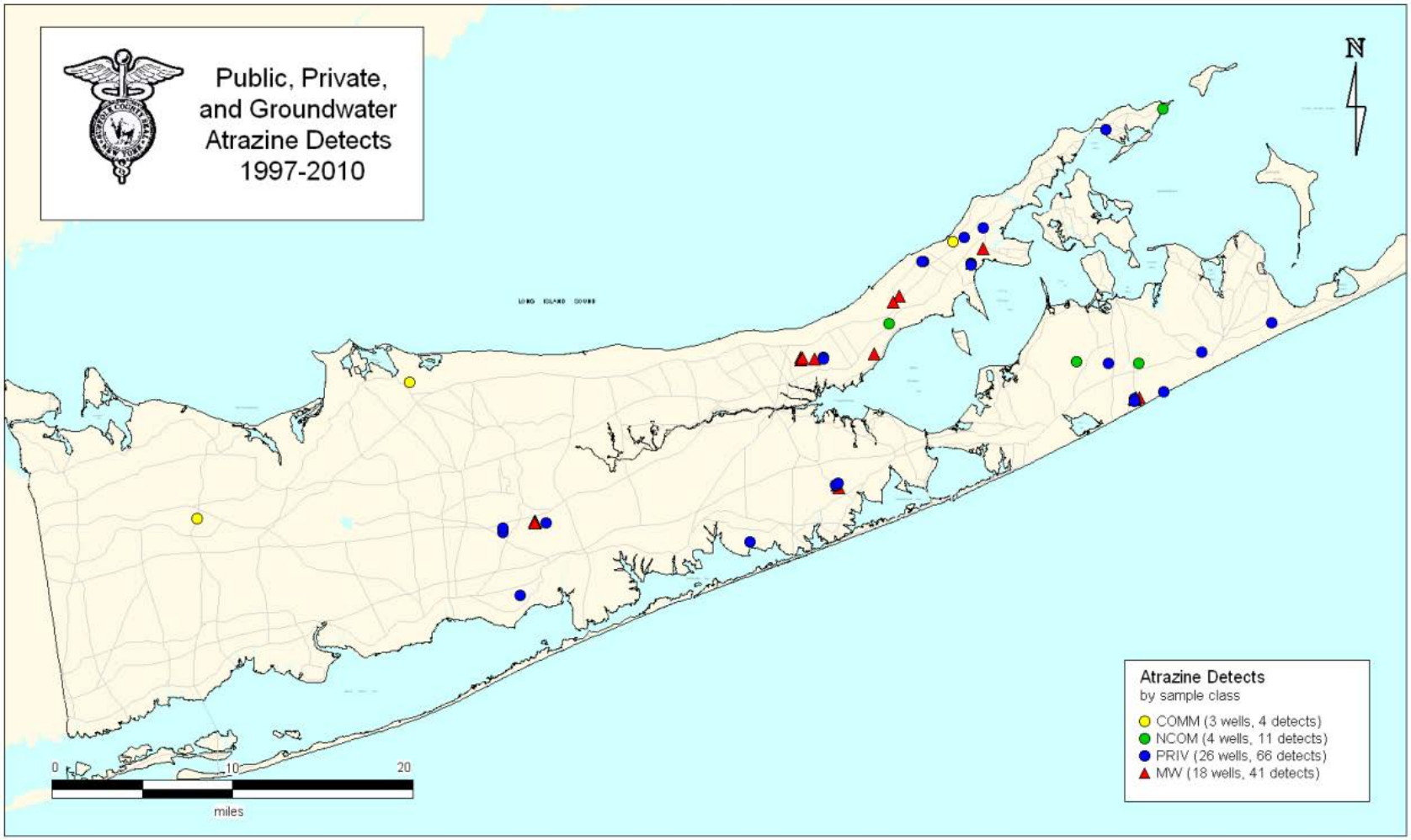
Metalaxyl Detections from Private Water Supply Wells …….. B-10

Metalaxyl Detections from Public Water Supply Wells …… B-10

Metalaxyl Detections from Groundwater Monitoring Wells ……..... B-11

Metalaxyl Detections from Surface Water Areas ……..... B-11

## Atrazine Detections – Map of Detection Sites (1997-2010)



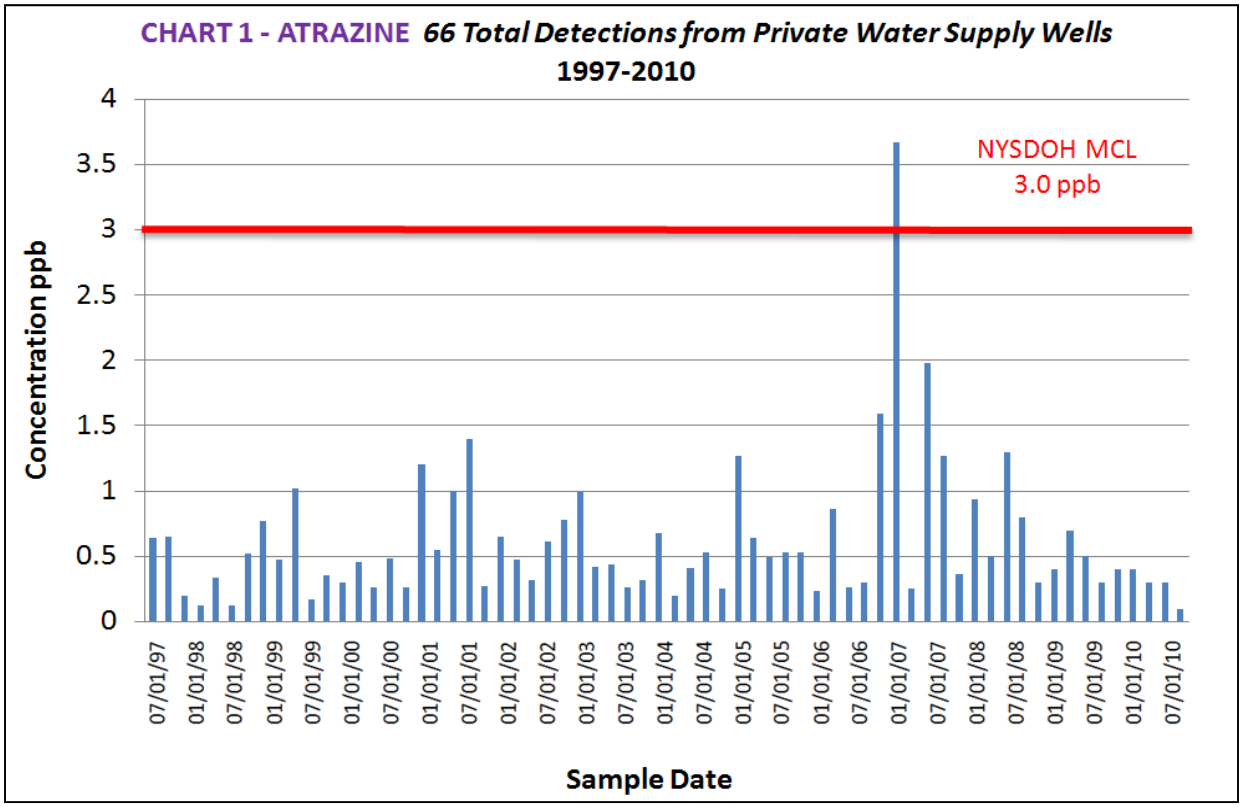


CHART 1 - ATRAZINE 66 Total Detections from Private Water Supply Wells
1997-2010
NYSDOH MCL
3.0 ppb
Concentration ppb
4
3.5
3
2.5
2
1.5
1
0.5
0
07/01/97
01/01/98
07/01/98
01/01/99
07/01/99
01/01/00
07/01/00
01/01/01
07/01/01
01/01/02
07/01/02
01/01/03
07/01/03
01/01/04
07/01/04
01/01/05
07/01/05
01/01/06
07/01/06
01/01/07
07/01/07
01/01/08
07/01/08
01/01/09
07/01/09
01/01/10
07/01/10
Sample Date

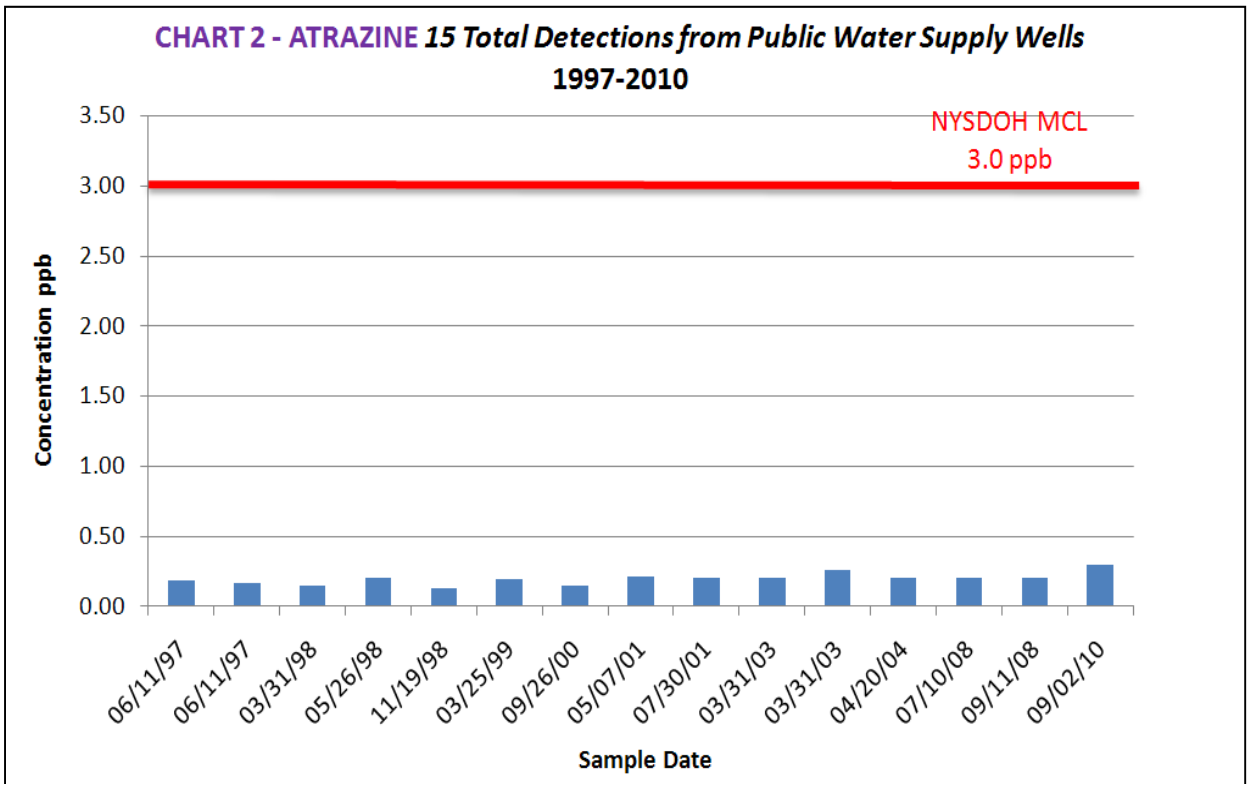


CHART 2 - ATRAZINE 15 Total Detections from Public Water Supply Wells
1997-2010
NYSDOH MCL
3.0 ppb
Concentration ppb
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
06/11/97
06/11/97
03/31/98
05/26/98
11/19/98
03/25/99
09/26/00
05/07/01
07/30/01
03/31/03
03/31/03
04/20/04
07/10/08
09/11/08
09/02/10
Sample Date

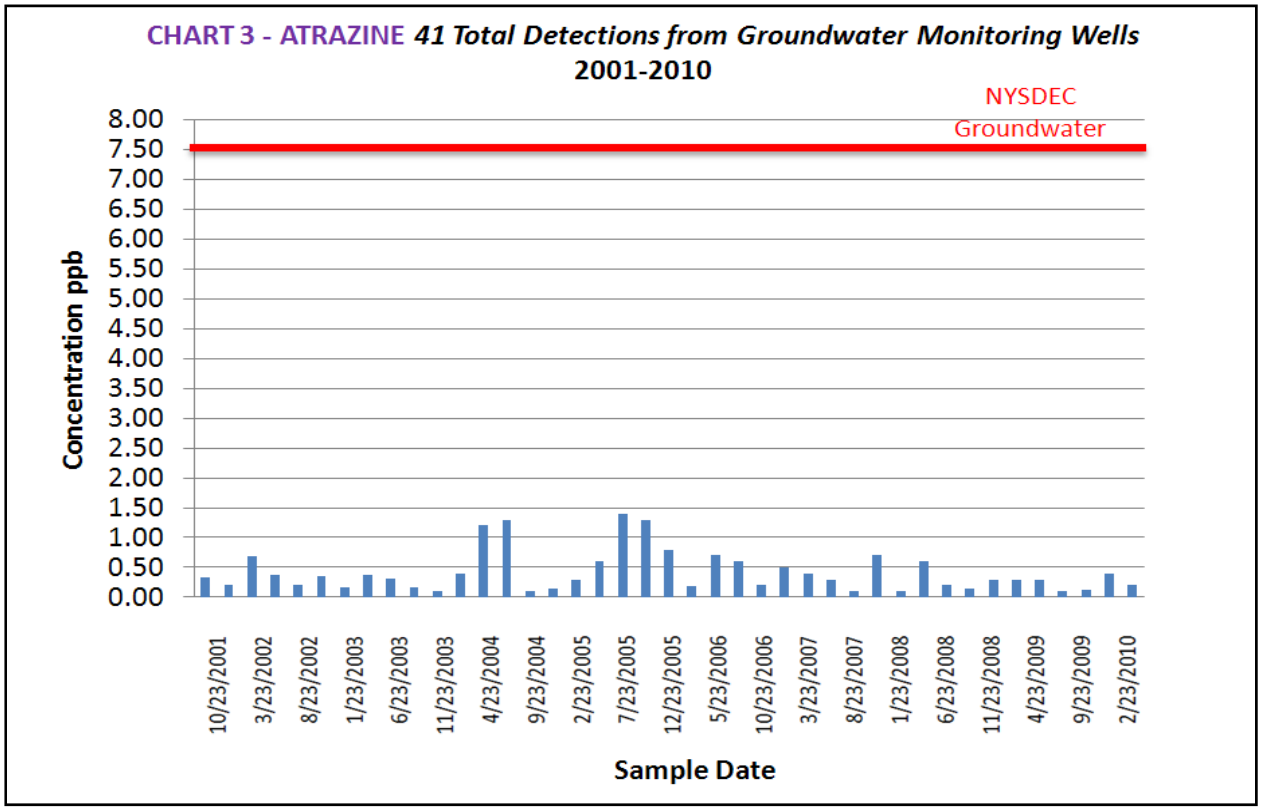
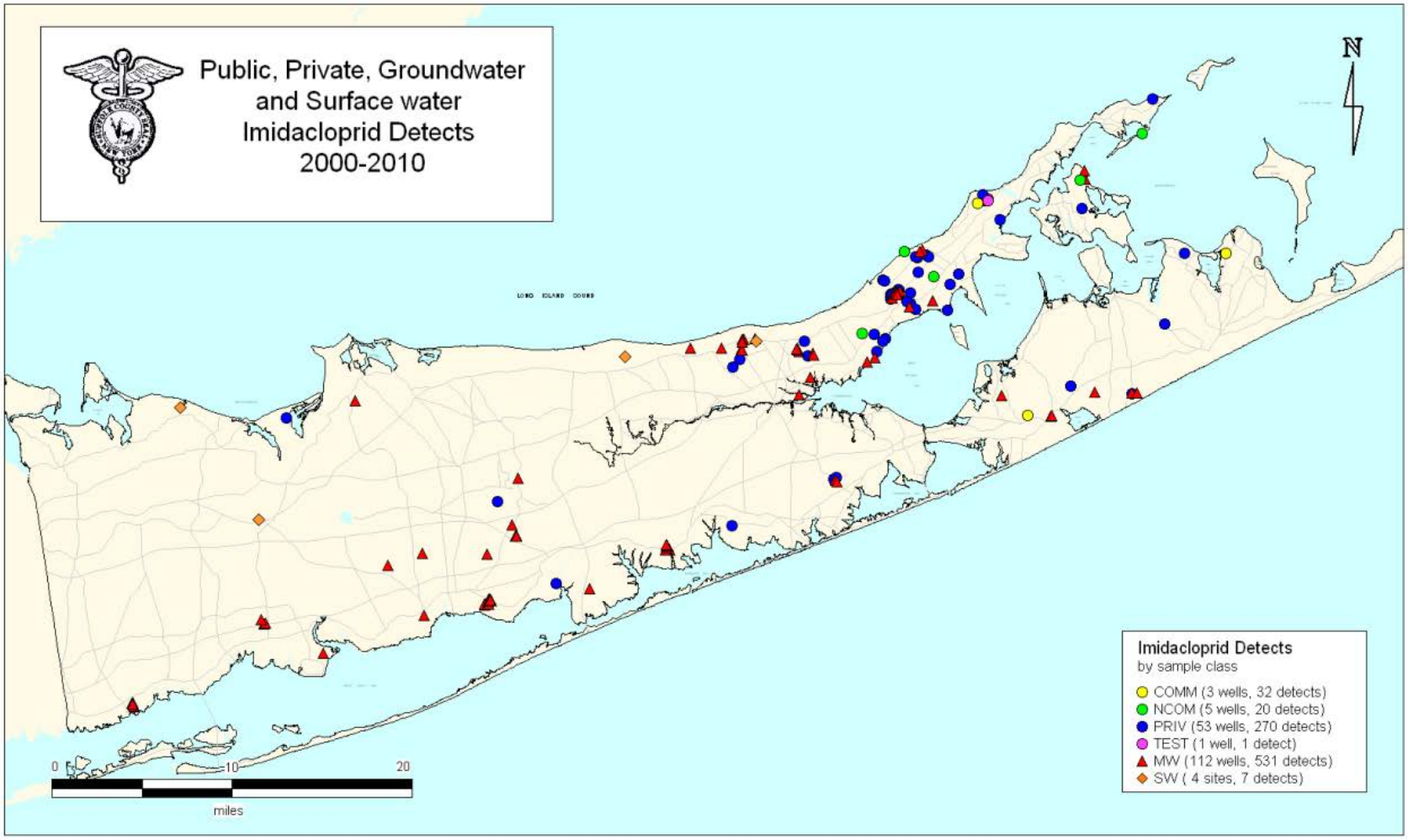


CHART 3 - ATRAZINE 41 Total Detections from Groundwater Monitoring Wells
2001-2010
NYSDEC
Groundwater
Concentration ppb
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
10/23/2001
3/23/2002
8/23/2002
1/23/2003
6/23/2003
11/23/2003
4/23/2004
9/23/2004
2/23/2005
7/23/2005
12/23/2005
5/23/2006
10/23/2006
3/23/2007
8/23/2007
1/23/2008
6/23/2008
11/23/2008
4/23/2009
9/23/2009
2/23/2010
Sample Date

## Imidacloprid Detections – Map of Detection Sites (2000-2010)



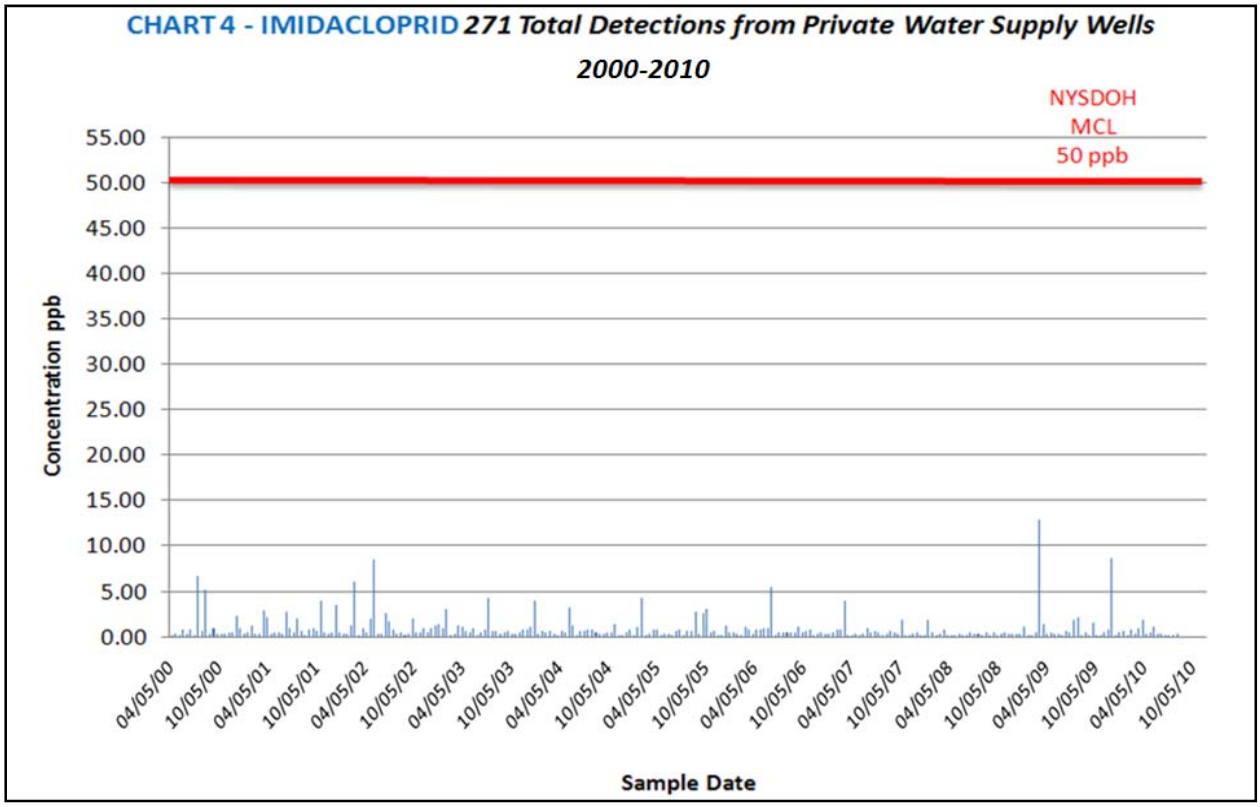


CHART 4 - IMIDACLOPRID 271 Total Detections from Private Water Supply Wells
2000-2010
NYSDOH
MCL
50 ppb
Concentration ppb
55.00
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
04/05/00
10/05/00
04/05/01
10/05/01
04/05/02
10/05/02
04/05/03
10/05/03
04/05/04
10/05/04
04/05/05
10/05/05
04/05/06
10/05/06
04/05/07
10/05/07
04/05/08
10/05/08
04/05/09
10/05/09
04/05/10
10/05/10
Sample Date

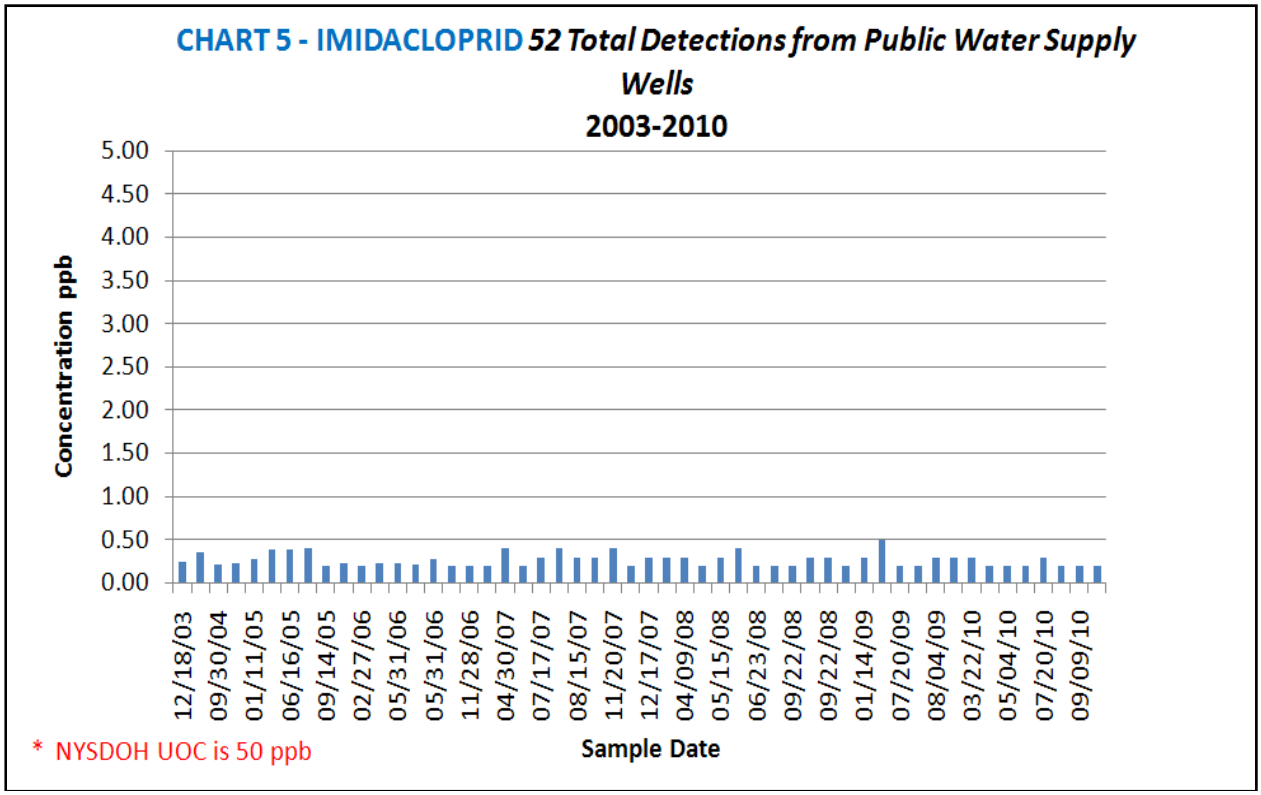


CHART 5 - IMIDACLOPRID 52 Total Detections from Public Water Supply Wells
2003-2010
Concentration ppb
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
12/18/03
09/30/04
01/11/05
06/16/05
09/14/05
02/27/06
05/31/06
05/31/06
11/28/06
04/30/07
07/17/07
08/15/07
11/20/07
12/17/07
04/09/08
05/15/08
06/23/08
09/22/08
09/22/08
01/14/09
07/20/09
08/04/09
03/22/10
05/04/10
07/20/10
09/09/10
* NYSDOH UOC is 50 ppb
Sample Date

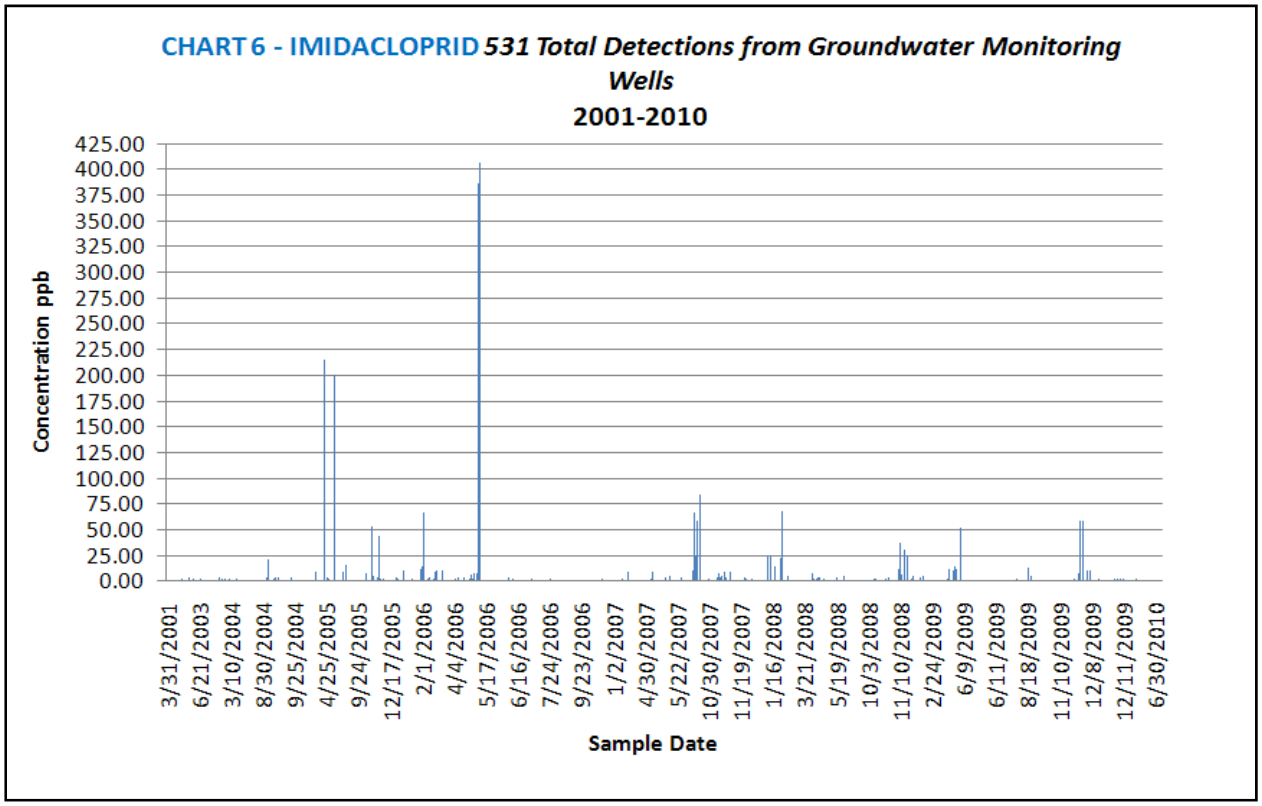


CHART 6 - IMIDACLOPRID 531 Total Detections from Groundwater Monitoring Wells
2001-2010
Concentration ppb
425.00
400.00
375.00
350.00
325.00
300.00
275.00
250.00
225.00
200.00
175.00
150.00
125.00
100.00
75.00
50.00
25.00
0.00
3/31/2001
6/21/2003
3/10/2004
8/30/2004
9/25/2004
4/25/2005
9/24/2005
12/17/2005
2/1/2006
4/4/2006
5/17/2006
6/16/2006
7/24/2006
9/23/2006
1/2/2007
4/30/2007
5/22/2007
10/30/2007
11/19/2007
1/16/2008
3/21/2008
5/19/2008
10/3/2008
11/10/2008
2/24/2009
6/9/2009
6/11/2009
8/18/2009
11/10/2009
12/8/2009
12/11/2009
6/30/2010
Sample Date

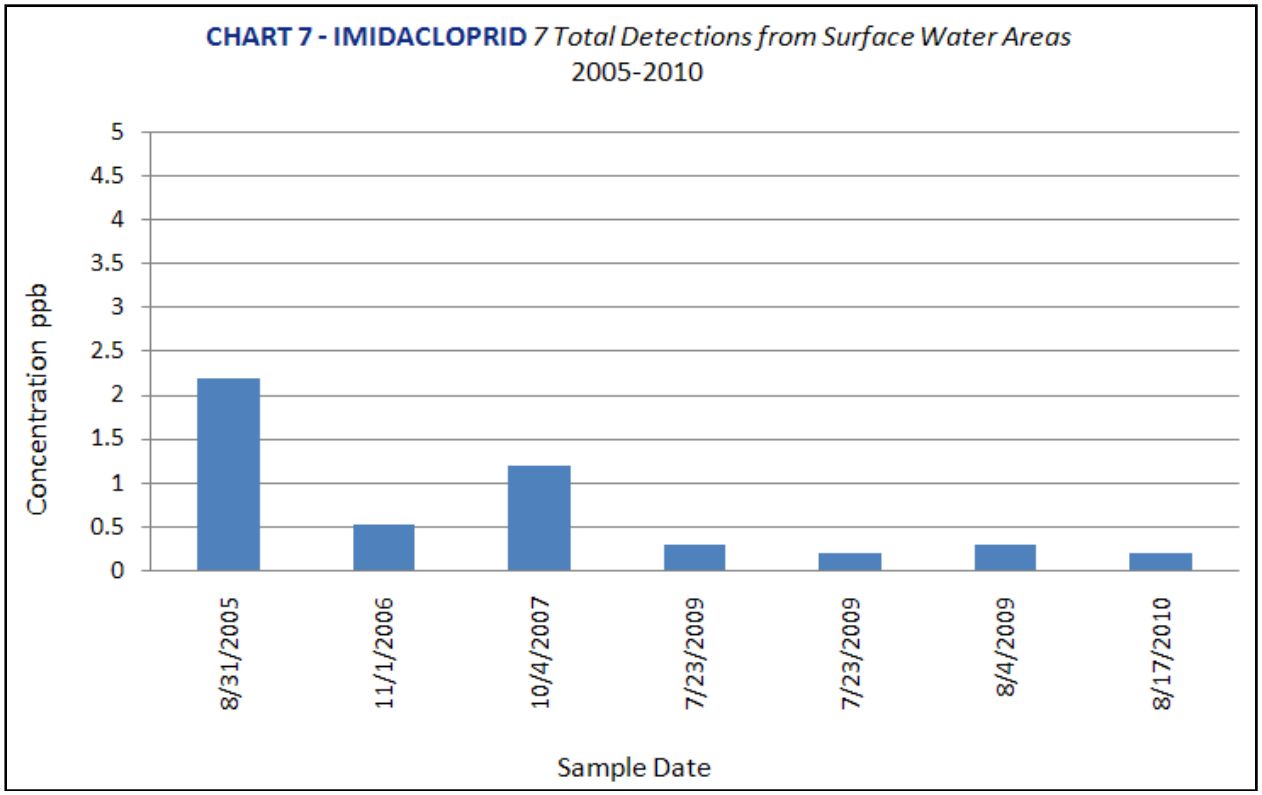
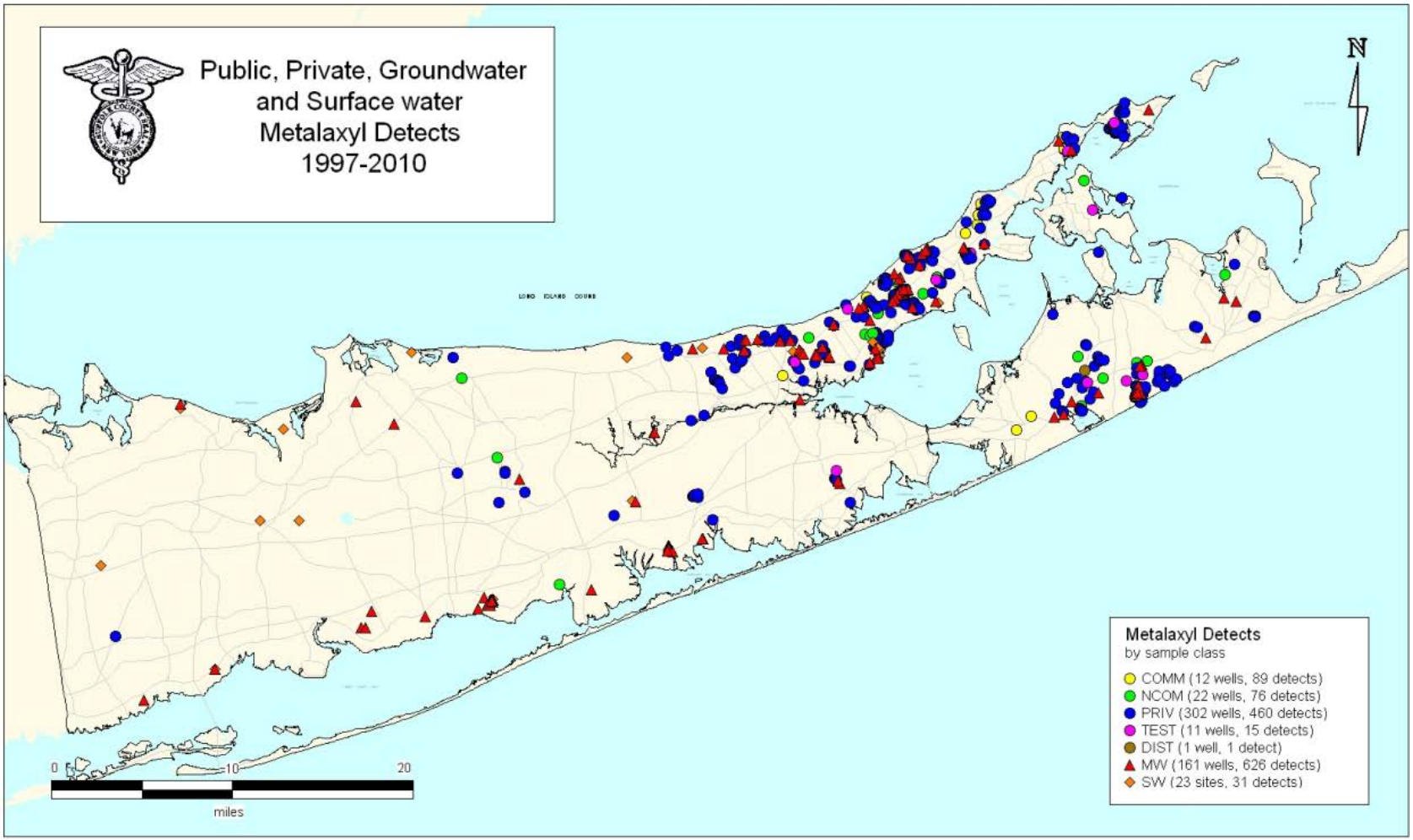


CHART 7 - IMIDACLOPRID 7 Total Detections from Surface Water Areas
2005-2010
Concentration ppb
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
8/31/2005
11/1/2006
10/4/2007
7/23/2009
7/23/2009
8/4/2009
8/17/2010
Sample Date

## Metalaxyl Detections – Map of Detection Sites (1997-2010)



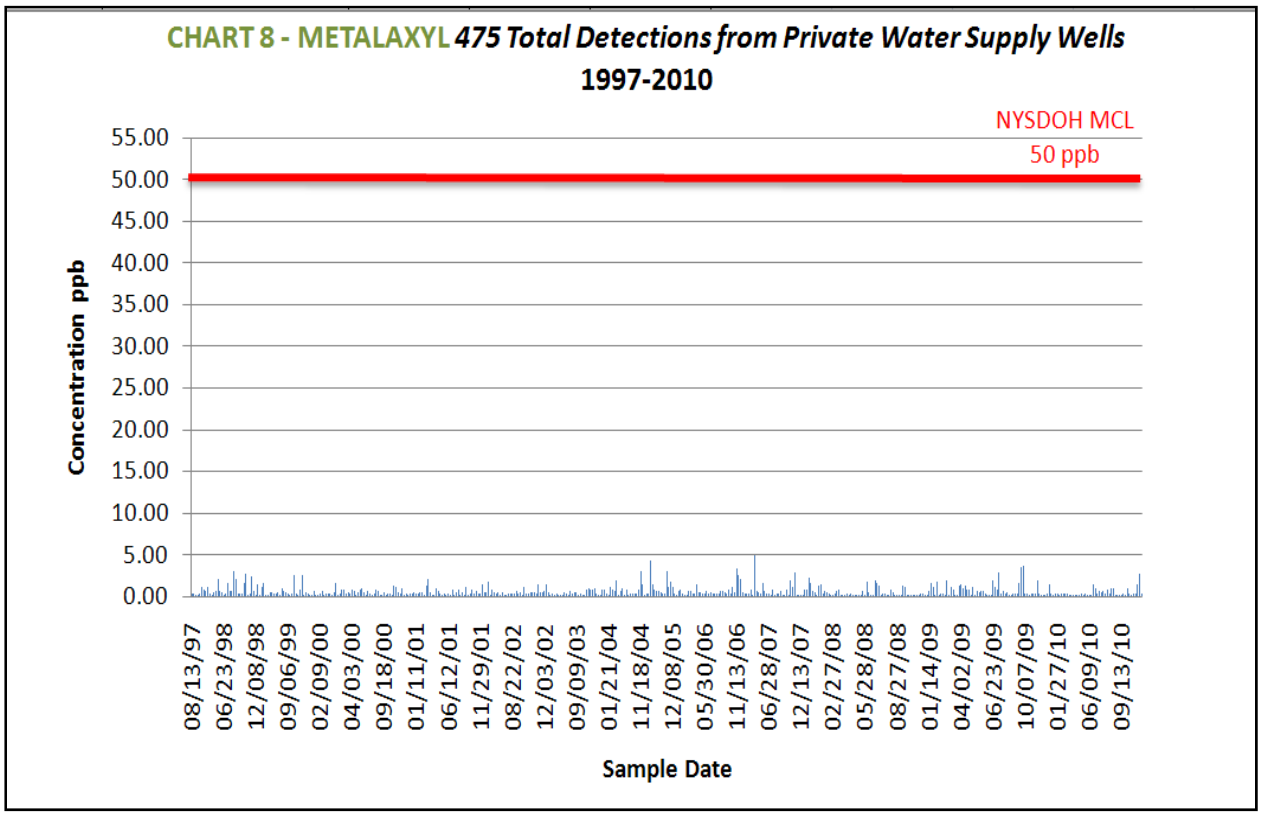


CHART 8 - METALAXYL 475 Total Detections from Private Water Supply Wells
1997-2010
NYSDOH MCL
50 ppb
Concentration ppb
55.00
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
08/13/97
06/23/98
12/08/98
09/06/99
02/09/00
04/03/00
09/18/00
01/11/01
06/12/01
11/29/01
08/22/02
12/03/02
09/09/03
01/21/04
11/18/04
12/08/05
05/30/06
11/13/06
06/28/07
12/13/07
02/27/08
05/28/08
08/27/08
01/14/09
04/02/09
06/23/09
10/07/09
01/27/10
06/09/10
09/13/10
Sample Date

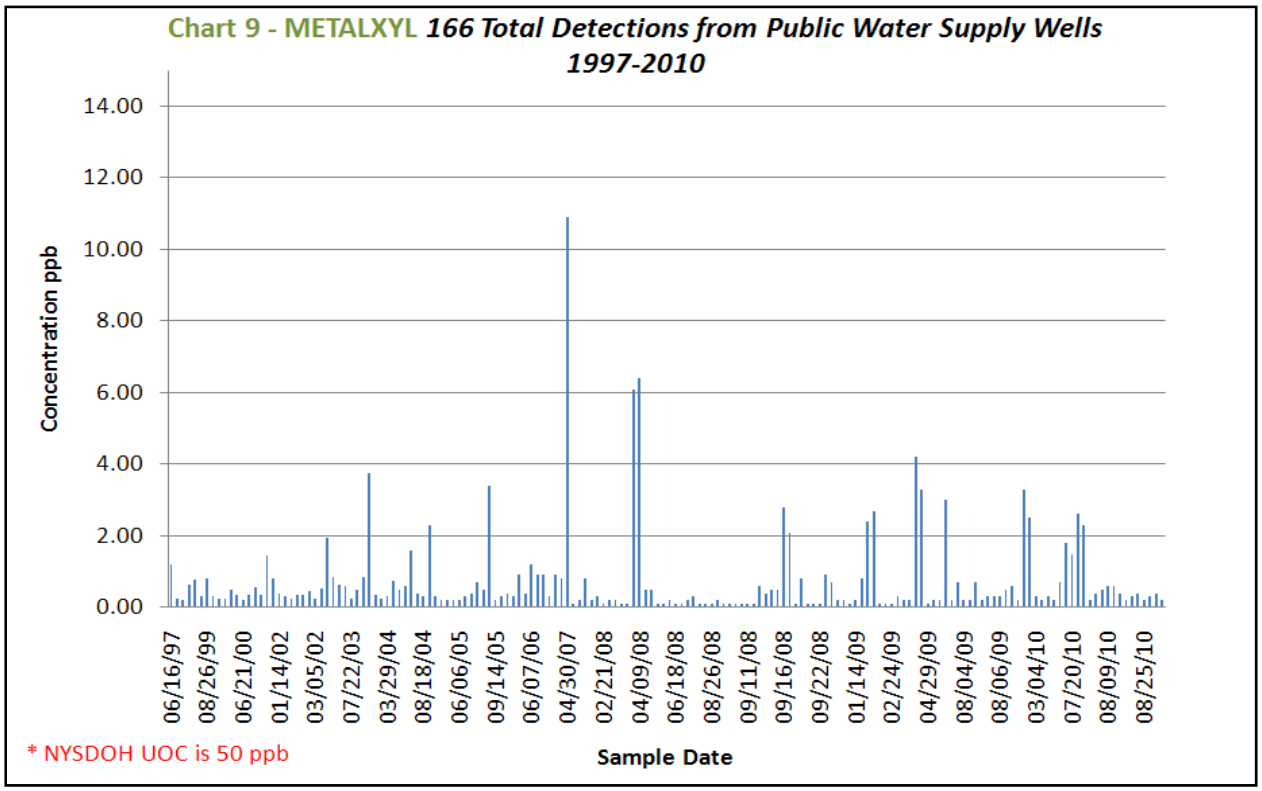


Chart 9 - METALXYL 166 Total Detections from Public Water Supply Wells
1997-2010
Concentration ppb
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
06/16/97
08/26/99
06/21/00
01/14/02
03/05/02
07/22/03
03/29/04
08/18/04
06/06/05
09/14/05
06/07/06
04/30/07
02/21/08
04/09/08
06/18/08
08/26/08
09/11/08
09/16/08
09/22/08
01/14/09
02/24/09
04/29/09
08/04/09
08/06/09
03/04/10
07/20/10
08/09/10
08/25/10
* NYSDOH UOC is 50 ppb
Sample Date

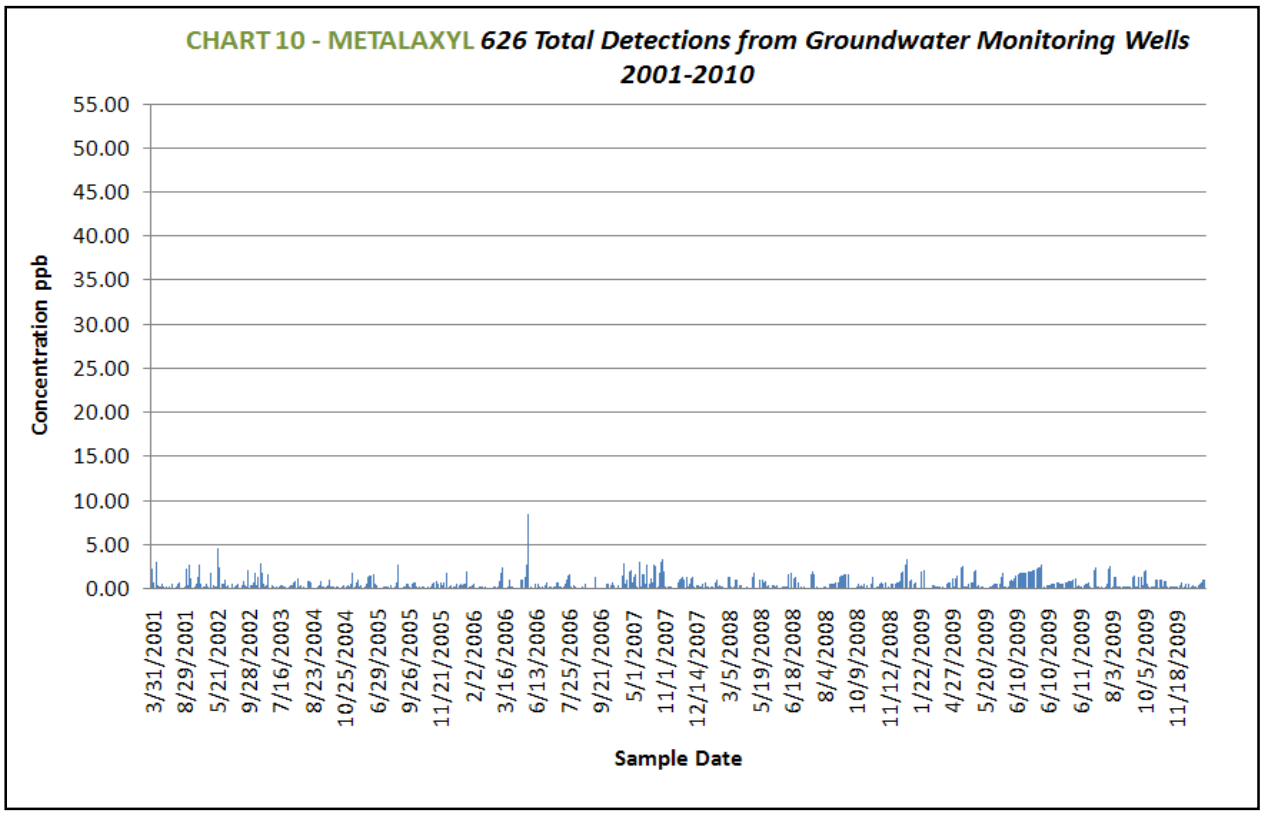


CHART 10 - METALAXYL 626 Total Detections from Groundwater Monitoring Wells 2001-2010
Concentration ppb
55.00
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
3/31/2001
8/29/2001
5/21/2002
9/28/2002
7/16/2003
8/23/2004
10/25/2004
6/29/2005
9/26/2005
11/21/2005
2/2/2006
3/16/2006
6/13/2006
7/25/2006
9/21/2006
5/1/2007
11/1/2007
12/14/2007
3/5/2008
5/19/2008
6/18/2008
8/4/2008
10/9/2008
11/12/2008
1/22/2009
4/27/2009
5/20/2009
6/10/2009
6/10/2009
6/11/2009
8/3/2009
10/5/2009
11/18/2009
Sample Date

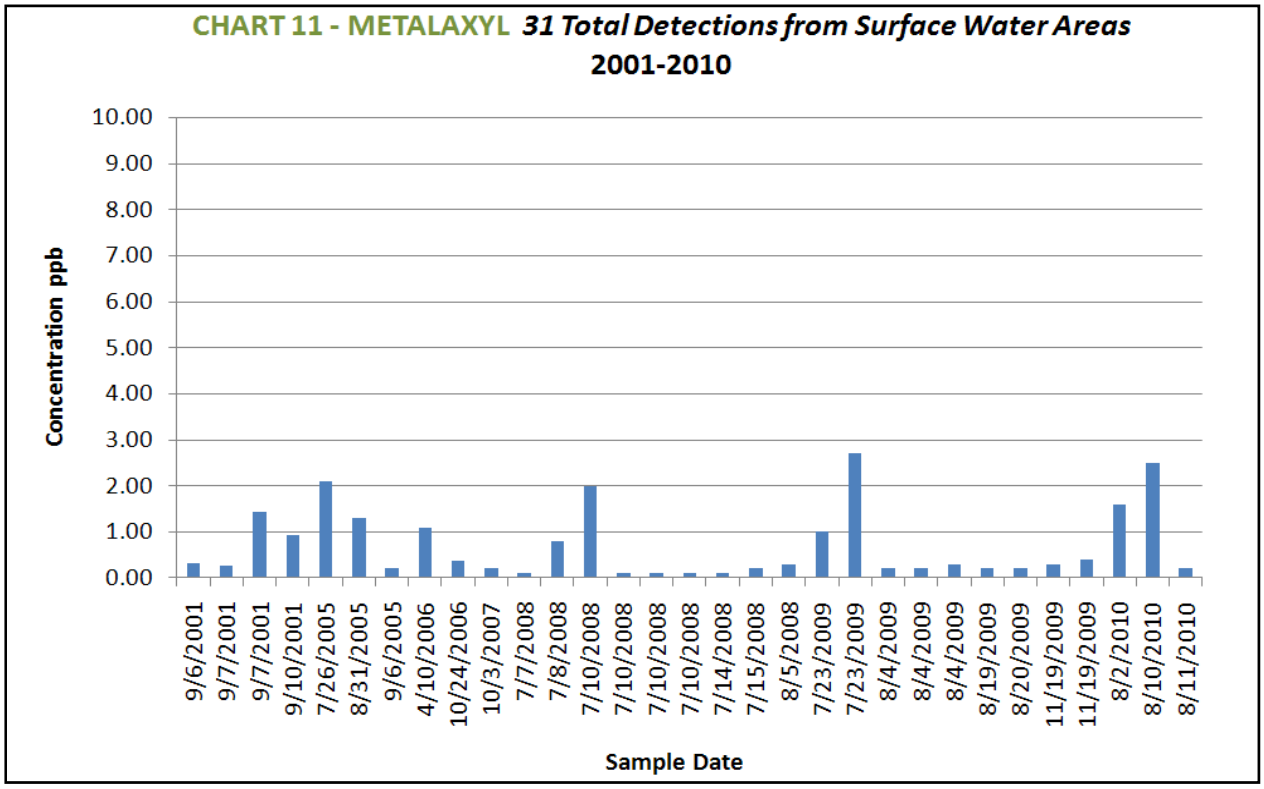


CHART 11 - METALAXYL 31 Total Detections from Surface Water Areas 2001-2010
Concentration ppb
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
9/6/2001
9/7/2001
9/7/2001
9/10/2001
7/26/2005
8/31/2005
9/6/2005
4/10/2006
10/24/2006
10/3/2007
7/7/2008
7/8/2008
7/10/2008
7/10/2008
7/10/2008
7/10/2008
7/14/2008
7/15/2008
8/5/2008
7/23/2009
7/23/2009
8/4/2009
8/4/2009
8/4/2009
8/19/2009
8/20/2009
11/19/2009
11/19/2009
8/2/2010
8/10/2010
8/11/2010
Sample Date

# APPENDIX C

# TECHNICAL REVIEW AND ADVISORY COMMITTEE (TRAC) DESCRIPTION

# AND

# ONGOING PEST MANAGEMENT OUTREACH AND EDUCATION EFFORTS

NOTE: Information provided in this appendix supplements information provided in Chapters 3 and 4 of the Strategy.

## TECHNICAL REVIEW AND ADVISORY COMMITTEE (TRAC)

**Composition**: DEC will convene, approximately six months after this Strategy is finalized, a TRAC to pool expertise of State and local government agencies as well as statewide and local public service and academic entities closely involved with pesticide regulation and water quality monitoring for Long Island:

- New York State: DEC (Chair), Department of Health, Department of Agriculture and Markets, Cornell University.
- Local Entities: Suffolk County Department of Health Services, Suffolk County Water Authority, Suffolk County Soil and Water Conservation District, Nassau County Health Department, Nassau County Soil and Water Conservation District, Cornell Cooperative Extension of Suffolk County

After 5 years, Department and involved participants assess ongoing need for TRAC.

**Primary purposes**:

- Assist DEC in investigation and assessment of active ingredients (AIs), identified and ranked by the Department (potential contaminants detected in Long Island groundwater)
- Consider factors such as groundwater monitoring data, exceedances of chemical-specific water quality standards, potential for human exposure, human health risks, existing needs for effective and lower-risk pest management alternatives
- Advise DEC regarding potential and feasible response actions to prevent further pesticide-related impacts to the Long Island aquifer while meeting pest management needs. (Scope of response actions - see P2 measures in Information Box ES-1.)

The following general approach is recommended for the activities and actions to be taken by DEC and the TRAC:

*Pesticides to be Considered:*

- DEC will rank and refer to the TRAC for evaluation, active ingredients and pesticide degradates for evaluation, based on water quality monitoring factors such as the concentrations, timing, and number and distribution of locations at which the contaminant has been detected, and its potential or estimated rate of migration.
- All pesticide products associated with a targeted active ingredient or pesticide degradate and the use patterns relevant to the potential contamination. will be included in TRAC review.
- In cases where the contaminant selected for review is a pesticide degradate, all related contaminants (parent active ingredients and any degradates) will be included in a single review (i.e., imidacloprid and its degradates imidacloprid guanidine, imidacloprid olefin, and imidacloprid urea).

*Factors to be Considered by the TRAC*:

- The TRAC will review available information compiled by DEC as well as other sources, such as groundwater monitoring data, evaluations of such data, registered pesticide labeling, methods of application, associated pest management needs and alternative management options relating to the relevant pests and selected pesticide. All relevant aspects of pesticide-related detections will be considered, particularly exceedances of a chemical-specific drinking water standard, groundwater standard, groundwater guidance values, federal health advisory levels, or other existing designated value.
- The TRAC will consider existing uses of and needs for each pesticide under review and identify actions most likely to prevent further pesticide-related impacts to Long Island's drinking water aquifer while meeting those pest management needs.

*Potential Response Actions:*

- Based on the findings of the reviews, the TRAC will submit recommendations for response actions to Department for consideration. These could include best management practices for relevant use patterns involving those products, suggestions for other feasible alternative management methods for pests targeted on the involved product labels, recommendations for education and outreach, or other steps.

*TRAC Meetings and Communications:*

- DEC will convene the first TRAC meeting withinsix months after the Strategy is finalized.
- To address current priority pesticides, DEC expects to arrange TRAC meetings on a regular basis for up to two years after the initial meeting (e.g., on a quarterly basis), depending upon the contaminants to be considered.
- Thereafter, DEC will schedule TRAC meetings based on the need to consider further contaminants on a schedule determined by the Department.
- It is recommended that the TRAC operate for 5 years, after which time the Department and the agencies involved would evaluate the role, responsibilities, and resource commitments of the TRAC and each members' involvement. If it is determined that the TRAC should continue, then the Department would specify the time frame and any changes in its operation.
- DEC will establish a list serve of TRAC members for sharing monitoring data and other information and TRAC members will communicate by e-mail, telephone, and other effective means as circumstances warrant.
- Operation of the TRAC will be an open process. Meetings will be opened to the public and relevant materials will be posted on a designated webpage.

# ONGOING PEST MANAGEMENT OUTREACH AND EDUCATION EFFORTS

## Outreach to Stakeholders and the Public on the Long Island Strategy

It will be important to inform stakeholders of the Strategy (e.g., water consumers, local governments on Long Island, pesticide applicators, pesticide product registrants, etc.) to ensure its successful implementation. Only if stakeholders are informed about the Strategy can it serve as a framework for benefits which accrue from protecting water quality while continuing to meet critical pest management needs. Therefore, outreach will be conducted on the completed draft and final Strategy, such as:

- Information about the Strategy and related outreach will be available on the Department website.
- DEC held public information meetings on the draft Strategy in Nassau and Suffolk counties and published notice of the meetings in the *Environmental Notice Bulletin* and potentially in publications of involved associations.
- The Department will reach out to involved organizations to expand information dissemination on the Strategy through the organizations' communication channels (e.g., websites, newsletters).

## Ongoing Outreach and Education Activities

Outreach and education regarding pesticide and pest management and water quality are provided by a number of governmental and non-governmental entities. Outreach also includes information regarding pollution prevention elements addressed in this Strategy, such as nonpoint source management and integrated pest management (IPM). Education is provided through a variety of mechanisms, including training courses, staff presentations, compliance assistance, website postings, and printed materials. Outreach activities of the primary entities are summarized below.[67]

## State Agency Outreach and Education

### DEC

As the lead State agency regulating pesticides, the Department conducts many forms of pesticide and pest management-related outreach and education, through the Division of Materials Management in Albany and in the nine DEC Regional Offices. [68]

Department Pesticide Control Specialists on Long Island (Region 1), and in all Regional Offices, provide information on a local level on many pesticide management matters, such as pesticide use restrictions for water quality protection which are communicated to user groups in the affected area. DEC outreach and education includes:

- Pesticides program staff training sessions for certified applicators and technicians,

[67] See Component 2 of this Plan for a summary of the overall roles of entities involved in pesticide management and water quality on Long Island.
[68] For more information about the NYSDEC pesticides program, see http://www.dec.state.ny.gov/chemical/298.html.

- Staff presentations, workshops and meetings with pesticide applicators and user groups, pesticide product registrants, and others regarding these matters,
- Pesticides compliance assistance regarding State pesticide laws and regulations,
- Information on registered pesticides through the New York State Pesticide Product, Ingredient and Manufacturer System (PIMS) databases and staff answers to questions on information in that database,
- Brochures and other printed materials on IPM, pesticides, and pest management, and
- Detailed website outreach resources.

The DEC Division of Water (DOW) provides information about groundwater in general and specifically about the Long Island aquifers[69], watershed management and assessments, water quality standards and guidance, oceans and estuaries and other subjects. DOW also manages the New York State Nonpoint Source (NPS) Management Program, which includes the NPS Management Plan and produces publications (e.g., Management Practices catalogue) and conducts special projects on these subjects.[70]

### NYS Department of Health

The NYS Department of Health (NYSDOH) oversees and conducts public notification for significant detections of pesticides in water supplies. Key responsibilities are assigned to local health departments and water suppliers with oversight and policy direction from NYSDOH (e.g., Suffolk County Department of Health Services would advise of detections above the reference point). For individual private supplies, the well owner will be notified regardless of the level of detection. NYSDOH determines the appropriate notification if a public health threat is indicated. In addition, the NYSDOH Bureau of Water Supply Protection prepared the Source Water Assessment Plan (SWAP). The program under that Plan focuses on assessing the susceptibility of public water systems to contamination. Information collected is used to direct local and state protection efforts and oversight of public drinking water systems.[71]

### NYS Department of Agriculture and Markets

The mission of the NYS Department of Agriculture and Markets, Division of Land and Water Resources includes development and implementation of environmental stewardship programs on farms to help protect water resources from pollution. The Department provides staff, office space and administrative support for the NYS Soil and Water Conservation Committee (S&WCC). The S&WCC and its network of district staff also provide outreach at the local level.

Agriculture and Markets also administers New York State funds for the S&WCC's Agricultural Nonpoint Source Abatement and Control Program, chairs the Agricultural Environmental Management (AEM) Steering Committee and administers New York State farmland protection programs. The S&WCC is responsible for the AEM program and the S&WCC and the Soil and Water Conservation District staff disseminates information.[72]

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[69] NYSDEC online information on Long Island aquifers can be found at http://www.dec.ny.gov/lands/36183.html.
[70] For more information about the NYSDEC DOW, see (http://www.dec.state.ny.us/website/dow/index.html.
[71] NYSDOH makes available information about the Source Water Assessment Plan and Program as well as other source water information at http://www.health.state.ny.us/nysdoh/water/swap.htm.
[72] For more information about the Department, S&WCC, and AEM, see http://www.agmkt.state.ny.us/.

### Nassau and Suffolk Counties

At the local government level, Suffolk and Nassau counties' county water quality coordinating committees and watershed protection committees have important roles regarding information dissemination on groundwater protection, water quality, and pesticides.[73]

### Federal Government

The U.S. Environmental Protection Agency (USEPA) provides many forms of outreach and education on water quality at the national level, beyond the scope of this document, as well as outreach regarding Long Island. USEPA maintains extensive resources online regarding groundwater and water quality in general as well as on Long Island, including a report on the Nassau-Suffolk Aquifer System and an explanation of the federal water quality standards.[74] USEPA is a partner in the Long Island Sound Study (LISS) and maintains information on and links to LISS and "Sound Health 2010, Status and Trends in the Health of Long Island Sound."[75]

The U.S. Geological Survey (USGS) has published numerous assessments of pesticides in water resources for New York State and the rest of the nation. The USGS maintains an online publication search engine, in which information on Long Island water resources and other areas of the State can be found.[76]

### Other Entities Conducting Outreach and Education

Cornell University**,** through its New York State College of Agriculture and Life Sciences Pesticide Management Education Program (PMEP) [77] disseminates information to pesticide applicators and others on subjects related to this Strategy by:

- Serving as a pesticide information center for Cornell Cooperative Extension field staff, growers, commercial applicators, pesticide formulators/distributors, and private citizens,
- Developing training manuals for pesticide applicators,
- Offering training for pesticide applicators,
- Providing online information to the regulated community, such as a calendar of available recertification courses and the New York State Pesticide Product, Ingredient and Manufacturer System (PIMS) databases (funded by DEC as a search system for pesticide product information).

The NYS Integrated Pest Management (NYSIPM) Program at Cornell provides information on IPM through meetings and brochures and other printed materials, to growers, golf courses, vineyards, schools, municipalities and homeowners on IPM and pest management. NYSIPM also

[73] For more information about Suffolk and Nassau County programs, see http://www.co.suffolk.ny.us/
[74] A link to the USEPA Nassau-Suffolk Aquifer System report is on the NYSDEC website at http://www.dec.ny.gov/lands/36183.html. Other USEPA information on Long Island water resources can be found at http://www.epa.gov .
[75] For information on "Sound Health 2010", visit http://longislandsoundstudy.net/ .
[76] The USGS online search engine for New York State can be found at http://ny.cf.er.usgs.gov/biblio/search_biblio.cfm.
[77] For information about PMEP, see http://pmep.cce.cornell.edu.

develops and makes available Organic Guides for Fruits, Vegetables and Dairy.[78] The NYSIPM Program also provides online resources and a publication list.[79]

Additionally, Cornell Cooperative Extension produces written information on pest management, such as "Lawn Care without Pesticides" (Information Bulletin 248). The document is a detailed manual entitled for homeowners on practices for lawn maintenance and pest management without pesticides.[80]

Other entities provide information on pest management, pesticides use, and water quality:

- Professional pesticide applicator associations,
- Advocacy groups, many of which have public education training missions, and hold trainings and/or maintain online information,
- regional planning agencies, and task forces and committees with a water quality focus, and the Non-point Source Committee, and
- Community Water Systems (Annual Water Quality Reports).

## Certified Pesticide Applicator Training

An essential element of pesticide pollution prevention is providing education and training to pesticide applicators regarding pesticides and water quality. New York State requires that private applicators be certified to apply "restricted use" pesticides and commercial applicators be certified to apply "restricted" and "general use" pesticides. Under New York State regulation, applicators must pass a DEC-monitored exam and complete DEC-approved training (to which DEC has assigned credits) to be certified or recertified.

As of June 2012, over 4,700 individuals on Long Island were certified by DEC to apply pesticides. This includes certified commercial applicators and technicians, certified private applicators (growers), and aquatic antifouling paint applicators. This regulated community needs to be aware of pesticides regulatory requirements and the relationship of pesticides application to groundwater on Long Island. The core sources of such information for applicators are certification and recertification training and training manuals.

Overall, applicator training is conducted on Long Island by PMEP/Cornell Cooperative Extension (CCE), private course sponsors, and DEC staff. Key to applicator training is the use of the *Pesticide Applicator Training Core Manual* and more than two dozen Pesticide Safety Training Manuals containing information tailored to a specific type of pesticide use by commercial and private applicators.
Examples include use of antifouling paints, termite control, agricultural plants, and sewer line root control. PMEP has had the central role in developing and updating the manuals, which are available from Cornell University for a fee. Examples of topics covered in PMEP/CCE training and/or manuals for pesticide applicators include pest management, pest and crop information, groundwater protection, integrated pest management, federal and State pesticide laws and

[78] For information on NYSIPM Organic Guides for Fruit, Vegetables and Dairy, see http://nysipm.cornell.edu/organic_guide/.
[79] http://www.nysipm.cornell.edu/.
[80] To view the Lawn Care without Pesticides manual, visit http://ecommons.cornell.edu/handle/1813/3574.

regulations, pesticide application technology, endangered species protection, pesticide efficacy, worker safety, labels, and many others.

# Appendix 10
# Special Groundwater Protection Area: "Appendix G: Golf Course Management and Nitrates in Groundwater"

# Appendix G: GOLF COURSE MANAGEMENT AND NITRATES IN GROUNDWATER*

It is impossible to overstate the importance of groundwater supplies to our nation. Groundwater - the water pumped from wells below the soil surface — presently accounts for 50 percent of our nation's drinking water. In rural areas 95 percent of drinking water supplies come from groundwater. Protecting this nonreplaceable natural resource should be a priority of every citizen.

Many chemicals can be considered potential contaminants of groundwater. The list usually includes pesticides, leachate from landfills, organics (such as cleaning solvents, gasoline and oil) and nitrates from septic fields or fertilizers. The issue having the potentially greatest ramifications for golf courses is nitrates from fertilizers.

Nitrates have been associated with several environmental problems, including surface water quality (eutrophication), productivity of both managed and natural ecosystems, acid rain and the depletion of the stratosphere ozone by nitrous oxides. When you consider groundwater as a main source of drinking water, however, the effect of nitrates on human health is the greatest concern.

The list of potential health risks associated with nitrates includes birth defects, cancer, nervous system impairments and the *blue baby* syndrome. This syndrome — called *methemoglobinemia* — is the main health hazard of consumption of nitrates and occurs when nitrate reduces the oxygen-carrying capacity of the blood. This condition occurs most often in infants less than 3 months old who are not on solid foods. Citrus fruits or vitamin A supplements reduce the chance of methemoglobinemia. Older children or adults are generally not affected by nitrates (or nitrites) in water or food. About 86 percent of the adult intake of nitrates comes from vegetables and only 1 percent from water. The average person in the United States consumes 22.5 mg (0.0008 ounces) of nitrate-N each day.

The U.S. EPA recommends the maximum concentrate limit of 10 mg of nitrate-N per liter, or 10 ppm, in drinking water. The lowest level recorded to cause a health problem was 20 mg nitrate-N per liter. There have been virtually no reports of methemoglobinemia in the United States in recent years. One report in 1982 concerned a 6-week-old infant whose formula was prepared with well water containing 121 mg nitrate-N per liter. The symptoms quickly disappeared when the well water was no longer used.

The other health-related effects of nitrates in drinking water have not been widely confirmed and are considered more speculative in nature. Thus, new research will have to show a clear health risk before stronger measures will be taken to reduce the nitrate levels acceptable in drinking water.

### Historical Perspective of Turfgrass Fertilization and Groundwater

In the early 1970s, one of the first areas of the country to find high nitrate levels in municipal drinking wells was Long Island, N.Y. With about 28 percent of the land area of Long Island's two counties (Nassau and Suffolk) being used in turfgrass culture, coupled with a high average rate of nitrogen applied (2.3 lbs. N/1,000 sq. ft. per year), implications were made that turfgrass fertilizers contaminated groundwater. The controversy was further fueled by preliminary research results. A study done on a *lawn type* turfgrass showed that between 20 percent and 80 percent of the nitrogen applied was accounted for by plant uptake. The conclusion was that an average value of 50 percent of the nitrogen fertilizer applied ended up in the plant, and the rest would leach (Selleck et al, 1980). It was assumed that nitrates not taken up by the plant must leach into the groundwater.

In the last 10 years, a wealth of knowledge has been generated about the fate of nitrogen applied to turfgrass. Even though about half of the nitrogen applied to turfgrass does end up in the plant, the other half can be found either stored in the soil, lost to the atmosphere, leached into groundwater or transported as run-off into surface water.

Petrovic, A. Martin. 1989, *Golf course management and nitrates in groundwater: the real story.* Golf Course Management 57 (9) : 54-64. Article reproduced with the permission of the author.

Fertilizer nitrogen found to be stored in the soil and thatch was shown to be between 36 percent to 47 percent of the amount applied (Starr and DeRoo, 1981). Nitrogen lost back to the atmosphere from an application to a turfgrass site occurs from two different processes: ammonia volatilization and denitrification of nitrate. If urea is used as the fertilizer source, ammonia volatilization can be as high as 40 percent of the fertilizer applied (Nelson et al, 1980). However, if weather conditions are dry or the urea is irrigated in, the losses are almost zero (Bowman et al, 1987).

Research on denitrification as related to turfgrass is limited to only one report, which notes that on soils that are either cool ( ≤68°F) or not saturated, little or no denitrification occurred. However, on warm soils ( >86°F) that were saturated, 93 percent of the applied nitrogen was denitrified and lost back to the atmosphere (Mancino et al, 1988). It is fair to say that, on average, about 25 percent to 35 percent of the fertilizer nitrogen applied may be lost back to the atmosphere — especially if urea is used as the nitrogen source.

The controversy of nitrates in groundwater as it relates to golf courses centers on the nature and management of golf course turfs. When people think of greens and tees, some think of very sandy, highly modified soils that drain very easily, are heavily irrigated and do not hold nutrients. Add the perception that golf courses use heavy amounts of fertilizer and it is easy to see how some people might conclude that golf courses contaminate groundwater with nitrates. A number of weaknesses are found in this conclusion:

- The highly sand portions of most golf courses are confined to greens and possibly tees, though this is usually true on courses younger than 20 years. This relates to about 2 to 4 acres of the 60 to 100 acres of turf on a *typical* 18 hole golf course. To put this in perspective, for a state like New York with 1,000 golf courses, there would be about 2,000 acres of greens and tees out of a total of 30 million acres in the state, or 0.00007 percent of the land area. Comparing this with lawns 700,000 acres, or 2.3 percent or cropland 6 million acres, or 20 percent, the portion of golf courses having the highest potential for nitrate leaching represent an insignificant threat to the environment as a whole.

- Research information on sites like golf greens containing high amounts of sand do not support the conclusion that golf courses are prone to heavy nitrate leaching, especially with today's trend toward lower nitrogen use rates and the use of slow-release sources. Early work done on USGA specification greens of bermudagrass (Brown et al, 1982) found that 22 percent of the fertilizer, in this case ammonium nitrate applied at an excessive rate of 3 lbs./1,000 sq. ft. in February, leached in the first 50 days after it was applied. However, when rates of nitrogen more typical of standard maintenance practices were applied (1 to 1.5 lbs. per application) to straight sand greens of either bentgrass or bermudagrass, nitrate leaching was only 1 percent to 2 percent of the amount of nitrogen applied (Sheard et al, 1985 and Synder et al, 1981), even for urea. In the case of bermudagrass (Synder et al, 1981), the average concentration of nitrate in the drainage water was 0.2 mg nitrate-N/1, far below the safe drinking water standard of 10 mg/1.

- Research findings from sites with less sandy soils, more typical of fairways, older greens and trees, roughs and general turfgrass sites, further support the conclusion that golf courses do not contaminate groundwater with high levels of nitrates. In an unirrigated (Starrand DeRoo, 1981) or conservatively irrigated *lawn-type* site with season-long fertilizer rates of 4 lbs. N/1,000 sq. ft. or less (Morton et al, 1988), nitrate levels leaving the root zone were not significantly higher than those of unfertilized plots.

- When research does show nitrate leaching from turfgrass areas, that leaching fortunately lends itself to being controlled by the best management practices. This most often occurs as follows: when excessive nitrogen amounts are used (Brown et al, 1977), more often when highly water soluble nitrogen sources are used (urea, ammonium nitrate, ammonium sulfate or potassium nitrate) (Synder et al, 1978); when nitrogen fertilizer is applied in a dormant or semi-dormant period of limited plant uptake and greater water percolation through the soil (Petrovic et al, 1986, and Synder et al, 1984); and where excessive irrigation has caused greater amounts of leaching (Synder et al, 1984, Brown et al, 1977, and Morton et al, 1988).

## Managing Golf Courses to Minimize Nitrate Leaching

Several factors are important in determining the leaching potential of a fertilizer applied to turf. These factors include the source of nitrogen and how readily available or soluble it is, the rate of application, the season of the year of the application, irrigation practices and soil type. Fortunately, a turfgrass manager has control over the first three factors; thus, nitrate leaching can be kept near zero or at least at an acceptable level. What follows is a discussion of these factors as they relate to golf course management.

## Summary of Nitrate Leaching From Fertilizers Applied to Turfgrass

| Information Source(location) | Nitrogen Source | Single N Application Rate | Total Yearly N Rate | Season Applied | Soil Type | Irrigation | Turfgrass Type | % of N Leached | Concentrate of Nitrate-N In Water |
|---|---|---|---|---|---|---|---|---|---|
| | | lbs N/1000 ft. | | | | | | | mg/1 |
| Brown et al 1977 (Texas) | Nitroform | 5.0 | 5.0 | June | sand/peat | 0.25"/day | Bermuda- | 0 | |
| | | 5.0 | 5.0 | June | sand/peat | 0.35"/day | grass | - | <1 |
| | | 5.0 | 5.0 | " | " | 0.41"/day | green | - | <1 |
| | Ammonium | 3.5 | 3.5 | Feb. | " | 0.25"/day | " | - | <1 |
| | Nitrate | 3.5 | 3.5 | " | " | 0.35"/day | " | - | >10 for 20 days |
| | | 3.5 | 3.5 | " | " | 0.41"/day | " | - | >10 for 28 days |
| | Milorganite | 3.0 | 3.0 | Oct. | " | 0.25"/day | " | - | <3 |
| | | 3.0 | 3.0 | " | " | 0.35"/day | " | - | <6 |
| | | 3.0 | 3.0 | " | " | 0.41"/day | " | - | <5 |
| | Ammonium | 0.5 | 0.5 | Summer | " | 0.4"/day | " | 37 | <10 |
| | Sulfate | 1.0 | 1.0 | " | " | 0.4"/day | " | 25 | <10 |
| | | 1.5 | 1.5 | " | " | 0.4"/day | " | 22 | >10 on 3 day |
| | | 2.0 | 2.0 | " | " | 0.4"/day | " | 6 | >10 on 3 day |
| Brown et al 1982 (Texas) | IBDU | 3.0 | 3.0 | June | sand/peat | 0.4"/day | " | 0.9 | 0 |
| | | 3.0 | 3.0 | " | sand/soil/ peat | " | " | 0.7 | <2 |
| | | 3.0 | 3.0 | " | sandy loam soil | " | " | 0.1 | <1 |
| | Milorganite | 3.0 | 3.0 | Oct. | sand/peat | " | " | 7.7 | 0 |
| | | 3.0 | 3.0 | " | sandy loam soil | " | " | 2.4 | 2.2 |
| | | 3.0 | 3.0 | " | sandy loam soil | " | " | 0.5 | 0 |
| | Nitroform | 5.0 | 5.0 | June | sand/peat | " | " | 0.2 | 0 |
| | | 5.0 | 5.0 | " | sand/soil/ peat | " | " | 0.3 | 0 |
| | | 5.0 | 5.0 | " | sandy loam soil | " | " | 0.1 | 0 |
| | Ammonium | 3.5 | 3.5 | Feb. | sand/peat | 0.4"/day* | " | 22 | >10 for 25 days |
| | Nitrate | 3.5 | 3.5 | " | sand/soil/ peat | 0.4"/day* | " | 22 | >10 for 25 days |
| | | 3.5 | 3.5 | " | sandy loam soil | 0.4"/day* | " | 8.6 | >10 for 25 days |
| Motron et al 1988 | Urea/Fluf | 1 | 2 | June-Nov. | sandy loam | 0.5"/wk** | | - | 0.87 |
| (Rhode Island) | | 1 | 2 | " | " | 1.5"/wk | Kentucky bluegrass | - | 1.77! |
| | | 1 | 5 | " | " | 0.5"/wk** | red fescue | - | 1.24 |
| | | 1 | 5 | " | " | 1.5"/wk | lawn | - | 4.02! |
| | | 0 | 0 | " | " | 0.5"/wk** | " | - | 0.61 |
| | | 0 | 0 | " | " | 1.5"/wk | " | - | 0.36 |
| Mosdell and Schmidt 1985 (growth chamber) | Ammonium | 1.5 | 1.5 | cool | silt loam | 1"/wk | Kentucky | 0 | - |
| | Nitrate | 1.5 | 1.5 | cool | " | 2"/wk | bluegrass | 0 | - |
| | | 1.5 | 1.5 | warm | " | 1"/wk | greenhouse | 1.2 | - |
| | | 1.5 | 1.5 | warm | " | 2"/wk | " | 2.6 | - |
| | IBDU | 1.5 | 1.5 | cool | " | 1"/wk | " | 2.7 | - |
| | | 1.5 | 1.5 | cool | " | 2"/wk | " | 0 | - |
| | | 1.5 | 1.5 | warm | " | 1'/wk | " | 0 | - |
| | | 1.5 | 1.5 | warm | " | 2"/wk | " | 0 | - |
| Nelson et al 1980 | IBDU | 5.0 | 5.0 | " | silt loam | 0.9"/day | Kentucky | 26 | - |
| | | 5.0 | 5.0 | " | thatch | " | bluegrass | 7 | - |
| | Urea | 5.0 | 5.0 | warm | silt loam | " | growth | 32 | - |
| | | 5.0 | 5.0 | " | thatch | " | chamber | 84 | - |
| Petrovic et al 1986 | Nitroform | 2.0 | 2.0 | Nov. | sandy loam | none | | 0.4 | - |
| (New York) | PCU (150D) | 2.0 | 2.0 | " | " | " | Kentucky bluegrass | 0.0 | - |
| | Milorganite | 2.0 | 2.0 | " | " | " | lawn | 0.3 | - |
| | Urea | 2.0 | 2.0 | " | " | " | " | 29-47 | - |
| | SCU | 2.0 | 2.0 | " | " | " | " | 11-12 | - |
| Sheard et al 1985 (Ontario) | Urea | 0.5 | 6.0 | whole year | sand | not given | Bentgrass | 2.0 | <1.3 |
| | SCU | 0.5 | 6.0 | " | " | " | greens | 1.2 | <1.3 |

## TABLE (Cont'd.)

| Information Source(location) | Nitrogen Source | Single N Application Rate | Total Yearly N Rate | Season Applied | Soil Type | Irrigation | Turfgrass Type | % of N Leached | Concentrate of Nitrate-N In Water |
|---|---|---|---|---|---|---|---|---|---|
| | | lbs N/1000 ft. | | | | | | | mg/1 |
| Starr and DeRoo 1981(Connecticut) | Ammonium Sulfate | 1.8 | 3.7 | May/Sept. | sandy loam | none | Kentucky bluegrass/ red fescue lawn | 0 | 0 |
| Synder et al 1981 (Florida) | Check | 0 | 0 | whole year | sand | as needed | Bermuda-grass | 0 | |
| | Methylene Urea | 0.8 | 5.0 | " | " | " | | <1 | <1 |
| | Nitroform | " | " | " | " | " | " | <1 | <1 |
| | SCU | " | " | " | " | " | " | 0 | <1 |
| | IBDU | " | " | " | " | " | " | 0.5 | <1 |
| | Urea | " | " | " | " | " | " | 0 | <1 |
| | Calcium Nitrate | " | " | " | " | " | " | 3.7 | <1 |
| | Menthylene Urea | 1.6 | 10.0 | " | " | " | " | 2.0 | <1 |
| | Nitroform | " | " | " | " | " | " | 0.1 | 1 |
| | SCU | " | " | " | " | " | " | 0.8 | <1 |
| | IBDU | " | " | " | " | " | " | 5.5 | 1.4 |
| | Urea | " | " | " | " | " | " | 0.9 | <1 |
| | Calcium Nitrate | " | " | " | " | " | " | 9.3 | 2.4 |
| Synder et al 1984 (Florida) | Ammonium Nitrate SCU Fertigation | 1/month | 2 | Feb.-Mar | " | 0.23"/day (daily) | " | 54.6 | 9.4 |
| | | " | " | " | " | " | " | 33.1 | 6.5 |
| | | - | " | " | " | " | " | 7.0 | 1.2 |
| | Ammonium Nitrate SCU Fertigation | 1/month | 2 | June-July | sand | 0.12"/day (sensor) | Bermuda-grass | 8.3 | 3.2 |
| | | | | | | | | 1.6 | 0.8 |
| | | " | " | " | " | " | " | 0.8 | 0.1 |
| | Ammonium Nitrate SCU Fertigation | 1/month | " | " | " | 0.48"/day (daily) | " | 22.2 | 3.2 |
| | | " | " | " | " | " | " | 10.1 | 1.4 |
| | | " | " | " | " | " | " | 15.3 | 2.1 |
| | Ammonium Nitrate SCU Fertigation | 1/month (season) | " | Apr.-May | " | 0.12"/day (sensor) | " | 1.9 | 6.2 |
| | | " | " | " | " | " | " | 0.3 | 1.0 |
| | | " | " | " | " | " | " | 0.3 | 1.0 |
| | Ammonium Nitrate SCU Fertigation | 1/month | " | " | " | 0.32"/day (daily) | " | 56.1 | 18.9 |
| | | " | " | " | " | | " | 14.4 | 4.8 |
| | | " | " | " | " | " | " | 3.6 | 1.2 |
| | Ammonium Nitate SCU Fertigation | 1/month | " | Feb.-Mar. | " | 0.06"/day (sensor) | " | 40.5 | 14.4 |
| | | " | " | " | " | " | " | 11.2 | 4.0 |
| | | " | " | " | " | " | " | 6.3 | 2.2 |

* Irrigation applied every other day

**Irrigation input delivered did not result in water moving out of the root zone.

! Values significantly higher than unfertilized control plots.

## Nitrogen Sources

Understanding the various nitrogen sources is essential to minimizing the nitrate leaching problem. The worst possible scenario occurs when a large amount of water-soluble nitrogen is present in the soil and a substantial volume of water passes through the soil. There are two ways to avoid this situation. One is to use slow-release nitrogen sources that control the amount of soluble nitrogen present at any one time. The second involves very light, but frequent, surface applications of soluble nitrogen sources; this may be done by using standard application procedures or by fertigation.

### The Properties of Nitrogen Sources Used on Golf Courses

| *Nitrogen Source* | *Type* | *Percentage Nitrogen* | *Low Temp Response** | *Initial Response*** | *Residual Response...* | *Water: Solubility* | *Folia: Burn Potential* | *Acidifying: Potential* | *Leaching Potential* |
|---|---|---|---|---|---|---|---|---|---|
| Ammonium nitrate | Synthetic Inorganic | 33 | G | F | L | H | H | M | H |
| Ammonium sulfate | | 21 | G | F | L | H | H | H | H |
| Activated sewage | Natural organic | 4-7 | M-P | M-S | E | L | L | L | L |
| Sludge (Milorganite) | | | | | | | | | |
| Digested sewage | | 1-3 | M-P | S | E | L | L | L | L |
| IBDU | Synthetic organic | 31 | M | M-S | M-E | L | L | L | M |
| Urea | | 45 | G | F | L | H | H | M | H |
| Urea formaldehyde | | 38 | P | M-S | E | L | L | L | L |
| Sulfur-coated urea | | 32 | M | M | M-E | M-L | L | M | M |

G, Good; M, Moderate: P, Poor
** F, Fast: M, Medium; S, Slow
...E, Extended; M, Moderate: L, Little
:H, High; M, Moderate; L, Low

Nitrogen sources that release nitrogen at a slow rate are called slow-release. The slow-release property is sometimes a result of synthetic or natural organics requiring microbial activity to convert the nitrogen to a plant available form. In some cases, water very slowly dissolves the nitrogen. Finally, the slow- release property can be due to the soluble nitrogen being physically protected with a coating. One practice a golf course superintendent can adopt is the use, whenever possible, of a slow-release nitrogen source to protect against an uncontrollable event that could lead to unusually high potential for leaching. Such an event occurs, for instance, when a significant amount of rain (1 or 2 inches) falls within several days of applying a highly soluble nitrogen source at the high rate of 1 lb. N/1,000 sq. ft. Another sound practice is to apply a soluble nitrogen source frequently, but at a lower rate (1/10 to 1/4 lb. N/1,000 sq. ft.) This *spoon feeding* approach avoids substantial leaching, even from sources that have a high potential for leaching.

So why not use only slow-release nitrogen sources to protect groundwater quality? In general, the slow-release nitrogen sources give poor to moderate response in cool weather. In such weather, therefore, it is necessary to use highly soluble nitrogen sources. Slow-release nitrogen sources generally are also more expensive and are usually applied in a dry form, which under some circumstances is inconvenient. If the golf course superintendent is following the *spoon feeding* approach, it would be more appropriate to use highly water soluble nitrogen sources. However, on less highly managed portions of the golf course that are fertilized (fairways, roughs and grounds areas), it may be wise to use slow-release nitrogen sources exclusively to reduce the potential for nitrate leaching.

## Nitrogen Application Rates and Timing

One of the main goals of any fertilizer program is to provide the *optimum amount* of a given nutrient necessary to provide the desired response. The *optimum amount* can vary from course to course and from grass to grass within a given course. Thus, general fertilizer programs have been broadly developed, recognizing the need for local adjustment. There has been a trend over the past 10 years to reduce the total yearly amount of nitrogen fertilizer applied to some portions of the golf course, especially greens and fairways. This has occurred in response to a variety of concerns, including the desire for a fast putting surface, the need to reduce maintenance costs, the relationship between higher nitrogen levels and the plants' ability to withstand environmental extremes and an increased awareness of environmental concerns.

The total amount of nitrogen to be used on warm-or cool-season grasses reflects differences in grass type and length of growing season. The range of recommended application rates takes into consideration differences between nitrogen sources and differences in superintendents' programming desires. Generally, lower rates (1/10 to 1/2 lb. N/1,000 sq. ft.) are recommended when using highly water soluble nitrogen sources (urea, ammonium sulfate/nitrate) as compared to the slow-release sources that can be applied at higher rates (1/2 to 1.0 lb. N/1,000 sq. ft.) In each case, the goal is to produce turf with consistent color and a uniform growth rate as evidence of a consistent supply of nitrogen.

From the perspective of groundwater quality, the time of year to avoid fertilizing with higher amounts of soluble nitrogen is when the temperatures are cool (reflecting little or no plant uptake) and precipitation is plentiful. Generally, this occurs in late fall (November-December) for cool-season grasses and early spring (February) for warm-season grasses. At this time, more water is percolating through the soil into the groundwater, the plant is not taking up much nitrogen and only limited amounts of nitrogen are being tied up by microbes. The net result is a much greater potential for substantial nitrate leaching. If nitrogen must be applied at this time, the golf course superintendent should use either lower rates of soluble nitrogen sources or use slow-release sources.

### Typical Yearly Nitrogen Fertilizer Program for Golf Courses

| | GRASS TYPE | | |
|---|---|---|---|
| *Location* | *Creeping Bentgrass** | *Bermudagrass*** | *Single Application Rate* |
| | -lbs. N/1,000 ft/yr- | | -lbs. N/1,000 ft- |
| green | 2 to 6 | 4 to 12 | 0.1 to 1.0 |
| tee | 2 to 6 | 5 to 10 | 0.1 to 1.0 |
| fairways | 1 to 4 | 3 to 9 | 0.5 to 1.0 |
| roughs/general areas | 1 to 2 | | |

* Creeping bentgrass or other cool-season grasses
**bermudagrass or other warm-season grasses

## Irrigation Management

Proper irrigation of a golf course is extremely important. First, it is obvious that there is a need to conserve and manage our freshwater supplies. Second, irrigation — particularly over-irrigation — results in significantly more nitrate leaching under some conditions. Therefore, in terms of water conservation and water quality, proper irrigation is critical.

An efficient irrigation program is one that relies on a well- designed and installed system and a procedure for adjusting irrigation events based on rainfall and plant water needs. The former is the responsibility of the designer/contractor, and the latter is under the control of the golf course superintendent. Programming of the irrigation system should be based on replacing the amount of water that is used by the plant and not supplied by rainfall. This implies that no water is wasted through over- irrigation and that soluble chemicals, such as nitrates, do not leach. The golf course superintendent must use the latest technology available to make the irrigation programs as efficient as possible. This technology includes irrigation controllers directly linked to instruments such as rain gauges or tensiometers or to other sources of data related to evapotranspiration. This information can then be used to support irrigation programs.

## Other Approaches

Several other approaches to consider to reduce potential nitrate leaching include using grasses or other plants that have a low nitrogen requirement; collecting, treating or recycling run-off or drainage water; and amending soils to retain nitrogen. These should be considered as minor in comparison to the previous section but can be a valuable part of an overall plan to reduce the potential for nitrate leaching.

### Nitrogen Requirement Ranking of Turfgrasses

| *Low* | *Moderate* | *High* |
|---|---|---|
| red fescue | perennial ryegrass | |
| chewings fescue | Kentucky bluegrass | bermudagrass |
| hard fescue | St. Augustinegrass | |
| tall fescue | - annual bluegrass - | |
| sheep fescue | - creeping bentgrass - | |
| centipedegrass | - colonial bentgrass - | |
| carpetgrass | - zoysiagrass - | |
| bahiagrass | | |

One approach to limit the potential of nitrate leaching is to reduce the total amount of nitrogen applied to the golf course. This can be accomplished either by decreasing the amount of land devoted to higher-nitrogen-requiring grasses or by using lower- nitrogen-requiring grasses. Reducing the size of fairways and roughs is a start in the right direction. Using grasses, where applicable, with a lower nitrogen requirement can also accomplish this goal. Wherever possible, grasses with lower nitrogen requirements should be used. Caution should be exercised in considering a reduction in the size of greens and tees. Greens must be large enough to provide a safe landing for the approach shot and to handle the amount of traffic placed on them. Small greens may make the hold too difficult to play and may suffer from too much traffic concentrated in a small area.

Many new golf courses are also using native plants, wildflowers or ornamental grasses in non-play areas. Generally, these plants are beneficial because they need lower amounts of water and nutrients (especially nitrogen) and require less mowing. The use of these plants can make the game more challenging and can make the course more aesthetically appealing. Most important, these plants help to conserve natural resources.

Other physical systems can be incorporated into a water quality management program. Included in this are collecting and possibly treating surface run-off and subsurface drainage water. Where run-off appears to be a problem, attempts could be made to intercept the water. Providing a level *grassed* intercept zone just below the sloped site would encourage infiltration of the water into the soil. A catchment system could also be used to hold run-off; such a system could be linked with the irrigation supply to recycle the run-off. Before an extensive system of this nature is installed, it must be shown that a problem does exist. For almost all situations, a measure this drastic is not necessary.

New golf course construction, where drainage systems are being installed, provides an opportunity to collect and recycle drainage water that could contain trace amounts of either nutrients or pesticides. Recycling of water by applying it back to the turfgrass surface will put any chemicals in the water through the natural biological filter and not into groundwater. The holding and recycling of drainage water may require the development of new technology. With regulations in some parts of the country requiring a *zero* level of any contaminate reaching the groundwater, mandatory drainage water recycling systems may be a way of life in the near future.

Amending sand for putting green construction may prove to be a valuable means of reducing nitrate leaching. Sand, by nature, does not absorb nutrients (low cation exchange capacity), especially the inorganic forms of nitrogen (ammonium and nitrate) and potassium. Most sources of nitrogen fertilizers generally go through a conversion from ammonium to nitrate (nitrification). Ammonium, being a cation (+ charge), is held in soils having a high cation exchange capacity (not sand). Nitrate, on the other hand, is an anion (- charge) and is not held in soil, so it is easily leached if water is passing through the soil.

The ideal amendment would stop nitrogen from leaching but still allow the green to have the physical properties of good drainage and aeration and compaction resistance. Clay has good cation holding properties but would destroy the physical properties of the green. One material potentially meets both criteria - natural zeolite. One natural zeolite, called clinoptilolite, is a secondary mineral with a high silica content formed from volcanic rock. Large deposits of clinoptilolite are found in the Western United States. Clinoptilolite can be crushed and screened to sandsize particles with good physical properties and a cation exchange capacity like clay.

Initial studies have shown that the physical properties of sand mixtures containing 5 percent clinoptilolite are maintained at the same time that the clinoptilolite protects the ammonium from being converted to nitrate (Ferguson et al, 1988). Large-scale field testing is now under way to determine to what extent clinoptilolite-amended sand will resist nitrate leaching.

## Implications for Golf Courses

As shown in this article, golf courses can be managed so that nitrates from fertilizers do not contaminate groundwater supplies. The following are practices that can help accomplish this goal:

- Apply frequent light rates of nitrogen or use slow-release nitrogen sources, even though they may be more costly.
- Avoid fertilizing at times of the year when turfgrass is naturally slow growing, especially in cool weather.
- Conservatively irrigate the golf course to save water and reduce leaching.
- Reduce the scope of the *heavily managed* areas of the golf course and use less energy-demanding plants where possible.

When one compares these practices to traditional row-crop agriculture, golf courses are far less likely to contaminate groundwater with nitrates. The following are typical row crop agricultural practices:

- Only one, possibly two, applications of nitrogen are made per growing season.
- Single application rates are up to four times higher than turfgrass.
- Only highly water soluble nitrogen sources are used because of the high cost of slow-release nitrogen sources.
- Irrigation is often not as highly controlled as that found on a golf course, thus resulting in a greater potential for leaching.
- Less diffuse and extensive surface root system exist to take up nutrients.

One study has compared the nitrate leaching losses from *lawns* and from row crop agriculture. Corn leaching losses were 36 percent of applied nitrogen fertilizer, compared with 12 percent for turfgrasses grown on similar soils with similar irrigation practices (Gold and Sullivan, 1988). Thus, row crop agriculture resulted in three times more nitrate leaching than turfgrass.

Golf courses have a positive environmental effect and value to society in these ways:

- Golf courses have little or no effect on municipal services like police, fire and school systems.
- Non-municipally owned golf courses provide tax revenue.
- The image of a community is enhanced by what recreation opportunities are available.
- The golf course serves as a local employer.
- Property values of lands surrounding golf courses increase markedly.
- Golf courses provide the beneficial *green spaces* in urban areas and often provide an opportunity for wildlife in flourish.

In summary, golf courses have been viewed by some as having a negative effect on the environment. With good management practices, groundwater quality can be protected from nitrate contamination. Communities in general benefit greatly from the presence of golf courses.

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# Appendix 11
# Leaching Potential of Turf Care Products: A Case Study of Long Island Golf Courses
# Nitrogen Management of Sandy Soils

# Leaching Potential of Turf Care Pesticides: A Case Study of Long Island Golf Courses

*by Patricia Primi, Michael H. Surgan, Ph.D., and Timothy Urban*


## Abstract

Pesticides used to maintain golf course turf can threaten ground water. This concern is particularly important in most of New York's Long Island, where generally sandy soils overlie a sole source aquifer. This study uses two methods to evaluate the potential for pesticides that are commonly used on Long Island's golf courses to leach to ground water.

Adapting the Pesticide Root Zone Model (PRZM), Release 1, for dense turf and applying site-specific soil data, certain pesticides, including metalaxyl and trichlorfon, are identified as potential problem leachers. PRZM simulations also identify the Long Island soils, including the sandy Plymouth and Carver soils, which are most vulnerable to leaching.

When adequate input data for PRZM is unavailable, the ground water ubiquity score (GUS) method may be useful. GUS leachability classifications of pesticides commonly applied on Long Island golf courses, and of pesticides actually detected in ground water samples taken on Long Island, agree with PRZM predictions and the field data. The GUS method is applied to the evaluation of the leaching potential of pesticide degradation products (DCPA, maneb, and mancozeb metabolites), and the degradation products are shown to be a greater threat to ground water than their parent compounds.

These methods are potentially useful in designing ground water monitoring programs and for guiding the pesticide use and selection decisions of golf course managers.


## Introduction

The potential for ground water contamination by pesticides is an issue of national concern. It is especially significant in Nassau and Suffolk counties on Long Island, New York, where ground water is the sole source of drinking water for 2.6 million residents. In recent years, a number of pesticides and pesticide degradation products, arising from both agricultural and nonagricultural use, have been detected in ground water at various sites on Long Island (SCDHS 1989; U.S. EPA 1991). The generally sandy surface soils in this region appear to provide for only limited attenuation of pesticides leaching from the surface.

According to a recent survey (New York State Department of Law 1991), golf courses on Long Island apply substantial quantities of pesticides. Of more than 100 golf courses on Long Island, 52 responded to this survey. They applied an average of 961 pounds (range: 0 to 2386 pounds) of active ingredients per golf course per year, comparable to a 1982 U.S. Environmental Protection Agency (EPA) estimated national average of 933 pounds per golf course per year (Kriner 1985). Particularly heavy pesticide use reported by many Long Island golf courses raised the concern that some hazard to ground water quality may be posed by current turf care practices. Without extensive ground water monitoring on Long Island for these turf care pesticides, this concern cannot be easily dismissed.

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To evaluate the potential for ground water contamination arising from pesticide applications, two analyses have been performed. The first is a computer simulation of pesticide leaching using the Pesticide Root Zone Model (PRZM), Release 1 (Carsel et al. 1984). (A new version of PRZM (PRZM-2, Release 2.0) is now available [Mullins et al. 1993].) PRZM, a continuous simulation model, estimates pesticide leaching using a modified version of the advection dispersion equation coupled with water balance equations. It includes additional terms for factors such as plant uptake, soil adsorption, and degradation processes. The second method of analysis is a simplified assessment method to differentiate between leachable and nonleachable pesticides (Gustafson 1989). This technique jointly considers pesticide persistence and mobility in soil to determine a ground water ubiquity score (GUS).

The GUS method is applied both to the pesticides evaluated with PRZM and to a number of other pesticides known to have reached ground water at various sites on Long Island. The GUS method, with minor modification, categorizes these pesticides into a hierarchy consistent with both the PRZM predictions and the actual Long Island monitoring data. While more sophisticated applications of the PRZM model are possible, these comparisons suggest that even limited modeling efforts can provide important insights into the hazards different pesticides pose to ground water quality.

## Part 1 – PRZM Simulations

### Methods

PRZM simulations were run for the application of 16 pesticides on 9 Long Island soil types. The pesticides evaluated with PRZM were those used in the greatest total amounts at Long Island golf courses, and accounted for approximately 85 percent of the total pesticide use reported (New York State Department of Law 1991). There may be lightly, infrequently, or less widely used pesticides that were not evaluated which, by virtue of their inherent leachability, may present a greater hazard to ground water than some of the pesticides considered. The nine soil types modeled are those frequently encountered at Long Island golf courses for which sufficient information was available to develop the required model inputs.

Certain input parameters had to be developed to specifically reflect Long Island golf course turf care conditions. These included soil drainage, evapotranspiration and snowmelt, precipitation and irrigation, rain interception, areal crop coverage, surface runoff and erosion, pesticide application rates, and pesticide degradation rates in soil and on foliage.

#### *Soil Drainage*

The soil drainage model option for freely draining soils was used in all simulations. This option is recommended for soils in hydrologic groups A and B which have infiltration rates in excess of 0.38 cm per hour, and it is the appropriate choice for seven of the nine soils modeled. The two Montauk soils are in hydrologic group C (U.S. Department of Agriculture 1986). Although the model option for more slowly drained soils might be more appropriate for modeling the Montauk soils, insufficient data were available to utilize this option. The model predictions for the Montauk soils may therefore be somewhat less accurate than those for the other soils.

#### *Evapotranspiration and Snowmelt*

Daily dew point data were used in place of specifying a pan evaporation factor. A snow factor was not used since snow accumulation on Long Island is generally negligible.

#### *Precipitation and Irrigation*

A trial simulation, using only precipitation, was run to determine the predicted moisture content of the top 15 cm of the Riverhead soil profile (corresponding to the rooting depth of turf grass). Irrigation dates were chosen which preceded, by a day or two, times when the soil moisture content in the root zone dropped below approximately 80 percent of field capacity. At these times, 2.54 cm of irrigation were added to the precipitation.

Irrigation events were simulated every two to four days during the summer months, consistent with reported practices at Long Island golf courses, where irrigation was common (almost every night) during the hot summer months. With the added irrigation events, the Riverhead soil moisture content in the upper 15 cm never dropped below 89 percent of field capacity. The schedule developed for Riverhead soil was used throughout the simulations. Subsequent simulations using other soil types showed this to be a reasonable irrigation schedule. Although the soil moisture content occasionally dropped below 75 percent of field capacity for Plymouth and Carver soils, and for the sandy variant of Montauk soil (Mf), these periods were never more than two days in duration, and soil moisture levels never dropped below wilting point in any soil. Irrigation events added a total of 93.38 cm of water per year, or 36 percent of the total water input, to the natural precipitation data stream, which amounted to 166.92 cm.

#### *Rain Interception*

The PRZM manual reports values of rain interception ranging from 0.1 to 0.3 for dense crop canopy. Since turf grass density and leaf surface area are greater than for most agricultural crops, rain interception by turf grass would be higher. Therefore, a slightly higher rain interception value (0.4) was assigned. This adjustment was found to have little effect on model results. In a three pesticide/two soil sensitivity analysis (trichlorfon, triadimefon, isofenphos/Plymouth, Hempstead), decreasing the rain interception parameter from 0.4 to 0.1 resulted in no more than a 2 to 5 percent increase in the maximum dissolved concentrations attained in the lowermost soil compartments.

**Table 1**
**Characteristics of Nine Long Island Soils**

| Soil[a] (Total Depth) | Horizon[a] | Texture[a] | Thick[a] (cm) | Bulk Dens.[b] | % Org. Carbon[c] | Field Cap.[d] | Wilt. Point[d] |
|---|---|---|---|---|---|---|---|
| Plymouth | 1 | loamy sand | 10 | 1.284 | 1.51 | 0.125 | 0.055 |
| (150 cm) | 2 | loamy sand | 55 | 1.440 | 0.29 | 0.125 | 0.055 |
| | 3 | gravelly sand | 85 | 1.531 | 0.06 | 0.091 | 0.033 |
| Carver | 1 | fine sand | 25 | 1.600 | 0.64 | 0.091 | 0.033 |
| (175 cm) | 2 | medium sand | 30 | 1.440 | 0.58 | 0.091 | 0.033 |
| | 3 | coarse sand | 20 | 1.760 | 0.12 | 0.091 | 0.033 |
| | 4 | gravelly sand | 100 | 1.550 | 0.00 | 0.091 | 0.033 |
| Sudbury | 1 | sandy loam | 15 | 1.090 | 2.33 | 0.207 | 0.095 |
| (150 cm) | 2 | sandy loam | 30 | 1.310 | 0.35 | 0.189 | 0.080 |
| | 3 | sandy loam | 25 | 1.520 | 0.17 | 0.137 | 0.045 |
| | 4 | sand | 80 | 1.580 | 0.12 | 0.091 | 0.033 |
| Riverhead | 1 | sandy loam | 5 | 1.145 | 1.16 | 0.207 | 0.095 |
| (150 cm) | 2 | sandy loam | 55 | 1.195 | 0.58 | 0.207 | 0.095 |
| | 3 | loamy sand | 25 | 1.475 | 0.17 | 0.125 | 0.055 |
| | 4 | sand | 65 | 1.541 | 0.06 | 0.091 | 0.033 |
| Montauk (Mf) | 1 | loamy sand | 43 | 1.380 | 0.52 | 0.125 | 0.055 |
| (150 cm) | 2 | sandy loam | 25 | 1.540 | 0.35 | 0.217 | 0.095 |
| | 3 | sandy loam | 32 | 1.570 | 0.23 | 0.207 | 0.095 |
| | 4 | sand | 50 | 1.700 | 0.00 | 0.091 | 0.033 |
| Haven | 1 | silt loam | 5 | 1.070 | 2.33 | 0.330 | 0.133 |
| (150 cm) | 2 | loam | 55 | 1.250 | 0.52 | 0.270 | 0.117 |
| | 3 | sandy loam | 12 | 1.370 | 0.29 | 0.207 | 0.095 |
| | 4 | loamy sand | 18 | 1.450 | 0.00 | 0.125 | 0.055 |
| | 5 | sand | 60 | 1.530 | 0.00 | 0.091 | 0.033 |
| Montauk (Mk) | 1 | silt loam | 23 | 1.280 | 1.16 | 0.330 | 0.133 |
| (150 cm) | 2 | sandy loam | 56 | 1.600 | 0.35 | 0.207 | 0.095 |
| | 3 | sandy loam | 71 | 1.610 | 0.12 | 0.207 | 0.095 |
| Hempstead | 1 | silt loam | 30 | 1.138 | 2.91 | 0.330 | 0.133 |
| (150 cm) | 2 | silt loam | 45 | 1.245 | 0.35 | 0.280 | 0.095 |
| | 3 | loamy sand | 10 | 1.475 | 0.17 | 0.125 | 0.055 |
| | 4 | sand | 65 | 1.541 | 0.06 | 0.091 | 0.033 |
| Bridgehampton | 1 | silt loam | 30 | 1.030 | 1.63 | 0.330 | 0.133 |
| (200 cm) | 2 | silt loam | 20 | 1.080 | 0.64 | 0.330 | 0.133 |
| | 3 | silt | 10 | 1.250 | 0.47 | 0.300 | 0.125 |
| | 4 | silt | 25 | 1.390 | 0.35 | 0.300 | 0.125 |
| | 5 | silt | 55 | 1.240 | 0.17 | 0.300 | 0.125 |
| | 6 | sand | 60 | 1.550 | 0.00 | 0.091 | 0.033 |

[a] From soil surveys for Nassau and Suffolk counties.
[b] Calculated:
BD = 100 /[(%OM / OMBD) + (100 - %OM / MBD)],
where:
BD = Bulk density
%OM = Percent organic matter, from soil surveys
OMBD = Organic matter bulk density = 0.224
MBD = Mineral Bulk Density, from PRZM manual, Figure 12, using percent clay reported in soil surveys and using median percent sand.
[c] Percent organic carbon = (Percent organic matter/1.72) (Carsel 1992).
[d] From PRZM manual, Table 19.

### *Cropping Factors*

Rooting depth of turf grass was specified as 15 cm. To model turf grass as a self-perpetuating crop, an emergence date of January 1, a maturation date of January 5, and a harvest date of December 31 were specified. Setting the crop maturation date early in the year allowed the establishment of soil moisture equilibrium before the first pesticide application of the year (the initial water content was set at 0.33 $cm^3\ cm^{-3}$ in all soils).

### Maximal Areal Coverage

To calculate pesticide interception and foliar decay, it was necessary to estimate the extent to which the grass covers the underlying soil. For crops such as alfalfa and prairie grass, maximal areal coverage ranges from 50 percent to 75 percent (Carsel et al. 1984). Since turf grass exhibits a much denser growth than any reported crop, a value of 95 percent was used.

### Surface Runoff and Erosion

Studies by Watschke and Mumma (1990) have shown that runoff from dense, highly managed turf typical of golf course greens and tees is negligible, even under extreme experimental irrigation conditions. We therefore sought to simulate conditions of zero pesticide loss via runoff. Trial runs of the model using successively lower runoff curve numbers (U.S. Department of Agriculture 1986) indicated that a CN of 25 resulted in zero runoff losses, and this value was used in all simulations. To whatever extent pesticide loss via runoff ever occurs on Long Island golf courses, this CN value may underestimate runoff losses and overestimate concomitant leaching. The model option which incorporates no pesticide loss by erosion was selected, in accordance with both the low runoff potential and the high vegetative cover density.

### Soil Parameters

Soil-related inputs were developed from information contained in the soil surveys for Nassau and Suffolk counties (Werner et al. 1975; Wulforst 1987) and from formulas in the PRZM manual. Textural characteristics of the nine Long Island soils modeled are summarized in Table 1. $K_d$ values (soil-water partition coefficients) for each pesticide in each horizon of each soil were derived according to the model documentation, from $K_{oc}$ values (organic carbon partition coefficients) reported in Wauchope et al. (1992) and from soil survey data. Each soil column was divided into 5-cm-thick compartments.

Site-specific conditions may vary from soil survey data. For instance, during construction of new greens and tees, the uppermost layer of a natural soil profile may be disturbed or completely replaced with sand and gravel containing little or no organic matter. However, this disturbance may not be of long-term significance. It has been reported (Cooper 1990) that within five to seven years growing turf will increase the organic matter content of even a putting green constructed over 100 percent sand to 6 to 8 percent. Organic matter contents in the upper 5 to 10 cm of the nine Long Island soils considered here are reported in the soil surveys as varying from 0.9 percent (Montauk (Mf) soil) to 5 percent (Hempstead soil). Use of this soil survey data may therefore overestimate the adsorptive capacity of soils underlying newly constructed greens and tees, a transient phenomenon, and underestimate adsorptive capacity in soils underlying established golf courses.

The presence of a thatch layer may also influence the leaching behavior of some pesticides by providing another layer of adsorptive organic material. For example, in a study of diazinon, a pesticide that until recently was widely used on golf courses, the presence of a 2.5-cm thatch layer reduced by 50 to 70 percent the amount of diazinon that leached below 5 cm in three weeks through a soil containing 2.8 percent organic matter (Branham and Wehner 1985).

To explore the effect of organic matter content on the upper 5 cm of soil, several additional simulations were performed. A modified Plymouth soil was modeled, with the organic matter content of the upper 5 cm of the soil profile increased threefold from the 2.6 percent reported in the soil surveys to 8 percent. These simulations represent a combination of thatch development and soil organic matter enrichment. As reported later on, those pesticides of greatest concern for their potential ground water impacts were least affected by this modification.

### Pesticide Applications

For each pesticide evaluated, a specific schedule of application rates and intervals was developed, based on either label recommendations for specific products or recommendations of the cooperative extension service (Hummel et al. 1991). A preventive application schedule for each pesticide was used as the simpler alternative to constructing arbitrary schedules for disease or infestation. Comparison to the limited data available for site-specific application rates for Long Island golf courses confirmed that the annual application rates modeled were generally consistent with the range of actual usage. Pesticide applications were made on days when no natural precipitation or irrigation events occurred. Table 2 summarizes the pesticide application rates and frequencies modeled.

### Pesticide Decay Rates in Soil

The half-life of a pesticide in soil may vary by a factor of 2 or 3 depending on conditions such as soil moisture, temperature, oxygen availability, and microbial activity. These conditions will in turn vary with location, season, weather, depth within the soil, and the history of cultural practices at the site (U.S. Department of Agriculture, SCS 1988). Boesten and Van der Linden (1991) estimate that changing a pesticide's soil half-life by a factor of 2 changes the amount leached below 1 m by roughly a factor of 10. The PRZM model calculates pesticide decay in the soil as a simple first-order transformation, calling for a "representative" decay rate that remains constant over the simulation period, although different representative decay rates may be specified at different depths within the soil column.

Absent representative values for the half-lives of the 16 pesticides considered when applied to turf, the pesticide decay rates used are based on the consensus half-lives reported in the SCS/ARS/CES Pesticide Properties Database (Wauchope et al. 1992). However, current research (Mullins 1992) indicates that decay rates are greatly reduced as pesticides move down the soil column. Accordingly, the decay rate in the bottom half of

## Table 2

**Pesticide Application Rates and Frequencies[a] Used in PRZM Simulations**

| Pesticide | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Anilazine | | | | | | 3.05 (2) | 3.05 (2) | 3.05 (2)<br>6.10 (1) | 3.05 (1) | | | | (8) 27.45 |
| Bendiocarb | | | | 3.36 (1) | | | | 3.36 (1) | 3.36 (1) | | | | (3) 10.08 |
| Benomyl | | | | | | 1.58 (2) | 1.58 (1)<br>3.17 (1) | 3.17 (2)<br>1.58 (1) | 1.58 (1) | | | | (8) 17.41 |
| Bensulide | | | | 9.81 (1) | | | | | | | | | (1) 9.81 |
| Carbaryl | | | | 8.98 (1) | | | 8.98 (2) | 8.98 (2) | | | | | (5) 35.92 |
| Chlorothalonil | | | | | | 7.10 (4) | 7.10 (3) | 7.10 (3) | 7.10 (2) | | | | (12) 85.20 |
| Chlorpyrifos | | | | 3.36 (1) | 2.24 (1) | 3.36 (2) | | | | | | | (4) 12.32 |
| 2,4-D | | | | | 1.12 (2) | | | | | 1.12 (1) | | | (3) 3.36 |
| DCPA | | | | | 7.90 (1) | | | | | | | | (1) 7.90 |
| Iprodione | | 3.05 (1) | | | | 3.05 (2) | 3.05 (1) | 3.05 (2) | 3.05 (1) | | | | (7) 21.35 |
| Isofenphos | | | | 2.24 (1) | | 2.24 (1) | | 2.24 (2) | | 2.24 (1) | | | (5) 11.20 |
| Mancozeb | | | | 10.68 (2) | 10.68 (2) | 10.68 (1)<br>15.26 (1) | 15.26 (3) | 15.26 (3) | 10.68 (2) | 10.68 (2) | | | (16) 181.04 |
| Metalaxyl | | | | | | 0.79 (3) | 0.79 (3) | 0.79 (5) | | | | | (11) 8.69 |
| PCNB | | | | 24.41 (1) | | 9.76 (1) | 9.76 (3) | 9.76 (4) | | | | 24.41 (1) | (10) 126.90 |
| Triadimefon | | | | 1.58 (1) | 1.58 (1) | 0.79 (2) | 0.79 (1) | 0.79 (1) | | 3.96 (1) | | | (7) 10.28 |
| Trichlorfon | | | | 8.98 (1) | 8.98 (1) | 6.06 (1) | | 8.98 (1) | 8.98 (1) | | | | (5) 41.98 |

[a] Number in parentheses is number of applications at given rate. Application rates are expressed as kilograms of active ingredient per hectare.

## Table 3

**Maximum Concentrations (ppb) Predicted in One-Year PRZM Simulations for Various Combinations of Turf Care Pesticides and Long Island Soils**

| | Plymouth | Carver | Sudbury | Riverhead | Mountauk (Mf) | Haven | Montauk (Mk) | Hempstead | Bridgehampton |
|---|---|---|---|---|---|---|---|---|---|
| Trichlorfon | 568 | 540 | 274 | 262 | 218 | 108 | 102 | 74 | 50 |
| Metalaxyl | 507 | 479 | 576 | 634 | 633 | 392 | 551 | 318 | 11 |
| 2,4-D | 24 | 22 | 15 | 14 | 14 | 12 | 7 | 4 | 2 |
| Isofenphos | 8 | 3 | 1 | 2 | 1 | 4 | <1 | <1 | <1 |
| Triadimefon | 5 | 3 | 1 | 3 | 3 | 2 | <1 | <1 | <1 |
| Bensulide | 2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Carbaryl | 1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Iprodione | <1 | <1 | —[a] | <1 | —[a] | <1 | —[a] | —[a] | <1 |
| Chlorothalonil | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Mancozeb | <1 | <1 | —[a] | <1 | —[a] | <1 | —[a] | —[a] | <1 |
| Benomyl | <1 | <1 | —[a] | <1 | —[a] | <1 | <1 | —[a] | <1 |
| Bendiocarb | <1 | <1 | —[a] | <1 | —[a] | <1 | <1 | —[a] | <1 |
| DCPA | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| PCNB | <1 | <1 | —[a] | <1 | —[a] | <1 | —[a] | —[a] | <1 |
| Anilazine | <1 | <1 | —[a] | <1 | —[a] | <1 | <1 | —[a] | <1 |
| Chlorpyrifos | <1 | <1 | —[a] | <1 | —[a] | <1 | —[a] | —[a] | <1 |

[a] No simulation performed for this soil-pesticide combination.

the soil columns was reduced by 50 percent in these simulations. This adjustment was found to have only a minor effect on model results. In a three pesticide/two soil sensitivity analysis (as in the preceding Rain Interception section), using a constant soil decay rate throughout the full depth of the soil columns resulted in predicted maximum dissolved concentrations 13 to 27 percent lower than the concentrations predicted when decay rates were reduced in the lower soil horizons.

### *Foliar Decay Rates for Pesticides*

A range of foliar decay rates were available (Willis and MacDowell 1987) for some of the pesticides modeled. When unavailable, decay rates were estimated from those reported for similar pesticides.

## PRZM Simulation Results and Discussion

Of the various PRZM outputs, the maximum dissolved concentration of pesticide in soil pore waters, at depths of 150 to 200 cm during one year of simulated application, was selected for comparisons. These depths correspond to the limit of the data presented in county soil surveys for each soil type (Table 1). The simulation predictions have not been calibrated against experimental field data, and only limited sensitivity analyses have been performed. Given the uncertainties associated with model input parameters, the reported numerical values should be viewed qualitatively as indicators of relative hazard to ground water quality.

### *Variations in Pesticide Leachability*

The 16 pesticides varied widely in their predicted leaching behavior, as reflected by the maximum dissolved concentrations at depth attained over a one-year simulation period (Table 3). The model predicted that 7 of the 16 pesticides would attain maximum dissolved concentrations of 1 ppb or more in at least one soil type, the sandy Plymouth soil (Figures 1a, 1b). Two of these, metalaxyl and trichlorfon, attained much higher maximum concentrations than the others.

### *Effect of Soil Type*

The model predicted that the concentrations of dissolved pesticides would be higher in coarse-textured soils having low organic matter content, such as Plymouth and Carver soils (Table 3). Lowest dissolved concentrations were predicted in Hempstead and Bridgehampton soils, which are finer-textured soils. Metalaxyl, unlike the other pesticides studied, showed a significant decrease in maximum concentration attained only in the finest textured Bridgehampton soil (Table 3). The model predicted that trichlorfon and metalaxyl, the most leachable pesticides, would attain dissolved concentrations of 568 ppb and 507 ppb, respectively, in Plymouth soil. In contrast, trichlorfon and metalaxyl concentrations peaked at 50 ppb and 11 ppb, respectively, in Bridgehampton soil (Table 3). The maximum predicted dissolved concentrations for 2,4-D varied between 24 and 2 ppb in all soils. Isofenphos and triadimefon

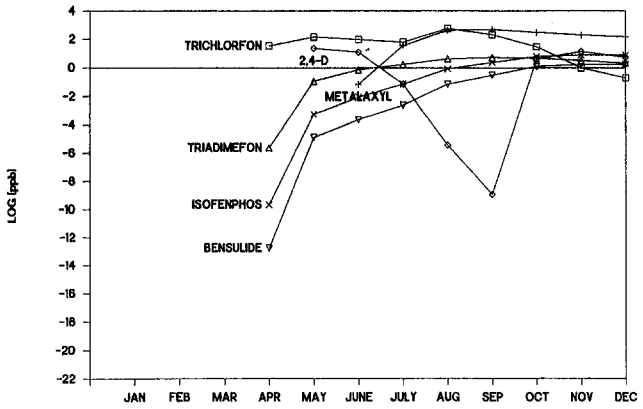


**Figure 1a. Soil pore water concentrations at a depth of 150 cm in Plymouth soil, predicted in one-year PRZM simulations.**

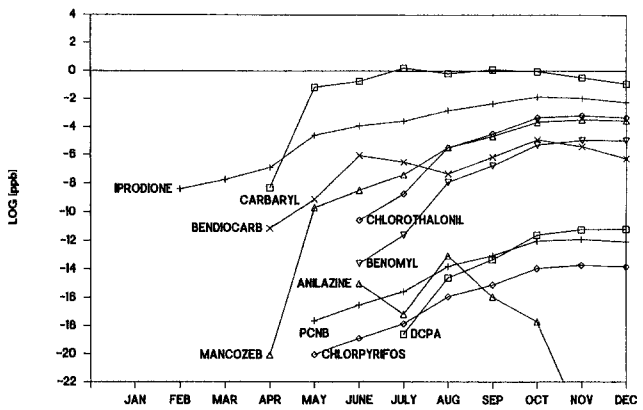


**Figure 1b. Soil pore water concentrations at a depth of 150 cm in Plymouth soil, predicted in one-year PRZM simulations.**

attained maximum predicted concentrations between 8 and 1 ppb and between 5 and 1 ppb, respectively, in Plymouth, Carver, Sudbury, Riverhead, Montauk (Mf), and Haven soils, and less than 1 ppb in the remaining soils. Bensulide and carbaryl concentrations were predicted to exceed 1 ppb only in Plymouth soil. All of the remaining pesticides had maximum predicted dissolved concentrations less than 1 ppb.

Extensive areas of Plymouth and Carver soils are found within the Pine Barrens region in Suffolk County and in many places on Long Island's South Fork. At the golf courses located within these areas, the PRZM results suggest that certain pesticides in common use are likely to pose greater ground water hazards than would be the case in areas with less vulnerable soils. Conversely, a large area in central Nassau County is underlain by the less vulnerable Hempstead soil, and certain commonly used pesticides may constitute a lesser threat to ground water quality in this area. However, highly vulnerable soils are also encountered at individual Long Island golf courses even in areas where less vulnerable soils predominate regionally. Therefore, the assessment of risks to ground water presented by golf course pesticide use should consider site-specific conditions.

### *Effect of Increased Soil Organic Matter Content*

The seven most leachable pesticides were the subject of additional simulations which used a modified Plymouth soil profile containing 8 percent (rather than 2.6 percent) organic matter in the upper 5 cm. As expected, the maximum predicted dissolved concentrations at 150 cm declined for each of the seven pesticides. The effect was variable but minor for the most highly leachable pesticides and moderate for the less leachable pesticides. The most leachable pesticides, trichlorfon and metalaxyl, had the greatest absolute change in maximum dissolved concentrations (−116.5 ppb and −56.8 ppb, respectively), but the smallest percentage change (−20.5 percent and −13.1 percent, respectively); the reduced concentrations for these two pesticides were still in the 300 to 400 ppb range. Percentage reductions in the maximum concentrations of the five other pesticides were greater, but the absolute changes in concentration were more modest (−20 ppb for 2,4-D; −4.5 ppb for isofenfos; −2.7 ppb for triadimefon; −1.0 ppb for both bensulide and carbaryl).

### *Depth to Water*

Along with soil type, depth from the ground surface to the ground water table should be considered in evaluating ground water hazards created by golf course pesticide use. A statistically significant negative correlation between sampling depth and the frequency of pesticide detections has been reported for sites nationwide (U.S. EPA 1992).

Depths to ground water tend to be greater within Long Island's deep flow recharge areas (USGS 1983), where precipitation recharges the deeper Magothy and Lloyd aquifers, from which most public Long Island water supplies are drawn. The Pine Barrens is a notable exception within the deep flow recharge areas. Average depths to water at golf courses located within this important recharge area range as little as 15 feet. Great depth to water elsewhere may provide some protection against pesticide contamination of the deeper drinking water aquifers. However, certain pesticides/pesticide degradation products have been detected in some deep public supply wells (>100 feet) on Long Island, indicating that even significant depths do not provide complete protection of Long Island ground water quality. It may be that where soils are coarse-textured and have low organic matter content, and where the pesticides in use have low $K_{oc}$ values, little retention by adsorption may occur despite great depth to ground water. Persistent compounds with low $K_{oc}$ values would appear to present the greatest hazard in such areas.

### *Pesticide Degradation Products*

Release 1 of PRZM predicts the degradation of a pesticide to determine the mass lost, but does not identify the degradation products or estimate their dissolved concentrations. (PRZM2, Release 2.0, can evaluate degradation product leaching.) Yet the soil degradation products of pesticides may present as much or more of a hazard to ground water quality as the pesticides themselves. Thus, PRZM analysis of the parent compounds alone may not be dispositive. For example, PRZM simulations do not predict significant leaching of DCPA (Dacthal), but its degradation products have been detected frequently in ground water. In fact, DCPA acid metabolites, the soil degradation products of DCPA, were the most frequently detected pesticide analytes in a recent national survey (U.S. EPA 1990). Subsequent analysis of that data revealed a statistical correlation between the rate of DCPA use by golf courses and the frequency of detections of DCPA metabolites in drinking water wells (U.S. EPA 1992). On Long Island, ground water monitoring detected the presence of DCPA metabolites at levels up to 1039 ppb in 56 out of 213 samples analyzed (SCDHS 1989).

## Part 2: Ground Water Ubiquity Score (GUS) Method

Gustafson (1989) suggested a method to differentiate between leachable and nonleachable pesticides by jointly considering their persistence and mobility in soil. Gustafson considered available ground water monitoring data and noted that known leachers (pesticides which had already been detected in ground water) were the more mobile and/or more persistent pesticides. He demonstrated that such known leachers could be distinguished from apparent nonleachers by use of a hyperbolic function:

$$GUS = \log_{10}(T_{1/2}^{soil}) \times (4\text{-}\log_{10}(K_{oc}))$$

and determined that pesticides having GUS values greater than or equal to 2.8 were leachers. Pesticides having GUS values between 2.8 and 1.8 were defined as transitional, with an uncertain potential to leach. Compounds having GUS values less than 1.8 were defined as nonleachers.

## GUS Results

Gustafson's analysis has been applied to the 16 pesticides evaluated with the PRZM model as well as to 9 other pesticides which have been detected in ground water in Long Island (Table 4). There is a clear break at GUS values between 2.7 and 3.0 in the maximum concentrations predicted by PRZM, corresponding to Gustafson's definition of leachers. The group above this break includes pesticides predicted by PRZM to attain maximum dissolved concentrations greater than 500 ppb and several which have been confirmed to have reached Long Island ground water by actual analyses. There is a second break in the GUS values at 1.5, slightly lower than the 1.8 threshold proposed by Gustafson to differentiate between nonleachers and transitional compounds. Using this slightly lower threshold, all of the remaining pesticides which have been detected in Long Island ground water are captured as transitional compounds. All pesticides predicted by PRZM to attain maximum dissolved concentrations less than 1 ppb are segregated as nonleachers. PRZM and GUS assess-

**Table 4**
**GUS Values for Turf Care Pesticides Evaluated with PRZM and for Other Pesticides Which Have Reached Long Island Ground Water**

| | Pesticide | GUS Value | Maximum Predicted Concentration (ppb) |
|---|---|---|---|
| Leachers | EDB | 5.8 | —[a] |
| | carbofuran | 4.5 | —[a] |
| | metalaxyl | 4.2 | 634[b] |
| | aldicarb | 3.7 | —[a] |
| | methomyl | 3.2 | —[a] |
| | ethoprop | 3.0 | —[a] |
| | trichlorfon | 3.0 | 568[b] |
| | dinoseb | 2.9 | —[a] |
| Transitional Compounds | 2,4-D | 2.7 | 24[b] |
| | isofenphos | 2.7 | 8[b] |
| | triadimefon | 2.2 | 5[b] |
| | alachlor | 2.1 | —[a] |
| | bensulide | 2.1 | 2[b] |
| | 1,2-dichloropropane | 1.8 | —[a] |
| | oxamyl | 1.6 | —[a] |
| | carbaryl | 1.5 | 1[b] |
| Nonleachers | iprodione | 1.3 | <1[b] |
| | mancozeb | 1.3 | <1[b] |
| | chlorothalonil | 1.3 | <1[b] |
| | benomyl | 1.3 | <1[b] |
| | bendiocarb | 0.9 | <1[b] |
| | Dacthal (DCPA) | 0.6 | <1[b] |
| | PCNB | 0.4 | <1[b] |
| | chlorpyrifos | 0.3 | <1[b] |
| | anilazine | 0.0 | <1[b] |

[a] Confirmed detection in L.I. ground water (SCDHS 1989).
[b] Predicted with PRZM in one year of simulated use.

ments appear to agree with each other and with available Long Island ground water monitoring data.

### *GUS Values for Additional Golf Course Pesticides*

Calculation of GUS values for other pesticides used at Long Island golf courses and determination of their leachability classification suggests additional candidates for future modeling efforts (Table 5). Among those pesticides, prometon, dicamba, propoxur, mecoprop, and fenarimol all qualify as leachers and merit further evaluation. In addition, siduron, dichlobenil, ethofumesate, propiconazole, disulfoton, chloroneb, and oryzalin qualify as transitional compounds and may be of ground water concern, depending on use patterns and local conditions.

### *GUS Analysis of Pesticide Degradation Products*

As previously noted, Release 1 of PRZM does not account for the fate of pesticide degradation products. The $K_{oc}$ and half-life data used in calculating GUS values are available for some pesticide degradation products (U.S. EPA 1992), including ETU, the principal soil degradation product of maneb and mancozeb, and the acid metabolites of DCPA. Comparison of GUS values for these degradation products to the GUS values of their parent compounds indicates that degradation products have the greater leaching potential (DCPA = 0.4, its acid metabolites = 5.3; maneb and mancozeb = 1.3, ETU = 2.5). While the parent compounds are all nonleachers, their metabolites qualify as either a transitional compound (ETU) or as leachers (DCPA acid metabolites). The difference in GUS classification is supported by the frequent detection of DCPA acid metabolites in Long Island ground water (SCDHS 1989) and the detection of DCPA acid metabolites and ETU in the U.S. EPA national ground water survey (U.S. EPA 1990, 1992).

## Conclusions

Using a PRZM simulation adapted for the dense turf typical of golf courses, we have identified turf care pesticides (trichlorfon and metalaxyl) that may endanger ground water quality on Long Island. Several others (2,4-D, isofenphos, triadimefon, bensulide, and carbaryl) may endanger ground water under conditions of unusually heavy use, particularly vulnerable soils, and/or very shallow depths to ground water.

**Table 5**
**GUS Values for Additional Turf Care Pesticides**

| | Pesticide | GUS Value |
|---|---|---|
| Leachers | prometon | 4.9 |
| | dicamba | 4.2 |
| | propoxur | 3.7 |
| | mecoprop | 3.6 |
| | fenarimol | 3.1 |
| Transitional Compounds | siduron | 2.7 |
| | dichlobenil | 2.5 |
| | propiconazole | 2.4 |
| | ethofumesate | 2.2 |
| | disulfoton | 1.8 |
| | chloroneb | 1.7 |
| | oryzalin | 1.6 |
| Nonleachers | thiram | 1.4 |
| | maneb | 1.3 |
| | 2,4-DP | 1.0 |
| | oxadiazon | 0.9 |
| | thiophanate-methyl | 0.7 |
| | captan | 0.7 |
| | pendimethalin | 0.6 |
| | trifluralin | 0.2 |
| | benfluralin | 0.1 |
| | fenoxaprop-ethyl | 0.0 |
| | glyphosate | −0.6 |
| | paclobutrazol | −1.5 |
| | fosetyl-Al | −2.7 |
| | propamocarb-HCL | −3.0 |

PRZM results provide a basis for assessing the relative vulnerability of Long Island soil types to pesticide leaching. Among the most vulnerable were the sandy Plymouth and Carver soils. The finer-textured Hempstead and Bridgehampton soils appeared to be the least vulnerable.

The assessment of risks to ground water quality presented by turf care pesticide use is most appropriately performed at the scale of individual golf courses. The determination of predominant soil types and depths to ground water can permit consideration of these general risk factors for individual golf courses on Long Island. For example, golf courses (or other sites of significant pesticide application) within the Pine Barrens region of Suffolk County and in many places on Long Island's South Fork should be of particular concern. In these areas, Plymouth and Carver soils predominate and a shallow water table is often encountered. However, vulnerable soils may also be encountered at individual golf courses in areas where less vulnerable soils predominate regionally.

Analysis of pesticides using the GUS method provides a simplified leachability assessment broadly consistent with both PRZM analysis and local ground water monitoring data. For Long Island, and other areas having similarly vulnerable soils, a somewhat lower GUS score than that proposed by Gustafson best distinguishes transitional compounds from nonleachers. Among the pesticides evaluated only with the GUS method, prometon, dicamba, propoxur, mecoprop, and fenarimol are categorized as leachers, and siduron, dichlobenil, propiconazole, ethofumesate, disulfoton, chloroneb, and oryzalin are categorized as transitional compounds.

The identification of pesticides whose degradation products, like those of DCPA, maneb, and mancozeb, appear to threaten ground water quality more than the parent compound should be a priority. The GUS method apparently can identify leachable degradation products if $K_{oc}$ and half-life are known. PRZM2, Release 2.0, can also now be applied to evaluate degradation product leachability. Unfortunately, for most pesticides leachability analysis is currently limited to consideration of the active ingredient itself and not its degradation products. Additional data is needed on the relative leachability of most turf care pesticide degradation products to allow a more informative analysis of potential ground water impacts.

To date, ground water monitoring for pesticide contamination conducted on Long Island has concentrated largely on pesticides used in agriculture. The methods described in this report could be advantageously applied to the selection of monitoring locations and analytes for expanded monitoring of nonagricultural pesticides, as may be contemplated by state or local authorities. Consideration of relative leachability of turf care pesticides and patterns for their use, along with relative soil vulnerability to leaching, will facilitate the design of monitoring programs that utilize available resources effectively and efficiently.

Finally, golf course managers seeking to minimize the potential for ground water contamination by turf care pesticides can find general guidance in these analyses, recognizing that the actual leaching behavior of a pesticide will be influenced by site-specific factors. The protection accorded to Long Island's sole source aquifer should recognize the local variations in vulnerability to contamination and the potential of various pesticides to migrate and persist in the environment.

## Acknowledgments

Robert F. Carsel and his staff at the U.S. EPA Athens Environmental Research Laboratory provided invaluable support in our initial efforts to apply the PRZM model. We would also like to thank Elise Bekele, Katherine McIntyre, and Christine Weber for their technical assistance in the course of this study.

## Biographical Sketches

***Patricia Primi*** *is an environmental scientist with the Environmental Protection Bureau of the New York State Department of Law (120 Broadway, New York, NY 10271), where she has been employed since 1987. In addition to her work concerning nonagricultural pesticides, she provides technical support for Bureau litigation and negotiations involving ground and surface water contamination in New York State. She holds a B.S. in geology from Queens College, City University of New York, and is pursuing an M.A. in geology, also at Queens College.*

***Michael H. Surgan*** *is chief scientist in the New York State Department of Law, Environmental Protection Bureau (120 Broadway, New York, NY 10271). For 14 years he has provided scientific guidance and support for the attorney general's litigation, legislation, and educational initiatives. He has worked on numerous pesticide issues, matters involving ground and surface water protection and remediation, hazardous waste disposal and the health and environmental effects of toxic substances. He earned a B.S. from Brooklyn College, City University of New York, and an M.S. and Ph.D. from the University of Massachusetts; he was a post-doctoral fellow at the Johns Hopkins University School of Public Health and Hygiene.*

***Timothy Urban*** *received a B.S. and M.S. in environmental biology from the State University of New York, College of Environmental Science and Forestry, and worked as an environmental science aide in the Environmental Protection Bureau of the New York State Department of Law for three years.*

## Disclaimer

The views expressed herein are the authors' and not necessarily those of the New York State Department of Law or of the New York State attorney general.

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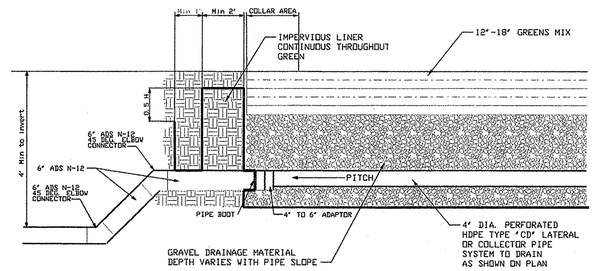
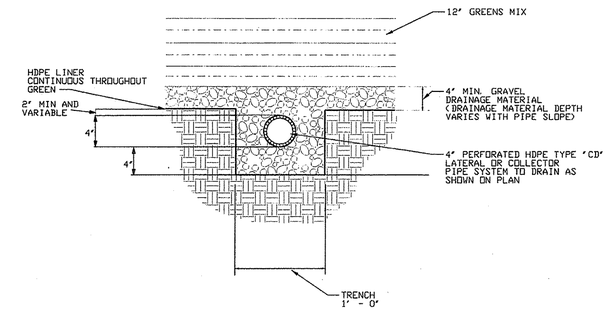
# Appendix 12
# Conceptual of Greens Liner System

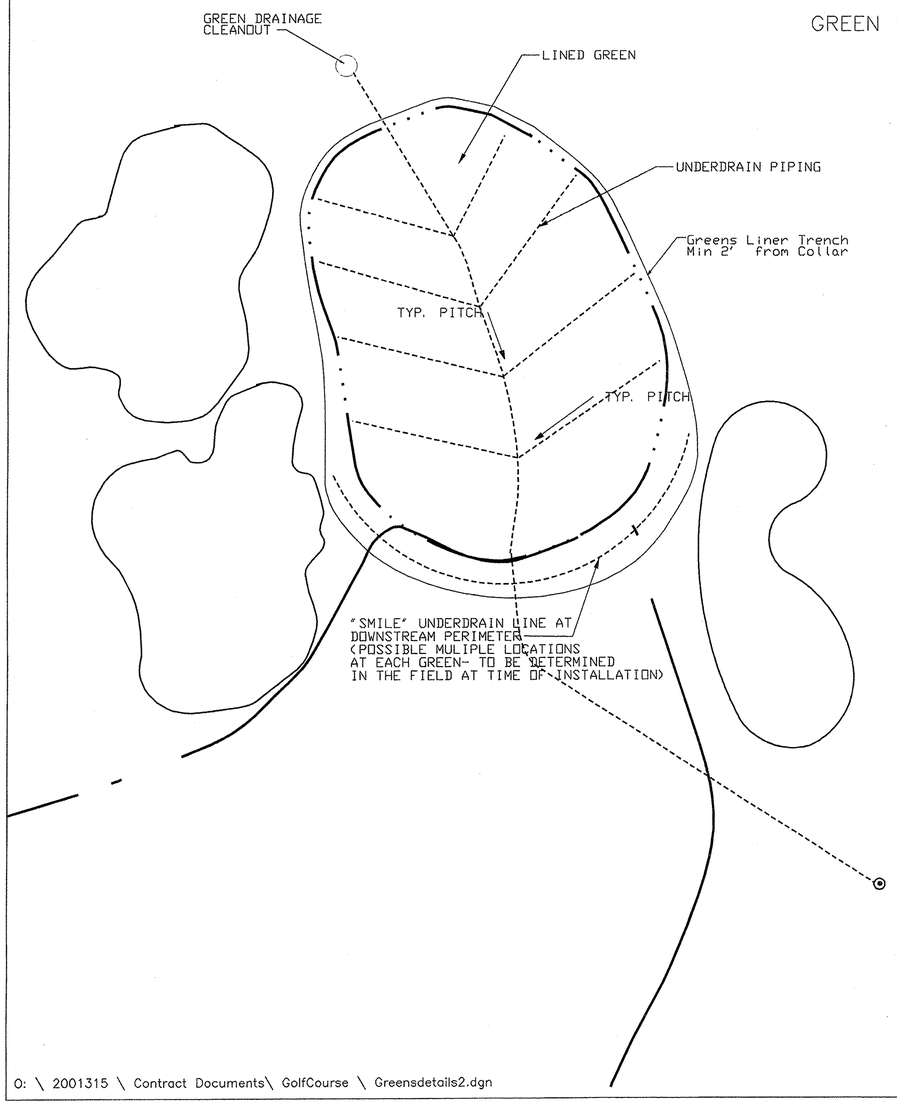


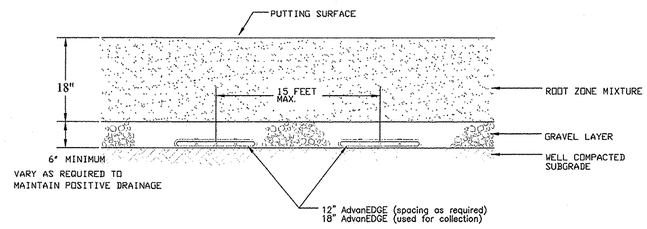

GREEN UNDERDRAIN TYPICAL PROFILE




GREEN UNDERDRAIN SYSTEM – TYP

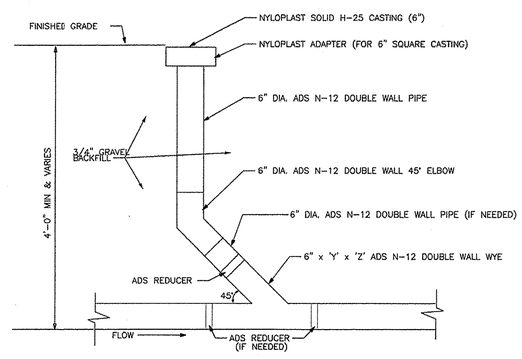
NTS



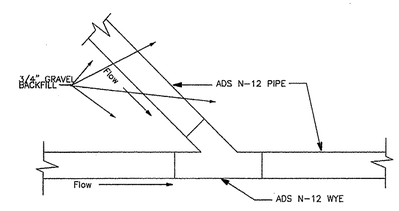




ALTERNATE
GREEN UNDERDRAIN SYSTEM – TYP

NTS




PIPE CLEANOUT DETAIL (TYP)




PLAN VIEW

PIPE JUNCTION DETAIL

TYPICAL AT ALL PIPE JUNCTIONS

NOTE:
1. COVER FOR GREENS DRAINAGE SYSTEM SHALL BE A MINIMUM OF 4' WITH A MINIMUM PIPE SLOPE AS SHOWN ON PLANS
2. CONTRACTOR SHALL PITCH SMILE LINE TO PROVIDE CONTINUOUS GRADIENT TO GDS EXIT POINT ON EACH GREEN.

O: \ 2001315 \ Contract Documents\ GolfCourse \ Greensdetails2.dgn


**GPI**
Greenman-Pedersen, Inc.
Engineers, Architects, Planners
Construction Engineers & Inspectors
325 West Main Street, Babylon, NY 11702
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This page is part of a set of 82 pages and complies with the approval of the Planning Board of August 26, 2004, and is subject to the conditions of that approval which are listed on the cover sheet stamped approved by the Planning Board

Client:
Sebonac Neck Holdings, LLC
270 South Service Road
Melville, NY 11747

Project:
SEBONACK GOLF CLUB

| No. | Date | Revision | Aprvd. |
|---|---|---|---|
| 6 | 03-18-05 | AMENDMENT TO SITE PLAN SUBMISSION | |
| 5 | 01-05-05 | CHANGES TO GREENS DRAINAGE SYSTEM- ADDITION OF 5TH PUMP ADDITIONS TO ROAD DRAINAGE | |
| 4 | 11-16-04 | FINAL SITE PLAN SUBMISSION WETLAND CONDITIONS ADDED HYDRANT PLAN ADDED | |
| 3 | 10-08-04 | GOLF COURSE AND DRIVEWAY DRAINAGE PLAN TO TOWN | |
| 2 | 4-28-04 | ADD GAS AND T/C UTILITIES | |
| 1 | 4-13-04 | SITE PLAN SUBMISSION | |

Drawing Title:
Greens Liner & Drainage Details

| Date: | Drawn By: |
|---|---|
| March 18, 2005 | KAH |
| Scale: N.T.S. | Checked By: JPG |

Drawing Number:
**37 of 82**

Project Number: 2001315.00

# Appendix 13
# Comprehensive Risk Assessment for Pesticides for the Proposed Golf Course at the Hills of Southampton: Environmental & Turf Services, Dec. 2, 2015-rev. Mar. 2016

# COMPREHENSIVE RISK ASSESSMENT FOR PESTICIDE USE AT THE PROPOSED *THE HILLS OF SOUTHAMPTON* GOLF COURSE AND HOMES

***by***

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**Agronomist**

**Environmental & Turf Services, Inc.**
**Wheaton, MD**

***with technical assistance from***

**Jeffrey Seeman, CGCS/CEP**
**East Quogue Golf Corporation**

***for***

**The Town of Southampton**

***on behalf of***

**Discovery Land Company**

**December 2, 2015**
**Revised March 28, 2016**
**Revised June 22, 2016**

## EXECUTIVE SUMMARY

The Discovery Land Company is proposing to develop seasonal residences and an 18-hole golf course in East Quogue. It is a Mixed-Use Planned Development District (MUPDD), and the development would be clustered on 168 acres of the 594-acre project site.

The Town of Southampton issued a scope for the draft environmental impact statement (DEIS) in mid-July (the document date is July 1, 2015). The DEIS scope contains nine requirements relevant to potential impacts by lawn and golf turf management. The purpose of this report is to address eight scope requirements. (The ninth requirement, regarding the maintenance facility, is being addressed by NP&V.) Our report does not address fertilizers in depth; that is being addressed in the Integrated Turf Health Management Plan (ITHMP) by Jeff Seeman.

Excerpts of the December 2, 2015 version of this 100+ page report (parts of pp. 23-34 and 60-64) were incorporated into Appendix H of the DEIS, the ITHMP. The ITHMP was reviewed by Dr. A. Martin Petrovic as part of the DEIS completeness review. This version of the report was revised in response to his comments. The most significant changes were a more in-depth evaluation of the toxicology of six of the proposed fungicides, the lawn care management program was refined, guidance relevant to the planned ground water monitoring protocol was added, and more pesticide restrictions were recommended.

Additional Layers of *de facto* Regulation

Pesticides are among the most intensely tested and heavily regulated chemicals in commerce. Typically, pesticides are registered - - for specific uses - - only after the completion of at least 75 studies (often near 100 or more) in the areas of human/mammalian toxicology, environmental chemistry, aquatic toxicology, terrestrial toxicology, worker exposure, pollinators, crop residues, and turf transferrable residues. The US EPA's scientists review the studies, and then conservatively model all potentially significant exposure routes. Further, since 1996 the EPA has only approved food-use chemicals (most turf pesticides have food uses) that meet the following test pursuant to the Food Quality Protection Act of 1996: a "safe" determination must be made regarding use of the pesticide such "…. ***that there is a reasonable certainty that no harm will result***" to sensitive human populations.

This risk assessment screening process that is being applied to the pesticides that could legally be used at this site **therefore constitutes an additional *de facto* layer of environmental assessment and regulation that goes well above and beyond the federal and State regulatory programs.**

Pathways and Receptors that are a Focus of the Risk Assessment

Weesuck Creek has no discernible flow in the vicinity of the proposed golf course. There is no surface drainage gradient that would be a pathway for stormwater runoff to reach Weesuck Creek.

The potential for pesticides to migrate to ground water was evaluated, in the context of the potential for those substances to travel laterally in the shallow aquifer and discharge to Weesuck Creek, public wells, and Shinnecock Bay.

The potential for pesticides to drift 1000 ft offsite was also evaluated.

First and Second Stage of Risk Screening and First Stage of Modeling

A list of 61 turf pesticides was compiled based on possible use on turf in this climate. That number was reduced to 49 based on redundancies and regulatory limits. This list of 49 pesticides was intensively evaluated for ground water contamination potential with the US EPA's new, conservative PRZM-GW model (Pesticide Root Zone Model – Ground Water). This model contains dozens of input parameters for environmental chemistry (mobility and persistence), agronomy (e.g., root zone depth), and site-specific parameters. The latter were partly determined by analysis of surface and subsurface soil samples we collected in August, and which were analyzed for various physical and chemical characteristics. Thirty years of daily weather records were used to enable PRZM-GW to calculate water flux and chemical transport. Many conservative assumptions were made regarding the model input (see below).

The PRZM-GW results were compared with lifetime drinking water Health Advisory Levels (HALs) for each pesticide, unless an EPA or NYSDEC standard exists, as well as aquatic life benchmark values. (We calculated several of the toxicologic reference points.) We used these comparisons of the calculated concentrations with the toxicity reference points to reduce the list further. This reduced list was evaluated in the next phase.

Application of the Field Environmental Impact Quotient and the AgDRIFT Model

The list of pesticides reduced based on PRZM-GW modeling was further evaluated using Cornell's Field Environmental Impact Quotient (Field EIQ) and the US EPA's AgDRIFT model. In addition to potential ground water risk, the Field EIQ considers potential effects on aquatic and terrestrial organisms. The AgDRIFT analysis flagged two pesticides for minor aquatic risk concerns.

The pesticides were then grouped according to the pests each addresses. When multiple pesticides are deemed efficacious for the same pest, the Field EIQ scores were used to flag the riskier pesticides for restrictions; i.e., the pesticides with the lowest risk are ranked first with regard to order of preference.

Conservative Assumptions

1. None of the pesticides would hydrolyze (break down in water).
2. None of the pesticides would be lost from the surface due to volatilization.
3. The pesticides are applied at their maximum rates and frequencies.
4. All pesticides would be used each year, every year.
5. There is no thatch layer to filter/sorb/degrade the pesticides.
6. Any pesticides that drift to Weesuck Creek are not diluted by stream flow, only static dilution.
7. The upper 90$^{th}$ percentile of drift potential was calculated, and the sensitive areas are assumed to be approximately 1000 ft away, rather than approximately 1500 ft and farther.

Pesticide Summary

This very conservative risk assessment process began with an initial list reduced from 61 to 49 pesticides. Five of the 49 are 'natural' and/or 'organic' and/or biochemical, and 10 are classified by the US EPA as "reduced risk". An extensive amount of environmental fate, mammalian/human toxicology, and aquatic toxicology data were collected for the remaining 43 conventional pesticides. Subsequent modeling using PRZM-GW, AgDRIFT, and Cornell's EIQ raised some potential risk and/or regulatory concerns. Our recommendations based on this intensive, conservative, lengthy process are as follows.

Pesticide Use

We identified 28 pesticides that would be appropriate for use on the golf course with no or minimal restrictions beyond the risk-assessed and heavily regulated product labeling. We recommend significant restrictions on another 11 golf course pesticides, and we recommend that eight pesticides that are legally registered for golf course use in Suffolk County not be used at this site. For the lawn care program, we recommend 16 pesticides for use without additional restrictions beyond the regulated labeling, and one with a timing restriction. We recommend that eight registered pesticides not be used on home lawns at this site. In addition, three pesticides will not be used and two pesticides will have limited use, based on Dr. Marty Petrovic's concerns. ***It is important to note that only a small fraction of this total is expected to be used in any single year.***

Ground Water and Pond Monitoring

In response to comments received from a Town consultant during the DEIS completeness review process, we developed a table that identifies pesticides that can be readily analyzed as well as those for which there do not appear to be readily available, feasible, methods for analysis of water samples. It is recommended that these pesticides not be used if there are still no lab methods available when the course is built. In response to other comments by the reviewer, we provide recommended methods for the pond monitoring as well.

Implementation

This report is lengthy and technical, with much detail. The golf course superintendent should be familiar with its content. But, based on past experience, the superintendent needs something much simpler to aid his/her compliance. Therefore we recommend that section VII(E), with its three risk-ranked pesticide tables, plus Table 19 should be incorporated into the ITHMP. In addition, the same pages should be bound into a field notebook.

Native Vegetation Restoration and Education Outreach

A native vegetation restoration and education outreach program could benefit the golf course, grade schools, and local researchers, as well as the local environment, and it could be a model for other golf courses throughout the US. It would consist of habitat plantings, followed by long-term species surveying. The field investigations could be incorporated into the biology curricula of the local schools, and local university researchers would approach it from a more advanced perspective. It could also

involve the golfers and enhance their golfing experience. Objective, third-party certification of this effort should be considered via the Wildlife Habitat Council.

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## I. INTRODUCTION AND PURPOSE

### A. Background

The Discovery Land Company proposes to develop a golf course in East Quogue (Figures 1a and 1b[*]). The Mixed-Use Planned Development District would include seasonal housing, a significant amount of open space, and an 18-hole Tom Fazio golf course. The golf course will consist of 78 acres of maintained turfgrass spread over a 98 acre portion of the 594 acre project site.

A positive declaration was determined, which triggered the requirement for the Environmental Impact Statement (EIS) by the Town of Southampton. In July, 2015, the Town issued the scope (the required contents) for the draft EIS (DEIS). The DEIS was completed and submitted in December, and it included this report. Subsequently, the DEIS was reviewed for completeness by consultants for the Town.

Thus the purpose of this report is to evaluate potential impacts identified in the DEIS scope relevant to turf management, and to recommend appropriate risk management measures. This version of the report also includes revisions that were made in response to comments received from Dr. A.M. Petrovic during the completeness review.

### B. DEIS Scope Requirements Relevant to this Risk Assessment

In this report we address the following requirements of the July 1, 2015 DEIS scope developed by the Town (see Table 1). We cite each relevant requirement at the beginning of each major section of the report (Sections II, III, etc.).

[*] Weesuck Creek does not flow through the project site, contrary to the base maps used for Figures 1a and b.

**Table 1. DEIS Scope Requirements Relevant to this Report**

| DEIS Scope Page | DEIS Scope Section | DEIS Scope Requirement | Addressed in this Section of the Report |
|---|---|---|---|
| 10 | Community Benefits | 1. Discuss the community benefits proposed . . . as follows:<br>1. Open space;<br>…..<br>3. Parks; | One component addressed in section IX |
| 12 | Project Design and Layout | 20. Provide information on the use of lawn chemicals (e.g., fertilizers, insecticides, pesticides, fungicides, rodenticides, etc.) and associated application procedures. | VIII |
| 14 | Water Resources | 18. Discuss the anticipated pollutant loadings and impacts on surface water quality from the project with a focus on nearby surface water bodies including Weesuck Creek and Shinnecock Bay particularly with respect to nitrogen and phosphorous loadings and pesticides and the potential to exacerbate brown or red tides. | II(B), V, VI, VII, IX) |
| 14 | Water Resources | 19. Analyze other potential sources of water quality impacts related to pesticides, chemical storage, fuel storage (if applicable) and the golf course activities. These golf course activities include, but are not limited to, the cleaning of golf course maintenance equipment and grass clipping management". | Addressed by NP&V in its section of the DEIS |
| 15 | Water Resources | 22. Use a series of pesticide risk assessments, starting with LEACHP[4] or PRZM and/or WIN PST to initially screen for high risk pesticides that will not be used and then develop a pesticides use ranking list for each pest based on the NYS Integrated Pest Management Field Environmental Impact Quotient (Field EIQ) for the remaining pesticides registered for use on that pest to help design an impact analysis related to golf course chemical usage. | V and VII |
| 15 | Water Resources | 23. Evaluate and report on the potential for the pesticides used to maintain the golf course to become air-borne, causing the spread of pollutants to sites outside of the project. | VI |
| 16 | Ecology | 11. Analyze impacts to vegetation, wildlife habitats, individuals and migratory patterns both quantitatively and qualitatively. Include any direct impacts due to change in habitat cover or indirect impacts on human activities, such as the use of pesticides and fertilizers on public health. | II(C), V-VIII, X |
| 16 | Ecology | 12. Identify the potential for any potential direct or indirect impacts on rare, threatened, or otherwise protected plant and animal species and their habitats. | II(C), VI, VII, VIII, X |
| 16 | Ecology | 13. Analyze and discuss the potential impacts of the proposed project on fisheries, saltwater vegetation, etc. of Weesuck Creek and Shinnecock Bay, and the red/brown tide and algae bloom conditions as well as the potential for the project to significantly contribute to such conditions. | Pesticide component addressed in sections V-VIII, IX (harmful algal blooms not addressed in this report) |

**Figure 1a. Golf Course and Project Location Map**

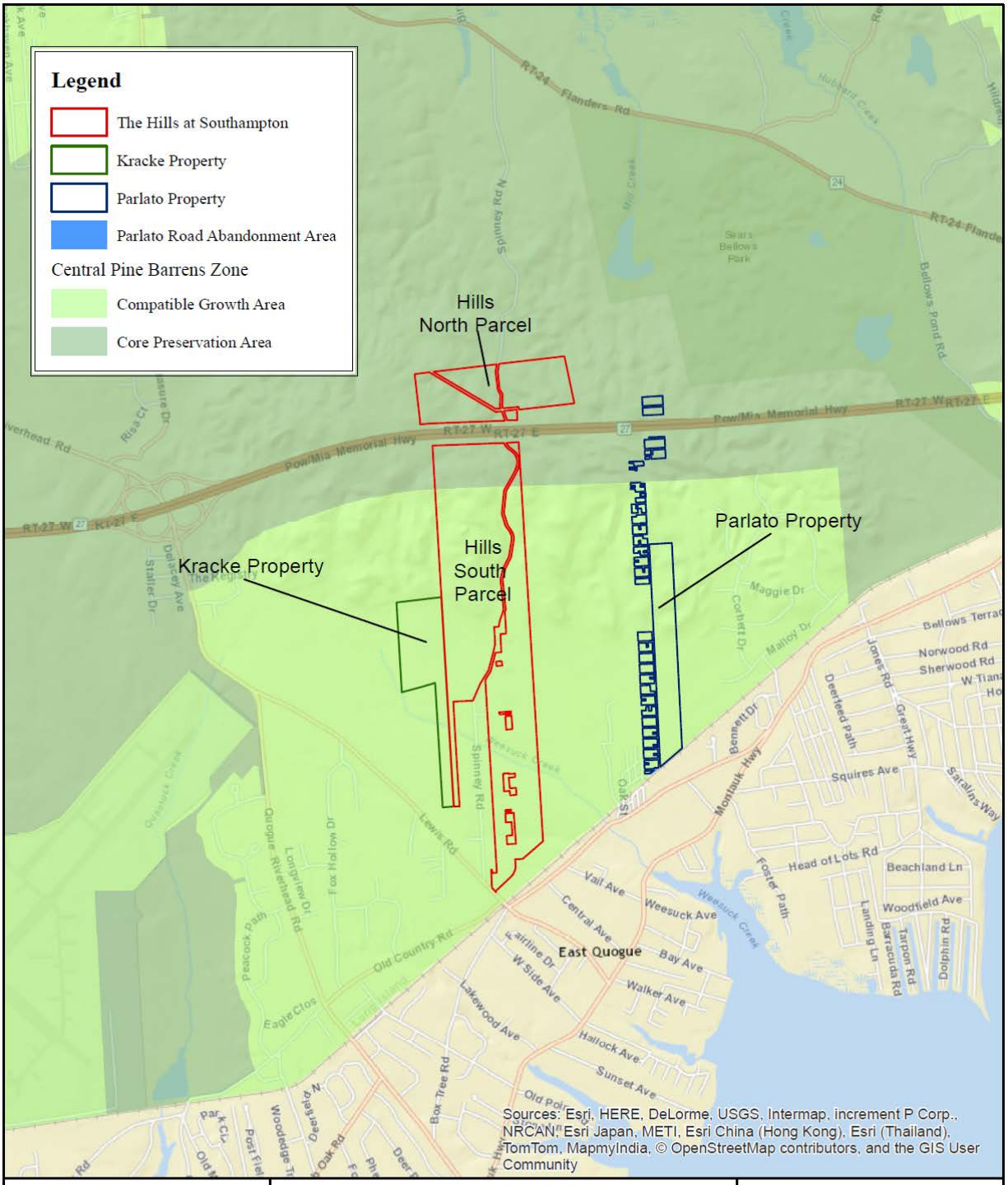


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**FIGURE 1a**
**General Location Map**

Source: ESRI WMS, NYSGIS Clearing House
Scale: 1 inch = 3,000 feet

**The Hills at Southampton**

**PDD Application**

**Figure 1b. Site Location Map**

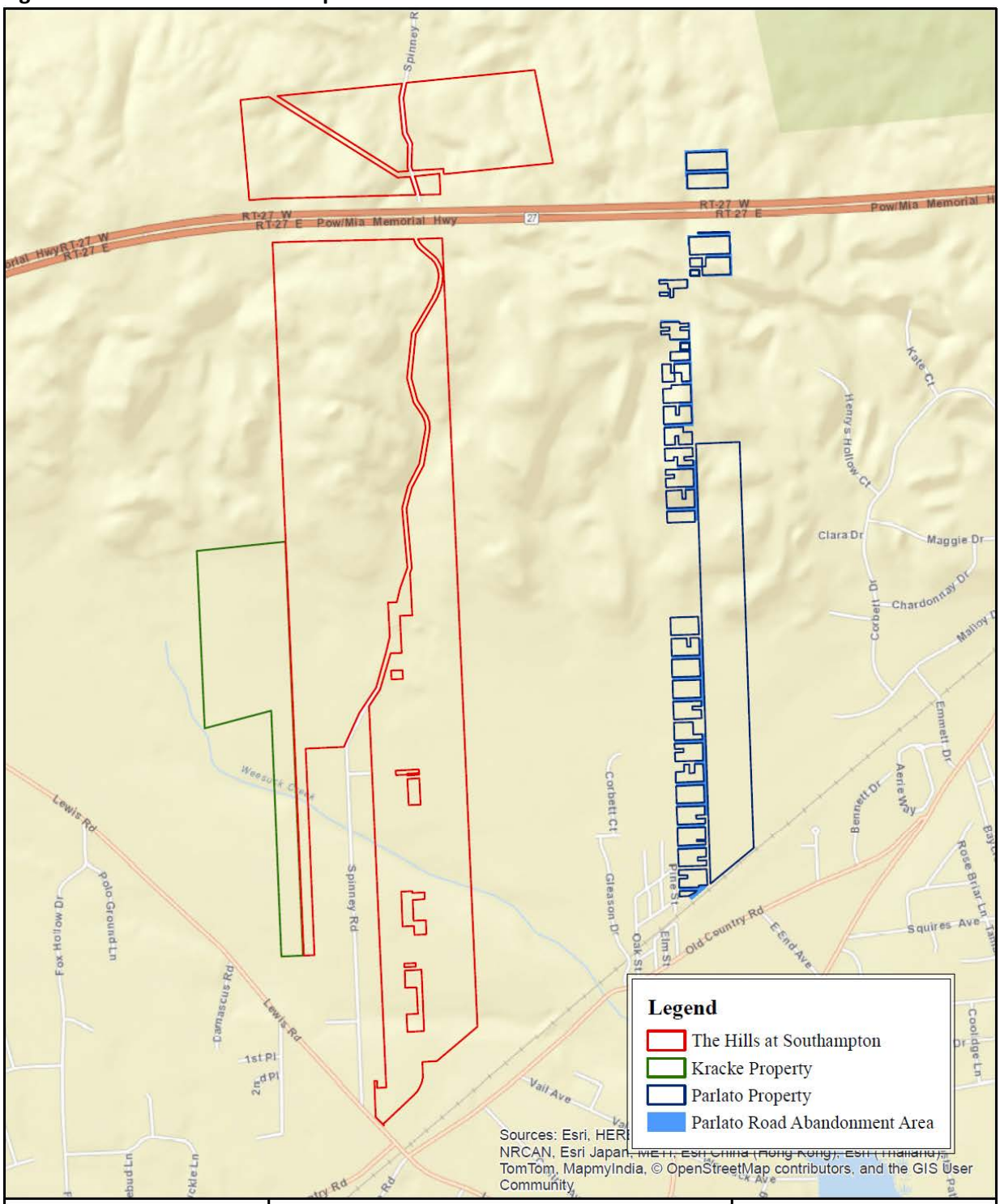


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**FIGURE 1b**
**Location Map**

Source: ESRI Web Mapping Service
Scale: 1 inch = 2,000 feet

N

**The Hills at Southampton**

**PDD Application**

## II. CONCEPTUAL MODEL OF RISK ASSESSMENT

This discussion is relevant to DEIS requirement #18 and #22 under "Water Resources", and #11, #12, and #13 under "Ecology".

The purposes of this section are to present the overall processes and approach for the risk assessment, and to describe the sensitive receptors and exposure pathways. An extensive amount of mobility, persistence, human toxicity, and ecotoxicity data are presented for each pesticide in Section V.

### A. Regulatory and Risk Assessment Overview

#### 1. DEIS Requirements

The DEIS scope requirements relevant to this risk assessment are listed in section I(B) above.

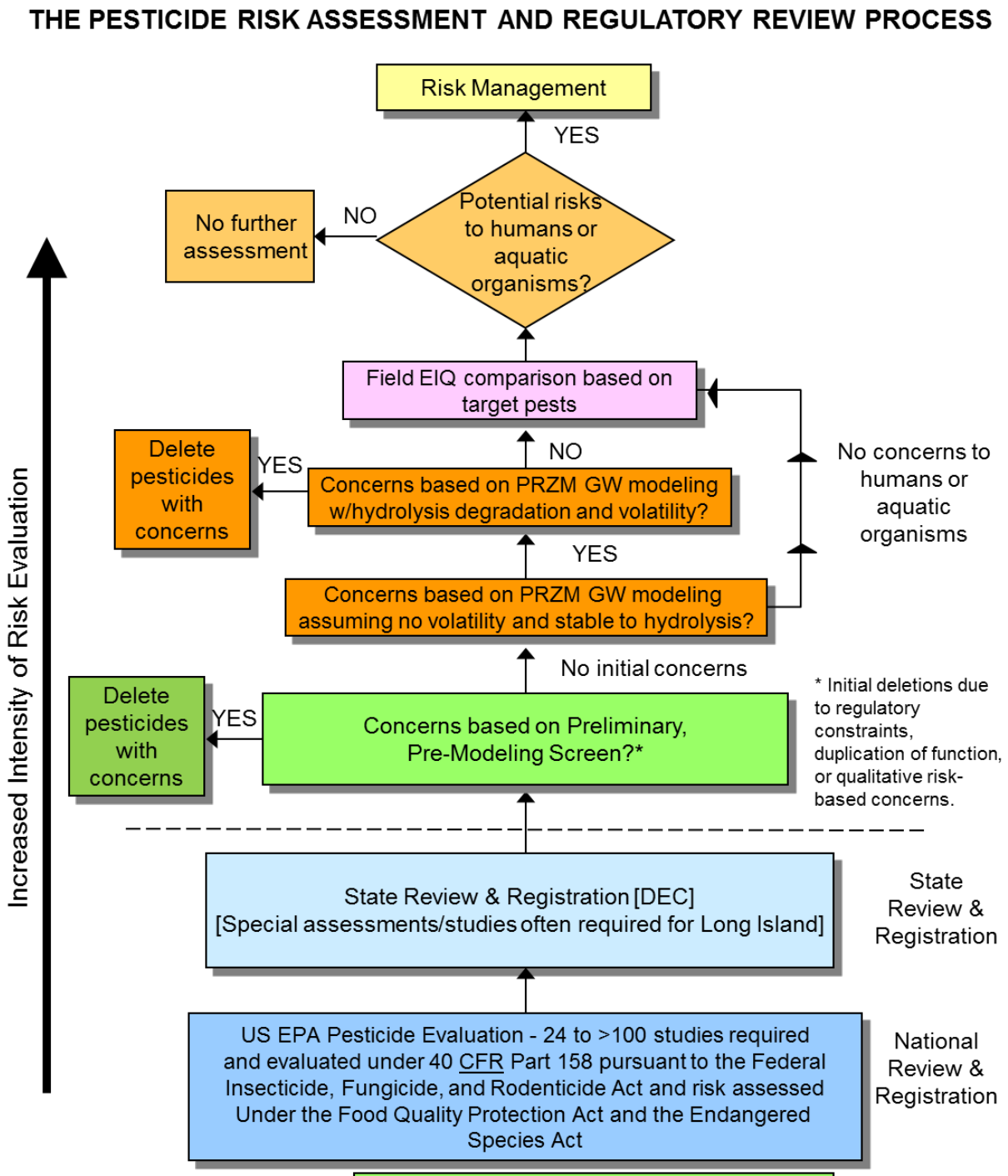
#### 2. The Pesticide Regulatory Risk Assessment Pyramid

Figure 2 depicts the pesticide risk assessment and regulatory review process for The Hills at Southampton golf course. The explanation follows.

Underlying the pyramid is the strong US EPA pesticide regulatory program pursuant to the federal pesticide law, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Conventional turf pesticides must undergo approximately 75 to greater than 100 studies, prior to registration, in the areas of mammalian toxicology, environmental chemistry (fate), terrestrial and aquatic toxicology, worker exposure, etc. (Title 40 of the Code of Federal Regulations Part 158; Appendix A).

The data are then integrated with the proposed use patterns into a comprehensive risk assessment by the EPA's scientists in its Office of Pesticide Program (OPP). One of the models developed and used by OPP scientists in this process is PRZM-GW, or Pesticide Root Zone Model – Ground Water. We are applying this model to all pesticides proposed for use at this site.

**Figure 2. The Pesticide Risk Assessment and Regulatory Review Process**




***In every step, except "Preliminary, Pre-Modeling Screen", pesticide mobility, persistence, and toxicity are carefully considered.***

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Ultimately, the risk-based standard that OPP scientists apply to any turf pesticide that also has a food use - - which applies to most turf pesticides - - is that there must be ". . . a reasonable certainty of no harm . . ." to children and others (Food Quality Protection Act of 1996). Detailed risk assessments are also conducted for federally listed threatened and endangered species, pursuant to the Endangered Species Act. There are over 1500 federally listed species.

Once a national pesticide registration is obtained, use is not permitted unless and until the state government has approved it. The NY DEC regulates pesticides, and New York is one of three states that conduct a comprehensive review of the pesticide data package (Environmental Conservation Law, Article 33, Pesticides). Further, the DEC frequently requires additional studies prior to a full registration throughout the State.

Most of the processes described in the boxes above the dotted line are driven by environmental and agronomic science. The DEIS scope dictates the choice of two of the models, the US EPA's PRZM-GW (Pesticide Root Zone Model-Ground Water) and Cornell's Field EIQ (Environmental Impact Quotient). Application of these models (sections V and VII below), plus the AgDRIFT pesticide drift model (section VI below), integrated with an extensive amount of toxicologic data, will result in the elimination of additional pesticides that have been thoroughly tested and which are legal for use pursuant to federal and state law.

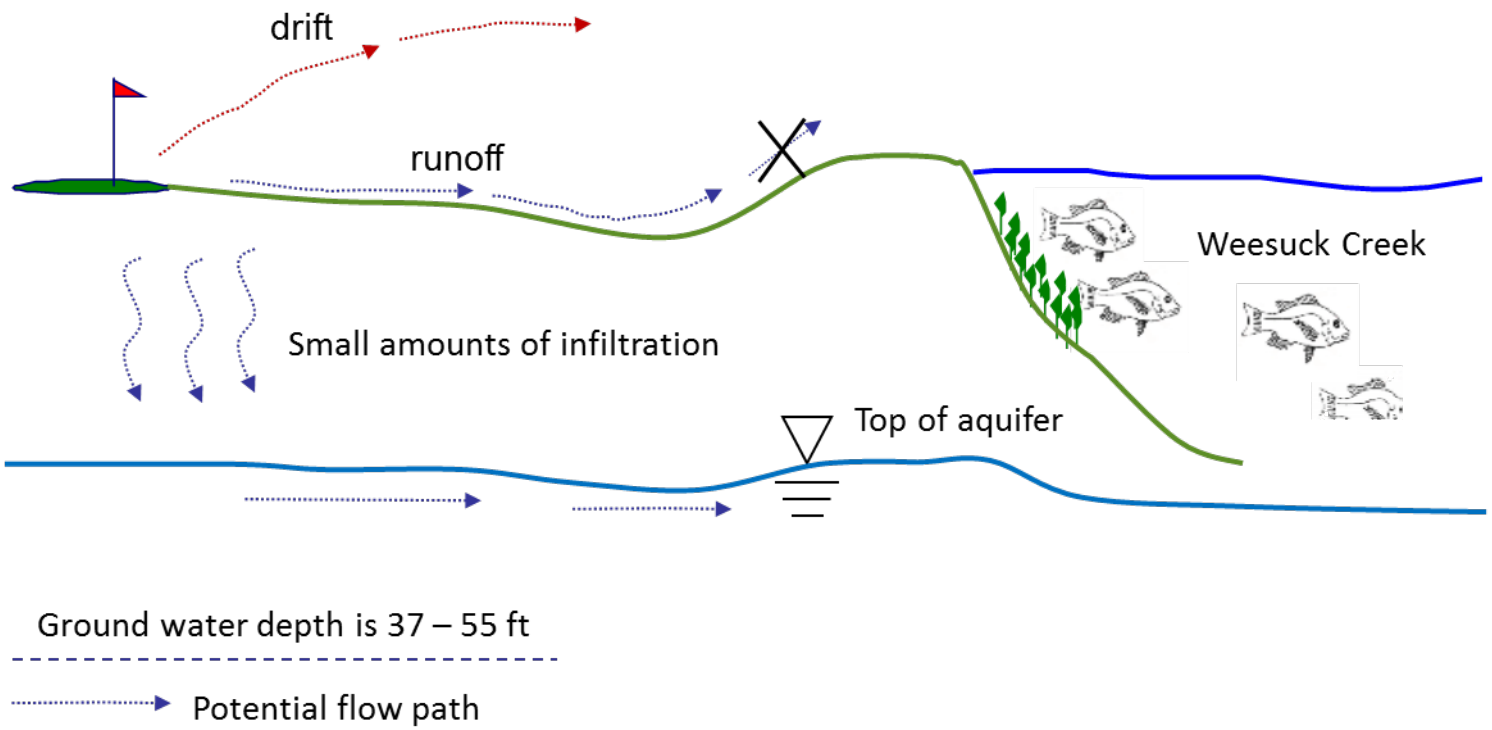
Thus this tiered assessment constitutes an additional *de facto* layer of regulation for a heavily regulated activity.

## B. Potential Exposure Pathways

### 1. Runoff

Existing topography, coupled with the sandy soils, prevents stormwater runoff from flowing to Weesuck Creek from golf turf areas (Figure 3).

**Figure 3. Conceptual Exposure Pathway**



### 2. Leaching

A pathway exists for turf pesticides and nutrients to leach down to ground water and then flow horizontally to Weesuck Creek (Figure 3), which ultimately empties into Shinnecock Bay. Contrary to the base map in figures 1a and 1b, there is no surface flow of Weesuck Creek in or adjacent to the proposed golf course.

This exposure pathway is examined in detail for pesticides in section V below.

### 3. Drift

A pathway exists for turf pesticides to drift offsite during application (Figure 3). This exposure pathway is examined in detail for pesticides in section VI below.

## C. Potentially Sensitive Receptors

### 1. Listed Species

No State- or federal-listed endangered or threatened species have been found on or adjacent to the proposed location of the golf course. Critical habitat has not been observed on or adjacent to the proposed golf course location. The proposed location of golf course turf may come as close as 1500 ft to the north parcel (north of Rt. 27), which may contain some sensitive habitat.

A majority of the species listed by the New York Natural Heritage Program require wetland areas with open waters, which do not occur at the site.

### 2. Drinking Water

The closest drinking water supply to the proposed site is SCWA's Spinney Road well field, which is located on the west side of Spinney Road just south of where the road terminates

into Lewis Road. The SCWA uses these wells to supply water services to the residential community in the vicinity.

Recharge from precipitation and irrigation will influence ground water, which must be protected. Therefore, a quantitative risk assessment was done for potential impacts on ground water.

### 3. Weesuck Creek and Shinnecock Bay

We are assuming there are fresh water vertebrates and invertebrates in the portion of Weesuck Creek that is not tidally influenced. The closest golf course turf to the Weesuck Creek headwater appears to be approximately 1500 ft away to the west.

## III. SITE DESCRIPTION

This discussion is relevant to DEIS requirement #22 under “Water Resources”.

### A. General

The site is mostly wooded with conifers. Part of the site has been cleared and is subject to unauthorized use by dirt bikes and all-terrain vehicles. Between 15 and 20 acres of the site are farmed as a nursery and for other crops. The terrain is flat to gently rolling.

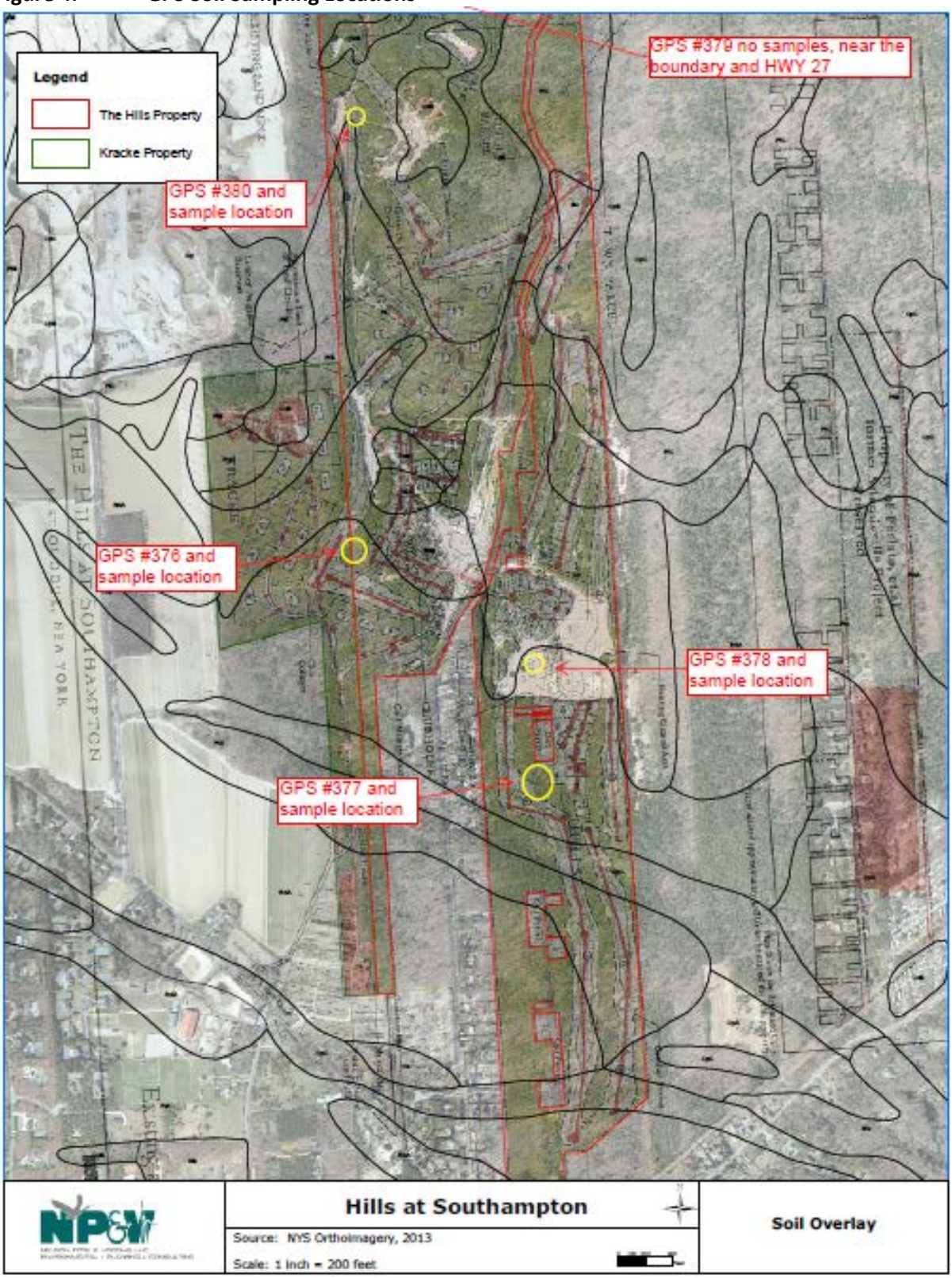
### B. ETS Soil Sampling

ETS collected soil samples from areas indicated to have different soil types as listed in the soil survey where the golf course is proposed on the southern parcel of the property (Figure 4 and Appendix B). We collected 15 soil samples from five depths at four locations near proposed golf holes (Figure 4). Not all soil samples were analyzed for all parameters (Table 2). The bulk density (BD) and the percent porosity analyses were applied to six samples at two depths: 0-4” and 4-8”. In addition, BD and percent porosity were applied to one sample deeper in the soil profile at one location (#380) because the soil appeared to be somewhat compacted at that deeper depth (i.e., 10-14”) compared with the 0-24” soil profile.

Additional analyses were applied to 14 soil samples at four locations: S3M, nitrate-nitrogen (N-N), textural class, field capacity (1/3 bar), and wilting point (15 Bar) analyses. The S3M analysis includes pH, percent organic matter (OM%), phosphorus (P), cation exchange capacity (CEC), and micronutrients (e.g., sodium, manganese, iron, etc.).

Some of the results are tabulated (Table 3) for easy reference. The detailed lab results are provided in Appendix C. The soil sample results show that the textural classification for most of the samples is sand. However, one sample location (GPS location #377, see Figure 4) was classified as a sand at the surface, loamy sand from 4” to 12”, and a clay loam at 12-24”.

**Figure 4. GPS Soil Sampling Locations**



The highest OM % was found at sample depth 0-4” (average 2.43%) with a range of 1.9 to 2.6%. The average OM % for the 0-4” depth excludes the samples collected in the gravel pit, which had no vegetation (Table 3). The average bulk density for the 0-4” sample is 1.208 g/mL and 1.236 g/mL at the 4-8” depth. The available moisture content (i.e., field capacity minus wilting point) in the surficial samples 0-4” range from 1 to 6%, including the gravel pit sample. The pH values range from 4.2 to 6.2 in the surficial sample 0-4”. See Table 3 for these results and Appendix C for detailed lab results.

**Table 2. The Hills Soil Sample Locations and Analyses Conducted**

| GPS # and Sample Identifier | Sample Location Description | Samples Depths | Analyses and Number of Samples and Depths Collected | Expected Soil Type from Survey |
|---|---|---|---|---|
| 376 | near golf holes 10 & 11; west center portion of the site | 4 depths<br>0-4”<br>4-8”<br>8-12”<br>12-24” | BD & Porosity– 2 depths<br>S3M – 4 depths<br>N – 4 depths<br>Texture – 4 depths<br>Avail Moisture – 4 depths | Plymouth/Riverhead |
| 377 | near Southern part of site S of gravelly area, near golf hole 8 | 4 depths<br>0-4”<br>4-8”<br>8-12”<br>12-24” | BD & Porosity– 2 depths<br>S3M – 4 depths<br>N – 4 depths<br>Texture – 4 depths<br>Avail Moisture – 4 depths | Plymouth |
| 378 | Gravel pit area S. central portion of site, near hole 9 | 2 depths<br>0-4”<br>4-8” | BD & Porosity – 2 depths | Gravel Pit |
| 380 | near golf hole 13 NW portion of site | 5 depths<br>0-4”<br>4-8”<br>10-14” BD<br>8-12”<br>12-24” | BD & Porosity – 3 depths<br>S3M – 4 depths<br>N-N – 4 depths<br>Texture – 4 depths<br>Avail Moisture – 4 depths | Carver- Plymouth |

These soil sample results (Table 3) compare well with the soil survey (USDA, SCS, 1975). The soil survey NRCS web soil survey (http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx) describes the Carver and Plymouth soils parent material as acid sandy glaciofluvial or deltaic deposits, which would provide acidic conditions in the sandy soils. This is consistent with the low pH observed in our samples (Table 3). The description for the textural class for the Carver and Plymouth soils are also consistent with the results: sand and loamy sand. The available moisture in the Carver Plymouth soils range from 3 to 8% according to the survey (USDA, SCS, 1975), which is consistent with the results that show available moisture, which are mostly within that range (i.e., 2 to 6%; Table 3), excluding the gravel pit samples (#37804 and #37848).

However, in response to comments received from Dr. A.M. Petrovic during the completeness review, revisions were made to the field capacity (FC), wilting point (WP), and organic carbon (OC). We used these three revised soil parameters in the remodeling of three pesticides to compare the results. See Section V(D) Table 7a for the original input parameters and Table 7b for the revised input parameters used in the remodeling of three pesticides (see Section V.E for all results).

**Table 3. The Hills Soil Sample Results**

| Soil Sample ID* | Depth of Sample (inches) | Textural Class | pH | OM % (ENR)† | N-N (ppm) | P (ppm) | CEC (meq/100g) | BD (g/cm$^3$) | Porosity (%) | FC (1/3 bar) % | WP (-15 Bar) % | Avail. Moisture % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 37604 | 0-4 | L. Sand | 5.4 | 1.9 (82) | 2 | 11 | 2.1 | 1.127 | 0.93 | 7 | 5 | 2 |
| 37648 | 4-8 | Sand | 6.4 | 0.3 (48) | 2 | 19 | 1.8 | 1.560 | 0.21 | 3 | 2 | 1 |
| 376812 | 8-12 | Sand | 6.7 | 0.5 (53) | 2 | 8 | 0.6 | NA | NA | 2 | 1 | 1 |
| 376124 | 12-24 | Sand | 6.5 | 0.3 (48) | 4 | 13 | 0.2 | NA | NA | 3 | 1 | 2 |
| | | | | | | | | | | | | |
| 37704 | 0-4 | Sand | 4.6 | 2.6 (96) | 3 | 7 | 0.9 | 1.056 | 0.05 | 14 | 8 | 6 |
| 37748 | 4-8 | L. Sand | 4.7 | 1.2 (68) | 2 | 3 | 0.4 | 1.198 | 0.22 | 10 | 5 | 5 |
| 377812 | 8-12 | L. Sand | 5.4 | 1.0 (64) | 2 | 7 | 0.8 | NA | NA | 9 | 4 | 5 |
| 377124 | 12-24 | C. Loam | 5.3 | 1.3 (70) | 2 | 5 | 0.3 | NA | NA | 8 | 4 | 4 |
| | | | | | | | | | | | | |
| 37804 | 0-4 | Sand | 6.2 | 0.7 (58) | 2 | 6 | 0.2 | NA | NA | 3 | 2 | 1 |
| 37848 | 4-8 | Sand | 6.2 | 0.6 (55) | 2 | 7 | 0.2 | NA | NA | 3 | 2 | 1 |
| | | | | | | | | | | | | |
| 38004 | 0-4 | Sand | 4.2 | 2.8 (100) | 2 | 5 | 1.2 | 1.442 | 0.14 | 27 | 25 | 2 |
| 38048 | 4-8 | Sand | 5.5 | 0.6 (55) | 2 | 3 | 0.2 | 0.949 | 0.06 | 6 | 3 | 3 |
| 380812 | 8-12 | Sand | 5.4 | 1.6 (76) | 2 | 5 | 0.2 | NA | NA | 8 | 4 | 4 |
| 380124 | 12-24 | Sand | 5.3 | 0.8 (60) | 2 | 4 | 0.2 | NA | NA | 6 | 3 | 3 |
| | | | | | | | | | | | | |
| 380104‡ | 10-14 | NA | NA | NA | NA | NA | NA | 1.365 | 0.4 | NA | NA | -- |

*The soil sample IDs are associated with GPS reading and depths. The first three numbers is the GPS reading, the remaining numbers represent the sampling depth (e.g., 37604 = GPS reading #376, soil sample depth 0-4 inches. See attached map for general sample locations.

N-N = nitrate as nitrogen (nitrate available to plant), lab cannot detect levels lower than 2 ppm. The results that indicate undetected levels of nitrate-nitrogen will display 2 ppm.

P = phosphorus (available to plant); CEC = Cation Exchange Capacity; BD = bulk density; FC = field capacity; WP = wilting point; % Porosity = percent porosity; avail moisture = available moisture, which is FC minus WP.

NA = not analyzed

L. Sand = loamy sand; C. Loam = clay loam

†ENR = estimated nitrogen release, e.g., ENR 68 = 68 lb N/A is released over the growing season.

‡This sample was analyzed for BD and % porosity only because there appeared to be a restricted layer at that depth, i.e., the soil seemed to be somewhat compacted or harder than the soil above it. Everything else appeared to be the same.

## IV. PESTICIDE APPLICATION SCENARIOS

This discussion is relevant to DEIS requirement #20 under "Project Design and Layout", #18, #19, #22, and #23 of "Water Resources" and #11, #12, and #13 under "Ecology".

Golf turf is stressed by low mowing and frequent traffic. But good superintendents use a holistic approach to manage turf to maintain its health and minimize infestations and damage from insect, weed, and disease pests. This approach is called Integrated Pest Management (IPM), and it is described in the Discovery Land Company's PDD application submission, the Integrated Turf Health Management Plan (J.L. Seeman, EQGC; 11/11/04).

### A. Turf Varieties and Anticipated Pests

There are tentative plans to grow the following types of grass. The grass species and varieties are being chosen with a goal of minimizing environmental inputs, i.e., fertilizers, fungicides, and water.

Tees and greens - - colonial and creeping bentgrass, respectively;
Fairways - - colonial bentgrass and fescue mixed; and
Roughs - - fescue/bluegrass or fescue/ryegrass.

Following is a list of potential pests at the proposed golf course. This list drives the potential list of pesticides in Section B below.

**Anticipated Turfgrass Pests**

| WEEDS | DISEASES | INSECTS |
|---|---|---|
| *Broadleaf weeds | Erwin a spp | *Cutworms |
| *Poa annua | Pseudomonas spp | *Annual bluegrass weevil |
| Barnyardgrass | Xanthomonas spp | *White grubs |
| *Chickweed | *Leaf spot | |
| *Henbit | Powdery mildew | |
| *Goosegrass | *Dollar Spot | |
| *Crabgrass | *Fairy ring | |
| *Nutsedge/killinga | *Brown patch | |
| *Sedge species | Grey leaf spot | |
| | *Anthracnose | |
| | *Pythium | |
| | *Snow molds | |

*These are the key pests; i.e., they are likely to occur and they are likely to be problematic.

## B. Preliminary List of Pesticides to be Evaluated

An initial list of 58 pesticide active ingredients was assembled for evaluation. They were chosen based on the anticipated pests (Section A above), Cornell recommendations, and use on nearby golf courses. The 58 pesticides were reduced to 48 in a preliminary screen based on redundancies and regulatory considerations, as shown in Table 4 below.

**Table 4. Pesticide Risk Screening: Initial Pre-Modeling Screen (n=58)**

| Pesticide | Trade Name | Chemical Abstract # | Reason for Deletion |
|---|---|---|---|
| **Fungicides** | | | |
| Aluminum tris O-ethyl (Fosetyl-Al) | Aliette®, Signature® | 39148-24-8 | |
| Azoxystrobin‡ | Heritage® | 131860-33-8 | |
| Bacillus subtilis* | Companion® Liquid or Rhapsody® | 68038-70-0 | |
| Boscalid‡ | Emerald® | 188425-85-6 | |
| Chloroneb | | | Duplicative with etridiazole. |
| Chlorothalonil | Daconil Ultrex® | 1897-45-6 | |
| Chlorothalonil + Acibenzolar | Daconil Action™ | 135158-54-2 (acibenzolar) | |
| Ethazole | | | Duplicative with etridiazole. |
| Etridiazole | [Banrot products only] | 2593-15-9 | [Only the Banrot products are allowed on Long Island turf.] |
| Fenarimol | | | No longer registered in New York |
| Fluazinam | Secure® | 079622-59-6 | |
| Fludioxonil‡ | | | Not registered for use on Long Island |
| Flutolanil | ProStar WP® | 66332-96-5 | |
| Fluxapryroxad | | | Not registered in Nassau and Suffolk Counties |
| Iprodione | Chipco 26019®, 26GT, Chipco GT® | 36734-19-7 | |
| Mefenoxam‡ | Quell®, Subdue® Maxx® | 70630-17-0 | |
| Metconazole | Tourney® | 125116-23-6 | |
| Mineral Oil + Pigment* | Civitas® | | |
| Myclobutanil | Eagle® | 88671-89-0 | |
| Oxytetracyline (OTC) | N/A at this time# | 000079-57-2 | Awaiting registration for turf# |

| Pesticide | Trade Name | Chemical Abstract # | Reason for Deletion |
|---|---|---|---|
| Penthiopyrad | Velista® | 183675-82-3 | |
| Polyoxin D* | Endorse® | 146659-78-1 | |
| Propamocarb hydrochloride | Banol® | 25606-41-1 | |
| Propiconazole | Banner Maxx® | 60207-90-1 | |
| Pyraclostrobin | Insignia® | 175013-18-0 | |
| Thiophanate-methyl | Cleary 3336® | 23564-05-8 | |
| Thiram | 42-S Thiram | 137-26-8 | |
| Triadimefon | Bayleton®25 (wsp) | 43121-43-3 | |
| Trifloxystrobin‡ | Compass® | 141517-21-7 | |
| Vinclozolin | | | potential endocrine disruptor; use is being phased out |
| **Herbicides** | | | |
| Bensulide | Betasan® | 741-58-2 | |
| Bispyribac-sodium‡ | Velocity® | 125401-92-5 | |
| Carfentrazone-ethyl‡ | Speed Zone® and Power Zone® | 128639-02-1 | |
| Dimethylamine salt of 2,4-dichlorophenoxyacetic acid (2,4-D) | a component of Trimec Classic® | 94-75-7 | |
| Dimethylamine salt of Dicamba | Banvel®, and a component of Trimec Classic® | 1918-00-9 | |
| Dimethylamine salt of methyl-chlorophenoxy propionic acid (MCPP) | a component of Trimec Classic® | 7085-19-0 | This is eliminated following the risk assessment in section V. |
| Dithiopyr | | | The maximum rate allowed in New York, 0.25 lb/A is too low to be efficacious |
| Ethofumesate | Progress® | 26225-79-6 | |
| Fenoxaprop | Acclaim® | 66441-23-4 | |
| Fluazifop-P-butyl | Fusilade® | 69806-50-4 | |
| Foramsulfuron | | | Warm season grass only |
| Glufosinate-ammonium | | | Not allowed in Suffolk and Nassau Counties |
| Glyphosate | Roundup Pro® | 1071-83-6 | |
| Halosulfuron | Manage® | 100784-20-1 | |
| Mesotrione‡ | Tenacity® | 104206-82-8 | |
| Pendimethalin | Pendulum® | | This was considered in the lawn care section only, and was deleted due to a high FEIQ score. |
| Prodiamine | Barricade® | 29091-21-2 | |
| Quinclorac | Drive® | 84087-01-4 | |

| Pesticide | Trade Name | Chemical Abstract # | Reason for Deletion |
|---|---|---|---|
| Sethoxydim | Vantage® | 74051-80-2 | |
| Siduron | | | The cost and limited applicability don't justify its inclusion |
| **Plant Growth Regulators** | | | |
| Ethephon | Proxy® | 16672-87-0 | |
| Paclobutrazol | Trimmit® 2 SC | 76738-62-0 | |
| Trinexapac-ethyl | Primo® | 95266-40-3 | |
| **Insecticides** | | | |
| Bifenthrin | Talstar® | 82657-04-3 | |
| Carbaryl | Sevin® | 63-25-2 | |
| Chlorantraniliprole‡ | Acelepryn® | | Not allowed in Suffolk County |
| Chlorpyrifos | Dursban® | 2921-88-2 | |
| Deltamethrin | DeltaGard® | 52918-63-5 | |
| Imidacloprid | Merit 75® | 138261-41-3 | |
| Lambda cyhalothrin‡ | Battle®<br>Scimitar® | 91465-08-6 | |
| Parasitic Nematodes*<br>Heterorhabditis bacteriophora<br>Steinernema carpocapsae | Cruiser,<br>Heteromask<br>Biosafe, Savior | N/A | |
| Spinosad*‡ | Conserve® | 168316-95-8 | |

*These products are generally considered to be "natural" and/or "organic" and/or biological in origin.
‡These products are on EPA's "Reduced Risk" ('Safer Pesticide') Program and are considered safer than alternative pesticides for the same use. Spinosad is classified as "Reduced Risk" for other uses.
[#]OTC is registered for use in New York and Long Island on trees. An OTC-containing product for turf is not yet registered in the State. OTC is included in this table in anticipation of a future product registration.

## V. MODELING GROUND WATER CONTAMINATION POTENTIAL RISKS USING PRZM-GW

This section is relevant to DEIS requirement #22 under "Water Resources".

In this section we describe the modeling of potential ground water impacts using the US EPA's Pesticide Root Zone Model-Ground Water (PRZM-GW). Then we list the human health and aquatic life reference points. Finally, we compare the PRZM-GW results with the toxicological reference points to assess pesticide risk potential.

### A. Modeling Purpose

The purpose of using PRZM-GW is to conservatively calculate drinking water concentrations in a vulnerable shallow aquifer environment. PRZM-GW is a recent innovation by the US EPA's Office of Pesticide Programs (Baris et al., 2012). It is highly conservative and it tends to over-predict actual concentrations.

Several presentations at the US EPA's Environmental Modeling Public Meeting (http://www2.epa.gov/pesticide-science-and-assessing-pesticide-risks/organizational-statement-epa-sponsored-public) have documented that it tends to be at least as conservative as the SCI-GROW model. The latter typically predicted the upper 98$^{th}$-99$^{th}$ percentile of ground water residues.

### B. Model Description

Figure 5 depicts the conceptual model of PRZM-GW. The following descriptive text was taken from EPA's guidance on the use of PRZM-GW (http://www.epa.gov/oppefed1/models/water/przm_gw/wqtt_przm_gw_guidance.htm).

"The model represents vulnerable private drinking water wells in the vicinity of agricultural environments. In this conceptualization, the pesticide is applied to the soil surface or plant canopy, and precipitation or irrigation drive pesticides into the soil. Meteorological, crop, biological, chemical, and management processes affect the transport of the pesticide as it moves through the soil and into a

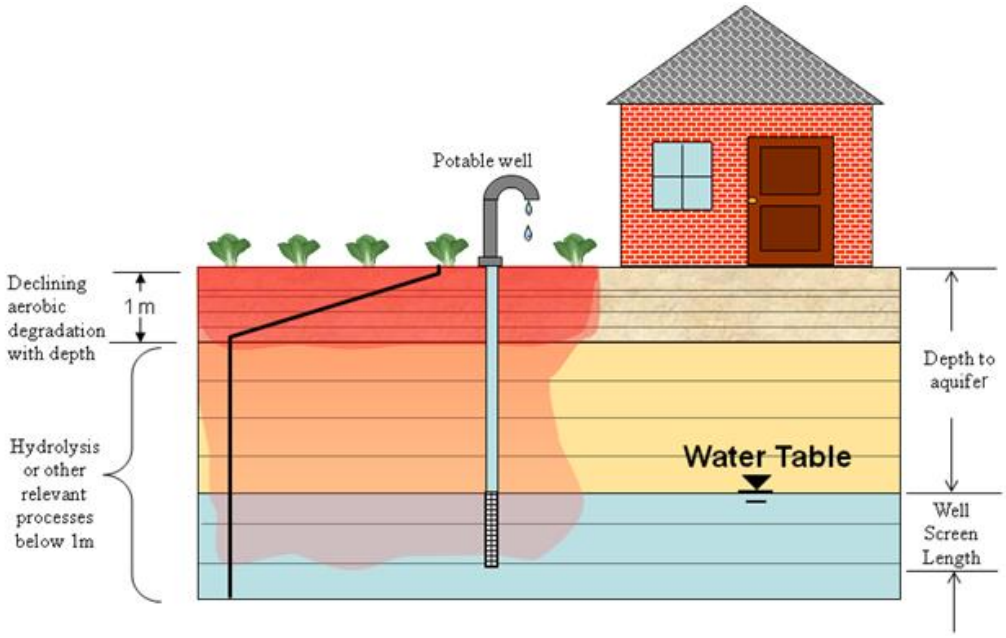
saturated zone. Horizontal surface movement of a pesticide (via runoff or erosion) and subsequent removal is assumed negligible for this model.

The saturated zone of the conceptual model is a shallow unconfined aquifer with a water table depth that corresponds to the scenario location. The well-screen extends from the aquifer surface to 1 meter below the surface, but this length is also adjustable according to common practices. The default well-screen length of 1 meter was chosen to sample the higher concentrations expected to be closest to the water table; however, this can be adjusted based on site-specific data. Pesticide concentrations in the well are taken as the average concentration in the screened zone.

The conceptual model includes meteorological events that can significantly affect pesticide transport, including precipitation, evaporation, snow, temperature, and wind. These weather processes vary and are simulated with daily resolution. Daily resolution is required by risk assessment applications within OPP's and PMRA's Health Effects Division."

Figure 5 is EPA's conceptual model for estimating pesticide concentrations in drinking water in an unconfined aquifer when PRZM-GW is implemented.

**Figure 5. EPA's PRZM-GW Conceptual Model**




(http://www.epa.gov/oppefed1/models/water/przm_gw/wqtt_przm_gw_guidance.htm)

## C. Model Input: Pesticide Application and Environmental Chemistry (Fate)

This section contains the chemical-specific model input parameters. Maximum legal pesticide use rates are listed in Table 5. They are based on the information contained in the pesticide product labeling, ***which is legally enforceable under federal and State law.***

Table 6 lists two of the more important pesticide environmental fate input parameters, the soil organic carbon/water partition coefficient - - Koc, and the aerobic soil metabolism half life. These are characteristics of sorption to the soil, i.e., mobility, and degradation by naturally occurring bacteria in the soil, respectively. Due to the very large number of pesticides we modeled in this second stage of screening, we took a conservative approach and assumed the pesticides would neither hydrolyze (break down in water) nor volatilize into the air. In the next phase, we refined the modeling by incorporating considerations for hydrolysis and volatilization for those pesticides that raised a concern in the initial stage of modeling.

**Table 5. PRZM-GW Pesticide Loading Input**

| Chemical | Example Trade Name | Max Number of appl'ns per year | Rate[§] lb a.i./ac | Month/Day of Application |
|---|---|---|---|---|
| **Herbicides** | | | | |
| Bensulide | Pre-San, Betasan | 2 | 8-15 | 4-1, 5-15 |
| Bispyribac-sodium | Velocity | 2 | 1.32 | 6-1,7-1 |
| Carfentrazone-ethyl[†] | Speedzone | 2 | 0.026** | 4-1,5-1 |
| Ethofumesate | Prograss | 1 | 1.5 | 10-1 |
| Fenoxaprop | Acclaim | 1 | 0.071** | 7-1 |
| Fluazifop-P-butyl | Fusilade | 1 | 0.375 | 7-15 |
| Glyphosate | Roundup Pro | 2 | 0.16** | 5-1, 6-1 |
| Halosulfuron-methyl | Sedgehammer | 2 | 0.062<br>0.124** | 7-1, 8-1 |
| Mesotrione | Tenacity | 1 | 0.25 | 6-1 |
| Pendimethalin | Pendulum AC | 1 | 9.2 | 4-1 |
| Prodiamine | Barricade | 1 | 0.98 | 4-15 |
| Quinclorac | Drive | 1 | 0.5** | 6-1 |
| Sethoxydim | Segment | 1 | 0.018 | 7-15 |
| 2,4-D | Trimec Classic | 2 | 1.23** | 4-1, 5-1[‡] |
| MCPP | | 2 | 0.65** | 4-1, 5-1 |
| Dicamba | | 2 | 0.12** | 4-1, 5-1 |
| **Insecticides** | | | | |
| Bifenthrin | Talstar | 2 | 0.1 | 5-15, 7-15 |
| Carbaryl | Sevin | 1 | 2.75 | 6-15 |
| Chlorpyrifos | Dursban | 1 | 16 | 7-1 |
| Deltamethrin | DeltaGuard | 1 | 0.13 | 8-15 |
| Imidacloprid | Merit 75 (wsp) | 1 | 0.3 | 6-15 |

| Chemical | Example Trade Name | Max Number of appl'ns per year | Rate[§] lb a.i./ac | Month/Day of Application |
|---|---|---|---|---|
| Lambda-cyhalothrin | Battle, Scimitar | 3 | 0.36 | 5-1, 7-1, 9-1 |
| Parasitic Nematodes*<br>Heterorhabditis bacteriophora<br>Steinernema carpocapsae | <br>Cruiser, Heteromask<br>Biosafe, Savior | <br>1-2<br>1-2 | <br>1-2 billion/A<br>50 million/A | <br>Summer, at night<br>Summer, at night |
| Spinosad[†]* | Conserve | 2 | 0.50 | Not modeled (biochemical) |
| **Fungicides** | | | | |
| Azoxystrobin[†] | Heritage 50 WG | 2 | 0.95<br>1.1 | 6-1, 8-1 |
| Bacillus subtilis* | Companion Liquid and Rhapsody | - - | - - | Not modeled (biological) |
| Boscalid[†] | Emerald | 2 | 0.4<br>0.56 | 5-15, 9-1 |
| Chlorothalonil & Acibenzolar-S-methyl | Daconil Action | 1 | 0.008 (acibenzolar)<br>6.1 (chlorothalonil) | 6-1 or 7-1 |
| Chlorothalonil | Daconil | 6 | 8.25 | 4-1, 5-1, 6-1, 7-1, 8-1, 9-1 |
| | | | | |
| Etridiazole | [Only Banrot products allowed on L.I.] | 1 | 4.125 | 7-15 |
| Fluazinam | Secure | 1 | 0.71 | 7-1 |
| Flutolanil | ProStar WP | 2 | 8.0<br>17.32 | 7-15, 8-15 |
| Fosetyl-Al (Aluminum tris) | Alliette | 1 | 17.42 | 7-1 |
| Iprodione | Chipco | 2 | 2.72 | 5-15, 7-15 |
| Mefenoxam[†] | Subdue | 1 | 0.60 | 8-1 |
| Metconazole | Tourney | 1 | 0.50 | 7-1 |
| Mineral oil + pigment* | Civatas | | | Not modeled |
| Myclobutanil | Eagle | 2 | 0.65<br>1.32 | 5-1, 9-1 |
| Penthiopyrad | Velista | 1 | 0.95 | 7-15 |
| Polyoxin D* | Endorse | 1 | 0.272 | 7-15 [Not modeled – biochemical] |
| Propamocarb | Banol | 1 | 3.65 | 7-15 |
| Propiconazole | Banner Max | 2 | 1.1<br>0.78 | 7-1, 9-1 |
| Pyraclostrobin | Insignia | 2 | 0.5<br>1.0 | 7-1, 12-1 |
| Thiophanate methyl | Fungo 50 | 1 | 4.2 | 7-15 |
| Thiram | Spotrete | 1 | 5.1 | 12-1 |
| Triadimefon (triadimenol-90% application of parent) | Bayleton 50 | 2 | 0.25<br>2.36 | 5-1, 9-1 |
| Trifloxystrobin[†] | Compass | 2 | 0.4<br>0.55 | 6-1, 8-1 |
| **Growth Regulators** | | | | |
| Ethephon | Proxy | 1 | 1.25 | 4-1 |
| Paclobutrazol | Trimmit 2 SC | 4 | 0.5<br>1.0 | 4-1, 5-1, 9-1, 10-1 |

| Chemical | Example Trade Name | Max Number of appl'ns per year | Rate[§] lb a.i./ac | Month/Day of Application |
|---|---|---|---|---|
| Trinexapac-ethyl | Primo | 4 | 0.25<br>1.0 | 5-15, 6-15, 7-15, 8-15 |

[§]The highest application rate (highlighted) was modeled if two are listed.
* These products are generally considered to be "natural" and/or "organic" and/or biological in origin.
[†]These products are on EPA's "Reduced Risk" (Safer Pesticide) Program and are considered safer than alternative pesticides for the same use.
**These herbicides will only be applied on a spot treatment basis.
[‡] During the DEIS completeness review, Dr. Petrovic commented that the second application of 2,4-D is usually made in the fall in that area. Therefore this second application date was changed to Oct. 1 when some remodeling was done in subsection E below.

**Table 6. PRZM-GW Pesticide Environmental Fate Input****

| CHEMICAL | Example Trade Names | $K_{oc}$ | Soil aerobic t½ (days) |
|---|---|---|---|
| **Herbicides** | | | |
| Bensulide | Betasan | 3900 | 365 |
| Bispyribac-sodium | Velocity | 114 | 58 |
| Carfentrazone-ethyl (+ its acid metabolite) | Speed Zone/Power Zone | 841, 6-48[#] | 0.5-1.3 |
| Dimethylamine salt of 2,4-dichlorophenoxyacetic acid (2,4-D) | Trimec Classic | 109 | 6.0 |
| Dimethylamine salt of dicamba | Banvel | 32 | 28<br>3.9<br>9 |
| Dimethylamine salt of methyl-chlorophenoxy propionic acid (MCPP) | Mecoprop | 32 | 8.2<br>9 |
| Ethofumesate | Prograss | Kd of 0.73 in sand | 3 |
| Fenoxaprop-ethyl | Acclaim | 9490 | 1<br>4 |
| Fluazifop-P-butyl | Fusilade | 3394 | 7<br>8.2 |
| Glyphosate | Roundup Pro | 2100 | 2 |
| Halosulfuron-methyl | Sedgehammer | 100 | 18 |
| Mesotrione | Tenacity | 122 | 5 |
| Pendamethalin | Pendulum | See lawn care section | See lawn care section |
| Potassium Salts of Fatty Acids | M-Pede | N/A | N/A |
| Prodiamine | Barricade | 5,500 | 63 |
| Quinclorac | Drive | Kd <1<br>50 | 450 |
| Sethoxydim | Vantage | 75 | 5-25<br>5 |
| **Insecticides** | | | |
| Bifenthrin | Talstar | 237,00 | 104 |
| Carbaryl | Sevin | 288 | 17 |
| Chlorpyrifos | Dursban | 13,400[l] | 10[l] |
| Deltamethrin | DeltaGard | 10,240,000 | 7-14<br>21 |
| Imidacloprid | Merit 75 (wsp) | 530 | 306 |
| Lambda-cyhalothrin | Battle, Scimitar | 333,000 | 38 |
| Parasitic Nematodes | | | |
| Spinosad | Conserve | N/A | N/A |

| CHEMICAL | Example Trade Names | $K_{oc}$ | Soil aerobic t½ (days) |
|---|---|---|---|
| **Fungicides** | | | |
| Aluminum tris O-ethyl (Fosetyl-Al) | Alliette | 166 | 0.12 |
| Azoxystrobin | Heritage 50 WG | 720 | 28 |
| Bacillus subtilis | Rhapsody/ Companion Liquid | N/A | N/A |
| Boscalid | Emerald | 1,622 | 337 |
| Chlorothalonil | Daconil | 2,680 | 13 |
| Daconil Action: chlorothalonil + acibenzolar (see the individual entries) | Daconil Action | See individual chemicals | See individual chemicals |
| Etridiazole | [Banrot products only] | 1,000 | 20 (typical) |
| Fluazinam | Secure | 1705-2316 | 132 |
| Flutolanil | ProStar WP | 681 | 81 |
| Iprodione | Chipco 26019 Flo | 381 | 30 |
| Mefenoxam [the R-enantiomer of metalaxyl; data are for metalaxyl] | Quell, Subdue Maxx | 16 | 16, 5-6<br>Use 11 |
| Metconazole | Tourney | 1026-2723‡ | 192.5-660<br>265 |
| Mineral oil + pigment | Civitas | N/A | N/A |
| Myclobutanil | Eagle | 500 | 20 |
| Penthiopyrad | Velista | 804 | 9.2 |
| Polyoxin D | Endorse | N/A | N/A |
| Propamocarb | Banol | Koc is inappropriate; use Kd=6 | 36 |
| Propiconazole | Banner Max | 682 | 60[j] |
| Pyraclostrobin | Insignia | 12,521 | 14.5 |
| Thiophanate methyl (+ its MBC metabolite) | Cleary 3336 | 1830 (parent), 225 for MBC metab | 1 (parent)<br>40[t] for MBC metab |
| Thiram | 42-S | 383 | 15<br>15 |
| Triadimefon (+ its triadimenol metabolite) | Bayleton 50 | **387** | 240 |
| Trifloxystrobin | Compass | 2,709 | 1.0 |
| **Growth Regulators** | | | |
| Ethephon | Proxy | 1870 | 9 |
| Paclobutrazol | Trimmit 2 SC | 500 | 214 |
| Trinexapac-ethyl | Primo | 278 | 0.16 |

**Unless otherwise noted, the numbers in this table were obtained from US EPA Reregistration Eligibility Decisions, Pesticide Fact Sheets, environmental risk assessments by the Environmental Fate & Effects Division, Office of Pesticide Programs, US EPA, and four papers published in the open literature, as follows ***[partial list]***: Durborow et al. (2000); NY DEC (2003); US EPA (2007a); EXTOXNET; Ahrens (1994); US EPA (2007); US EPA (2003); US EPA (2000); Branham & Gardner (2002); Horst et al. (1996); FAO (1998); Feb., 2006, Environmental Fate and Effects Chapter for Triadimefon (US EPA). NOTE: Specific citations and references can be provided on request.

[#]Koc (est) for parent = 841 ml/gm; Koc for degradates = 6-48 ml/gm (US EPA/Carleton, 12/22/99).

## D. Model Input: Field Parameters and Weather File

### 1. Soil Parameters

The results in Table 7a below are based on the analyses of samples we collected from the site in August as described in III(B) above.

The average values for samples were calculated for all parameters. The samples collected from the sand pit (#37804 & #37848) were not used to determine the averages for any of the parameters used in the modeling. We also did not take credit for a thatch layer. A thatch layer and the results from the gravel area (which had no vegetation) would lower the pesticides concentrations. Using the site-specific soil input parameters for the modeling produces highly conservative pesticide concentrations (i.e., higher concentrations).

**Table 7a. PRZM-GW Soil Input Parameters**

| Sampled Depths (in) | Modeled Depths (m) | Bulk Density (g/mL)*† | Max Water Capacity** (FC; 1/3 bar) | Min Water Capacity‡‡ (WP; -15 Bar) | OC %§ |
|---|---|---|---|---|---|
| 0-4 | 0-0.1 | 1.208 | 16.00 | 12.67 | 1.41 |
| 4-8 | 0.1-0.2 | 1.236 | 6.33 | 3.33 | 0.41 |
| 8-12 | 0.2-0.4 | 1.236 | 6.33 | 3.00 | 0.6 |
| 12-24 | 0.4-0.6 | 1.236 | 5.67 | 2.67 | 0.46 |
| No Sample | 0.6-0.8 | 1.236 | 5.67 | 2.67 | 0.46 |
| No Sample | 0.8-1.0 | 1.236 | 5.67 | 2.67 | 0.46 |
| No Sample | 1-11 | 1.236 | 5.67 | 2.67 | 0.46 |
| No Sample | 11 to (11+1) | 1.236 | 5.67 | 2.67 | 0.46 |

***Bulk Density (g/ml):** We used the average bulk density for this parameter from site-specific soil samples collected. Bulk Density samples were collected from 0-4" and 4-8"depths. We assumed the BD for remaining profile below 8" was the same as the 4-8" depth since it is a sandy soil.

†One additional sample was collected for BD at 10-14" in one area where there appeared to be a zone that was somewhat compacted: BD = 1.365. It was not used in the average bulk density.

****Max. Water Capacity:** We used the average field capacity (FC) for this parameter from site-specific soil samples collected. We assume that FC in the soil profile below 24" is the same as the 12-24" value. The sample collected from the sand pit (#37804 & #37848) was not used to determine the average since there was no vegetation.

‡‡**Min. Water Capacity:** We used the average wilting point (WP) for this parameter from site-specific soil samples collected. We assume that the WP in the soil profile below 24" is the same as the 12-24" value. The sample collected from the sand pit (#37804 & #37848) was not used to determine the average since there was no vegetation.

§**OC %:** We calculated the %OC (percent organic carbon) from the organic matter of the site specific soil samples collected. OC% = OM%/1.724. We assume that there is not much organic carbon in the soil profile below 24". Therefore, we used the OC% Value as determined in the 12-24" sample for depths below 24". The sample collected from the sand pit (#37804 & #37848) was not used to determine the average OC% since there was no vegetation.

However, in response to comments received from Dr. A.M. Petrovic during the completeness review we adjusted the field capacity (FC), wilting point (WP), and organic carbon

(OC) for three pesticides: 2,4-D, dicamba, and MCPP (see results below). The average of the three samples collected to determine FC and WP at the 0-4 inch depth used in modeling pesticides was 16% at 1/3 bar [(7+14+27)/3=16%] and 12.67% at -15 bar [(5+8+25)/3=12.67%], respectively (see Table 3). Although the results for the one sample appear to be relatively high, it is within the range of values for PRZM-GW modeling for sand and sandy loam soils. The FC range of values for sand is 0.018 to 0.164, and for WP the range for sandy loam is 0.031 to 0.159 (Suarez, 2005). The average values that we used are within these ranges. In addition, according to the Northeast Regional Certified Crop Advisor (NRCCA) Study Resources from Cornell University, the "moisture content remaining at FC is about 15 to 25% for sandy soils" (http://nrcca.cals.cornell.edu/soil/CA2/CA0212.1-3.php). The 16% we used for FC is on the low end of that range. The NRCCA study also shows that the range for WP in sandy soils is 5 to 10%. We were only slightly outside the high end for WP. However, the RPD for the 27% FC and 25% WP sample is only ~8% compared with the other samples with lower FC and WP values (i.e., RPDs = 33 and 55% for the two lower values, respectively). Therefore, the average values used for the original modeling for FC and WP at the 0-4" depth are well within the appropriate ranges for water holding capacities for The Hills soils.

Nonetheless, in response to Dr. Petrovic's comments, we remodeled three pesticides, omitting the higher FC and WP values, and averaged two samples instead of three, which lowered the FC and WP values: FC = 10.5 [(7+14)/=10.5%] instead of 16.0 and 6.5 [(5+8)/=6.5%] instead of 12.67 for WP (see Table 7b below). In addition, we used 0.0 OC% (i.e., no organic matter) for the input parameter at depths >24" as requested. See sub section E below for the original and remodeling results.

**Table 7b. Revised PRZM-GW Soil Input Parameter for Remodeling**

| Sampled Depths (in) | Modeled Depths (m) | Bulk Density (g/mL)*† | Max Water Capacity** (FC; 1/3 bar) | Min Water Capacity‡‡ (WP; -15 Bar) | OC %§ |
|---|---|---|---|---|---|
| 0-4 | 0-0.1 | 1.208 | 10.5 | 6.5 | 1.41 |
| 4-8 | 0.1-0.2 | 1.236 | 6.33 | 3.33 | 0.41 |
| 8-12 | 0.2-0.4 | 1.236 | 6.33 | 3.00 | 0.6 |
| 12-24 | 0.4-0.6 | 1.236 | 5.67 | 2.67 | 0.46 |
| No Sample | 0.6-0.8 | 1.236 | 5.67 | 2.67 | 0.0 |
| No Sample | 0.8-1.0 | 1.236 | 5.67 | 2.67 | 0.0 |
| No Sample | 1-11 | 1.236 | 5.67 | 2.67 | 0.0 |
| No Sample | 11 to (11+1) | 1.236 | 5.67 | 2.67 | 0.0 |

2. Weather

We selected a weather file from the U.S. EPA database in the northeast that has a similar annual average rainfall and temperature to The Hills site. The weather file selected is Atlantic City, New Jersey, and the EPA provides it in the specialized format required to run the PRZM-GW model (http://www2.epa.gov/exposure-assessment-models/meteorological-data). The Atlantic City weather data for the PRZM-GW modeling was used because it is a coastal environment similar to Long Island. However, in response to comments received from Dr. A.M. Petrovic during the completeness review, we quantitatively compared the precipitation and temperatures for Atlantic City and Long Island, as follows.

We compared the Atlantic City (NJ-3 coastal) and Long Island (NY-4 coastal) precipitation and temperature for the 30 modeled years (1961-1990) using the regional data tables from the NRCC (National Regional Climate Center; Cornell University) to show the similarities (Figures 6 and 7 below). The data show that the 30-yr average precipitation for the NY-4 coastal (44.69") is slightly higher than the NJ-3 coastal (42.79") for the same years; NY-4 is only 4.4% higher. The RPD (relative percent difference) is only 7% for the 30 year period, which indicates consistency between the amounts. In addition, we compared the temperatures for those stations for the same time period. The average temperature for the NY-4 coastal is 51.46ºF compared with NJ-3 coastal of 52.10ºF, a 3% RPD, also a very minor difference (http://www.nrcc.cornell.edu/regional/tables/tables.html). Therefore, the Atlantic City weather file that was selected and provided by the US EPA in the correct format for the PRZM-GW modeling is comparable to Long Island weather. In addition, the US EPA does not offer datasets for Long Island or coastal NY for modeling. In any case, the differences in weather between NJ-3 coastal and NY-4 coastal are insignificant, i.e., RPDs are very low for precipitation and temperatures.

**Figure 6. Annual Average Temperatures NJ-3 vs. NY-4 Coastal Regions**

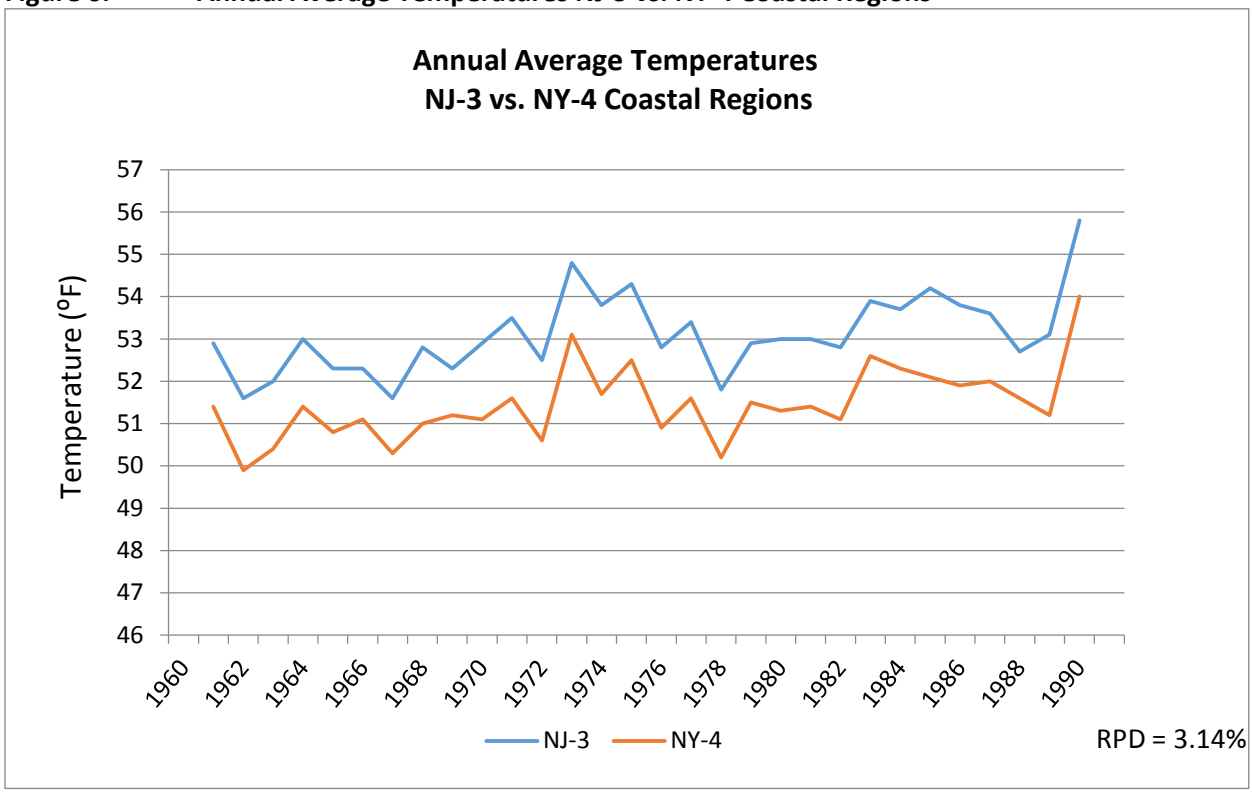
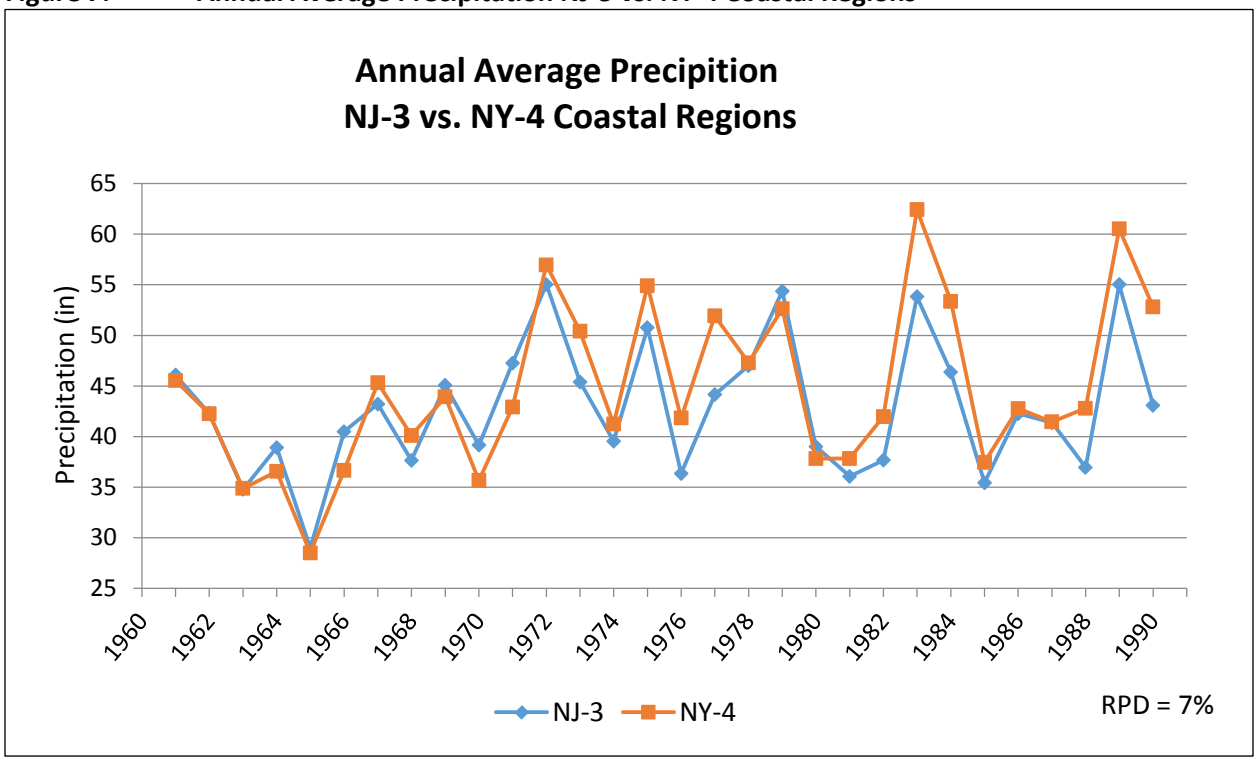



**Figure 7. Annual Average Precipitation NJ-3 vs. NY-4 Coastal Regions**



## E. Results

In this section, we produce peak and mean ground water concentrations predicted by the conservative PRZM-GW modeling runs.

Table 8a lists the peak and chronic ground water concentrations predicted by the PRZM-GW modeling runs. A CD is attached that contains the output of all 46 modeling runs. These results are compared with human and aquatic toxicologic endpoints in section H below.

**Table 8a. PRZM-GW Results**

| CHEMICAL | Peak Concentration (ppb) | Entire Simulation Mean Concentration (ppb) |
|---|---|---|
| **Herbicides** | | |
| Bensulide | 4.68E-19 | 1.77E-20 |
| Bispyribac-sodium | 58.6 | 31.8 |
| Carfentrazone-ethyl | 1.17E-20 | 2.72E-22 |
| 2,4-D (Dimethylamine salt of 2,4-dichlorophenoxyacetic acid) | 0.031 | 0.0105 |
| Dicamba (Dimethylamine salt of dicamba) | 1.31 | 0.583 |
| MCPP (Dimethylamine salt of methyl-chlorophenoxy propionic acid) | 7.09 | 3.16 |
| Ethofumesate | 5.11E-05 | 9.9E-06 |
| Fenoxaprop | 0 | 0 |
| Fluazifop-P-butyl | 0 | 0 |
| Glyphosate | 0 | 0 |
| Halosulfuron-methyl | 0.883 | 0.396 |
| Mesotrione | 0.00107 | 0.000406 |
| Potassium Salts of Fatty Acids | Not modeled | - - |
| Prodiamine | 0 | 0 |
| Quinclorac | 74.2 | 53.5 |
| Sethoxydim | 0.123 | 0.0459 |
| **Insecticides** | | |
| Bifenthrin | 0 | 0 |
| Carbaryl | 0.0378 | 0.00537 |
| Chlorpyrifos | 0 | 0 |
| Deltamethrin | 0 | 0 |
| Imidacloprid | 0.0372 | 0.00285 |
| Lambda-cyhalothrin | 0 | 0 |
| Parasitic Nematodes | Not modeled | - - |
| Spinosad* | Not modeled | - - |
| **Fungicides** | | |
| Aluminum tris O-ethyl (Fosetyl-Al) | 0 | 0 |
| Azoxystrobin | 1.75E-07 | 1.15E-08 |
| Bacillus subtilis | Not modeled | - - |
| Boscalid | 1.11E-10 | 5.22E-12 |
| Chlorothalonil | 0 | 0 |

| CHEMICAL | Peak Concentration (ppb) | Entire Simulation Mean Concentration (ppb) |
|---|---|---|
| Chlorothalonil + acibenzolar (Daconil Action) | 1.44E-20 (Acibenzolar) | 3.46E-22 (Acibenzolar) |
| Etridiazole | 3.31E-11 | 1.81E-12 |
| Fluazinam | 9.09E-15 | 4.31E-16 |
| Flutolanil | 0.00202 | 0.000139 |
| Iprodione | 0.0342 | 0.00372 |
| MBC (TM metabolite) | 4.44 | 1.11 |
| Mefenoxam | 32.5 | 11.2 |
| Metconazole | 2.64E-12 | 1.19E-13 |
| Mineral oil + pigment | Not modeled | - - |
| Myclobutanil | 2.08E-05 | 1.76E-06 |
| Oxytetracyline (OTC) | Not modeled[#] | Not modeled[#] |
| Penthiopyrad | 1.11E-09 | 6.4E-11 |
| Polyoxin D | Not modeled | - - |
| Propamocarb | 9.24E-11 | 5.12E-12 |
| Propiconazole | 2.86E-05 | 1.99E-06 |
| Pyraclostrobin | 0 | 0 |
| Thiophanate methyl[‡] | 0 | 0 |
| Thiram | 0.000124 | 1.53E-05 |
| Triadimefon + Triadimenol* (Triadimefon metabolite) | 12.6 | 1.33 |
| Trifloxystrobin | 0 | 0 |
| **Growth Regulators** | | |
| Ethephon | 0 | 0 |
| Paclobutrazol | 0.56 | 0.0458 |
| Trinexapac-ethyl | 0 | 0 |

[‡]Thiophanate methyl was not modeled in PRZM-GW because of the very low half life of 1 day (see Table 6).
*Triadimenol was modeled at 90% of the parent application rate.
[#]OTC was not modeled due to the extremely high $K_d/K_{oc}$ and the fact that it is an antibiotic for use in mammals.

As described above, In response to comments received from Dr. A.M. Petrovic during the completeness review we remodeled three pesticides: 2,4-D, dicamba, and MCPP. Those results are shown in Table 8b below. In addition to adjusting the FC, WP, and OC%, the Town's consultant Dr. A.M. Petrovic, thought we needed to change the application timing to one spring (May) and one fall (October) application for these three pesticides, which was done only in the remodeling. We agree the timing for these products should be changed to one spring and one fall application each.

**Table 8b. Risk Quotient Calculations – remodeled results**

| CHEMICAL | Peak Concentration (ppb) | Entire Simulation Mean Concentration (ppb) |
|---|---|---|
| **Herbicides** | | |
| Dimethylamine salt of 2,4-dichlorophenoxyacetic acid (2,4-D) | 0.454 | 0.106 |
| Dimethylamine salt of dicamba | 11.5 | 7.76 |
| Dimethylamine salt of methyl-chlorophenoxy propionic acid (MCPP) | 14.1 | 6.3 |

## F. Human Health Reference Points

**Sources.** Several sources were tapped to obtain and/or derive toxicity reference points, as follows. Many of these sources are listed in and below the table (Table 9).

- New York State: Title 6, Chapter X Parts 700-706 "Water Quality Regulations"
- US EPA: Federal Register notices of crop tolerances decisions; human health risk assessments by the Health Effects Division of the Office of Pesticide Programs (OPP); the human health benchmark database (www.epa.gov/pesticides/hhbp); OPP fact sheets; the "2012 Edition of the Drinking Water Standards and Health Advisories"; OPP Reregistration Eligibility Decisions for specific pesticides; internal EPA memoranda; and "Chemicals Evaluated for Carcinogenic Potential" (US EPA, 2015).
- ETS: We have an extensive internal file of lifetime drinking water Health Advisory Levels (HALs) that we have developed.

**Priorities.** The human health reference points are listed in Table 9, along with supporting information. We highlighted in **bold** the single reference point to be compared with the modeling results when there was more than one reference point. *This was based on the following ranking of public health significance*:

> federal standard ≈ State standard > EPA HAL > ETS HAL > State POC (Principal Organic Contaminant; 5 ppb) > State GV (Guidance Value; 50 ppb). The default 50 ppb GV has the lowest priority because it is not scientifically based and the regulation states that it does not apply ". . . if adequate and sufficient data are available to justify values greater than 50 µg/L using procedures from both section 702.4 and 702.5 of this Part" (NY DEC Water Quality Regulations Title 6, Chapter X Parts 700-706). *The procedures to calculate lifetime drinking water HALs used by us and the US EPA satisfy the requirements of those regulations*.

**Chemical Carcinogenicity**. The reader may note some differences in the terms used for cancer classification in Table 9 below. For example, compare "Not likely to be carcinogenic to humans" with "Group E: evidence of non-carcinogenicity for humans". *The meanings and implications of both phrases are the same.* The reason for these language differences is that EPA changed its cancer classification language twice between 1976 and 2015.

Also, it is important to understand that these oncogenicity classifications are made based only on the dosing in the laboratory studies, i.e., mice and rats. They do not imply that the use of the pesticide in accordance with the product labeling will cause cancer in people who, e.g., eat the pesticide-treated broccoli or walk across the pesticide-treated golf course. That is because *risk is a function of toxicity AND exposure*. Since 1996, with the passage of the Food Quality Protection Act (FQPA), the EPA does not register products that are likely to pose more than a *de minimus* risk to the public when used in accordance with the product labeling. A *de minimus* risk in this context is the upper 90$^{th}$ percentile probability estimate of a 1 chance in a million risk.

In most cases that we examined, the *de minimus* risk concentration for cancer effects is higher (less toxic) than the concentration threshold for non-cancer effects; i.e., for these substances, protecting for classic chronic toxicity effects is more than adequate compared with protecting for cancer effects.

## G. Aquatic Toxicity Reference Points

The US EPA's Office of Pesticide Programs (OPP) has developed aquatic life benchmarks to evaluate the potential toxic effects of pesticides to aquatic organisms. These benchmarks are based on toxicity data used in OPP's ecological risk assessments of pesticides. Acute and chronic toxicity values or endpoints obtained from laboratory and field studies are used to calculate these benchmark concentrations for a variety of taxa including fish, invertebrates, and nonvascular as well as vascular plants. Most of the numbers in Table 10 below were obtained from this database.

These experimentally-based toxicity reference points are multiplied by the appropriate level of concern (LOC; 0.5 and 1.0) to generate the endpoint concentrations in Table 10 below. Benchmark concentrations are periodically updated when new risk assessments are conducted and/or new toxicity data becomes available (http://www.epa.gov/oppefed1/ecorisk_ders/aquatic_life_benchmark.htm).

**Table 9. Summary of Pesticide Health Effects Reference Points***

| Common Name | Chronic RfD or cPAD when available (mg/kg/d) | FQPA Safety Factor‡ | Carcinogenicity Classification (US EPA, 2015) ["N/A" = not applicable] ‡‡ | Cancer Slope (mg/kg-day)$^{-1}$ ["N/A" = not applicable] | Source (see footnotes below the table) | NYDEC** (ppb) | US EPA HAL (ppb) | US EPA MCL (ppb) | ETS HAL (ppb)# |
|---|---|---|---|---|---|---|---|---|---|
| **HERBICIDES** | | | | | | | | | |
| 2,4-D | 0.005 | 1 | Group D: Not classifiable as to human carcinogenicity | N/A | 1 | **50** (MCL; former regulation) | 70 | 70 | — |
| Bensulide | 0.005 | 1 | "Not Likely To Be Carcinogenic To Humans" | N/A | 2 | [50 GV] | **35** | | |
| Bispyribac-sodium | 0.1 | 1 | "Not Likely To Be Carcinogenic To Humans" | N/A | 3 | [50 GV] | **700** | | |
| Carfentrazone-ethyl | 0.06 | 1 | "Not Likely To Be Carcinogenic To Humans" | N/A | 4 | [50 GV] | **210** | | 210‡ |
| Dicamba | 0.45 | 3 | Group D: Not classifiable as to human carcinogenicity | N/A | 5 | **0.44** (very old; "former regulation") | 4,000 | | |
| Ethofumesate | 0.300 | | "Not likely to be carcinogenic to humans" | N/A | 6 | [50 GV] | **1980** | | 2100 |
| Fenoxaprop Ethyl | 0.0025 | 1 | "[the evidence] provides no more than a weak suggestion of possible carcinogenic effects and thus does not support a linear assessment of risk based on the tumor incidence….EPA concludes that the chronic reference dose (cRfD] for [fenoxaprop] will adequately protect for all chronic toxicity, including carcinogenicity…" | N/A | 51, 7 | [50 GV] | **18** | | |
| Fluazifop-p-butyl | 0.0074 | 1 | "Not Likely To Be Carcinogenic To Humans" | N/A | 8 | [50 GV] | **52** | | |
| Glyphosate | 2 | 1 | Group E: Evidence of Non-carcinogenicity for Humans | N/A | 9 | [50 GV] | 700 | **700** | |
| Halosulfuron-methyl | 0.1 | 1 | "Not Likely To Be Carcinogenic To Humans" | N/A | 10 | [50 GV] | **700** | | 700 |
| Mecoprop (MCPP) | 0.04 | | Suggestive Evidence of Carcinogenicity, but Not Sufficient to Assess Human Carcinogenic Potential | N/A | 11 | **0.44** (very old; "former regulation") | 280 | | 1400 |
| Mesotrione | 0.0007 | 10 | "Not Likely To Be Carcinogenic To Humans" | N/A | 12 | [50 GV] | **49** | | |

| Common Name | Chronic RfD or cPAD when available (mg/kg/d) | FQPA Safety Factor‡ | Carcinogenicity Classification (US EPA, 2015) ["N/A" = not applicable] ‡‡ | Cancer Slope (mg/kg-day)$^{-1}$ ["N/A" = not applicable] | Source (see footnotes below the table) | NYDEC** (ppb) | US EPA HAL (ppb) | US EPA MCL (ppb) | ETS HAL (ppb)# |
|---|---|---|---|---|---|---|---|---|---|
| Pendimethalin | 0.030 | | Group C-possible human carcinogen, but EPA determined that the cRfD is also protective of cancer, which demonstrated a non-linear response. Not mutagenic. | N/A | 50 | | 210 | | |
| Prodiamine | 0.02 | 0.38 | Group C-Possible Human Carcinogen, but the RFD approach provides adequate protection (SAP). See also Table 18. | Not Calculated | 13a&b | [50 GV] | | | **700** |
| Quinclorac | 0.38 | 1 | Group D": Not classifiable as to human carcinogenicity, but "The chronic RfD will adequately account for all chronic effects, including carcinogenicity…." (Fed. Register, 12/21/12; 77(246), p. 75563.) See Table 18. | N/A | 14 | | **2,660** | | **2,660** |
| Sethoxydim | 0.09 | 1 | Not likely to be carcinogenic to humans. | N/A | 15 | [50 GV] | **980** | | |
| **FUNGICIDES**** | | | | | | | | | |
| Acibenzolar-methyl | 0.082 | | Not likely to be carcinogenic to humans. | N/A | 16 | [50 GV] | **541** | | |
| Azoxystrobin | 0.18 | 1 | "Not Likely To Be Carcinogenic To Humans" | N/A | 17 | [50 GV] | **1260** | | 1260 |
| *Bacillus subtillis,* strain GB 03** | | | N/A | | 18 | N/A | | N/A | |
| *Bacillus subtillis,* strain QST 713** | | | N/A | | 19 | N/A | | N/A | |
| Boscalid | 0.218 | 1 | "Suggestive evidence of carcinogenicity but not sufficient to assess human carcinogenic potential." | N/A | 20 | [50 GV] | **1526** | | 1526 |
| Chlorothalonil (See notes) | 0.02 | 1 | Group B: Probable Human Carcinogen (Not for use, see Table 18) | 7.66E-03 | 21 | 5 (POC) | **2** | — | — |
| Daconil Action: chlorothalonil + acibenzolar | See individual chemicals | - - | - - | - - | - - | - - | - - | - - | See the individual components above. |

| Common Name | Chronic RfD or cPAD when available (mg/kg/d) | FQPA Safety Factor‡ | Carcinogenicity Classification (US EPA, 2015) ["N/A" = not applicable] ‡‡ | Cancer Slope (mg/kg-day)$^{-1}$ ["N/A" = not applicable] | Source (see footnotes below the table) | NYDEC** (ppb) | US EPA HAL (ppb) | US EPA MCL (ppb) | ETS HAL (ppb)# |
|---|---|---|---|---|---|---|---|---|---|
| Etridiazole | 0.016 | 3 | Group B: Probable Human Carcinogen (Not for use, see Table 18) | 3.33E-02 | 22 | [50 GV] | | | 35 for general chronic tox and **1** for a $10^{-6}$ risk level |
| Fluazinam | 0.011 | 1 | "Suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential." However, the EPA determined that use of the RfD or cPAD would adequately account for all chronic toxicity, including the possibility of carcinogenicity. | | 23 | [50 GV] | **77** | | 77 |
| Flutolanil | 0.63 | 1 | Group E: No Evidence of carcinogenic potential. | | 24 | [50 GV] | **3500** | | 3500 |
| Fosetyl-AL | 2.5 | 1 | "Unlikely to Pose a Carcinogenic Risk to Humans" | N/A | 25 | [50 GV] | **17,500** | NA | 17,500 |
| Iprodione | 0.02 | 3 | "Likely human carcinogen" (Not for use, see Table 18) | 4.39E-03 | 26 | [50 GV] | 350 for general chronic tox and **0.8** for a $10^{-6}$ risk level | | **0.8** for a $10^{-6}$ risk level |
| Mefenoxam | 0.074 | 1 | "Not Likely To Be Carcinogenic To Humans" | N/A | 27 | [50 GV] | 519 | | **518** |
| Metconazole | 0.04 | 1 | "Not Likely To Be Carcinogenic To Humans" | | 28 | [50 GV] | **280** | | |
| Mineral oil or Iso-parafin | | | | | | **[50 GV]** | | | |
| Myclobutanil | 0.025 | 1 | Group E: No Evidence of carcinogenic potential. | N/A | 30 | [50 GV] | **175** | | 175 |
| Penthiopyrad | 0.27 | | Suggestive evidence of carcinogenic potential. | N/A | 31 | [50 GV] | **1890** | | |
| Polyoxin | N/A | N/A | N/A | N/A | 32, 18 | **[50 GV]** | N/A | | |

| Common Name | Chronic RfD or cPAD when available (mg/kg/d) | FQPA Safety Factor‡ | Carcinogenicity Classification (US EPA, 2015) ["N/A" = not applicable] ‡‡ | Cancer Slope (mg/kg-day)$^{-1}$ ["N/A" = not applicable] | Source (see footnotes below the table) | NYDEC** (ppb) | US EPA HAL (ppb) | US EPA MCL (ppb) | ETS HAL (ppb)# |
|---|---|---|---|---|---|---|---|---|---|
| Propamocarb hydrochloride | 0.12 | 1 | "Not Likely To Be Carcinogenic To Humans" | N/A | 33 | [50 GV] | 540 | | |
| Propiconazole | 0.1 (0) | 1 | Group C-Possible Human Carcinogen, but the cRfD is more protective (see Table 18) | N/A | 34 | [50 GV] | **700** | | 700 |
| Pyraclostrobin | 0.011 | 3 | "Not Likely To Be Carcinogenic To Humans" | N/A | 35 | [50 GV] | **238** | | |
| Thiophanate-methyl NOTE: metabolite=MBC (carbendazim) | 0.08 [metabolite MBC: 0.025] | 3 | Parent/TM: "Likely human carcinogen" Metabolite/MBC: Group C-Possible Human Carcinogen | 2.39E-03 | 36 | [50 GV] | **187** MBC (carbendazim) =**175** for general chronic tox and 15 for a for a $10^{-6}$ risk level | | |
| Thiram | 0.015 | 1 | "Not likely human carcinogen" | N/A | 37 | [50 GV] | **105** | | |
| Triadimefon (metabolite= triadimenol) | 0.034 | 10 | Parent: Group C-Possible Human Carcinogen Metabolite: Group C-Possible Human Carcinogen. However, the cRfD is more protective (see Table 18) | Not calculated | 38 | [50 GV] | **238** [triadimenol=**24**] | | 24 |
| Trifloxystrobin | 0.038 | | Not likely to be carcinogenic to humans | | 39 | [50 GV] | **266** | | |
| **INSECTICIDES** | | | | | | | | | |
| Bifenthrin | 0.015 | 1 | Group C: Possible Human Carcinogen (Not for use) | Not Calculated | 40 | [50 GV] | | | **105** |
| Carbaryl | 0.01 (acute RfD) | 1 | "Likely to be carcinogenic to humans" (Not for use) | $8.75 \times 10^{-4}$ | 41 | **29** (std) | 40 for $10^{-6}$ risk | | 20 |
| Chlorpyrifos-methyl | 0.0003 | 10 | Group E: Evidence of Non-carcinogenicity for Humans | N/A | 42 | [50 GV] | **7** | | — |
| Deltamethrin | 0.005 | 3 | Not Likely to be Carcinogenic to Humans | N/A | 43 | [50 GV] | | | **10** |
| Imidacloprid | 0.019 | 1 | Group E: No Evidence of carcinogenic potential. | N/A | 44 | [50 GV] | **399** | | 133 |

| Common Name | Chronic RfD or cPAD when available (mg/kg/d) | FQPA Safety Factor‡ | Carcinogenicity Classification (US EPA, 2015) ["N/A" = not applicable] ‡‡ | Cancer Slope (mg/kg-day)$^{-1}$ ["N/A" = not applicable] | Source (see footnotes below the table) | NYDEC** (ppb) | US EPA HAL (ppb) | US EPA MCL (ppb) | ETS HAL (ppb)# |
|---|---|---|---|---|---|---|---|---|---|
| Lambda-cyhalothrin | 0.001 | 1 | Group D: Not classifiable as to human carcinogenicity | N/A | 45 | [50 GV] | **7** | | |
| Parasitic Nematodes | N/A | N/A | N/A | N/A | N/A | | | | |
| Spinosad | 0.02 | 1 | Not likely to be carcinogenic to humans. | N/A | 46 | [50 GV] | **174** | | 140 |
| **PLANT GROWTH REGULATOR (PGR)** | | | | | | | | | |
| Ethephon | 0.06 | 1 | Group D: Not Classifiable as to Human Carcinogenicity | | 47 | [50 GV] | **420** | | 120 |
| Paclobutrazol | 0.013 | | Group D: Not Classifiable as to Human Carcinogenicity | | 48 | [50 GV] | | | **455** |
| Trinexapac-ethyl | 0.32 | | Not Likely to be Carcinogenic to Humans | N/A | 49 | [50 GV] | **2240** | | 11200 |

*We highlighted in **bold** the single reference point to be compared with the modeling results when there was more than one reference point. See text.
‡ An additional safety factor used to determine the toxicity reference point due to concerns about pesticide effects on children, pursuant to the Food Quality Protection Act (FQPA) of 1996.
‡‡US EPA (2015). Chemicals Evaluated for Carcinogenic Potential. Office of Pesticide Programs.
** Water quality standards pursuant to §§700.1(18), 700.1(36), 702.3, 7002.4, 702.5, and 703.5 of NYDEC regulations, Title 6, Chapter X. GV=Guidance Value (default = 50 ppb ["general organic guidance value"])
# These are lifetime drinking water Health Advisory Levels (HALs) that we calculated using US EPA procedures and in accordance with NYDEC Water Quality Regulations Title 6, Chapter X, §702.5.
1 US EPA 2005. Reregistration Eligibility Decision for 2,4-D.
2 US EPA 1999. Overview of Bensulide Risk Assessment.
3 US EPA 2001. Bispyribac-Sodium; Pesticide Tolerance.
4 US EPA 2004. Carfentrazone-ethyl; Pesticide Tolerance.
5 US EPA 2006: Dicamba RED.
6 US EPA Sept. 2005 RED.
7 US EPA 1998. Fenoxaprop-ethyl; Pesticide Tolerance.
8 US EPA 2005. Report of the Food Quality Protection Act (FQPA) Tolerance Reassessment Progress and Risk Management Decision (TRED) for Fluazifop-P-butyl.
9 US EPA 2000. Glyphosate Final Rule.
10 US EPA 2001. Halosulfuron-methyl; Pesticide Tolerance.
11 US EPA (2014, 2015, and 2016) and US EPA Human Health Benchmarks for Pesticides website.
12 June 4, 2001 Pesticide Fact Sheet (RfD=0.007, cPAD=0.0007).
13a Lindsay, 2/7/92 and 10/30/90 "Reference Dose for Chronic Oral Exposure"; 13b US EPA (2010).
14 US EPA (2014), US EPA Human Health Benchmarks for Pesticides website, and Federal Register notice given in the table entry above.

15 US EPA 1998. Sethoxydim; Pesticide Tolerance.
16 US EPA (2014, 2015, and 2016) and US EPA Human Health Benchmarks for Pesticides website
17 US EPA 2000. Azoxystrobin; Pesticide Tolerance. FR 65(190)
18 Inherently safe bacterial product
19 Inherently safe bacterial product20 US EPA 2005. Boscalid; Pesticide Tolerances for Emergency Exemptions
21 US EPA 1999. Reregistration Eligibility Decision. & EPA 1999. R.E.D. Facts.
22 US EPA 1999. Revised Acute & Chronic (Cancer/Non-Cancer) Dietary Exposure Analyses. EPA 2000. RED for Etridiazole General Chronic HAL (General chronic non-cancerous endpoint=35, Chronic cancerous endpoint=1.0)
23 US EPA (2014, 2015, and 2016) and US EPA Human Health Benchmarks for Pesticides website
24 US EPA 1998. Flutolanil; Pesticide Tolerance; EPA 2001. Flutolanil; Pesticide Tolerance.
25 US EPA 1999. Fosetyl-Al; Pesticide Tolerance. FR 64(134)
26 US EPA 1999. Iprodione; Pesticide Tolerance (Vol 64, # 105). (General chronic non-cancerous endpoint = 140, Chronic cancerous endpoint = 0.8)
27 US EPA 2001. Mefenoxam; Pesticide Tolerance (vol. 66 # 180)
28 Pesticide Fact Sheet (Aug. 2006)
30 US EPA May 10, 2000. Myclobutanil; Pesticide Tolerances. FR 65(91), 29963-29973.
31 US EPA (2014, 2015, and 2016) and US EPA Human Health Benchmarks for Pesticides website
32 US EPA. July 1, 2003. Consideration of Eligibility for Registration of the New Pesticide Active Ingredient Polyoxin D Zinc Salt-DECISION MEMORANDUM, J. Anderson to D.M. Barolo. Polyoxin is a biochemical produced by bacterial fermentation.
33 US EPA 2000. Propamocarb hydrochloride; Pesticide Tolerance.
34 US EPA 2006. RED
35 US EPA 2002. Federal Register Pyraclostrobin Pesticide Tolerance (Vol. 67, # 188).
36 US EPA 2002. Thiophanate-methyl; Pesticide Tolerance (Fed. Reg. Vol. 67, # 167). EPA 2005. RED Thiophanate-Methyl. (General chronic non-cancerous endpoint=18, Chronic cancerous endpoint=3)
37 US EPA 2004. Reregistration Eligibility Decision for Thiram.
38 US EPA 2006. Reregistration Elegibility Decision for Triadimefon
39 US EPA (2014, 2015, and 2016) and US EPA Human Health Benchmarks for Pesticides website
40 US EPA 1999. Bifenthrin; Pesticide Tolerance.
41 US EPA September 2007. Reregistration Eligibility Decision (RED) for Carbaryl. EPA-738R07-018.
42 US EPA 1999 & 2000. R.E.D. Chlorpyrifos.
43 US EPA Notice of Filing a Pesticide Petition to Estimate Tolerance for Certain Pesticide Chemicals in or on Food. 2000.
44 US EPA 1998. Imidacloprid; Pesticide Tolerance. 2003 EPA FR 68(43)
45 US EPA 2003. Lambda-cyhalothrin Pesticide Tolerences for Emergency Exemptions
46 US EPA 2000. Spinosad; Pesticide Tolerance.
47 US EPA 6/15/06 FQPA/TRED report; USEPA/HED/OPP. 2002. List of Chemicals Evaluated for Carcinogenic Potential
48 US EPA 1992. IRIS Database; US EPA, 2015. List of Chemicals Evaluated for Carcinogenic Potential
49 US EPA 2008. Trinexapac-Ethyl: Revised Human Health Assessment Scoping Document in Support of Reregistration Review. (Lifetime HAL)
50 US EPA 1997. Reregistration Eligibility Decision. Pendimethalin. EPA 797-R-97-007.
51 US EPA May 7, 2014. Fenoxaprop-ethyl; Pesticide Tolerances. Federal Register, 79(88) pp.26158-26164.

**Table 10. Eco Effects/Aquatic Life Benchmark Concentrations** (freshwater - µg/L; ppb)

| Pesticide (classification) | | Fish | | Invertebrates | | Nonvascular Plants | Vascular Plants |
|---|---|---|---|---|---|---|---|
| | | Acute[1] | Chronic[2] | Acute[3] | Chronic[4] | Acute[5] | Acute[6] |
| 2,4-D | (H) | 12075 | 14200 | 12500 | 16050 | 3880 | 13.1 |
| Acibenzolar | (F) | 800[7] | 900[7] | 1450[7] | 48[7] | 3300[7] | 3.2[7] |
| Fosetyl Al (Aluminum tris O-ethyl) | (F) | 60000[7] | 45000[7] | 94000[7] | 75000[7] | 840[7] | |
| Azoxystrobin | (F) | 235 | 147 | 130 | 44 | 49 | 3400 |
| Bacillus subtilis | (F) | | | | | | |
| Bensulide | (H) | 360 | 374 | 290 | | 1500 | |
| Bifenthrin | (I) | 0.075 | 0.04 | 0.8 | 0.0013 | | |
| Bispyribac sodium | (H) | > 51000 | 9200 | > 49600 | 110000 | 250 | 12 |
| Boscalid | (F) | 1350 | 116 | > 533 | 298 | 1340 | 3900 |
| Carbaryl* | (I) | 110 | 6 | 0.85 | 0.5 | 660 | 1500 |
| Carbendazim (MBC) | (F) | 280[7] | 1160[7] | 1.75[7] | 33[7] | 340[7] | 9743[7] |
| Carfentrazone-ethyl | (H) | 1000[7] | 1500[7] | 4900[7] | 2200[7] | 6.5[7] | 5.9[7] |
| Chlorothalonil | (F) | 5.25 | 3 | 1.8 | 0.6 | 6.8 | 630 |
| Chlorpyrifos* | (I) | 0.9 | 0.57 | 0.05 | 0.04 | 140 | |
| Deltamethrin | (I) | 0.29 | 0.017 | 0.055 | 0.0041 | | |
| Dicamba acid | (H) | 14000 | 49000 | > 50000 | 11 | 61 | > 3250 |
| Dicamba, dimethylamine salt | (H) | 488500 | | 781500 | | | |
| Dicamba, sodium salt | (H) | 253600 | | 17300 | | | |
| Ethephon | (GR) | 44000 | | 15850 | 17000 | 23500 | 2500 |
| Ethofumesate | (H) | 8750 | 2560 | 147000 | 300 | >2760 | |
| Etridiazole | (F) | 1635[7] | 2700[7] | 1540[7] | 610[7] | 72[7] | |
| Fenoxaprop-p-ethyl | (H) | 155 | 22 | > 529 | | 430 | > 3000 |
| Fluazifop-P-butyl | (H) | 1635[7] | 2700[7] | 1540[7] | 610[7] | 2[7] | 8120[7] |
| Fluazinam | (F) | 18 | 0.69 | 90 | 68 | 1.1 | |
| Flurprimidol | (GR) | 8600 | 944 | 5900 | 2960 | 840 | 10400 |
| Flutolanil | (F) | 1250 | 233 | > 3400 | 530 | 8010 | 8010 |
| Glyphosate | (H) | 21500 | 1800 | 26600 | 49900 | 12100 | 11900 |
| Halosulfuron | (H) | 10500[7] | 21000[7] | 53500[7] | 6900[7] | 4.1[7] | |
| Imidacloprid | (I) | > 41500 | 1200 | 34.5 | 1.05 | > 10000 | |
| Indoxacarb | (I) | 145 | 150 | 300 | 75 | > 110 | > 84 |
| Iprodione | (F) | | 260 | 120 | | > 130 | > 12640 |
| Lambda-cyhalothrin | (I) | 0.105 | 0.031 | 0.0035 | 0.002 | > 310 | |
| Mecoprop (MCPP)-P acid | (H) | | | > 45500 | 50800 | | |
| Mecoprop (MCPP)-P DMAS | (H) | > 46500 | | | | 14 | 1300 |
| Metconazole | (F) | 1650[7] | 814[7] | | | | |
| Mefenoxam | (F) | > 60500 | | 20950 | 100 | | 77000 |

| Pesticide (classification) | | Fish | | Invertebrates | | Nonvascular Plants | Vascular Plants |
|---|---|---|---|---|---|---|---|
| | | Acute[1] | Chronic[2] | Acute[3] | Chronic[4] | Acute[5] | Acute[6] |
| Mesotrione | (H) | > 60000 | 11000 | 420000 | 180000 | 1900 | 9.8 |
| Mineral Oil + Pigment (Civitas) | (F) | | | | | | |
| Myclobutanil | (F) | 1200 | 980 | 5500 | | 830 | |
| Paclobutrazol | (GR) | 7950 | 49 | 120 | 9 | 40800 | 8 |
| Parasitic Nematodes | (I) | | | | | | |
| Pendimethalin | (H) | 69 | 6.3 | 140 | 14.5 | 5.2 | 12.5 |
| Pentachloronitrobenzene (PCNB) | (F) | 50 | 13 | 385 | 18 | | |
| Penthiopyrad (Velista) | (F) | 145 | 100 | 1265.5 | 471 | 1200 | > 1205 |
| Polyoxin D | (F) | | | | | | |
| Prodiamine | (H) | > 6.5 | | > 6.5 | 1.5 | | |
| Propamocarb hydrochloride | (F) | 55000[7] | 110000[7] | 51700[7] | 15000[7] | 170000[7] | |
| Propiconazole | (F) | 425 | 95 | 650 | 260 | 21 | 4828 |
| Pyraclostrobin | (F) | 3.1 | 2.35 | 7.85 | 4 | 1.5 | 1720 |
| Quinclorac | (H) | 15800 | 16000 | 14900 | 110000 | > 500 | > 500 |
| Sethoxydim | (H) | 85000 | 2700 | 39050 | 250 | | > 281 |
| Spinosad | (I) | 2970 | 498 | 7000 | 0.6 | 90 | 10600 |
| Sulfentrazone | (H) | 46900 | 2950 | 30200 | 200 | 1.8 | 28.8 |
| Thiophanate methyl | (F) | 4150 | 2 | 2700 | 3 | 930 | > 4700 |
| Thiram | (F) | 21 | 530 | 105 | 170.6 | 140 | 1600 |
| Triadimefon (metabolite=triadimenol[7]; see below) | (F) | Parent: 2050 Metabolite: 7000 | Parent: 41 Metabolite: 6900 | Parent: 800 Metabolite: 1250 | Parent: 52 Metabolite: 145 | Parent: 17000 Metabolite: 3200 | |
| Trifloxystrobin | (F) | 7.15 | 4.3 | 12.65 | 2.76 | 37.1 | > 1930 |
| Trinexapac-ethyl | (GR) | 17500 | 410 | > 72750 | 2400 | 350 | 190 |

[1] Benchmark=Toxicity value x LOC. For acute fish, toxicity value is generally the lowest 96-hour LC50 in a standardized test (usually with rainbow trout, fathead minnow, or bluegill), and the LOC is 0.5.

[2] Benchmark=Toxicity value x LOC. For chronic fish, toxicity value is usually the lowest NOEAC from a life-cycle or early life stage test (usually with rainbow trout or fathead minnow), and the LOC is 1.

[3] Benchmark=Toxicity value x LOC. For acute invertebrate, toxicity value is usually the lowest 48- or 96-hour $EC_{50}$ or $LC_{50}$ in a standardized test (usually with midge, scud, or daphnids), and the LOC is 0.5.

[4] Benchmark=Toxicity value x LOC. For chronic invertebrates, toxicity value is usually the lowest NOAEC from a life-cycle test with invertebrates (usually with midge, scud, or daphnids), and the LOC is 1.

[5] Benchmark=Toxicity value x LOC. For acute nonvascular plants, toxicity value is usually a short-term (less than 10 days) $EC_{50}$ (usually with green algae or diatoms), and the LOC is 1.

[6] Benchmark=Toxicity value x LOC. For acute vascular plants, toxicity value is usually a short-term (less than 10 days) EC50 (usually with duckweed) and the LOC is 1.

[7] Toxicity values used to calculate benchmark concentrations were obtained from US EPA's ECOTOX Database (http://cfpub.epa.gov/ecotox/).

* Aquatic Life Criteria (Maximum Concentration [CMC] and Continuous Concentration [CCC]) for carbaryl and chlorpyrifos was available from the US EPA Office of Water. Carbaryl: CMC = 2.1 and CCC = 2.1; Chlorpyrifos: CMC = 0.083 and CCC = 0.041.

**Generic footnotes, Definitions, and Table References**
(H)=Herbicide; (I)=Insecticide; (F)=Fungicide; (GR)=Growth Regulator
Empty cells indicate that acceptable aquatic toxicity values are not available.
Benchmarks preceded by a "greater-than" symbol (for example, >265,000) were derived from a "greater-than" value and may overestimate toxicity. Conversely, benchmarks preceded by a "less-than" symbol (for example, <1,500) were derived from a "less-than" value and may underestimate toxicity.
CCC = Criterion continuous concentration; CMC = Criterion maximum concentration
$EC_{50}$ = 50 percent effect concentration; $LC_{50}$ = 50 percent lethal concentration
LOC = level of concern; NOAEC = no-observed-adverse-effects concentration
µg/L = microgram per liter; — = no benchmark available
**References**
[a]Stephan, C.E, D.I. Mount, D.J. Hanson, J.H. Gentile, G.A. Chapman, and W.A. Brungs. 1985. Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses. EPA PB85-227049.
[b]US EPA. 2004. Overview of the Ecological Risk Assessment Process in the Office of Pesticide Programs. Office of Prevention, Pesticides, and Toxic Substances. Office of Pesticide Programs. Washington, D.C. January 23, 2004.

## H. Comparisons of PRZM-GW Modeling Results with Toxicity Reference Points

In this section we conclude the second phase of risk screening by comparing the PRZM-GW modeling results in Table 8a with the human health and aquatic effects reference points in Tables 9 and 10, respectively.

### 1. Human Health

A risk quotient was calculated to determine whether the use of each pesticide should warrant concern for human health based on the assumptions of the assessment. The risk quotient for ground water is the estimate of the upper 99$^{th}$ percentile confidence limit (approximate) ground water concentration divided by the Health Advisory Level (HAL) or EPA MCL or the NY standard/guidance values. (The relative importance of the various toxicologic reference points is described in section V(F) above.) Risk quotient values greater than or equal to 1.0 indicate that there should be a presumption of risk with the use of the pesticide as defined in the calculations. A value less than 1.0 suggests that the use of the pesticide would not present undue risk to human health. The entire mean concentration was used in the risk ratio calculations to determine the presumption of risk for human health (Table 11a).

Results for two pesticides exceeded their respective human health reference points. The modeled concentrations for mecoprop (MCPP) and dicamba were 3.15 ppb and 0.58 ppb, respectively, compared with a pre-1980 State regulatory standard of 0.44 ppb for both

pesticides. However, their more health/science-based standards are 280 ppb (MCPP) and 4,000 ppb (dicamba). The 30+ year-old standard should have been updated decades ago. No other pesticide was modeled to have a human health reference point exceedance; however, the chronic concentrations of the following pesticides were modeled to exceed 1 ppb (mean concentrations in parentheses):

- MCPP (3 ppb);
- quinclorac (54 ppb);
- MBC (carbendazim, a metabolite of thiophanate methyl; 1 ppb);
- mefenoxam (11 ppb);
- bispyribac (32 ppb); and
- triadimefon/triadimenol (metabolite; 13 ppb).

**2. Aquatic Toxicity**

Risk quotients were also developed for aquatic vertebrates and invertebrates (Table 11a). The "peak concentrations" calculated by PRZM-GW were compared with acute aquatic toxicity reference points (Table 10), and the "entire simulation mean concentrations" were compared with the chronic aquatic reference points (Table 10).

Only one pesticide and one metabolite exceeded an aquatic ecological reference point: the 12 ppb acute reference point for bispyribac exposure to vascular plants (12 ppb vs. a peak concentration of 59 ppb (risk quotient = 4.88) and 1.75 ppb acute reference point for the thiophanate methyl metabolite (MBC/carbendazim) to invertebrates (1.75 ppb vs. a peak concentration of 4.44 ppb (risk quotient = 2.54; see Table 11a).

However, it is important to realize that any concentrations that migrate to ground water must travel a long distance to Weesuck Creek, and then they will be diluted with streamflow.

**3. Summary**

Thus the following pesticides were flagged in this second phase of screening for having risk- and/or regulatory-based issues:

- the herbicide MCPP/mecoprop (very old drinking water regulation; suggestive evidence of carcinogenicity)[†];
- the herbicide dicamba (old drinking water regulation);
- bispyribac-sodium (vascular aquatic plants);
- thiophanate methyl and its MBC/carbendazim metabolite (elevated concentration and carcinogenicity classifications);
- mefenoxam (elevated concentration, but good tox profile);
- quinclorac (elevated concentration);
- etridiazole (low HAL); and
- iprodione (low HAL).

The team decided to delete thiophanate methyl from the program prior to the next steps, application of the EIQ, Cornell's Environmental Impact Quotient, and the US EPA's AgDRIFT model. The possibility of restrictions on the use of the other pesticides that are flagged is considered following the drift and EIQ assessments, which follow.

Table 11b shows the results for the three pesticides that were remodeled in response to comments received from Dr. A.M. Petrovic during the completeness review. The results show that there was basically no change to the human or aquatic health risks for 2,4-D (i.e., the risk quotients were well below 1, which indicates no presumption of risk as modeled to humans or the environment). However, for dicamba and MCPP the risk quotient for humans and the aquatic environment increased; significantly for humans for both. The risk quotient of MCPP for acute aquatic organisms is at 1.0, which indicates a presumption of risk as modeled, but still well below 1.0 for the chronic aquatic environment. The risk quotients increased for both the acute and chronic aquatic environments for dicamba but are still well below 1.0. See Table 11b below.

This information is integrated with the other components of the risk assessment at the end of this report.

[†] We are not recommending restrictions on the herbicide dicamba, despite the fact that it has the same extremely low DEC standard, which yielded a drinking water risk ratio >1.0, for these reasons:

- The old standard of 0.44 ppb is superseded scientifically by a more modern science-based HAL of 4,000 ppb (vs. 280 ppb for MCPP);
- The DEC standard is probably >30 years old, perhaps >40 years old;
- Dicamba has a less definitive cancer classification than MCPP; and
- The mean PRM GW-generated concentration is 0.6 ppb, vs. 3 ppb for MCPP.

**Table 11a. Risk Quotient Calculations**

| CHEMICAL | Peak Concentration (ppb) | Did the Result Exceed One of the Acute Values in Table 10? | Entire Simulation Mean Concentration (ppb) | Did the Result Exceed One of the Chronic Values in Tables 10 or 9? | Risk Quotient | | |
|---|---|---|---|---|---|---|---|
| | | | | | Human | Aquatic | |
| | | | | | | Acute | Chronic |
| **Herbicides** | | | | | | | |
| Bensulide | 4.68E-19 | No | 1.77E-20 | No | 5.06E-22 | 1.61E-21 | 4.73E-23 |
| Bispyribac-sodium | 58.6 | 12 (vascular plants) | 31.8 | No | 4.5E-2 | 4.88E+00 | 3.46E-03 |
| Carfentrazone-ethyl | 1.17E-20 | No | 2.72E-22 | No | 1.3E-24 | 1.98E-21 | 1.81E-25 |
| Dimethylamine salt of 2,4-dichlorophenoxyacetic acid (2,4-D) | 0.031 | No | 0.0105 | No | 2.1E-4 | 2.37E-03 | 7.39E-07 |
| Dimethylamine salt of dicamba | 1.31 | No | 0.583 | 0.44 (NYDEC Health) | 1.33 | 2.15E-02 | 5.30E-02 |
| Dimethylamine salt of methyl-chlorophenoxy propionic acid (MCPP) | 7.09 | No | 3.16 | 0.44 (NYDEC Health) | 7.18 | 5.06E-01 | 6.22E-05 |
| Ethofumesate | 5.11E-05 | No | 9.9E-06 | No | 4.7E-9 | 1.85E-08 | 3.30E-08 |
| Fenoxaprop | 0 | No | 0 | No | 0 | 0.00E+00 | 0.00E+00 |
| Fluazifop-P-butyl | 0 | No | 0 | No | 0 | 0.00E+00 | 0.00E+00 |
| Glyphosate | 0 | No | 0 | No | 0 | 0.00E+00 | 0.00E+00 |
| Halosulfuron-methyl | 0.883 | No | 0.396 | No | 5.7E-4 | 2.15E-01 | 5.74E-05 |
| Mesotrione | 0.00107 | No | 0.000406 | No | 8.3E-6 | 1.09E-04 | 3.69E-08 |
| Potassium Salts of Fatty Acids* | [not modeled] | | | | - - | | |
| Prodiamine | 0 | No | 0 | No | 0 | 0.00E+00 | 0.00E+00 |
| Quinclorac | 74.2 | No | 53.5 | No | 0.02 | 1.48E-01 | 3.34E-03 |
| Sethoxydim | 0.123 | No | 0.0459 | No | 4.7E-5 | 4.38E-04 | 1.84E-04 |
| **Insecticides** | | | | | | | |
| Bifenthrin | 0 | No | 0 | No | 0 | 0.00E+00 | 0.00E+00 |
| Carbaryl | 0.0378 | No | 0.00537 | No | 1.9E-4 | 4.45E-02 | 1.07E-02 |
| Chlorpyrifos | 0 | No | 0 | No | 0 | 0.00E+00 | 0.00E+00 |
| Deltamethrin | 0 | No | 0 | No | 0 | 0.00E+00 | 0.00E+00 |
| Imidacloprid | 0.0372 | No | 0.00285 | No | 7.14E-6 | 1.08E-03 | 2.71E-03 |
| Lambda-cyhalothrin | 0 | No | 0 | No | 0 | 0.00E+00 | 0.00E+00 |
| Parasitic Nematodes* | [not modeled] | | | | - - | | |
| Spinosad* | [not modeled] | | | | | | |
| **Fungicides** | | | | | | | |
| Aluminum tris O-ethyl (Fosetyl-Al) | 0 | No | 0 | No | 0 | 0.00E+00 | 0.00E+00 |
| Azoxystrobin | 1.75E-07 | No | 1.15E-08 | No | 9.1E-12 | 3.57E-09 | 2.61E-10 |

| CHEMICAL | Peak Concentration (ppb) | Did the Result Exceed One of the Acute Values in Table 10? | Entire Simulation Mean Concentration (ppb) | Did the Result Exceed One of the Chronic Values in Tables 10 or 9? | Risk Quotient | | |
|---|---|---|---|---|---|---|---|
| | | | | | Human | Aquatic | |
| | | | | | | Acute | Chronic |
| Bacillus subtilis | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Boscalid | 1.11E-10 | No | 5.22E-12 | No | 3.4E-14 | 2.08E-13 | 4.50E-14 |
| Chlorothalonil | 0 | No | 0 | No | 0 | 0.00E+00 | 0.00E+00 |
| Daconil Action: chlorothalonil + acibenzolar | 1.44E-20 (Acibenzolar) | No | 3.46E-22 (Acibenzolar) | No | 6.4E-25 | 4.5E-21 | 7.21E-24 |
| Etridiazole | 3.31E-11 | No | 1.81E-12 | No | 5.2E-14 | 4.60E-13 | 2.97E-15 |
| Fluazinam | 9.09E-15 | No | 4.31E-16 | No | 5.6E-18 | 8.26E-15 | 6.25E-16 |
| Flutolanil | 2.02E-3 | No | 1.39E-4 | No | 4.0E-8 | 1.62E-06 | 5.97E-07 |
| Iprodione | 0.0342 | No | 0.00372 | No | 1.1E-5 | 2.85E-04 | 1.43E-05 |
| MBC (TM metabolite; Carbendazim) | 4.44 | Yes (invertebrates) | 1.11 | No | 5.9E-3 | 2.54 | 3.36E-02 |
| Mefenoxam | 32.5 | No | 11.2 | No | 2.2E-2 | 1.55E-03 | 1.12E-01 |
| Metconazole | 2.64E-12 | No | 1.19E-13 | No | 4.3E-16 | 1.60E-15 | 1.46E-16 |
| Mineral oil* + pigment | [not modeled] | | | | | | |
| Myclobutanil | 2.08E-05 | No | 1.76E-06 | No | 1.0E-8 | 2.51E-08 | 1.80E-09 |
| | | | | | | | |
| Penthiopyrad | 9.58E-11 | No | 5.53E-12 | No | 2.9E-15 | 6.61E-13 | 5.53E-14 |
| Polyoxin D | [not modeled] | | | | | | |
| Propamocarb | 9.24E-11 | No | 5.12E-12 | No | 9.5EE-15 | 1.79E-15 | 3.41E-16 |
| Propiconazole | 2.86E-05 | No | 1.99E-06 | No | 2.8E-9 | 1.36E-06 | 2.09E-08 |
| Pyraclostrobin | 0 | No | 0 | No | 0 | 0.00E+00 | 0.00E+00 |
| Thiophanate methyl | 0 | No | 0 | No | 0 | 0 | 0 |
| Thiram | 1.24E-04 | No | 1.53E-05 | No | 1.46E-7 | 5.90E-06 | 8.97E-08 |
| Triadimefon/Triadimenol (metabolite) | 12.6 | No | 1.33 | No | 0.53 | 1.58E-02 | 0.307 |
| Trifloxystrobin | 0 | No | 0 | No | 0 | 0.00E+00 | 0.00E+00 |
| **Growth Regulators** | | | | | | | |
| Ethephon | 0 | No | 0 | No | 0 | 0.00E+00 | 0.00E+00 |
| Paclobutrazol | 0.56 | No | 0.0458 | No | 1.0E-4 | 7.00E-02 | 5.09E-03 |
| Trinexapac-ethyl | 0 | No | 0 | No | 0 | 0.00E+00 | 0.00E+00 |

*Natural products not modeled

**Table 11b. Risk Quotient Calculations – remodeled results**

| CHEMICAL | Peak Concentration (ppb) | Did the Result Exceed One of the Acute Values in Table 10? | Entire Simulation Mean Concentration (ppb) | Did the Result Exceed One of the Chronic Values in Tables 10 or 9? | Risk Quotient | | |
|---|---|---|---|---|---|---|---|
| | | | | | Human | Aquatic | |
| | | | | | | Acute | Chronic |
| **Herbicides** | | | | | | | |
| Dimethylamine salt of 2,4-dichlorophenoxyacetic acid (2,4-D) | 0.454 | No | 0.106 | No | 2.12E-4 | 3.47E-02 | 7.46E-06 |
| Dimethylamine salt of dicamba | 11.5 | No (dicamba acid chronic invertebrate = 11 ppb) | 7.76 | 0.44 (NYDEC Health) | 17.6 | 1.89E-01 | 7.05E-01 |
| Dimethylamine salt of methyl-chlorophenoxy propionic acid (MCPP) | 14.1 | No (MCPP-P DMAS nonvascular plants acute = 14 ppb) | 6.3 | 0.44 (NYDEC Health) | 14.3 | 1.01E+00 | 1.24E-04 |

## VI. PESTICIDE DRIFT

This discussion is relevant to DEIS requirement #23 under "Water Resources".

Offsite pesticide drift is not likely to be a significant risk factor for this project, for several reasons. (1) The pesticides will be applied with a tractor boom that is approximately 18-24 inches above the ground, with the nozzles directed downward. (2) There are no sensitive surface water bodies nor critical habitats (habitats for listed species) adjacent to the proposed golf course areas. (3) The developer has committed to using spray shrouds on the tractor boom. However, we ran the AgDRIFT model for the sake of completeness (Section B below).

### A. Empirical Results

As stated above, drift from low boom sprayers tends to be minimal. For example, Caldwell and Wolf (2006) found that amounts of ground-spray drift deposited 0.4 km downwind in windy conditions were 0.001% of the applied amounts, and those spray nozzles were at a greater height than would be used at this golf course.

### B. AgDRIFT Modeling

AgDRIFT (v 2.1.1) was created jointly by the US EPA, the US Department of Agriculture's Forest Service, and the Spray Drift Task Force (http://www2.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment#agdrift). It is based on empirical field study results. AgDRIFT is used to predict spray drift and offsite deposition of liquid formulations of pesticides. It can also be used to evaluate the potential for buffer zones to protect sensitive aquatic and terrestrial habitats from undesired pesticide exposures. The application method most relevant to this assessment is ground boom.

#### 1. Conceptual Approach

As stated in section II(C)(1) and (3), the smallest separation between managed golf course turf and both Weesuck Creek to the east-southeast and possible sensitive habitats in the

north parcel is approximately 1500 ft. However, this empirically-based model is limited to distances of 997 ft or less for Tier 1 (see below). Therefore, this distance was used for drift estimation. In this conceptual model, the pesticide that is being applied drifts east-southeast, where it is deposited on Weesuck Creek, and north, where it is deposited on the north parcel.

## 2. Selection of Model Input Parameters

We ran AgDRIFT in the Tier 1 mode. As noted above, the maximum range for predictions of ground-applied (vs. aerial) pesticides is 997 ft (US EPA, 2013). Following are the input parameters, in accordance with the project site, the model's requirements, and the model's guidance (US EPA, 2013):

- drift distance - - 997 ft (see above);
- application equipment - - low boom (typical), with no spray shroud;
- wind speed - - 5-15 mph (fixed, and see below);
- pesticide application rates - - Table 5 of this report;
- droplet size distribution - - very fine to fine (EPA conservative recommendation); and
- statistical distribution - - upper 90$^{th}$ percentile.

Most pesticide applications to golf course turf are done very early in the morning when winds are calm or nearly calm. Most pesticide label statements regarding drift are either qualitative, or they require that wind speeds not exceed 10 mph during application.

We simulated drift followed by terrestrial deposition and mixing into a non-flowing 10 ha, 2 m deep pond. The latter was done as a worst-case representation of the flowing Weesuck Creek. Further, the model's inherent assumption is that the treated area at least equals the pond area (10 ha; 24.7 A). It is extremely unlikely that 24.7 A of the golf course would be treated with the same chemical in one day.

## 3. Results

The key results (upper 90$^{th}$ percentiles) of the AgDRIFT modeling are listed in Table 12 below. The modeled pond concentration is an extremely conservative representation for the Weesuck Creek headwater. The upper 90$^{th}$ percentile numbers in the last column -- "Initial

Average Concentration in the Pond" -- should be compared with the acute aquatic concentrations in Table 10 (section V(G)).

All modeled pond concentrations are below 1 ppb, and there are only five pesticides listed in Table 10 with acute aquatic criteria below 1 ppb: bifenthrin (0.075 ppb and 0.8 ppb); carbaryl (0.85 ppb); chlorpyrifos (0.9 and 0.05 ppb); deltamethrin (0.29 and 0.055 ppb); and lambda cyhalothrin (0.105 and 0.0035 ppb). The upper 90$^{th}$ percentile predictions for 997 ft downwind at 5-15 mph with no spray shroud indicate the following exceedances for the liquid formulations: bifenthrin (0.0048 ppb) – invertebrate chronic; chlorpyrifos (0.77 ppb) -- invertebrate acute and chronic, and fish chronic; deltamethrin (0.0063 ppb) -- invertebrate chronic; and lambda cyhalothrin (0.017 ppb) -- invertebrate acute and chronic. All of these pesticides are insecticides.

These are conservative (protective) calculations for the following reasons: the modeled distance is 997 ft instead of 1500 ft (Figure 8 depicts an example plot [exponential decline] of drift fraction as a function of distance); golf course pesticides are rarely applied in 13 knot (15 mph) winds; Weesuck Creek is a flowing water body, not a static pond, which tends to over-estimate concentrations; and the developer has committed to using a spray shroud.

**Table 12. Results of AgDRIFT Modeling** *(upper 90$^{th}$ percentile)**

| Pesticide | Application Rate (lb ai/A) | Initial Average Terrestrial Distribution (g/ha; lb/A) | Initial Average Concentration in the Pond (ppb) |
|---|---|---|---|
| Herbicides | | | |
| Bensulide | 15 | 16; 0.014 | 0.72 |
| Bispyribac-sodium | 1.32 | 1.4; 0.0013 | 0.064 |
| Carfentrazone-ethyl | 0.026 | 0.028; 2.5E-05 | 0.0013 |
| Dimethylamine salt of 2,4-D | 1.23 | 1.3; 0.0012 | 0.059 |
| Ethofumesate | 1.5 | 1.6; 0.0014 | 0.072 |
| Fenoxaprop | 0.071 | 0.077; 6.8E-05 | 0.003 |
| Fluazifop-P-butyl | 0.375 | 0.41; 0.0004 | 0.018 |
| Glyphosate | 0.16 | 0.17; 0.0002 | 0.008 |
| Halosulfuron-methyl | 0.124 | 0.27; 0.0002 | 0.0060 |
| MCPP# | | | |
| Mesotrione | 0.25 | 0.27; 0.0002 | 0.012 |
| Potassium Salts of Fatty Acids* | [not modeled] | | |
| Prodiamine | 0.98 | 1.1; 0.0008 | 0.047 |
| Quinclorac | 0.5 | 0.54; 0.0005 | 0.024 |
| Sethoxydim | 0.018 | 0.0195; 1.7E-05 | 0.001 |

| Pesticide | Application Rate (lb ai/A) | Initial Average Terrestrial Distribution (g/ha; lb/A) | Initial Average Concentration in the Pond (ppb) |
|---|---|---|---|
| Fungicides | | | |
| Aluminum tris O-ethyl (Fosetyl-Al) | 17.42 | 18.9; 0.017 | 0.84 |
| Azoxystrobin | 1.1 | 1.2; 0.0011 | 0.053 |
| Bacillus subtilis | [not modeled] | | |
| Boscalid | 0.56 | 0.61; 0.0005 | 0.027 |
| Chlorothalonil | 8.25 | 8.9; 0.008 | 0.40 |
| Chlorothalonil (C) + Acibenzolar (A) | 0.008 (A)<br>6.1 (C) | 0.0087; 7.7E-06 (A)<br>6.6; 0.0059 (C) | 0.00 (A)<br>0.29 (C) |
| Etridiazole | 4.125 | 4.5; 0.004 | 0.20 |
| Fluazinam | 0.71 | 0.77; 0.0007 | 0.034 |
| Flutolanil | 17.32 | 19; 0.017 | 0.84 |
| Iprodione | 2.72 | 2.9; 0.0026 | 0.13 |
| Mefenoxam | 0.60 | 0.65; 0.0006 | 0.029 |
| Metconazole | 0.50 | 0.54; 0.0005 | 0.024 |
| Mineral oil + pigment | [not modeled] | | |
| Myclobutanil | 1.32 | 1.4; 0.0013 | 0.064 |
| Penthiopyrad | 0.95 | 1.0; 0.0009 | 0.046 |
| Polyoxin D | 0.272 | 0.29; 0.0003 | 0.013 |
| Propamocarb | 3.65 | 4.0; 0.0035 | 0.18 |
| Propiconazole | 1.1 | 1.2; 0.0011 | 0.053 |
| Pyraclostrobin | 1.0 | 1.08; 0.001 | 0.048 |
| Thiram | 5.1 | 5.5; 0.0049 | 0.246 |
| Triadimefon | 2.36 | 2.6; 0.0023 | 0.114 |
| Triadimenol[§] | 2.12 | 2.3; 0.002 | 0.102 |
| Trifloxystrobin | 0.55 | 0.60; 0.0005 | 0.027 |
| Insecticides | | | |
| Bifenthrin | 0.1 | 0.096; 8.6E-05 | 0.0048** |
| Carbaryl | 2.75 | 2.98; 0.0027 | 0.13 |
| Chlorpyrifos | 16 | 17.3; 0.016 | 0.77** |
| Deltamethrin | 0.13 | 0.14; 0.0001 | 0.0063** |
| Imidacloprid | 0.3 | 0.32; 0.0003 | 0.014 |
| Lambda-cyhalothrin | 0.36 | 0.39; 0.0003 | 0.017** |
| Parasitic Nematodes | [not modeled] | | |
| Spinosad | 0.50 | 0.54; 0.0005 | 0.024 |
| Growth Regulators | | | |
| Ethephon | 1.25 | 1.4; 0.0012 | 0.060 |
| Paclobutrazol | 1.0 | 1.1; 0.001 | 0.048 |
| Trinexapac-ethyl | 1.0 | 1.1; 0.001 | 0.048 |

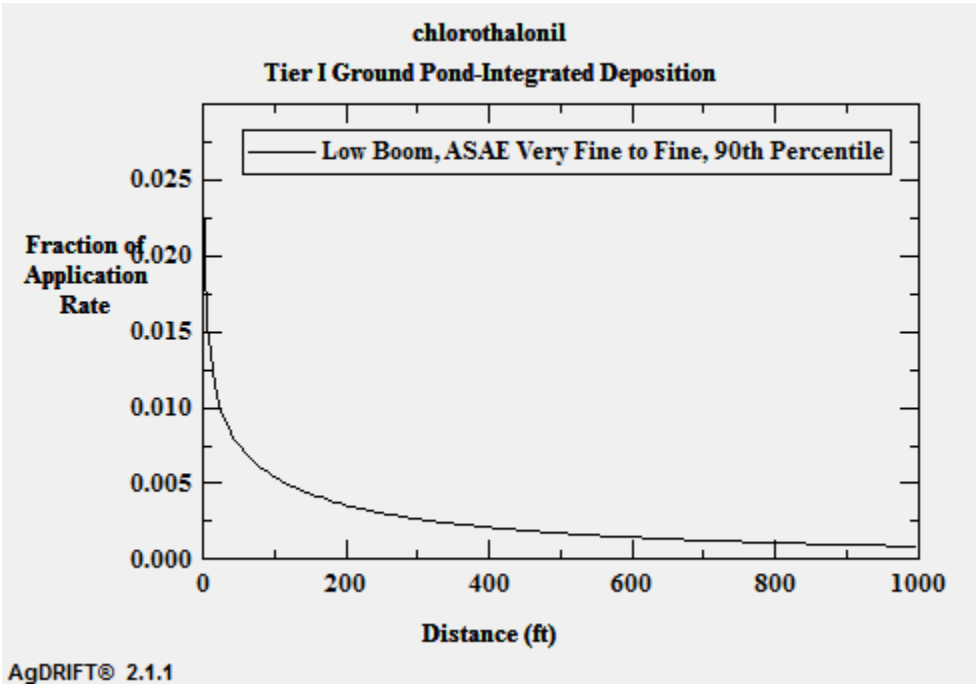
*The fraction of the applied amount that is calculated to drift 997 ft is 0.0009 (0.09%). The actual distance is approx. 1500 ft.
[#]The decision was made to delete this pesticide prior to drift modeling.
[§] 90% of parent triadimefon.
**Exceeds one or more aquatic criteria without a spray shroud (see text).

Terrestrial deposition rates due to drift were also calculated ("Initial Average Terrestrial Distribution" column in Table 12 above). This was done now to prepare for possible future needs; i.e., if

someone ever wishes to assess exposure to terrestrial species offsite. If this need ever does occur in the future, the appropriate terrestrial organism toxicity data would have to be integrated into the assessment.

The detailed input and output of all Ag DRIFT modeling runs is provided in a separate CD. This information is integrated with the other components of the risk assessment at the end of this report.

**Figure 8. Drift Fraction of Application Rate vs. Distance (Example Output)**



## VII. FIELD ENVIRONMENTAL IMPACT QUOTIENT

This discussion is relevant to DEIS requirements #20 under “Project Design and Layout”, #18, #19, #22, and #23 of “Water Resources”, #11-13 of “Ecology”.

### A. Description

The Environmental Impact Quotient or EIQ is a calculation intended to identify pesticide impacts to both the environment and human health. The EIQ was initially developed by the New York State’s Integrated Pest Management Program (NYSIPM) in 1992, and is continuously maintained by the NYSIPM, with older EIQ values reviewed and new EIQ values calculated periodically (Kovach et al., 1992). The NYSIM continues to add EIQ values of new chemicals (Personal Communication, Brian Eshenaur, Sr. Extension Associate at Cornell University. 9/23/15).

The EIQ method for calculating pesticide impacts takes into account three components: farm worker risk, consumer risk, and ecological risk. Farm worker risk includes the assessment of both applicator and picker exposure, which is equivalent to a golfer or athlete as well as chronic toxicity. The consumer component includes exposure of the consumer to the pesticide as well as any ground water effects. Lastly, ecological risk is assessed by examining the aquatic and terrestrial effects to fish, birds, bees, and arthropods. The equation is listed below (Kovach et al., 1992).

$$EIQ=\{C[(DT*5)+(DT*P)]+[(C*((S+P)/2)*SY)+(L)]+[(F*R)+(D*((S+P)/2)*3)+(Z*P*3)+(B*P*5)]\}/3$$

DT = dermal toxicity, C = chronic toxicity, SY = systemicity, F = fish toxicity, L = leaching potential, R = surface loss potential, D = bird toxicity, S = soil half-life, Z = bee toxicity, B = beneficial arthropod toxicity, P = plant surface half-life.

A Field Use EIQ Calculator, also maintained by NYSIPM, is available through Cornell University’s website. The Field EIQ is determined by multiply the EIQ by the percent active ingredient and the application rate. Thus, the Field Use EIQ can be used to determine different management strategies.

EIQ Field Use Rating = EIQ x % active ingredient x Rate

## B. EIQs from the New York State Integrated Pest Management Program

The NYSIPM has calculated EIQ values for all of the current chemical pesticide active ingredients. Metabolites (e.g., MBC) are not listed in the NYSIPM database. Thus, no EIQ values are available for metabolites (Eshenaur et al., 2015). We did not include the natural products (e.g., mineral oil) nor the products that will not be used at The Hills (e.g., dithiopyr).

## C. Calculation of New EIQ Values

The EIQ values were obtained from the NYSIPM database (Table 13). One pesticide (penthiopyrad) listed for use at The Hills is not listed on the NYSIPM released website database; however, ETS was provided its EIQ value, which had been calculated in 2014 (Personal Communication, Brian Eshenaur, Sr. Extension Associate at Cornell University. 10/8/15).

## D. Field EIQ Values in the Context of Target Pests

The Field EIQ values (Table 13) are used to guide decisions on deleting pesticides from use when multiple pesticides can be applied for the same pest. Table 13 shows the results of the Field EIQs and the use ratings for each component. The EIQ Field Use Rating was developed to account for different formulations of the same active ingredient and use patterns. The ratings (i.e., Field EIQ * % a.i. * rate) are compared with the field use rating levels to qualify potential risk (e.g., FEIQ rating of 20 for the worker has a low risk potential for the worker/golfer):

- <25 = very low;
- <50 = low;
- 50-99 = moderate;
- 100-199 = high; and
- 200+ = very high.

The pesticides in Table 13 are listed in ascending order of overall field EIQ rating within a use class (herbicides, insecticides, fungicides, and growth regulators). Individual FEIQ components are listed for all pesticides except those with an overall “very low” rating. The pesticides in Tables 14a-c are listed in the same order, but they are grouped according to target pests.

**Table 13. Environmental Impact Quotient (EIQ)***

| CHEMICAL | EIQ | Rate lb a.i./ac | Field EIQ | Rating Qualifier | Worker** FEIQ | Worker Rating | Consumer/ Leaching‡ FEIQ | Consumer/ Leaching Rating | Ecological† FEIQ | Ecological Rating |
|---|---|---|---|---|---|---|---|---|---|---|
| **Herbicides** | | | | | | | | | | |
| Sethoxydim | 20.9 | 0.018 | 0.4 | v. low | | | | | | |
| MCPP | 15.3 | 0.12 | 1.8 | v. low | | | | | | |
| Glyphosate | 15.3 | 0.16 | 2.5 | v. low | | | | | | |
| Halosulfuron-methyl | 20.2 | 0.124 | 2.5 | v. low | | | | | | |
| Fenoxaprop | 43.7 | 0.071 | 3.1 | v. low | | | | | | |
| Dicamba | 26.3 | 0.12 | 3.2 | v. low | | | | | | |
| Mesotrione | 18.7 | 0.25 | 4.7 | v. low | | | | | | |
| Carfentrazone-ethyl | 20.2 | 0.26 | 5.2 | v. low | | | | | | |
| Fluazifop-P-butyl | 28.7 | 0.375 | 10.8 | v. low | | | | | | |
| Prodiamine | 11.7 | 0.98 | 11.5 | v. low | | | | | | |
| Bispyribac-sodium | 11.5 | 1.32 | 15.1 | v. low | | | | | | |
| Quinclorac | 32.1 | 0.5 | 16.0 | v. low | | | | | | |
| 2,4-D acid | 16.7 | 1.23 | 20.5 | v. low | | | | | | |
| Ethofumesate | 25.8 | 1.5 | 38.7 | low | 12 | low | 9 | low | 95.2 | moderate |
| Bensulide | 26 | 8.15 | 211.9 | v. high | 48.9 | low | 32.6 | low | 554.2 | v. high |
| Pendimethalin | 30.2 | 9.2 | 265.5 | v. high | 105.6 | high | 48.4 | low | 642.4 | v. high |
| **Insecticides** | | | | | | | | | | |
| Deltamethrin | 28.38 | 0.13 | 3.7 | v. low | | | | | | |
| Bifenthrin | 44.35 | 0.1 | 4.4 | v. low | | | | | | |
| Spinosad | 14.38 | 0.5 | 7.2 | v. low | | | | | | |
| Imidacloprid | 36.71 | 0.3 | 11.0 | v. low | | | | | | |
| Lambda-cyhalothrin | 44.17 | 0.36 | 15.9 | v. low | | | | | | |
| Carbaryl | 22.73 | 2.75 | 62.5 | moderate | 41.3 | low | 15.1 | v. low | 131.2 | high |
| Chlorpyrifos | 26.85 | 16 | 429.6 | v. high | 96 | moderate | 32 | low | 1160.8 | v. high |
| Parasitic Nematodes | | | | | | | | | | |
| **Fungicides** | | | | | | | | | | |
| Acibenzolar S-methyl | 20.74 | 0.008 | 0.2 | v. low | | | | | | |

| CHEMICAL | EIQ | Rate lb a.i./ac | Field EIQ | Rating Qualifier | Worker** FEIQ | Worker Rating | Consumer/ Leaching‡ FEIQ | Consumer/ Leaching Rating | Ecological† FEIQ | Ecological Rating |
|---|---|---|---|---|---|---|---|---|---|---|
| Polyoxin D | 24.6 | 0.272 | 6.7 | v. low | | | | | | |
| Mefenoxam | 19.07 | 0.6 | 11.4 | v. low | | | | | | |
| Metconazole | 24 | 0.5 | 12.0 | v. low | | | | | | |
| Boscalid | 26.44 | 0.56 | 14.8 | v. low | | | | | | |
| Trifloxystrobin | 29.78 | 0.55 | 16.4 | v. low | | | | | | |
| Fluazinam | 23.33 | 0.71 | 16.6 | v. low | | | | | | |
| Penthiopyrad | 26.75 | 0.95 | 25.4 | low | 12.5 | v. low | 12.3 | v. low | 55.87 | moderate |
| Pyraclostrobin | 27.01 | 1 | 27.0 | low | 8.1 | v. low | 4.1 | v. low | 68.9 | moderate |
| Azoxystrobin | 26.92 | 1.1 | 29.6 | low | 8.9 | v. low | 6.7 | v. low | 73.3 | moderate |
| Myclobutanil | 24.01 | 1.32 | 31.7 | low | 10.7 | v. low | 16 | v. low | 68.4 | moderate |
| Propiconazole | 31.63 | 1.1 | 34.8 | low | 13.2 | v. low | 20.9 | v. low | 70.3 | moderate |
| Triadimefon | 26.96 | 2.3 | 62.0 | moderate | 27.9 | low | 34.8 | low | 123.2 | moderate |
| Iprodione | 24.25 | 2.72 | 66.0 | moderate | 44.1 | low | 24.8 | low | 129.1 | high |
| Propamocarb | 23.89 | 3.65 | 87.2 | moderate | 44.3 | low | 44.6 | low | 172.6 | high |
| Etridiazole | 23.1 | 4.125 | 95.3 | moderate | 99 | moderate | 16.5 | v. low | 166.2 | high |
| Thiram | 29.28 | 5.1 | 149.3 | high | 103.3 | high | 44 | low | 300.6 | v. high |
| Fosetyl-Al | 12 | 17.42 | 209.0 | v. high | 104.5 | high | 69.7 | moderate | 452.9 | v. high |
| Chlorothalonil | 37.42 | 8.25 | 308.7 | v. high | 165 | high | 90.8 | moderate | 670.3 | v. high |
| Flutolanil | 23.07 | 17.32 | 399.6 | v. high | 140.3 | high | 262.4 | v. high | 795.9 | v. high |
| **Growth Regulators** | | | | | | | | | | |
| Trinexapac-ethyl | 19 | 1 | 19.0 | low | 7.1 | v. low | 4.6 | v. low | 45.5 | moderate |
| Paclobutrazol | 26.4 | 1 | 26.4 | low | 21.3 | v. low | 6.6 | v. low | 51.5 | moderate |
| Ethephon | 24.8 | 1.25 | 31.0 | low | 26.6 | low | 7.1 | v. low | 59.3 | moderate |

* The pesticides are arranged in ascending order of overall field EIQ rating within a use class. For example, acibenzolar has a much more favorable overall risk profile according to the EIQ scoring system. Individual EIQ scores are not listed for pesticides that ranked “very low”.

** The worker component is equivalent to the applicator or athlete/golfer

‡ The leaching component (i.e., likelihood of leaching to ground water) includes food residue, which is not applicable on a golf course.

† The ecological component includes fish, birds, bees, and beneficial insects.

## E. FEIQ-Based Pesticide Risk Screening Summary

Tables 11-14a-c reflect the comprehensive risk screening that was conducted of the 61 original pesticides. Each summary table 14a-c lists the pesticides, appropriate for each pest, in increasing potential rank of risk as measured by the FEIQ. Thus 14 herbicides are identified to treat nine types of weeds, seven insecticides for three insets, and 19 fungicides for 24 diseases, for a total of 40 pesticides.

However, it is highly unlikely that a majority of the pesticides would be used in a given year; it is more likely that 10 or fewer products would be used in a single growing season. But a key principle of IPM (integrated pest management - - see the Integrated Turf Health Management Plan in this submission package) is that multiple chemical and non-chemical approaches should be used to prevent or control pests within a manageable threshold. This helps protect against the development of pest resistance.

We recommend that the last two or three pesticides in each column be used on limited areas - - mostly greens and tees - - and only after it is apparent that the preceding lower risk products would be inadequate. Similarly, the cultural practices listed in Table 14c should be used to prevent disease, preferable, and prior to, pesticide applications.

This information is integrated with the other components of the risk assessment at the end of this report.

**Table 14a. Weeds and Herbicide Control***

| Broadleaf Weeds | Poa annua | Chickweed | Henbit | Goosegrass | Crabgrass | Nutsedge/Kyllinga | Sedge Species | Barnyard Grass |
|---|---|---|---|---|---|---|---|---|
| Sethoxydim | Sethoxydim | Glyphosate | Glyphosate | Sethoxydim | Sethoxydim | Sethoxydim | Sethoxydim | Sethoxydim |
| Glyphosate | Glyphosate | Carfentrazone-ethyl[#] | Carfentrazone-ethyl[#] | Glyphosate | Glyphosate | Glyphosate | Glyphosate | Glyphosate |
| Carfentrazone-ethyl[#] | Mesotrione[#] | Bispyribac-sodium[#] | Bispyribac-sodium[#] | Fenoxaprop | Fenoxaprop | Halosulfuron-methyl | Halosulfuron-methyl | Fenoxaprop |
| Fluazifop-p-butyl | Fluazifop p-butyl | Dicamba | Dicamba | Fluazifop p-butyl | Fluazifop p-butyl | Fluazifop p-butyl | Fluazifop p-butyl | Fluazifop p-butyl |
| Bispyribac-sodium[#] | Prodiamine | 2,4-D | 2,4-D | Prodiamine | Prodiamine | Prodiamine | Prodiamine | Prodiamine |
| Dicamba | Bispyribac-sodium[#] | Bensulide[‡] | Bensulide[‡] | Bispyribac-sodium[#] | Bispyribac-sodium[#] | Bispyribac-sodium[#] | Bispyribac-sodium[#] | Bispyribac-sodium[#] |
| 2,4-D | 2,4-D | | | Quinclorac | Quinclorac | Quinclorac | Quinclorac | Quinclorac |
| Bensulide[‡] | Ethofumesate | | | Bensulide[‡] | Bensulide[‡] | Bensulide[‡] | Bensulide[‡] | Bensulide |
| | Bensulide[‡] | | | | | | | |

*The pesticides that will be used to treat the pests listed are in ascending order of potential risk (i.e., lower risk pesticides at the top of the columns will be used first).

[‡]We recommend that these pesticides be used primarily on the lined greens, and occasionally on the tees when the need is significant, and that there be no applications made to fairways or roughs. Note: chickweed and henbit are broadleaf weeds.

[#]These products are on EPA's "Reduced Risk" ('Safer Pesticide') Program and are considered safer than alternative pesticides for the same use.

**Table 14b. Insect Pests and Insecticide Control***

| Cutworms | Annual bluegrass weevil | White grubs |
|---|---|---|
| Deltamethrin | Deltamethrin | Deltamethrin |
| Spinosad[#] | Spinosad[#] | Bifenthrin |
| Imidacloprid | Imidacloprid | Spinosad[#] |
| Lambda-cyhalothrin[#] | Lambda-cyhalothrin[#] | Imidacloprid |
| Chlorpyrifos[‡] | Chlorpyrifos[‡] | Chlorpyrifos[‡] |

*The pesticides that will be used to treat the pests listed are in ascending order (i.e., lower risk pesticides at the top of the columns will be used first).

[‡]We recommend that these pesticides be used primarily on the lined greens, and occasionally on the tees when the need is significant, and that no applications are made to fairways or roughs.

[#]These products are on EPA's "Reduced Risk" ('Safer Pesticide') Program and are considered safer than alternative pesticides for the same use. Spinosad is classified as "Reduced Risk" for other uses.

**Table 14c. Cultural Practices and Chemical Treatment Guide for Disease Control[§]**

| Diseases | Host Turfgrass | Area of Occurrence (G, T, F, R)[†] | Examples of Cultural Practices | Chemical Treatments* |
|---|---|---|---|---|
| Algae | All turfgrass | G, T, F, R | Reduce shade, avoid excessive watering, improve soil drainage, fertilize and irrigate to maintain vigor | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Fluazinam, Penthiopyrad |
| Anthracnose | Annual Bluegrass (*Poa)* | G, T | Maintain adequate nitrogen and a balanced fertility level, irrigate to prevent wilting, core aerate and overseed in the fall | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Fluazinam, Penthiopyrad, Azoxystrobin[#], Propiconazole |
| Brown Patch | Annual bluegrass, creeping bentgrass, tall fescue, fine leaf fescue | G, T, F, R | Reduce nitrogen, increase air circulation | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Trifloxystrobin[#], Fluazinam, Penthiopyrad, Azoxystrobin[#], Flutolanil |
| Dollar Spot | Creeping bentgrass, annual bluegrass, bluegrasses, perennial ryegrass, fine fescue, colonial bentgrass, Kentucky bluegrass | G, T, F, R | Maintain accurate levels of nitrogen and nutrients, remove dew | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Boscalid[#], Fluazinam, Penthiopyrad, Myclobutanil, Propiconazole, Triadimefon |
| Erwin a spp Foliar Anthracnose | Annual bluegrass, creeping bent grass Kentucky bluegrass, fine fescue, rye grass | G, T, F | Reduce watering, increase nitrogen | Trifloxystrobin[#], Pyraclostrobin, Azoxystrobin[#], Myclobutanil, Propiconazole, Triadimefon |
| Fairy Ring | All turfgrass | G, T, F, R | Remove infested sod and soil, replace with clean soil and seed/sod. Improve water penetration with aerification and wetting agents. | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Fluazinam, Penthiopyrad, Azoxystrobin[#], Flutolanil |
| Gray Leaf Spot | Perennial ryegrass | R | Reduce nitrogen. Daytime watering | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Trifloxystrobin[#], Fluazinam, Penthiopyrad, Pyraclostrobin, Azoxystrobin[#], Myclobutanil, Propiconazole, Triadimefon |

| Diseases | Host Turfgrass | Area of Occurrence (G, T, F, R)[†] | Examples of Cultural Practices | Chemical Treatments* |
|---|---|---|---|---|
| Leaf Spot | Kentucky bluegrass, perennial ryegrass, fine leaf fescue, creeping bentgrass | G, T, F, R | Remove clippings, raise mowing heights, provide adequate nutrients | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Fluazinam, Penthiopyrad |
| Melting Out | Kentucky bluegrass | R | Remove clippings, raise mowing heights, provide adequate nutrients | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Fluazinam, Penthiopyrad |
| Pink Snow Mold | Annual bluegrass, creeping bentgrass, fine leaf fescue, perennial ryegrass, Kentucky bluegrass | G, T, F, R | Avoid late fall nitrogen applications, rake leaves and short cut, control drifting snow; may occur without snow cover. | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Trifloxystrobin[#], Fluazinam, Penthiopyrad, Pyraclostrobin, Azoxystrobin[#], Myclobutanil, Propiconazole, Triadimefon, Thiram |
| Necrotic Ring | Kentucky bluegrass, annual bluegrass | R | Provide adequate nitrogen and nutrients, provide light-daily irrigation | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Fluazinam, Penthiopyrad, Myclobutanil, Propiconazole |
| Pink Patch | Fine leaf fescue, perennial ryegrass, colonial bentgrass, creeping bentgrass, annual bluegrass, tall fescue | G, T, F, R | Provide adequate levels of nitrogen and nutrients. | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Fluazinam, Penthiopyrad, Myclobutanil, Propiconazole, Triadimefon |
| Powdery Mildew | Kentucky bluegrass, fine leaf fescues | F, R | Reduce shade, increase air circulation | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Trifloxystrobin[#], Fluazinam, Penthiopyrad, Pyraclostrobin, Azoxystrobin[#], Myclobutanil, Propiconazole, Triadimefon |

| Diseases | Host Turfgrass | Area of Occurrence (G, T, F, R)[†] | Examples of Cultural Practices | Chemical Treatments* |
|---|---|---|---|---|
| Pythium Blight | Annual bluegrass, fine leaf fescue, perennial ryegrass | F, R | Improve soil drainage, increase air circulation, maintain nutrients to improve vigor | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Fluazinam, Penthiopyrad, Propamocarb, Foestyl-Al |
| Red leaf Spot | Creeping bentgrass | G | Maintain nutrient levels to improve vigor | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Fluazinam, Penthiopyrad |
| Red Thread | Fine leaf fescue, perennial ryegrass, Kentucky bluegrass, creeping bentgrass, annual bluegrass | G, T, F, R | Remove clippings, Maintain nutrient levels to improve vigor. | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Fluazinam, Penthiopyrad, Myclobutanil, Propiconazole, Triadimefon |
| Rust | Kentucky bluegrass, perennial ryegrass | F, R | Provide adequate nutrient levels. Mow frequently | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Trifloxystrobin[#], Fluazinam, Penthiopyrad, Pyraclostrobin, Azoxystrobin[#], Myclobutanil, Propiconazole, Triadimefon |
| Slime Molds | All turfgrass | G, T, F, R | Remove mechanically by mowing or raking | No pesticides used |
| Stripe Smut | Kentucky bluegrass, creeping bentgrass | G, R | Reduce nitrogen, irrigate to prevent dormancy | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Fluazinam, Penthiopyrad, Myclobutanil, Propiconazole, Triadimefon |
| Summer Patch | Kentucky bluegrass, annual bluegrass | R | Apply light, frequent watering during dry periods to reduce heat stress, do not water heavily or deeply, provide adequate nutrient levels | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Fluazinam, Penthiopyrad, Pyraclostrobin, Azoxystrobin[#], Myclobutanil, Propiconazole, Triadimefon |

| Diseases | Host Turfgrass | Area of Occurrence (G, T, F, R)[†] | Examples of Cultural Practices | Chemical Treatments* |
|---|---|---|---|---|
| Take All patch | Creeping bentgrass, colonial bentgrass | G, T, F | Avoid drought stress | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Fluazinam, Penthiopyrad, Myclobutanil, Propiconazole |
| Typhula Blight | Creeping bentgrass, annual bluegrass, fine leaf fescue, perennial ryegrass | G, T, F, R | Avoid early fall nitrogen applications, rake leaves, mow short, control snow drifting | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Trifloxystrobin[#], Fluazinam, Penthiopyrad, Pyraclostrobin, Propiconazole |
| Xanthomonas spp Bacterial wilt | Creeping bentgrass, annual bluegrass, Kentucky bluegrass, perennial ryegrass | G,T,F, R | Raise Mowing heights, re-establish with resistant species- major host is Toronto creeping bentgrass | Oxytetracycline |
| Yellow Tuft | Annual bluegrass, Kentucky bluegrass, creeping bentgrass | G, R | Avoid standing water | Acibenzolar, Polyoxin, Mefenoxam[#], Metconazole, Fluazinam, Penthiopyrad |

[§] adapted from Vargas 2005

[†] G, T, F, R = greens, tees, fairways, roughs

*Chemical treatments will be used as a last resort. When used to treat a disease(s), the lower risk pesticides will be used first as listed (See Table 13). Flutolanil should only be applied to lined greens, or occasionally to tees, as needed. Prodiamine will be used when benfluralin and benefin are not successful for control.

[#]These products are on EPA's "Reduced Risk" ('Safer Pesticide') Program and are considered safer than alternative pesticides for the same use.

## VIII. LAWN CARE ON THE EAST END

This discussion is relevant to DEIS requirement #20 under “Project Design and Layout”.

The DEIS scope requires information on lawn chemicals (Table 1, first item). The extent to which pesticides and fertilizers are applied to Suffolk County lawns is highly variable, i.e., there is a wide range of turf chemical inputs to residential lawns.

### A. Context

Lawns comprise a large percentage of land in the Southampton area. It is a unique area with much high-end real estate. These properties usually have highly maintained lawns and landscapes. Property owners typically have a low tolerance for weeds and damage from pests. These landscapes are not only aesthetically pleasing, but they enhance property values and provide important ecosystem services. Among the benefits of turfgrass are the prevention of erosion, filtration of pollutants, and protection of ground water (Beard, 2006). Research has shown that healthy turfgrass provides more of these benefits than unhealthy, poorly managed lawns (Rossi, 2015). For example, unfertilized lawns with thin turf are more susceptible to soil erosion and weed invasion. A consequence occurs when annual weeds die, more soil is exposed to the elements. Important pollutants such as phosphorus move with eroding soil particles (Horgan, 2007). It is difficult to produce high quality lawn turf on Long Island without the use of fertilizer and pesticides.

Lawns are maintained by both homeowners and professional lawn care companies. Professional lawn care is a thriving business in the Southampton area. A simple internet search discloses over 40 lawn care companies operating in the area. This list includes branch offices of all the major, national firms and many independent companies. Professional lawn care on Long Island follows a model set by national companies across the country with somewhere between 6-8 visits annually. Each one of these visits includes fertilization. Homeowners maintaining their own property typically make fewer applications, but often lack the skill required to identify pests, select quality products, and to calibrate sprayers and spreaders to make accurate applications. Studies show that homeowners typically apply more product than required and much more per acre than agricultural operations.

Turfgrass is impacted by management practices more than crops and other plants. These often daily, cultural best management practices such as proper mowing, watering, fertilization, etc. are extremely important. These practices also include decisions made before lawns are established, such as the choice of turf, soil amendments, drainage, etc. (Rossi, 2015). A problem with professional lawn care is that cultural decisions such as mowing and watering are often left to the untrained homeowner.

Ideally, a lawn is maintained with an integrated management plan where fertilizer and pesticides are applied when needed and not on a calendar basis. This program works best for pest control and is called Integrated Pest Management (IPM) (Rossi, 2015). Even with these management plans, turfgrass is a perennial crop, and annual applications often follow a pattern. The following items would be factors in determining a lawn turf management plan.

**B. Fertility**

Soil tests should determine the nutrient requirement for lawns in the Southampton area. Soil testing works very well for all the essential nutrients except the most important nutrient, nitrogen. There are several variables that determine nitrogen requirements such as the type of turf, use and traffic, soil types, etc., but most lawns on Long Island should receive between 2-3 lbs. of actual nitrogen per 1,000 sq ft annually. There is a wide array of fertilizer products available, both organic and inorganic, that are appropriate for use.

The timing of these fertilizer applications is very important. Contrary to popular conceptions and marketing trends, the bulk of this nitrogen fertilization should be applied in the early fall with very little, if any, applied in the spring (Rossi, 2015). Lawn fertilizer use in Suffolk County is regulated and may not be applied between November 1$^{st}$ and April 1$^{st}$. Application rates should not exceed 1 lb. of actual nitrogen per 1,000 sq ft. Applications should be avoided if heavy rain is forecast.

## C. Pests and Pesticides

### 1. Weed Control

Weeds are easily recognizable and a major concern in lawn care. They are unsightly and compete with desired turfgrasses. As a result, most of the pesticides used in lawn care are herbicides. Nationally, herbicides constitute approximately 70% of agrochemicals (US EPA, 2007).

There is a very long list of broadleaf weeds for the area (dandelion, plantain, chickweed, clover, etc.) and a fairly long list of grass weeds (crabgrass, foxtail, etc.). Lawn weeds are generally grouped into two categories, broadleaf and grass weeds. A third category, sedges, are usually classified as grasses. Weeds can have an annual or perennial life cycle. These classifications have a tremendous influence on control strategies and the herbicides used.

There are many herbicides labelled and approved for use on lawns In New York. Nassau and Suffolk counties have more stringent lists. Taking all the above factors into consideration, herbicides are generally classified as broadleaf weed control or grass control products (graminicides). Also, herbicides are classified by their activity and application method as being pre-emergent or post-emergent herbicides. With regard to summer annual grass control (crabgrass), pre-emergent applications are extremely important. Post emergent control is difficult and limited to one product on Long Island (fenoxaprop).

A typical lawn care program in this area would involve a spring application of a pre-emergent herbicide using one or two active ingredients and two applications per year of post-emergent herbicides using three to six active ingredients (Table 15 below).

### 2. Insects

Insect problems are less frequent than weed problems, but insecticides usually account for at least one pesticide application annually. The list of insects is much shorter than weeds. Insect pests are usually classified as root or surface feeders. Root feeding insects are usually the

larval stage (grub) of beetles usually referred to as white grubs (Japanese beetle, masked chafer, etc.). Surface feeders can be the larval stage (caterpillars) of moths (sod webworms, cutworms) or adult insects such as chinch bugs.

White grubs are the most frequent lawn insect problem, usually requiring annual insecticide applications. Developed landscapes provide ideal environments for these pests. Lawns provide food for the larval stage, harborage for the pupal stage, and adults feed and mate on trees and shrubs. Additionally, grubs are an important food source for raccoons and skunks and spectacular damage can occur to lawns by the nightly burrowing of these animals.

A typical lawn care program in this area would involve one application targeting white grubs with one active ingredient. On a sunny lawn, one additional application (annually) targeting surface feeding insects may be required using one of several active ingredients (Table 15 below).

**Table 15. Lawn Care Application Scheduling in Southampton**

| Timing | Target | Typical Pesticides | Comments |
|---|---|---|---|
| April/May | Broadleaf weed control | 2,4-D<br>Dicamba<br>Carfentrazone<br>Topramezone<br>Mesotrione<br>Glyphosate | Note: professionally maintained lawns might be treated once every year or two for Red Thread disease using one of the risk-assessed fungicides in Table 14c that do not have any restrictions recommended in Table 19. |
| | Pre-emergent annual grass control | Prodiamine<br>Benefin plus Trifluralin | |
| | Post emergent grass control | Fenoxaprop | |
| June/July | White grub control | Imidacloprid<br>Spinosad<br>Parasitic nematodes<br>Indoxacarb | Recommend professional use. Carbaryl deleted (see below). |
| | Surface insect control on sunny lawns | Bifenthrin<br>Deltamethrin<br>Lambda-cyhalothrin | |
| September | Fertilization | | |

* Nitrogen-containing fertilizer may not be applied in Suffolk County between November 1 and April 1.

### 3. Diseases

There are several important turfgrass diseases affecting lawns in New York. Most of the pathogens are fungi, which are active in warm, humid weather. Generally, lawns recover from turf disease and fungicides are not frequently used. One exception is Red Thread disease, which is very problematic in the Southampton area. Red Thread prefers cool, humid conditions and thrives in the somewhat maritime environment of Southampton. Red Thread also prefers under nourished turfgrass, especially ryegrasses, and is usually controlled with adequate fertility. Red Thread is the only turf disease that might require fungicide application in Southampton. Turf diseases are a much larger concern for golf courses and there is a fairly long list of fungicides available for use on Long Island.

A typical lawn care program in this area probably would not involve a fungicide application. However, a high value property might include a fungicide application targeting Red Thread with cool, wet early summer weather conditions. Fungicide application would range from zero to one application per year using one or two active ingredients (Table 14c above).

### 4. Pesticide Summary

A typical lawn care application schedule in Southampton is described in Table 15 above. For customer appeal and satisfaction, professional lawn care companies usually include fertilization, even trace amounts, in each application.

## D. Lawn Care EIQ-Based Risk Evaluation

All pesticides initially considered for inclusion in the lawn care plan are listed below, along with their Field EIQ scores. We decided to delete from the program carbaryl and pendimethalin based on the FEIQ scores and toxicologic information in Table 9, “Summary of Pesticide Health Effects Reference Points.” This information is integrated with the other components of the risk assessment at the end of this report.

**Table 16. Lawn Care Pesticides and EIQ Values**

| Pesticide | Active Ingredient | # of apps | Timing | Rate/A | Total Annual A.I. | EIQ | FEIQ | Consumer | Worker | Ecological |
|---|---|---|---|---|---|---|---|---|---|---|
| **Broadleaf Herbicides** | | | | | | | | | | |
| Weedestroy | 2,4-D | 1 | April | 2 qt | 2 lb/A | 16.7 | 33.3 | 16 | 16 | 68 |
| Banvel | Dicamba | 1 | April | ¼ pt | 0.12 lb/A | 26.3 | 3.2 | 1.0 | 1.4 | 7.1 |
| Quicksilver | Carfentrazone | 1 | April | 2.1 oz | 0.5 oz/A | 20.2 | 0.6 | 0.2 | 0.3 | 1.5 |
| Pylex | Topramezone | 1 | May/June | 1.5 oz | 0.525 oz/A | 27.2 | 0.9 | 0.2 | 0.4 | 2.1 |
| Tenacity | Mesotrione | 1 | May/June | 8 oz | 4 oz/A | 18.7 | 4.7 | 1.8 | 4.0 | 8.3 |
| Roundup | Glyphosate | spot | spot | | 0.16 lb/A | 15.3 | 2.5 | 0.5 | 1.3 | 5.6 |
| **Pre-emergent Herbicides** | | | | | | | | | | |
| Pendulum AC | Pendimethalin | 1 | April | 4.2 pt (67.2 oz) | 1.1 gal/A | 30.2 | 265.5 | 48.4 | 105.6 | 642.4 |
| Barricade 65W | Prodiamine | 1 | April | 1 lb | 10.4 oz/A | 11.7 | 7.6 | 2.6 | 5.9 | 14.4 |
| Team | Benefin / Trifluralin | 1 | April | 120 lb | 1.6 lb/A<br>0.8 lb/A | 17.0<br>18.8 | 27.2<br>15.1 | 6.4<br>4.4 | 14.4<br>7.2 | 62.4<br>33.6 |
| Acclaim | Fenoxaprop-P-ethyl | 1 | August | 20 oz | 1.425 oz/A | 4.20 | 3.7 | 0.5 | 2.1 | 8.5 |
| **Insecticides** | | | | | | | | | | |
| Sevin SL | Carbaryl | 1 | Sept | 2 gal | 8 lb/A | 22.7 | 181.8 | 44.0 | 120.0 | 381.6 |
| Merit | Imidacloprid | 1 | June | 6.4 oz | 4.8 oz/A | 36.7 | 11.0 | 3.1 | 2.1 | 27.9 |
| Sevin SL | Carbaryl* | 1 | June | 1 gal | 4 lb/A | 22.7 | 90.9 | 22.0 | 60.0 | 190.8 |
| Provaunt | Indoxacarb | 1 | June | 4 oz | 1.2 oz/A | 31.2 | 2.3 | 0.2 | 0.5 | 6.3 |
| Talstar | Bifenthrin | 1 | June | 22 oz | 1.73 oz/A | 44.4 | 4.8 | 0.9 | 1.5 | 12.0 |
| Scimitar | Lambda cyhal. | 1 | June | 10 oz | 0.97 oz/A | 44.2 | 2.7 | 0.2 | 1.3 | 6.6 |
| DeltaGuard | Deltamethrin | 1 | June | 17.5 oz | 0.06 lb/A (0.96 oz/A) | 28.4 | 1.7 | 0,1 | 1.1 | 3.9 |

*reducing the application rate by half also reduces the FEIQ by half.

## IX. RECOMMENDATIONS BASED ON COMPREHENSIVE RISK ASSESSMENT AND ADDITIONAL RISK ISSUES RAISED DURING THE DEIS COMPLETENESS REVIEW PROCESS

### A. Recommendations Regarding Ground Water and Pond Monitoring

During the draft DEIS completeness review process, Dr. Petrovic commented that only pesticides that could be included in the ground water monitoring program should be allowed for use. Accordingly, we created this table to aid compliance with this recommendation.

**Table 17. Pesticides and Analytical Methods**

| Pesticide | Methods | Method Reporting Limit (µg/L) | COMMENTS |
|---|---|---|---|
| Herbicides | | | |
| Benefin | S150 | 0.1 | |
| Bensulide | L300/L302 | 0.5 | |
| Bispyribac-sodium | L302 | 0.5 | |
| Carfentrazone-ethyl | L302 | 0.5 | |
| Dimethylamine salt of 2,4-D | 515.3 | 0.1 | |
| Dicamba | 515.3 | 0.1 | |
| Ethofumesate | S150 | 0.1 | |
| Fenoxaprop | S150 | 0.1 | |
| Fluazifop-P-butyl | S150 | 0.1 | |
| Glyphosate | 547 | 6.0 | |
| Halosulfuron-methyl | L300/L302 | 0.5 | |
| MCPP | 515.3 | 0.5 | Will not be used at The Hills |
| Mesotrione | L305 | 1.0 | |
| Pendimethalin | S150 | 0.1 | |
| Potassium Salts of Fatty Acids* | -- | -- | Not applicable |
| Prodiamine | L302 | 0.5 | |
| Quinclorac | L302 | 0.5 | |
| Sethoxydim | RD-100† | 0.1 | Special Eaton lab method – LC/MS |
| Trifluralin | S150 | 0.1 | |
| Fungicides | | | |
| Aluminum tris O-ethyl (Fosetyl-Al) | L303 | 1.0 | |
| Azoxystrobin | L300/L302 | 0.5 | |
| Bacillus subtilis | -- | -- | Not applicable |
| Boscalid | L302 | 0.5 | |
| Chlorothalonil | S150 | 0.1 | Will not be used at The Hills |
| Acibenzolar | * | * | No Eaton Lab method |
| Etridiazole | S150 | 0.1 | Will not be used at The Hills |
| Fluazinam | * | * | No Eaton Lab method |
| Flutolanil | S150 | 0.1 | |
| Iprodione | S150 | 0.5 | Will not be used at The Hills |
| Mefenoxam (Metalaxyl) | L302 | 0.5 | |
| Metconazole | S150 | 0.5 | |
| Mineral oil + pigment | -- | -- | Not applicable |

| Pesticide | Methods | Method Reporting Limit (µg/L) | COMMENTS |
|---|---|---|---|
| Myclobutanil | S150 | 0.1 | |
| Penthiopyrad | * | * | No Eaton Lab method |
| Polyoxin D | -- | -- | Not applicable |
| Propamocarb | L301 | 0.5 | |
| Propiconazole | S150 | 0.1 | |
| Pyraclostrobin | L302 | 0.5 | |
| Thiram | L301 | 10.0 | |
| Triadimefon | L300 | 0.5 | |
| Triadimenol[§] | L300 | 0.5 | |
| Trifloxystrobin | L302 | 0.5 | |
| Insecticides | | | |
| Bifenthrin | S150 | 2.0 | Will not be used at The Hills |
| Carbaryl | L300/L302 | 0.5 | Will not be used at The Hills |
| Chlorpyrifos | S150 | 0.1 | |
| Deltamethrin | S150 | 0.1 | |
| Imidacloprid | L300/L302 | 0.5 | |
| Lambda-cyhalothrin | S150 | 0.1 | |
| Parasitic Nematodes | -- | -- | Not applicable |
| Spinosad | -- | -- | Not applicable |
| Growth Regulators | | | |
| Ethephon | L303 | 1.0 | |
| Paclobutrazol | L300/L302 | 0.5 | |
| Trinexapac-ethyl | S150 | 1.0 | |

[†]This method was developed from the standard and run using the LC/MS (liquid chromatography/mass spectrometry) technique.
*Eurofins Eaton Analytical Laboratory does not currently analyze for these three pesticides. However, they can obtain the standards for each, if available, and develop a method or run it under their special RD-100 method, which is a method they use for pesticides not in one of their current analytical methods.
[§] triadimenol – metabolite of triadimefon

Dr. Petrovic also questioned the plan to sample the pond for nutrients. We concur that such testing is necessary, but it need not be highly accurate nor very precise. Therefore we recommend that the future golf course superintendent acquire colorimetric test kits, and measure the water for nitrate and phosphate. These test kits, e.g., www.chemetrics.com, can detect less than 1 ppm nitrate and phosphate, and, assuming the superintendent reads the results, the precision is probably ±1 ppm. Each test kit can be used to process typically 20 samples. They address various concentration ranges; the test kit should be purchased with the appropriate concentration range. The sampling should be done biweekly in the peak season, monthly in the shoulder season, and once or twice during the off-season.

## B. More Detailed Toxicology Assessments

During the draft DEIS completeness review process, the Town's reviewer of our work, Dr. Petrovic, stated that "… The Hills should consider not using pesticides that have been classified now or in the future as possible, probable, or likely carcinogenic to humans…." But, he also stated, "… USEPA and NYSDEC in registering these pesticides take into consideration many factors including long-term chronic effects and can be used in accordance with the label directions without causing oncogenic effects in humans. Environmental & Turf Services did consider all of these factors and included them in their report."

Dr. Petrovic raises a valid issue, and also acknowledges that this science policy issue is implicitly mitigated by the science. Therefore, we explore this issue below in more detail than we did in our December draft. Specifically, we elucidate the distinction between threshold/nonlinear carcinogens, which tend to only exert an oncogenic effect at doses far above what would be encountered in the environment, and nonthreshold carcinogens, which could conceivably have an adverse effect at low doses, albeit at low probabilities (Table 18 below). For the former class, maximum safe doses based on conventional systemic effects are almost always more protective than limits extrapolated from the rodent cancer studies, as explained in Table 18 below. We also include information about the field EIQ.

This information is integrated with the other components of the risk assessment at the end of this report.

**Table 18. Recommendations for Restricting Pesticide Use Based on a Higher Level Toxicologic Analysis**

| Pesticides Flagged for Oncogenic Characteristics | Comments on Toxicology | Detected in Sebonack's or The Bridge's Ground Water? [PRZMGW results mean conc. ppb in brackets] | Field EIQ > 25? Yes or No | Field EIQ >50? Yes or No | Recommendation |
|---|---|---|---|---|---|
| Triadimefon + metabolite triadimenol | The most sensitive No Observed Adverse Effects Level (NOAEL) in the mouse carcinogenicity study was 13.5 mg/kg-day, and the NOAEL in the subchronic neurotoxicity study in rats was 3.4 mg/kg-day (Griffin et al., 2006). Therefore basing the drinking water HAL on the latter effect is more protective of the cancer effect. (Group C) | Triadimefon [3.2E-6] not detected, but the triadimenol metabolite [7.9E-3] was detected. | Yes (62) | Yes | Use on turf at the project should not be prohibited, but use on home lawns should be minimized. |
| Propiconazole | "Propiconazole is not genotoxic and this fact, together with special mechanistic studies, indicate that propiconazole is a threshold carcinogen . . . At doses below the RfD, liver toxicity is not expected; therefore tumors are also not expected" (US EPA 2014). Therefore basing the drinking water HAL on the 0.1 mg/kg-d RfD will be protective for the cancer effect. (Group C) | Propiconazole detected [1.99E-6] | Yes (34.8) | No | Use on tees and greens should be limited. Not recommended for the lawn care program. The FEIQ score is "low". |
| Iprodione ***NOT FOR USE*** | "Likely" human carcinogen (Taylor, 2012). Linear low dose extrapolation yields a *de minimus* HAL of 0.8 ppb, vs. an HAL of 350 ppb (US EPA, 2013) based on a hormonal effect (Taylor, 2012). | Iprodione detected [3.72E-3] | Yes (66.0) | Yes | Based on Dr. Petrovic's concerns, this pesticide is not recommended for use in the lawncare program, and is not recommended for use on the golf course except for lined greens. |
| Prodiamine | "The EPA Peer Review Committee classified prodiamine as a Group C carcinogen based on a weight of evidence consideration. They concluded that a Reference Dose (RfD) approach was indicated as being appropriate for quantification of human risk. Their recommendation was based on the absence of genotoxicity, the nature of the response (benign thyroid follicular cell tumors) and the lack of a clear neoplastic response at sites other than the thyroid" (Lindsay, 1992). Therefore an HAL based on the chronic reference dose is more protective of the cancer effect. | Not detected [0.0] | No (11.5) | No | Use on turf at the project should not be prohibited. The FEIQ score is "very low", and cancer is not a risk to people exposed to levels much higher than might occur in the environment.<br>Use when benfluralin or benefin are not successful for control. |

| Pesticides Flagged for Oncogenic Characteristics | Comments on Toxicology | Detected in Sebonack's or The Bridge's Ground Water? [PRZMGW results mean conc. ppb in brackets] | Field EIQ > 25? Yes or No | Field EIQ >50? Yes or No | Recommendation |
|---|---|---|---|---|---|
| Chlorothalonil ***NOT FOR USE*** | "EPA has determined that the mechanism of carcinogenicity is non-linear (i.e., not a non-threshold effect) and that the point of departure used in calculating the cPAD is protective of the cancer effects" (Federal Register, 2008). This conclusion appears to form the basis for the fact that the US EPA has issued tolerances for chlorothalonil use (residues) on more than 40 crops (40 CFR §180.275). Also, the FEIQ score is very high, mostly due to chlorothalonil's toxicity to aquatic organisms (Tables 10 and 13 of our report), but no aquatic organisms will be exposed. | Chlorothalonil detected [0.0] | Yes (308.7) | Yes | No residential lawn use, based on Dr. Petrovic's concerns. Use on tees and greens should be prohibited. |
| Etridiazole ***NOT FOR USE*** | It is a category B2 carcinogen ("probable"), with linear low dose extrapolation (US EPA 2000). Its carcinogenic potency factor is also relatively high, yielding a low HAL. "Moderate" FEIQ. | No [1.81E-12] | Yes (95.3) | Yes | Prohibit use on all turf, based on Dr. Petrovic's concerns. |
| | "Low" FEIQ. Group C ("possible" carcinogen), but the cRfD protects for cancer, which followed a nonlinear response (US EPA, 1997) | Pendimethalin† not modeled w/PRZM GW | Yes (265.5) | Yes | No residential lawn use. |
| | Not a carcinogen (Group E), and "low" FEIQ score, but detections very long after use, albeit at low levels, warrant caution. | Myclobutanil [1.76E-6] | Yes (31.7) | No | Recommend use on tees and greens only. |
| | Flutolanil is in carcinogenicity category Group E, "no evidence of carcinogenic potential," and its HAL is very high (low toxicity), but its FEIQ score is very high. | Flutolanil* [1.39E-4] | Yes (399.6) | Yes | Allow use on golf course, prohibit use in lawn care. |
| | "Low" FEIQ score (close to "very low"). | Paclobutrazol [4.58E-2] | Yes (26.4) | No | Allow use on all turf. |
| | "Low" FEIQ score. High HAL (low toxicity). | Ethofumesate* [9.9E-6] | Yes (38.7) | No | Allow use on all turf. |
| | "Very low" FEIQ score. Not carcinogenic (Group E). | Imidacloprid [2.285E-3] | No (11) | No | Allow use on all turf, but do not apply within two weeks of blossoming of adjacent flowers. |
| | "Very low" FEIQ score, but high PRZSM-GW result. | Quinclorac* [53.5] | No (16) | No | Allow limited use on tees and greens only. |

*It was not used on the golf courses; it may have originated from purchased sod after application by a sod farm.
† listed for lawn care not golf course use.

## X. NATIVE VEGETATION RESTORATION AND EDUCATION OUTREACH

This section is relevant to item #1, DEIS Scope page 10, "Community Benefits of the Project". We have recommended the following program to the developer, which would be a benefit to the community.

As stated in the DEIS Scope (Section 2.0, pg. 3), 426.38 A of the 594 combined acres (71.72%) will be permanently protected open space. Some of the areas adjacent to the golf course will be disturbed during the initial development, but will then be planted with native vegetation. These types of environments should be ideal for grassland birds and edge species. This situation provides an ideal opportunity for native vegetation restoration and education outreach with local schools and research institutes, as follows.

There should be some initial consultations on habitat creation between a botanist/landscape architect familiar with local flora and fauna, the future golf course superintendent, a researcher from a local college, the golf course designer, and others, as the developer may deem appropriate. They should choose the appropriate habitats to plant/restore, and then develop plant palettes to construct those habitats. The plant palettes should not be large, perhaps 20 m X 20 m or so. Once a consensus is reached on a design, baseline information should be collected on species/taxa richness and abundance. This could involve students from local schools – theoretically, high schools students all the way down to elementary school students could have some involvement, in addition to the original team.

Once the baseline data are gathered, the planting can begin in accordance with the construction schedule. The expanded team would then track changes – hopefully increases – in species/taxa richness and abundance. These field surveys should occur seasonally. They should be integrated with the local school curricula, as part of the biology program, and academic freedom to publish should be granted to the institutional research collaborator(s). In addition, educational signs should be placed along the golf course and walking paths. These signs should describe the habitat and its occupants (plant and animal species) and their places in the larger environment.

<u>An Environmental Scorecard.</u> Even golfers could play a role: they can be given a wildlife score card concurrent with their golf score card, and the former would allow them to record species sightings

by golf hole. They would drop the wildlife score cards at the clubhouse at the end of their game, and the results would be tabulated and used to track species abundance and richness. This action, in combination with educational signs, will enhance the golfing experience.

Third Party Certification. The golf course should report annually about trends, in addition to whatever the schools and college researchers may report and/or publish. In any case, all publications should be a collaborative effort.

We recommend that Discovery Land Company attempt to obtain third party certification through the Wildlife Habitat Council (WHC), Inc. of Silver Spring, MD. The WHC is a 501(c)(3) corporation, and following is a quote from a recent audited financial report (which 501(c)(3) corporations are required to make publicly available) about one of the services it provides:

> ***Certification/International Accreditation****: WHC offers third-party review and recognition of exemplary corporate habitat and environmental education programs that meet stringent criteria. Since 1990, WHC has certified 640 Wildlife at Work℠ programs and 128 Corporate Lands for Learning℠ programs worldwide.*

The WHC produces project guidance documents that help applicants achieve certification. These documents are typically 18-20 pages long.

If this program is successful, it could become a model for others around the country.

## XI. CONCLUSIONS AND RECOMMENDATIONS

This very conservative risk assessment process began with an initial list of 61 pesticides. Twelve were deleted due to regulatory restrictions and/or duplication of function. Ten of the 49 pesticides are designated by the US EPA as “reduced risk” pesticides; five are ‘natural’ and/or ‘organic’ and/or biochemicals. An extensive amount of environmental fate, mammalian/human toxicology, and aquatic toxicology data were collected for the remaining 44 conventional pesticides. They were then modeled using PRZM-GW. Three pesticides were deleted, and the remaining 41 pesticides were modeled for drift potential using AgDRIFT, and Cornell’s field EIQ scores were tabulated. In addition, pesticides will not be used or there will be limited use of pesticides, based on Dr. Petrovic’s concerns (see Tables 18 and 19). Our recommendations based on this intensive, conservative, lengthy process are summarized in Table 19 below.

The superintendent should maintain a field notebook that contains section VII(E) with its risk-ranked pesticide lists in Tables 14a, b, and c, and Table 19 below. These excerpts from the report should also be incorporated into the final version of the Integrated Turf Health Management Plan.

Guidance is also provided for two components of the water quality monitoring program.

A native vegetation restoration and education outreach program could benefit the golf course, grade schools, and local researchers, and it could be a model for other golf courses throughout the US.

**Table 19. Summary List of Pesticide Recommendations**

| Pesticide | Are Special Golf Course Restrictions Recommended? | Are Special Home Lawn Restrictions Recommended? |
|---|---|---|
| **Herbicides** | | |
| 2,4-D acid or salt | No | No |
| Benefin (with trifluralin below) | -- | No |
| Bispyribac-sodium | Yes (lined greens only) | -- |
| Carfentrazone-ethyl | No | No |
| Dicamba | No | No |
| Ethofumesate | No | -- |
| Fenoxaprop | No | No |
| Fluazifop-p-butyl | No | -- |
| Glyphosate | No | No |
| Halosulfuron-methyl | No | -- |
| MCPP | Yes (no GC use) | Yes (no lawn use) |
| Mesotrione | No | No |
| Pendimethalin | -- | Yes (no lawn use) |
| Prodiamine† | No | No |
| Quinclorac | Yes (limited use G&T only) | -- |
| Sethoxydim | No | -- |
| Topramezone | -- | No |
| Trifluralin (with benefin above) | -- | No |
| **Fungicides** | | |
| Acibenzolar S-methyl | No (pending lab method) | ***Fungicides not generally recommended for lawn care; professional firms should choose one of the pesticides in the left column with no restrictions for rare applications*** |
| Azoxystrobin | No | |
| Bacillus subtilis | No | |
| Boscalid | No | |
| Chlorothalonil | Yes (no GC use) | Yes (no lawn use) |
| Etridiazole | Yes (no GC use) | Yes (no lawn use) |
| Fluazinam | No (pending lab method) | |
| Flutolanil | Yes (lined G &T) | |
| Fosetyl-Al | Yes (no GC use) | |
| Iprodione | Yes (no GC use) | Yes (no lawn use) |
| Mefenoxam | No | |
| Metconazole | No | |
| Mineral Oil | No | |
| Myclobutanil | Yes (G&T use only) | |
| Penthiopyrad | No (pending lab method) | |
| Polyoxin D | No | |
| Propamocarb | Yes (G&T use only) | |
| Propiconazole | Yes (G&T only, limited use) | |
| Pyraclostrobin | No | |
| Thiram | Yes (no GC use) | |
| Triadimefon | Yes (lined greens only) | |
| Trifloxystrobin | No | |
| **Insecticides** | | |
| Bifenthrin* | Yes (no GC use) | Yes (no lawn use) |
| Carbaryl | Yes (no GC use) | Yes (no lawn use) |

| Pesticide | Are Special Golf Course Restrictions Recommended? | Are Special Home Lawn Restrictions Recommended? |
|---|---|---|
| Chlorpyrifos | Yes (G &T) | Yes (no lawn use) |
| Deltamethrin* | * | * |
| Imidacloprid | Yes (timing restriction) | Yes (timing restriction) |
| Indoxacarb | -- | No |
| Lambda-cyhalothrin* | * | * |
| Parasitic Nematodes | No | No |
| Spinosad | No | No |
| **Growth Regulators** | | |
| Ethephon | No | No |
| Paclobutrazol | No | No |
| Trinexapac-ethyl | No | No |

"--" means it is not part of the program.

†Use when benfluralin or benefin are not successful for control.

*A spray shroud should be placed over the tractor boom, if it is used. Otherwise, granular and hand-directed applications do not need additional restrictions beyond the legally enforceable product labeling.

**REFERENCES** ***See also the 51 references listed with Table 9, section V(F).***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**APPENDIX A. Pre-Registration Testing Requirements for Pesticides (Title 40 CFR Part 158)**

## §158.310 Product chemistry data requirements table.

(a) *General.* Sections 158.100 through 158.130 describe how to use this table to determine the product chemistry data requirements for a particular pesticide product. Notes that apply to an individual test and include specific conditions, qualifications, or exceptions to the designated test are listed in paragraph (f) of the section.

(b) *Use patterns.* Product chemistry data are required for all pesticide products and are not use-specific.

(c) *Test substance.* Data requirements that list only the manufacturing-use product as the test substance apply to products containing solely the technical grade of the active ingredient and manufacturing-use products to which other ingredients have been intentionally added.

(d) *Key.* R=Required; CR=Conditionally required; MP=Manufacturing-use product; NR=Not required; EP=End-use product; TGAI=Technical grade of the active ingredient; PAI=Pure active ingredient.

(e) *Table.* The following table shows the data requirements for product chemistry. The table notes are shown in paragraph (f) of this section.

**Product Chemistry Data Requirements**

| Guideline Number | Data Requirement | Use Pattern | Test substance to support | | Test Note No. |
|---|---|---|---|---|---|
| | | All | MP | EP | |
| Product Identity and Composition | | | | | |
| 830.1550 | Product identity and composition | R | MP | EP | 1 |
| 830.1600 | Description of materials used to produce the product | R | MP | EP | 2 |
| 830.1620 | Description of production process | R | MP | EP | 3 |
| 830.1650 | Description of formulation process | R | MP | EP | 4 |
| 830.1670 | Discussion of formulation of impurities | R | MP, and possibly TGAI | EP, and possibly TGAI | 5 |
| 830.1700 | Preliminary analysis | CR | MP, and possibly TGAI | EP, and possibly TGAI | 6, 9, 10 |
| 830.1750 | Certified limits | R | MP | EP | 7 |
| 830.1800 | Enforcement analytical method | R | MP | EP | 8 |
| 830.1900 | Submittal of samples | CR | MP, PAI and TGAI | EP, PAI, TGAI | 9, 11 |
| Physical and Chemical Properties | | | | | |
| 830.6302 | Color | R | MP and TGAI | EP | 9 |
| 830.6303 | Physical state | R | MP and TGAI | EP and TGAI | 9 |
| 830.6304 | Odor | R | MP and TGAI | EP | 9 |
| 830.6313 | Stability to normal and elevated temperatures, metals, and metal ions | R | MP and TGAI | EP | 9, 12, 26 |
| 830.6314 | Oxidation/reduction: chemical incompatibility | CR | MP | EP | 13 |
| 830.6315 | Flammability | CR | MP | EP | 14 |
| 830.6316 | Explodability | CR | MP | EP | 15 |

| | | | | | |
|---|---|---|---|---|---|
| 830.6317 | Storage stability | R | MP | EP | |
| 830.6319 | Miscibility | CR | MP | EP | 16 |
| 830.6320 | Corrosion characteristics | R | MP | EP | |
| 830.6321 | Dielectric breakdown voltage | CR | NR | EP | 17 |
| 830.7000 | pH | CR | MP and TGAI | EP and TGAI | 9, 18 |
| 830.7050 | UV/visible light absorption | R | TGAI or PAI | NR | -- |
| 830.7100 | Viscosity | CR | MP | EP | 19 |
| 830.7200 | Melting point/melting range | R | TGAI or PAI | TGAI or PAI | 9, 20 |
| 830.7220 | Boiling point/boiling range | R | TGAI or PAI | TGAI or PA | 9, 21 |
| 830.7300 | Density/relative density/bulk density | R | MP and TGAI | EP and TGAI | 9 |
| 830.7370 | Dissociation constants in water | R | TGAI or PAI | TGAI or PAI | 9, 22 |
| 830.7520 | Particle size, fiber length, and diameter distribution | CR | TGAI or PAI | EP | 23 |
| 830.7550<br>830.7560<br>830.7570 | Partition coefficient (n-octanol/water) | R | TGAI or PAI | TGAI or PAI | 24 |
| 830.7840<br>830.7860 | Water solubility | R | TGAI or PAI | TGAI or PAI | 9 |
| 830.7950 | Vapor pressure | R | TGAI or PAI | TGAI or PAI | 9, 25 |

(f) *Test notes.* The following test notes are applicable to the product chemistry data requirements in the table to paragraph (e) of this section:

1. Data must be provided in accordance with §158.320.
2. Data must be provided in accordance with §158.325.
3. Data must be provided in accordance with §158.330.
4. Data must be provided in accordance with §158.335.
5. Data must be provided in accordance with §158.340.
6. Data must be provided in accordance with §158.345.
7. Data must be provided in accordance with §158.350.
8. Data must be provided in accordance with §158.355.
9. If the TGAI cannot be isolated, data are required on the practical equivalent of the TGAI.
10. Data are required if the product is produced by an integrated system.
11. Basic manufacturers are required to provide the Agency with a sample of each TGAI used to formulate a product produced by an integrated system when the new TGAI is first used as a formulating ingredient in products registered under FIFRA. A sample of the active ingredient (PAI) suitable for use as an analytical standard is also required at this time. Samples of end-use products produced by an integrated system must be submitted on a case-by-case basis.
12. Data on the stability to metals and metal ions are required only if the TGAI is expected to come into contact with either material.
13. Required when the product contains an oxidizing or reducing agent.
14. Required when the product contains combustible liquids.
15. Required when the product is potentially explosive.
16. Required when the product is an emulsifiable liquid and is to be diluted with petroleum solvent.
17. Required when the EP is a liquid and is to be used around electrical equipment.
18. Required when the test substance is soluble or dispersible in water.
19. Required when the product is a liquid.
20. Required when the TGAI is solid at room temperature.
21. Required when the TGAI is liquid at room temperature.

22. Required when the test substance contains an acid or base functionality (organic or inorganic) or an alcoholic functionality (organic).
23. Required for water insoluble test substances (>$10^{-6}$ g/l) and fibrous test substances with diameter of ≥0.1 µm.
24. Required if technical chemical is organic and non-polar.
25. Not required for salts.
26. Data on stability of the MP and TGAI to storage at normal temperatures are required. Data on the stability of the TGAI to high temperatures are required if the TGAI is expected to be subjected to temperatures >50 °C (122 °F) during production or storage.

## §158.400 Product performance data requirements table.

(a) *General.* Sections 158.100 through 158.130 describe how to use this table to determine the product performance data requirements for a particular pesticide product. Notes that apply to an individual test, including specific conditions, qualifications, or exceptions to the designated test are listed in paragraph (e) of this section.

(b) *Use patterns.* The terrestrial use pattern includes products classified under the general use patterns of terrestrial food crop and terrestrial nonfood crop. The aquatic use pattern includes products classified under the general use patterns of aquatic food crop and aquatic nonfood. The greenhouse use pattern includes products classified under the general use patterns of greenhouse food crop and greenhouse nonfood crop. Data are also required for the general use patterns of forestry use, residential outdoor use, and indoor use, which includes both food and nonfood uses.

(c) *Key.* CR=Conditionally required; NR=Not required; R=Required; EP=End-use product; MP=Manufacturing-use product; TEP=Typical end-use product.

(d) *Table.* The following table lists the data requirements that pertain to product performance. The table notes are shown in paragraph (e) of this section.

**Table—Product Performance Data Requirements**

| Guideline Number | Data Requirement | Use Pattern | | | | | | | | | Test substance to support | | Test Note No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Terrestrial | | Aquatic | | Greenhouse | | Forestry | Residential Outdoor | Indoor | MP | EP | |
| | | Food Crop | Nonfood Crop | Food | Nonfood | Food Crop | Nonfood Crop | | | | | | |
| 810.2700 | Products with prion-related claims | NR | NR | NR | NR | NR | NR | NR | NR | R | NR | EP | 1 |
| Efficacy of fungicides and nematicides | | | | | | | | | | | | | |
| 93-16 | Products for control of organisms producing mycotoxins | CR | NR | CR | NR | CR | NR | NR | NR | NR | NR | EP | 1 |
| Efficacy of vertebrate control agents | | | | | | | | | | | | | |
| 96-5 | Avian toxicants | R | R | NR | NR | NR | NR | NR | R | R | NR | EP | 1 |
| 96-6 | Avian repellents | R | R | NR | NR | NR | NR | NR | R | NR | NR | EP | 1 |
| 96-7 | Avian frightening agents | R | R | NR | NR | NR | NR | NR | R | NR | NR | EP | 1 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 96-9 | Bat toxicants and repellents | NR | NR | NR | NR | NR | NR | NR | NR | R | NR | EP | 1 |
| 96-10 | Commensal rodenticides | R | R | NR | NR | NR | NR | NR | R | R | TEP | EP | 1 |
| 96-12 | Rodenticides on farm and rangelands | R | R | NR | NR | NR | NR | NR | R | NR | NR | EP | 1 |
| 95-13 | Rodent fumigants | R | R | NR | NR | NR | NR | NR | R | R | NR | EP | 1 |
| 95-16 | Rodent reproductive inhibitors | R | R | NR | NR | NR | NR | NR | R | R | NR | EP | 1 |
| 95-17 | Mammalian predacides | R | R | NR | NR | NR | NR | NR | R | NR | NR | EP | 1 |

(e) *Test notes.* The following notes appy to the data requirements table in paragraph (d) of this section.

1. The Agency has waived the requirement to submit product performance data unless the pesticide product bears a claim to control pest microorganisms that pose a threat to human health and whose presence cannot readily be observed by the user including, but not limited to, microorganisms infectious to man in any area of the inanimate environment, or a claim to control vertebrates (such as rodents, birds, bats, canids, and skunks) that may directly or indirectly transmit diseases to humans. However each registrant must ensure through testing that his product is efficacious when used in accordance with label directions and commonly accepted pest control practices. The Agency reserves the right to require, on a case-by-case basis, submission of product performance data for any pesticide product registered or proposed for registration.

2. [Reserved]

[72 FR 60957, Oct. 26, 2007, as amended at 78 FR 13507, Feb. 28, 2013; 78 FR 26978, May 8, 2013]

## §158.500 Toxicology data requirements table.

(a) *General.* Sections 158.100 through 158.130 describe how to use the data table in paragraph (d) of this section to determine the toxicology data requirements for a particular pesticide product. Notes that apply to an individual test and include specific conditions, qualifications, or exceptions to the designated test in the table are listed in paragraph (e) of this section.

(b) *Use patterns.* (1) Food use patterns include products classified under the general use patterns of terrestrial food crop use, terrestrial feed crop use, aquatic food crop use, greenhouse food crop use, and indoor food use.

(2) Nonfood use patterns include products classified under the general use patterns of terrestrial nonfood crop use, aquatic nonfood use, greenhouse nonfood crop use, forestry use, residential outdoor use, and indoor nonfood use.

(c) *Key.* R=Required; CR=Conditionally required; NR=Not required; MP=Manufacturing-use product; EP=End-use product; TGAI=Technical grade of the active ingredient; PAI=Pure active ingredient; PAIRA=Pure active ingredient radio-labeled; Choice=Choice of several test substances depending on study required.

(d) *Table.* The following table lists the toxicology data requirements. The table notes are shown in paragraph (e) of this section.

**Table—Toxicology Data Requirements**

| Guideline Number | Data Requirements | Use Pattern | | Test substance to support | | Test Note No. |
|---|---|---|---|---|---|---|
| | | Food | Nonfood | MP | EP | |
| Acute Testing | | | | | | |
| 870.1100 | Acute oral toxicity - rat | R | R | TGAI and MP | TGAI, EP, and possibly diluted EP | 1, 2 |
| 870.1200 | Acute dermal toxicity | R | R | TGAI and MP | TGAI, EP | 1, 2, 3 |
| 870.1300 | Acute inhalation toxicity - rat | R | R | TGAI and MP | TGAI and EP | 4 |
| 870.2400 | Primary eye irritation - rabbit | R | R | TGAI and MP | TGAI and EP | 3 |
| 870.2500 | Primary dermal irritation | R | R | TGAI and MP | TGAI and EP | 1, 3 |
| 870.2600 | Dermal sensitization | R | R | TGAI and MP | TGAI and EP | 3, 5 |
| 870.6100 | Delayed neurotoxicity (acute) - hen | CR | CR | TGAI | TGAI | 6 |
| 870.6200 | Acute neurotoxicity - rat | R | R | TGAI | TGAI | 7 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Subchronic Testing | | | | | | |
| 870.3100 | 90-day Oral - rodent | R | CR | TGAI | TGAI | 8, 9 |
| 870.3150 | 90-day Oral - non-rodent | R | CR | TGAI | TGAI | 36 |
| 870.3200 | 21/28-day Dermal | R | NR | TGAI | TGAI and EP | 10, 11 |
| 870.3250 | 90-day Dermal | CR | R | TGAI | TGAI and EP | 11, 12 |
| 870.3465 | 90-day Inhalation - rat | CR | CR | TGAI | TGAI | 13, 14 |
| 870.6100 | 28-day Delayed neurotoxicity-hen | CR | CR | TGAI | TGAI | 6, 15 |
| 870.6200 | 90-day Neurotoxicity - rat | R | R | TGAI | TGAI | 7, 16 |
| Chronic Testing | | | | | | |
| 870.4100 | Chronic oral - rodent | R | CR | TGAI | TGAI | 17, 18, 19 |
| 870.4200 | Carcinogenicity - two rodent species - rat and mouse preferred | R | CR | TGAI | TGAI | 9, 17, 18, 19, 20, 21 |
| Developmental Toxicity and Reproduction | | | | | | |
| 870.3700 | Prenatal Developmental toxicity - rat and rabbit, preferred | R | R | TGAI | TGAI | 22, 23, 24, 25, 26 |
| 870.3800 | Reproduction and fertility effects | R | R | TGAI | TGAI | 26, 27, 29 |
| 870.6300 | Developmental neurotoxicity | CR | CR | TGAI | TGAI | 27, 28, 29 |
| Mutagenicity Testing | | | | | | |
| 870.5100 | Bacterial reverse mutation assay | R | R | TGAI | TGAI | 30 |
| 870.5300<br>870.5375 | *In vitro* mammalian cell assay | R | R | TGAI | TGAI | 30, 31 |
| 870.5385<br>870.5395 | *In vivo* cytogenetics | R | R | TGAI | TGAI | 30, 32 |
| Special Testing | | | | | | |
| 870.7485 | Metabolism and pharmacokinetics | R | CR | PAI or PAIRA | PAI or PAIRA | 33 |
| 870.7200 | Companion animal safety | CR | CR | NR | TGAI or EP | 34 |
| 870.7600 | Dermal penetration | CR | CR | Choice | Choice | 35 |
| 870.7800 | Immunotoxicity | R | R | TGAI | TGAI | |

(e) *Test notes.* The following test notes apply to the requirements in the table to paragraph (d) of this section:

1. Not required if test material is a gas or a highly volatile liquid.

2. Diluted EP testing is required to support the end product registration if results using the EP meet the criteria for restricted use classification under §152.170(b) or special review consideration under §154.7(a)(1).
3. Not required if the test material is corrosive to skin or has a pH of less than 2 or greater than 11.5.
4. Required if the product consists of, or under conditions of use will result in, a respirable material (e.g., gas, vapor, aerosol, or particulate).
5. Required if repeated dermal exposure is likely to occur under conditions of use.
6. Required if the test material is an organophosphorus substance, which includes uncharged organophosphorus esters; thioesters or anhydrides of organophosphoric, organophosphonic, or organophosphoramidic acids; or of related phosphorothioic, phosponothioic, or phosphorothioamidic acids; or is structurally related to other substances that may cause the delayed neurotoxicity sometimes seen in this class of chemicals.
7. As determined by the Agency, additional measurements may also be required, such as cholinesterase activity for certain pesticides, e.g., organophosphates and some carbamates. The route of exposure must correspond with the primary route of exposure.
8. Required for nonfood use pesticides if oral exposure could occur.
9. The 90-day study is required in the rat for hazard characterization (possibly endpoint selection) and dose-setting for the chronic/carcinogenicity study. It is not required in the mouse, but the Agency would strongly encourage the registrant to conduct a 90-day range finding for the purposes of dose selection for the mouse carcinogenicity study to achieve adequate dosing and an acceptable study. The registrant is also encouraged to consult with the Agency on the results of the 90-day mouse study prior to conducting the carcinogenicity study.
10. Required for agricultural uses or if repeated human dermal exposure may occur. Not required if an acceptable 90-day dermal toxicity study is performed and submitted.
11. EP testing is required if the product, or any component of it, may increase dermal absorption of the active ingredient(s) as determined by testing using the TGAI, or increase toxic or pharmacologic effects.
12. Required for food uses if either of the following criteria is met:
(i) The use pattern is such that the dermal route would be the primary route of exposure; or
(ii) The active ingredient is known or expected to be metabolized differently by the dermal route of exposure than by the oral route, and a metabolite is the toxic moiety.
13. Required if there is the likelihood of significant repeated inhalation exposure to the pesticide as a gas, vapor, or aerosol.
14. Based on estimates of the magnitude and duration of human exposure, studies of shorter duration, e.g., 21- or 28-days, may be sufficient to satisfy this requirement. Registrants should consult with the Agency to determine whether studies of shorter duration would meet this requirement.
15. Required if results of acute neurotoxicity study indicate significant statistical or biological effects, or if other available data indicate the potential for this type of delayed neurotoxicity, as determined by the Agency.
16. All 90-day subchronic studies in rats can be designed to simultaneously fulfill the requirements of the 90-day neurotoxicity study using separate groups of animals for testing. Although the subchronic guidelines include the measurement of neurological endpoints, they do not meet the requirement of the 90-day neurotoxicity study.
17. Required if either of the following are met:
(i) The use of the pesticide is likely to result in repeated human exposure over a considerable portion of the human lifespan, as determined by the Agency;
(ii) The use requires a tolerance or an exemption from the requirement of a tolerance.
18. Based on the results of the acute and subchronic neurotoxicity studies, or other available data, a combined chronic toxicity and neurotoxicity study may be required.
19. Studies which are designed to simultaneously fulfill the requirements of both the chronic oral and carcinogenicity studies (*i.e.*, a combined study) may be conducted. Minimum acceptable study durations are:

(i) Chronic rodent feeding study (food use) - 24 months.
(ii) Chronic rodent feeding study (nonfood use) - 12 months.
(iii) Mouse carcinogenicity study - 18 months.
(iv) Rat carcinogenicity study - 24 months.
20. Required if any of the following, as determined by the Agency, are met:
(i) The use of the pesticide is likely to result in significant human exposure over a considerable portion of the human life span which is significant in terms of either frequency, duration, or magnitude of exposure;
(ii) The use requires a tolerance or an exemption from the requirement of a tolerance; or
(iii) The active ingredient, metabolite, degradate, or impurity (a) is structurally related to a recognized carcinogen, (b) causes mutagenic effects as demonstrated by *in vitro* or *in vivo* testing, or (c) produces a morphologic effect in any organ (e.g., hyperplasia, metaplasia) in subchronic studies that may lead to a neoplastic change.
21. If this study is modified or waived, a subchronic 90-day oral study conducted in the same species may be required.
22. Testing in two species is required for all uses.
23. The oral route, by oral intubation, is preferred unless the chemical or physical properties of the test substance or the pattern of exposure suggests a more appropriate route of exposure.
24. Additional testing by other routes may be required if the pesticide is determined to be a prenatal developmental toxicant after oral dosing.
25. May be combined with the 2-generation reproduction study in rodents by utilizing a second mating of the parental animals in either generation.
26. Required to support products intended for food uses and to support products intended for nonfood uses if use of the product is likely to result in significant human exposure over a portion of the human life span in terms of frequency, magnitude or duration of exposure.
27. An information-based approach to testing is preferred, which utilizes the best available knowledge on the chemical (hazard, pharmacokinetic, or mechanistic data) to determine whether a standard guideline study, an enhanced guideline study, or an alternative study should be conducted to assess potential hazard to the developing animal, or in some cases to support a waiver for such testing. Registrants should submit any alternative proposed testing protocols and supporting scientific rationale to the Agency prior to study initiation.
28. Study required using a weight-of-evidence approach considering:
(i) The pesticide causes treatment-related neurological effects in adult animal studies (*i.e.*, clinical signs of neurotoxicity, neuropathology, functional or behavioral effects).
(ii) The pesticide causes treatment-related neurological effects in developing animals, following pre- and postnatal exposure (*i.e.*, nervous system malformations or neuropathy, brain weight changes in offspring, functional or behavioral changes in the offspring).
(iii) The pesticide elicits a causative association between exposures and adverse neurological effects in human epidemiological studies.
(iv) The pesticide evokes a mechanism that is associated with adverse effects on the development of the nervous system (e.g., SAR relationship to known neurotoxicants, altered neuroreceptor or neurotransmitter responses).
29. The use of a combined study that utilizes the 2-generation reproduction study in rodents as a basic protocol for the addition of other endpoints or functional assessments in the immature animal is encouraged.
30. At a minimum, an initial battery of mutagenicity tests with possible confirmatory testing is required. Other relevant mutagenicity tests that may have been performed, plus a complete reference list must also be submitted.
31. Choice of assay using either:
(i) Mouse lymphoma L5178Y cells, thymidine kinase (tk) gene locus, maximizing assay conditions for small colony expression or detection;

(ii) Chinese hamster ovary (CHO) or Chinese hamster lung fibroblast (V79) cells, hypoxanthine-guanine phosphoribosyl transferase (hgprt) gene locus, accompanied by an appropriate *in vitro* test for clastogenicity; or
(iii) CHO cells strains AS52, xanthine-guanine phosphoribosyl transferase (xprt) gene locus.
32. The micronucleus rodent bone marrow assay is preferred; however, rodent bone marrow assays using metaphase analysis (aberrations) are acceptable.
33. Required when chronic or carcinogenicity studies are required. May be required if significant adverse effects are seen in available toxicology studies and these effects can be further elucidated by metabolism studies.
34. May be required if the product's use will result in exposure to domestic animals through, but not limited to, direct application.
35. A risk assessment assuming that dermal absorption is equal to oral absorption must be performed to determine if the study is required, and to identify the doses and duration of exposure for which dermal absorption is to be quantified.
36. A 1-year non-rodent study (*i.e.*, 1-year dog study) would be required if the Agency finds that a pesticide chemical is highly bioaccumulating and is eliminated so slowly that it does not achieve steady state or sufficient tissue concentrations to elicit an effect during a 90-day study. EPA would require the appropriate tier II metabolism and pharmacokinetic studies to evaluate more precisely bioavailability, half-life, and steady state to determine if a longer duration dog toxicity study is needed.

## §158.630 Terrestrial and aquatic nontarget organisms data requirements table.

(a) *General.* Sections 158.100 through 158.130 describe how to use this table to determine the terrestrial and aquatic nontarget data requirements for a particular pesticide product. Notes that apply to an individual test including specific conditions, qualifications, or exceptions to the designated test are listed in paragraph (e) of this section.

(b) *Use patterns.* (1) The terrestrial use pattern includes products classified under the general use patterns of terrestrial food crop, terrestrial feed crop, and terrestrial nonfood crop. The aquatic use pattern includes products classified under the general use patterns of aquatic food crop and aquatic nonfood use patterns. The greenhouse use pattern includes products classified under the general use patterns of greenhouse food crop and greenhouse nonfood crop. The indoor use pattern includes products classified under the general use patterns of indoor food and indoor nonfood use.

(2) Data are also required for the general use patterns of forestry and residential outdoor use.

(3) In general, for all outdoor end-uses, including turf, the following studies are required: Two avian oral $LD_{50}$, two avian dietary $LC_{50}$, two avian reproduction studies, two freshwater fish $LC_{50}$, one freshwater invertebrate $EC_{50}$, one honeybee acute contact $LD_{50}$, one freshwater fish early-life stage, one freshwater invertebrate life cycle, and three estuarine acute $LC_{50}/EC_{50}$ studies -- fish, mollusk and invertebrate. All other outdoor residential uses, *i.e.*, gardens and ornamental will not usually require the freshwater fish early-life stage, the freshwater invertebrate life-cycle, and the acute estuarine tests.

(c) *Key.* R=Required; CR=Conditionally required; NR=Not required; TGAI=Technical grade of the active ingredient; TEP=Typical end-use product; PAI=Pure active ingredient; EP=end-use product. Commas between the test substances (*i.e.*, TGAI, TEP) indicate that data may be required on the TGAI or the TEP depending on the conditions set forth in the test note.

(d) *Table.* The following table shows the data requirements for nontarget terrestrial and aquatic organism. The table notes are shown in paragraph (e) of this section.

**Terrestrial and Aquatic Nontarget Organism Data Requirements**

| Guideline Number | Data Requirement | Use Pattern | | | | | | Test substance | Test Note No. |
|---|---|---|---|---|---|---|---|---|---|
| | | Terrestrial | Aquatic | Forestry | Residential Outdoor | Greenhouse | Indoor | | |
| Avian and Mammalian Testing | | | | | | | | | |
| 850.2100 | Avian oral toxicity | R | R | R | R | CR | CR | TGAI | 1, 2, 3 |
| 850.2200 | Avian dietary toxicity | R | R | R | R | NR | NR | TGAI | 1, 4 |
| 850.2400 | Wild mammal toxicity | CR | CR | CR | CR | NR | NR | TGAI | 5 |
| 850.2300 | Avian reproduction | R | R | R | R | NR | NR | TGAI | 1, 4 |
| 850.2500 | Simulated or actual field testing | CR | CR | CR | CR | NR | NR | TEP | 6, 7 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Aquatic Organisms Testing | | | | | | | | | |
| 850.1075 | Freshwater fish toxicity | R | R | R | R | CR | CR | TGAI, TEP | 1, 2, 8, 9, 26 |
| 850.1010 | Acute toxicity freshwater invertebrates | R | R | R | R | CR | CR | TGAI, TEP | 1, 2, 9, 10, 26 |
| 850.1025<br>850.1035<br>850.1045<br>850.1055<br>850.1075 | Acute toxicity estuarine and marine organisms | R | R | R | R | NR | NR | TGAI, TEP | 1, 9, 11, 12, 26 |
| 850.1300 | Aquatic invertebrate life cycle (freshwater) | R | R | R | R | NR | NR | TGAI | 1, 10, 12 |
| 850.1350 | Aquatic invertebrate life cycle (saltwater) | CR | CR | CR | CR | NR | NR | TGAI | 12, 14, 15 |
| 850.1400 | Fish early-life stage (freshwater) | R | R | R | R | NR | NR | TGAI | 1, 12, 13 |
| 850.1400 | Fish early-life stage (saltwater) | CR | CR | CR | CR | NR | NR | TGAI | 12, 15, 16 |
| 850.1500 | Fish life cycle | CR | CR | CR | CR | NR | NR | TGAI | 17, 18 |
| 850.1710<br>850.1730<br>850.1850 | Aquatic organisms bioavailability, biomagnification, toxicity | CR | CR | CR | CR | NR | NR | TGAI, PAI, degradate | 19 |
| 850.1950 | Simulated or actual field testing for aquatic organisms | CR | CR | CR | CR | NR | NR | TEP | 7, 20 |
| Sediment Testing | | | | | | | | | |
| 850.1735 | Whole sediment: acute freshwater invertebrates | CR | CR | CR | CR | NR | NR | TGAI | 21 |
| 850.1740 | Whole sediment: acute marine invertebrates | CR | CR | CR | CR | NR | NR | TGAI | 21, 23 |
| | Whole sediment: chronic invertebrates freshwater and marine | CR | CR | CR | CR | NR | NR | TGAI | 22, 23 |
| Insect Pollinator Testing | | | | | | | | | |
| 850.3020 | Honeybee acute contact toxicity | R | CR | R | R | NR | NR | TGAI | 1 |
| 850.3030 | Honey bee toxicity of residues on foliage | CR | CR | CR | CR | NR | NR | TEP | 24 |
| 850.3040 | Field testing for pollinators | CR | CR | CR | CR | NR | NR | TEP | 25 |

(e) *Test notes.* The following test notes apply to terrestrial and aquatic nontarget organisms data requirements in the table to paragraph (d) of this section:

1. Data using the TGAI are required to support all outdoor end-use product uses including, but not limited to turf. Data are generally not required to support end-use products in the form of a gas, a highly volatile liquid, a highly reactive solid, or a highly corrosive material.
2. For greenhouse and indoor end-use products, data using the TGAI are required to support manufacturing-use products to be reformulated into these same end-use products or to support end-use products when there is no registered manufacturing-use product. Avian acute oral data are not required for liquid formulations for greenhouse and indoor uses. The study is not required if there is no potential for environmental exposure.
3. Data are required on one passerine species and either one waterfowl species or one upland game bird species for terrestrial, aquatic, forestry, and residential outdoor uses. Data are preferred on waterfowl or upland game bird species for indoor and greenhouse uses.
4. Data are required on waterfowl and upland game bird species.
5. Tests are required based on the results of lower tier toxicology studies, such as the acute and subacute testing, intended use pattern, and environmental fate characteristics that indicate potential exposure.
6. Higher tier testing may be required for a specific use pattern when a refined risk assessment indicates a concern based on laboratory toxicity endpoints and refined exposure assessments.
7. Environmental chemistry methods used to generate data associated with this study must include results of a successful confirmatory method trial by an independent laboratory. Test standards and procedures for independent laboratory validation are available as addenda to the guideline for this test requirement.
8. Data are required on one coldwater fish and one warmwater fish for terrestrial, aquatic, forestry, and residential outdoor uses. For indoor and greenhouse uses, testing with only one of either fish species is required.
9. EP or TEP testing is required for any product which meets any of the following conditions:
i. The end-use pesticide will be introduced directly into an aquatic environment (e.g., aquatic herbicides and mosquito larvicides) when used as directed.
ii. The maximum expected environmental concentration (MEEC) or the estimated environmental concentration (EEC) in the aquatic environment is ≥one-half the $LC_{50}$ or $EC_{50}$ of the TGAI when the EP is used as directed.
iii. An ingredient in the end-use formulation other than the active ingredient is expected to enhance the toxicity of the active ingredient or to cause toxicity to aquatic organisms.
10. Data are required on one freshwater aquatic invertebrate species.
11. Data are required on one estuarine/marine mollusk, one estuarine/marine invertebrate and one estuarine/marine fish species.
12. Data are generally not required for outdoor residential uses, other than turf, unless data indicate that pesticide residues from the proposed use(s) can potentially enter waterways.
13. Data are required on one freshwater fish species. If the test species is different from the two species used for the freshwater fish acute toxicity tests, a 96-hour $LC_{50}$ on that species must also be provided.
14. Data are required on one estuarine/marine invertebrate species.
15. Data are required on estuarine/marine species if the product meets any of the following conditions:
i. Intended for direct application to the estuarine or marine environment.
ii. Expected to enter this environment in significant concentrations because of its expected use or mobility patterns.
iii. If the acute $LC_{50}$ or $EC_{50}$ <1 milligram/liter (mg/l).
iv. If the estimated environmental concentration (EEC) in water is ≥0.01 of the acute $EC_{50}$ or $LC_{50}$ or if any of the following conditions exist:
A. Studies of other organisms indicate the reproductive physiology of fish and/or invertebrates may be affected.
B. Physicochemical properties indicate bioaccumulation of the pesticide.
C. The pesticide is persistent in water (e.g., half-life in water >4 days).

16. Data are required on one estuarine/marine fish species.
17. Data are required on estuarine/marine species if the product is intended for direct application to the estuarine or marine environment, or the product is expected to enter this environment in significant concentrations because of its expected use or mobility patterns.
18. Data are required on freshwater species if the end-use product is intended to be applied directly to water, or is expected to be transported to water from the intended use site, and when any of the following conditions apply:
i. If the estimated environmental concentration (EEC) is ≥0.1 of the no-observed-effect level in the fish early-life stage or invertebrate life cycle test;
ii. If studies of other organisms indicate that the reproductive physiology of fish may be affected.
19. Not required when:
i. The octanol/water partition coefficients of the pesticide and its major degradates are <1,000; or
ii. There are no potential exposures to fish and other nontarget aquatic organisms; or
iii. The hydrolytic half-life is <5 days at pH 5, 7 and 9.
20. Data are required based on the results of lower tier studies such as acute and chronic aquatic organism testing, intended use pattern, and environmental fate characteristics that indicate significant potential exposure.
21. Data are required if:
i. The half-life of the pesticide in the sediment is ≤10 days in either the aerobic soil or aquatic metabolism studies and if any of the following conditions exist:
A. The soil partition coefficient (Kd) is ≥50.
B. The log Kow is ≥3.
C. The Koc ≥1,000.
ii. Registrants must consult with the Agency on appropriate test protocols prior to designing the study.
22. Data are required if:
i. The estimated environmental concentration (EEC) in sediment is >0.1 of the acute $LC_{50}$/$EC_{50}$ values and
ii. The half-life of the pesticide in the sediment is >10 days in either the aerobic soil or aquatic metabolism studies and if any of the following conditions exist:
A. The soil partition coefficient (Kd) is ≥50.
B. The log Kow is ≥3.
C. The Koc ≥1,000.
iii. Registrants must consult with the Agency on appropriate test protocols prior to designing the study.
23. Sediment testing with estuarine/marine test species is required if the product is intended for direct application to the estuarine or marine environment or the product is expected to enter this environment in concentrations which the Agency believes to be significant, either by runoff or erosion, because of its expected use or mobility pattern.
24. Data are required only when the formulation contains one or more active ingredients having an acute $LD_{50}$ of <11 micrograms per bee as determined in the honey bee acute contact study and the use pattern(s) indicate(s) that honey bees may be exposed to the pesticide.
25. Required if any of the following conditions are met:
i. Data from other sources (Experimental Use Permit program, university research, registrant submittals, etc.) indicate potential adverse effects on colonies, especially effects other than acute mortality (reproductive, behavioral, etc.);
ii. Data from residual toxicity studies indicate extended residual toxicity.
iii. Data derived from studies with terrestrial arthropods other than bees indicate potential chronic, reproductive or behavioral effects.
26. The freshwater fish test species for the TEP testing is the most sensitive of the species tested with the TGAI. Freshwater invertebrate and acute estuarine and marine organisms must also be tested with the EP or TEP using the same species tested with the TGAI.

## §158.660 Nontarget plant protection data requirements table.

(a) *General.* Sections 158.100 through158.130 describe how to use this table to determine the nontarget plant data requirements for a particular pesticide product. Notes that apply to an individual test and include specific conditions, qualifications, or exceptions to the designated test are listed in paragraph (e) of this section.

(b) *Use patterns.* (1) The terrestrial use pattern includes products classified under the general use patterns of terrestrial food crop, terrestrial feed crop, and terrestrial nonfood. The aquatic use pattern includes only the general use patterns of aquatic food crops and aquatic nonfood.

(2) Data are also required for the general use patterns of forestry use and residential outdoor use.

(c) *Key.* R=Required; CR=Conditionally required; NR=Not required; TGAI=Technical grade of the active ingredient; TEP=Typical end-use product.

(d) *Table.* The following table shows the nontarget plant protection data requirements. The table notes are shown in paragraph (e) of this section.

**Table—Nontarget Plant Protection Data Requirements**

| Guideline Number | Data Requirement | Use Pattern | | | Test substance | Test Note No. |
|---|---|---|---|---|---|---|
| | | Terrestrial | Aquatic | Forestry and Residential Outdoor | | |
| Nontarget Area Phytotoxicity - Tier I | | | | | | |
| 850.4100 | Seedling emergence | R | R | R | TEP | 1, 2, 7 |
| 850.4150 | Vegetative vigor | R | R | R | TEP | 1, 2, 3, 7 |
| 850.4400<br>850.5400 | Aquatic plant growth (algal and aquatic vascular plant toxicity) | R | R | R | TEP or TGAI | 1, 2, 7 |
| Nontarget Area Phytotoxicity - Tier II | | | | | | |
| 850.4100 | Seedling emergence | CR | CR | CR | TEP | 1, 4, 5, 7 |
| 850.4150 | Vegetative vigor | CR | CR | CR | TEP | 1, 3, 4, 5, 7 |
| 850.4400<br>850.5400 | Aquatic plant growth (algal and aquatic vascular plant toxicity) | CR | CR | CR | TEP or TGAI | 1, 4, 6, 7 |
| Nontarget Area Phytotoxicity - Tier III | | | | | | |
| 850.4300 | Terrestrial field | CR | CR | CR | TEP | 1, 7, 8, 10 |
| 850.4450 | Aquatic field | CR | CR | CR | TEP | 1, 7, 8, 10 |
| Target Area Phytotoxicity | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 850.4025 | Target area phytotoxicity | CR | CR | CR | TEP | 1, 7, 9, 10 |

(e) *Test notes.* The following test notes apply to the table in paragraph (d) of this section.

1. Not required for contained pesticide treatments such as bait boxes and pheromone traps unless adverse effects reports are received by the Agency.
2. Not required for known phytotoxicants.
3. Generally not required for granular formulations. May be requested on a case-by-case basis.
4. Required for known phytotoxicants such as herbicides, desiccants and defoliants.
5. Required if a tested terrestrial species exhibits a 25 percent or greater detrimental effect in the Tier I study. When Tier II testing is required, the test species should be the species that showed detrimental effects in the Tier I testing.
6. Required if the tested aquatic species exhibits a 50 percent or greater detrimental effect in the Tier I study. When Tier II testing is required, the test species should be the species that showed detrimental effects in the tier I testing.
7. Not required for aquatic residential uses.
8. Environmental chemistry methods used to generate data must include the results of a successful confirmatory method trial by an independent laboratory.
9. Tests are required on a case-by-case basis based on the results of lower tier phytotoxicity studies, adverse incident reports, intended use pattern, and environmental fate characteristics that indicate potential exposure.
10. Registrants must consult with the Agency on appropriate test protocols prior to designing the study.

## §158.1020 Applicator exposure data requirements table.

(a) *General.* Sections 158.100 through 158.130 describe how to use this table to determine the applicator exposure data requirements for a particular pesticide product. Notes that apply to an individual test and include specific conditions, qualifications, or exceptions to the designated test are listed in paragraph (e) of this section.

(b) *Use patterns.* (1) Occupational use patterns include products classified under the general use patterns of terrestrial food crop, terrestrial feed crop, terrestrial nonfood crop, aquatic food, aquatic nonfood use, forestry, greenhouse food, greenhouse nonfood, indoor food use, and indoor nonfood use. Occupational use patterns also include commercial ("for hire") applications to residential outdoor and indoor sites. (2) Residential use patterns include residential outdoor use and residential indoor use. These use patterns are limited to nonoccupational, *i.e.*, nonprofessional, pesticide applications.

(c) *Key.* R=Required; CR=Conditionally required; TEP=Typical end-use product.

(d) *Table.* The data requirements listed pertain to pesticide products that meet the testing criteria outlined in §158.1010. The table notes are shown in paragraph (e) of this section.

**Table—Applicator Exposure Data Requirements**

| Guideline Number | Data requirement | Use pattern | | Test substance | Test Note No. |
|---|---|---|---|---|---|
| | | Occupational | Residential | | |
| 875.1100 | Dermal outdoor exposure | R | R | TEP | 1, 2, 3 |
| 875.1200 | Dermal indoor exposure | R | R | TEP | 1, 2, 4 |
| 875.1300 | Inhalation outdoor exposure | R | R | TEP | 1, 2, 3 |
| 875.1400 | Inhalation indoor exposure | R | R | TEP | 1, 2, 4 |
| 875.1500 | Biological monitoring | CR | CR | TEP | 1, 2 |
| 875.1600 | Data reporting and calculations | R | R | TEP | 5 |
| 875.1700 | Product use information | R | R | TEP | -- |

(e) *Test notes.* The following notes apply to the data requirements in the table to paragraph (d) of this section:

1. Protocols must be submitted for approval prior to the initiation of the study. Details for developing protocols are available from the Agency.
2. Biological monitoring data may be submitted in addition to, or in lieu of, dermal and inhalation exposure data, provided the human pharmacokinetics of the pesticide and/or metabolite/analog compounds (*i.e.*, whichever method is selected as an indicator of body burden or internal dose) allow for the back calculation to actual dose.
3. Data are required if the product is applied outdoors.
4. Data are required if the product is applied indoors.
5. Data reporting and calculations are required when handler exposure data are submitted.

## §158.1070 Post-application exposure data requirements table.

(a) *General.* Sections 158.100 through 158.130 describe how to use this table to determine the post-application data requirements for a particular pesticide product. Notes that apply to an individual test and include specific conditions, qualifications, or exceptions to the designated test are listed in paragraph (e) of this section.

(b) *Use patterns.* (1) Occupational use patterns include products classified under the general use patterns of terrestrial food crop, terrestrial feed crop, terrestrial nonfood use, aquatic food, aquatic nonfood use, forestry, greenhouse food, greenhouse nonfood, indoor food, and indoor nonfood. Occupational use patterns also include commercial ("for hire") applications to residential outdoor and indoor sites.
(2) Residential use patterns include residential outdoor use and indoor residential use. These use patterns are limited to nonoccupational, *i.e.*, nonprofessional, pesticide applications.

(c) *Key.* R=Required; CR=Conditionally required; NR=Not required; TEP=Typical end-use product.

(d) *Table.* The data requirements listed in the following table pertain to pesticide products that meet the testing criteria outlined in §158.1060. The table notes are shown in paragraph (e) of this section.

**Table—Post-Application Exposure Data Requirements**

| Guideline Number | Data Requirement | Use Pattern | | Test Substance | Test Note No. |
|---|---|---|---|---|---|
| | | Occupational | Residential | | |
| 875.2100 | Dislodgeable foliar residue and turf transferable residues | R | R | TEP | 1, 2, 3, 4, 5 |
| 875.2200 | Soil residue dissipation | R | CR | TEP | 1, 2, 6, 7 |
| 875.2300 | Indoor surface residue dissipation | R | R | TEP | 1, 2, 8, 9 |
| 875.2400 | Dermal exposure | R | R | TEP | 1, 2, 10, 11, 12 |
| 875.2500 | Inhalation exposure | R | R | TEP | 1, 10, 11, 12 |
| 875.2600 | Biological monitoring | CR | CR | TEP | 1, 12, 13 |
| 875.2700 | Product use information | R | R | TEP | -- |
| 875.2800 | Description of human activity | R | R | TEP | -- |
| 875.2900 | Data reporting and calculations | R | R | TEP | 14 |
| 875.3000 | Nondietary ingestion exposure | NR | R | TEP | 1, 11, 15 |

(e) *Test notes.* The following test notes apply to the data requirements in the table to paragraph (d) of this section:
1. Protocols must be submitted for approval prior to the initiation of the study. Details for developing protocols are available from the Agency.
2. Bridging applicable residue dissipation data to dermal exposure data is required.
3. Turf grass transferable residue dissipation data are required when pesticides are applied to turf grass. Dislodgeable foliar residue dissipation data are required when pesticides are applied to the foliage of plants other than turf grass.

4. Data are required for occupational sites if (i) there are uses on turf grass or other plant foliage, and (ii) the human activity data indicate that workers are likely to have post-application dermal contact with treated foliage while participating in typical activities.
5. Data are required for residential sites if there are uses on turf grass or other plant foliage.
6. Data are required for occupational sites, if (i) there are outdoor or greenhouse uses to or around soil or other planting media, and (ii) the human activity data indicate that workers are likely to have post-application dermal contact with treated soil or planting media while participating in typical activities.
7. Data are required for residential sites if the pesticide is applied to or around soil or other planting media both outdoors and indoors, e.g., residential greenhouse or houseplant uses.
8. Data are required for occupational sites if the pesticide is applied to or around on non-plant surfaces, e.g., flooring or countertops, and if the human activity data indicate that workers are likely to have post-application dermal contact with treated indoor surfaces while participating in typical activities.
9. Data are required for residential sites if the pesticide is applied to or around non-plant surfaces, e.g., flooring and countertops.
10. Data are required for occupational sites if the human activity data indicate that workers are likely to have post-application exposures while participating in typical activities.
11. Data are required for residential sites if post-application exposures are likely.
12. Biological monitoring data may be submitted in addition to, or in lieu of, dermal and inhalation exposure data provided the human pharmocokinetics of the pesticide and/or metabolite/analog compounds (*i.e.*, whichever method is selected as an indicator of body burden or internal dose) allow for a back-calculation to the total internal dose.
13. Data are required when passive dosimetry techniques are not applicable for a particular exposure scenario, such as a swimmer exposure to pesticides.
14. Data reporting and calculations are required when any post-application exposure monitoring data are submitted.
15. The selection of a sampling method will depend on the nondietary pathway(s) of interest. Data must be generated to consider all potential pathways of nondietary ingestion exposure that are applicable (e.g., soil ingestion, hand-to-mouth transfer, and object-to-mouth transfer of surface residues).

## §158.1100 Spray drift data requirements table.

(a) *General.* Sections 158.100 through 158.130 describe how to use this table to determine the spray drift data requirements for a particular pesticide product. Notes that apply to an individual test, including specific conditions, qualifications, or exceptions to the designated test are listed in paragraph (e) of this section.

(b) *Use patterns.* The terrestrial use pattern includes products classified under the general use patterns of terrestrial food crop and terrestrial nonfood crop. The aquatic use pattern includes products classified under the general use patterns of aquatic food crop and aquatic nonfood. The greenhouse use pattern includes products classified under the general use patterns of greenhouse food crop and greenhouse nonfood crop. Data are also required for the general use patterns of forestry use, residential outdoor use, and indoor use.

(c) *Key.* CR=Conditionally required; NR=Not required; TEP=Typical end-use product; MP=Manufacturing use product; EP=End-use product.

(d) *Table.* The following table lists the data requirements that pertain to spray drift. The table notes are shown in paragraph (e) of this section.

**Table—Spray Drift Data Requirements**

| Guideline Number | Data Requirement | Use Pattern | | | | | | | | | Test substance | | Test Note No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Terrestrial | | Aquatic | | Greenhouse | | Forestry | Residential Outdoor | Indoor | MP | EP | |
| | | Food Crop | Nonfood Crop | Food | Nonfood | Food Crop | Nonfood Crop | | | | | | |
| 201-1 | Droplet size spectrum | CR | CR | CR | CR | NR | NR | CR | NR | NR | TEP | TEP | 1 |
| 202-1 | Droplet size spectrum | CR | CR | CR | CR | NR | NR | CR | NR | NR | TEP | TEP | 1 |

(e) *Test notes.* The following notes apply to the requirements in the table to paragraph (d) of this section:

1. This study is required when aerial applications (rotary and fixed winged) and mist blower or other methods of ground application are proposed and it is estimated that the detrimental effect level of those nontarget organisms expected to be present would be exceeded. The nontarget organisms include humans, domestic animals, fish and wildlife, and nontarget plants.

## §158.1300 Environmental fate data requirements table.

(a) *General.* All environmental fate data, as described in paragraph (c) of this section, must be submitted to support a request for registration.

(b) *Use patterns.* (1) The terrestrial use pattern includes products classified under the general use patterns of terrestrial food crop, terrestrial feed crop, and terrestrial nonfood. The aquatic use pattern includes the general use patterns of aquatic food crop, and aquatic nonfood. The greenhouse use pattern includes both food and nonfood uses. The indoor use pattern includes food, nonfood, and residential indoor uses.

(2) Data are also required for the general use patterns of forestry use and residential outdoor use.

(c) *Key.* CR=Conditionally required; NR=Not required; R=Required; PAIRA=Pure active ingredient radio-labeled; TGAI=Technical grade of the active ingredient; TEP=Typical end-use product.

(d) *Table.* The following table shows the data requirements for environmental fate. The test notes are shown in paragraph (e) of this section.

**Table—Environmental Fate Data Requirements**

| Guideline Number | Data Requirement | Use Pattern | | | | | | Test substance | Test Note No. |
|---|---|---|---|---|---|---|---|---|---|
| | | Terrestrial | Aquatic | Greenhouse | Indoor | Forestry | Residential Outdoor | | |
| Degradation Studies - Laboratory | | | | | | | | | |
| 835.2120 | Hydrolysis | R | R | R | CR | R | R | TGAI or PAIRA | 1 |
| 835.2240 | Photodegradation in water | R | R | NR | NR | R | NR | TGAI or PAIRA | 2 |
| 835.2410 | Photodegradation on soil | R | NR | NR | NR | R | NR | TGAI or PAIRA | 3 |
| 835.2370 | Photodegradation in air | CR | NR | CR | NR | CR | CR | TGAI or PAIRA | 4 |
| Metabolism Studies - Laboratory | | | | | | | | | |
| 835.4100 | Aerobic soil | R | CR | R | NR | R | R | TGAI or PAIRA | 5 |
| 835.4200 | Anaerobic soil | R | NR | NR | NR | NR | NR | TGAI or PAIRA | -- |
| 835.4300 | Aerobic aquatic | R | R | NR | NR | R | NR | TGAI or PAIRA | -- |
| 835.4400 | Anaerobic aquatic | R | R | NR | NR | R | NR | TGAI or PAIRA | -- |
| Mobility Studies | | | | | | | | | |
| 835.1230<br>835.1240 | Leaching and adsorption/desorption | R | R | R | NR | R | R | TGAI or PAIRA | 6 |
| 835.1410 | Volatility - laboratory | CR | NR | CR | NR | NR | NR | TEP | 4 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 835.8100 | Volatility - field | CR | NR | CR | NR | NR | NR | TEP | -- |
| Dissipation Studies - Field | | | | | | | | | |
| 835.6100 | Terrestrial | R | CR | NR | NR | CR | R | TEP | 5, 7, 12 |
| 835.6200 | Aquatic (sediment) | CR | R | NR | NR | NR | NR | TEP | 7, 8 |
| 835.6300 | Forestry | NR | NR | NR | NR | CR | NR | TEP | 7, 9, 12 |
| 835.6400 | Combination and tank mixes | CR | CR | NR | NR | NR | NR | TEP | 10 |
| Ground Water Monitoring | | | | | | | | | |
| 835.7100 | Ground water monitoring | CR | NR | NR | NR | CR | CR | TEP | 7, 9, 11 |

(e) *Test notes.* The following test notes apply to the requirements in the table to paragraph (d) of this section:

1. Study is required for indoor uses in cases where environmental exposure is likely to occur. Such sites include, but are not limited to, agricultural premises, in or around farm buildings, barnyards, and beehives.
2. Not required when the electronic absorption spectra, measured at pHs 5, 7, and 9, of the chemical and its hydrolytic products, if any, show no absorption or tailing between 290 and 800 nm.
3. Not required when the chemical is to be applied only by soil injection or is incorporated in the soil.
4. Requirement based on use patterns and other pertinent factors including, but not limited to, the Henry's Law Constant of the chemical. In view of methodological difficulties with the study of photodegradation in air, prior consultation with the Agency regarding the protocol is recommended before the test is performed.
5. Required for aquatic food and nonfood crop uses for aquatic sites that are intermittently dry. Such sites include, but are not limited to, cranberry bogs and rice paddies.
6. Adsorption and desorption using a batch equilibrium method is preferred. However in some cases, for example, where the pesticide degrades rapidly, soil column leaching with unaged or aged columns may be more appropriate to fully characterize the potential mobility of the parent compound and major transformation products.
7. Environmental chemistry methods used to generate data associated with this study must include results of a successful confirmatory method trial by an independent laboratory. Test standards and procedures for independent laboratory validation are available as addenda to the guideline for this test requirement.
8. Requirement for terrestrial uses is based on potential for aquatic exposure and if pesticide residues have the potential for persistence, mobility, nontarget aquatic toxicity or bioaccumulation. Not required for aquatic residential uses. Field testing under the terrestrial field dissipation requirement may be more appropriate for some aquatic food crops, such as rice and cranberry uses, that are managed to have a dry-land period for production. The registrant is encouraged to consult with the Agency on protocols.
9. Agency approval of a protocol is necessary prior to initiation of the study.
10. This study may be triggered if there is specific evidence that the presence of one pesticide can affect the dissipation characteristics of another pesticide when applied simultaneously or serially.
11. Required if the weight-of-evidence indicates that the pesticide and/or its degradates is likely to leach to ground water, taking into account other factors such as the toxicity of the chemicals(s), available monitoring data, and the vulnerability of ground water resources in the pesticide use area.
12. If the terrestrial dissipation study cannot assess all of the major routes of dissipation, the forestry study will be required.

**APPENDIX B. Soil Sampling Photos**

Off Montauk, looking north at Weesuck Creek.

Off Montauk, looking south at Weesuck Creek.

Looking east at railroad tracks. Weesuck Creek supposed to cross?

Weesuck Creek, looking south, off of Old County Road.

First sample site, near holes 10/11, west side.

24 inch sample area at hole 10/11.

24 inch sample area at hole 10/11.

Dirt pile from soil removal at hole 10/11.

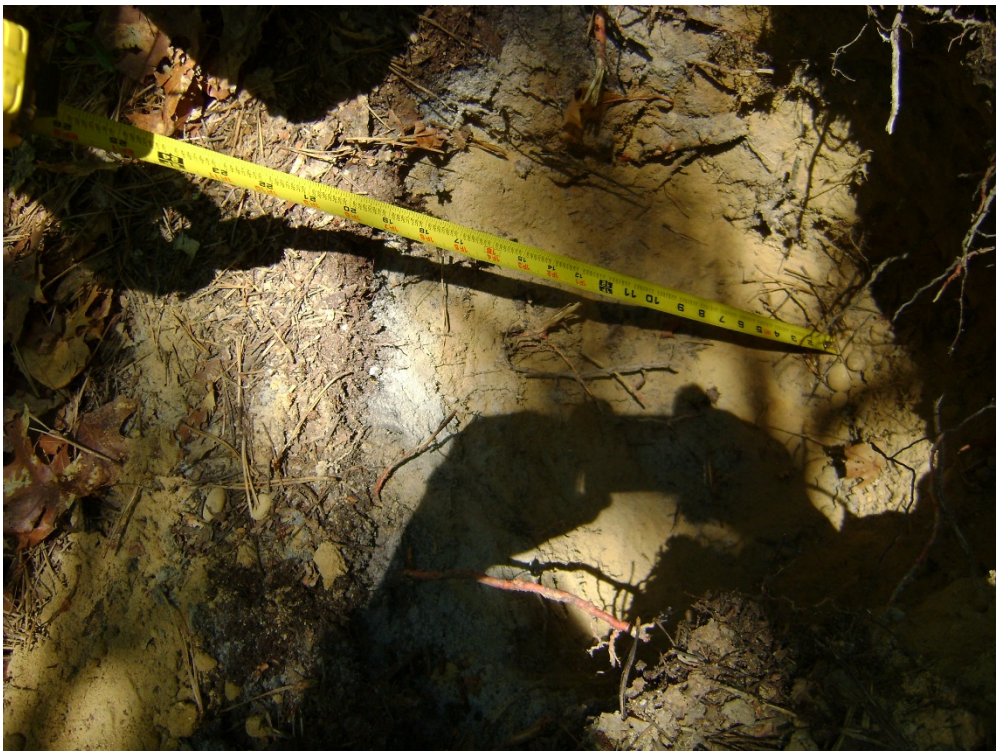
0-33 inch sample at site 1, hole 10/11.

Soil profile.

Bulk density tube and bag of soil (0-4 inch).

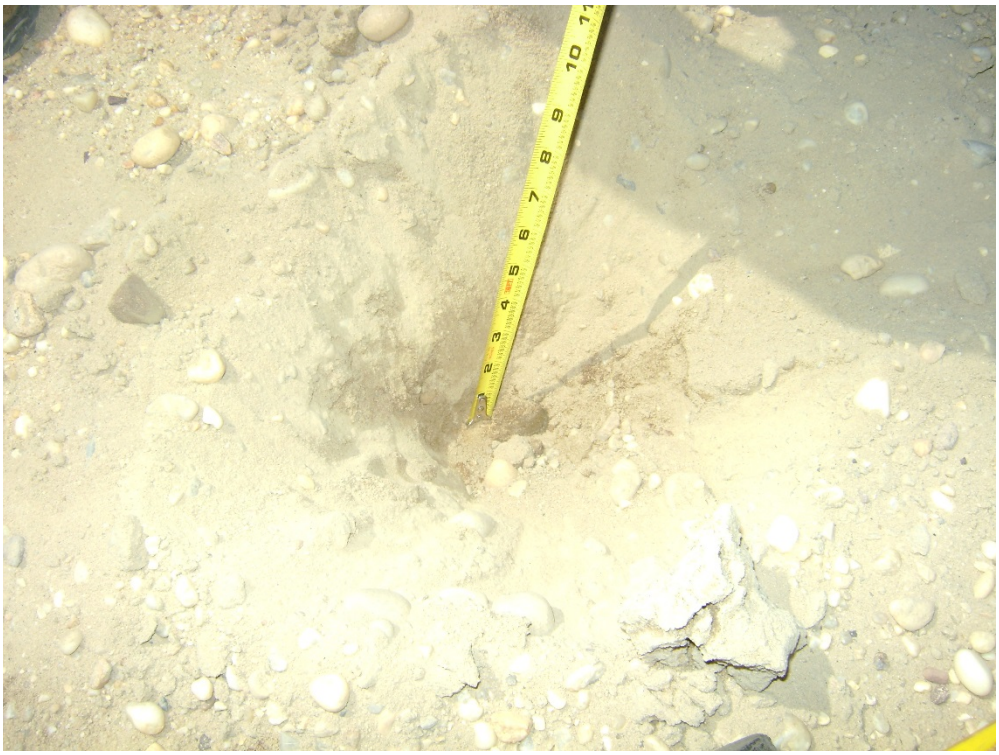
Bulk density tube and bag of soil (4-8 inch).

Soil bag (12-24 inch).



Soil profile at 0-24 inch.

Looking northwest at sample site #378 (gravel pit).



Looking at gravel pit soil profile.

**APPENDIX C. Soil Results**

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# *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94709
Sample Id : 37604

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Moisture @ 1/3 Bar , % | 7 | 0 | WHC | 08/17/2015 08:30 | TAW |
| Moisture @ 15 Bar , % | 5 | 0 | WHC | 08/17/2015 08:30 | TAW |

**Method Reference:**
Methods of Soil Analysis, Part 3 - Chemical Methods, 2nd Ed. Rev. Soil Science Society of America, Black, C.A et al. 1982, p 663
**Comments:**

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## *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94723
Sample Id : 37648

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Moisture @ 1/3 Bar , % | 3 | 0 | WHC | 08/17/2015 08:30 | TAW |
| Moisture @ 15 Bar , % | 2 | 0 | WHC | 08/17/2015 08:30 | TAW |

**Method Reference:**
Methods of Soil Analysis, Part 3 - Chemical Methods, 2nd Ed. Rev. Soil Science Society of America, Black, C.A et al. 1982, p 663
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## *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94724
Sample Id : 376812

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Moisture @ 1/3 Bar , % | 2 | 0 | WHC | 08/17/2015 08:30 | TAW |
| Moisture @ 15 Bar , % | 1 | 0 | WHC | 08/17/2015 08:30 | TAW |

**Method Reference:**
Methods of Soil Analysis, Part 3 - Chemical Methods, 2nd Ed. Rev. Soil Science Society of America, Black, C.A et al. 1982, p 663
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## *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94725
Sample Id : 376124

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Moisture @ 1/3 Bar , % | 3 | 0 | WHC | 08/17/2015 08:30 | TAW |
| Moisture @ 15 Bar , % | 1 | 0 | WHC | 08/17/2015 08:30 | TAW |

**Method Reference:**
Methods of Soil Analysis, Part 3 - Chemical Methods, 2nd Ed. Rev. Soil Science Society of America, Black, C.A et al. 1982, p 663
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## *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94726
Sample Id : 37704

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Moisture @ 1/3 Bar , % | 14 | 0 | WHC | 08/17/2015 08:30 | TAW |
| Moisture @ 15 Bar , % | 8 | 0 | WHC | 08/17/2015 08:30 | TAW |

**Method Reference:**
Methods of Soil Analysis, Part 3 - Chemical Methods, 2nd Ed. Rev. Soil Science Society of America, Black, C.A et al. 1982, p 663
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## *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94727
Sample Id : 37748

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Moisture @ 1/3 Bar , % | 10 | 0 | WHC | 08/17/2015 08:30 | TAW |
| Moisture @ 15 Bar , % | 5 | 0 | WHC | 08/17/2015 08:30 | TAW |

**Method Reference:**
Methods of Soil Analysis, Part 3 - Chemical Methods, 2nd Ed. Rev. Soil Science Society of America, Black, C.A et al. 1982, p 663
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## *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94728
Sample Id : 377812

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Moisture @ 1/3 Bar , % | 9 | 0 | WHC | 08/17/2015 08:30 | TAW |
| Moisture @ 15 Bar , % | 4 | 0 | WHC | 08/17/2015 08:30 | TAW |

**Method Reference:**
Methods of Soil Analysis, Part 3 - Chemical Methods, 2nd Ed. Rev. Soil Science Society of America, Black, C.A et al. 1982, p 663
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## *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94729
Sample Id : 377124

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Moisture @ 1/3 Bar , % | 8 | 0 | WHC | 08/17/2015 08:30 | TAW |
| Moisture @ 15 Bar , % | 4 | 0 | WHC | 08/17/2015 08:30 | TAW |

**Method Reference:**
Methods of Soil Analysis, Part 3 - Chemical Methods, 2nd Ed. Rev. Soil Science Society of America, Black, C.A et al. 1982, p 663
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## *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94730
Sample Id : 37804

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Moisture @ 1/3 Bar , % | 3 | 0 | WHC | 08/17/2015 08:30 | TAW |
| Moisture @ 15 Bar , % | 2 | 0 | WHC | 08/17/2015 08:30 | TAW |

**Method Reference:**
Methods of Soil Analysis, Part 3 - Chemical Methods, 2nd Ed. Rev. Soil Science Society of America, Black, C.A et al. 1982, p 663
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## *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94731
Sample Id : 37848

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Moisture @ 1/3 Bar , % | 3 | 0 | WHC | 08/17/2015 08:30 | TAW |
| Moisture @ 15 Bar , % | 2 | 0 | WHC | 08/17/2015 08:30 | TAW |

**Method Reference:**
Methods of Soil Analysis, Part 3 - Chemical Methods, 2nd Ed. Rev. Soil Science Society of America, Black, C.A et al. 1982, p 663
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## *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94732
Sample Id : 38004

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Moisture @ 1/3 Bar , % | 27 | 0 | WHC | 08/17/2015 08:30 | TAW |
| Moisture @ 15 Bar , % | 25 | 0 | WHC | 08/17/2015 08:30 | TAW |

**Method Reference:**
Methods of Soil Analysis, Part 3 - Chemical Methods, 2nd Ed. Rev. Soil Science Society of America, Black, C.A et al. 1982, p 663
**Comments:**

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**Date Received :** 08/06/2015

## *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94733
Sample Id : 38048

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Moisture @ 1/3 Bar , % | 6 | 0 | WHC | 08/17/2015 08:30 | TAW |
| Moisture @ 15 Bar , % | 3 | 0 | WHC | 08/17/2015 08:30 | TAW |

**Method Reference:**
Methods of Soil Analysis, Part 3 - Chemical Methods, 2nd Ed. Rev. Soil Science Society of America, Black, C.A et al. 1982, p 663
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## *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94734
Sample Id : 380812

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Moisture @ 1/3 Bar , % | 8 | 0 | WHC | 08/17/2015 08:30 | TAW |
| Moisture @ 15 Bar , % | 4 | 0 | WHC | 08/17/2015 08:30 | TAW |

**Method Reference:**
Methods of Soil Analysis, Part 3 - Chemical Methods, 2nd Ed. Rev. Soil Science Society of America, Black, C.A et al. 1982, p 663
**Comments:**

Jimmy R. Ferguson

**Report Number**
15-219-0294 **Page:** 14 of 14

**Account Number**
14930

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11510 Georgia Ave
Ste 227
Wheaton , MD 20902

**Project :** Stuart Cohen

**Purchase Order :**
**Report Date :** 08/25/2015
**Date Received :** 08/06/2015

## *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94735
Sample Id : 380124

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Moisture @ 1/3 Bar , % | 6 | 0 | WHC | 08/17/2015 08:30 | TAW |
| Moisture @ 15 Bar , % | 3 | 0 | WHC | 08/17/2015 08:30 | TAW |

**Method Reference:**
Methods of Soil Analysis, Part 3 - Chemical Methods, 2nd Ed. Rev. Soil Science Society of America, Black, C.A et al. 1982, p 663
**Comments:**

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**Report Number**
15-219-0295 **Page:** 1 of 7

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Wheaton , MD 20902

**Project :** Stuart Cohen

**Purchase Order :**
**Report Date :** 08/19/2015
**Date Received :** 08/06/2015

# *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94740
Sample Id : 37604

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Bulk Density , lbs/yd3 | 1900 | 18.0 | BULK DENSITY | 08/17/2015 09:29 | TAW |
| Soil Porosity , % | 0.93 | | SDA-HANDBOOK 60-6-39/ | 08/17/2015 09:00 | TAW |

**Method Reference:**
USDA Agricultural Handbook 60, Chapter 6 (38).
USDA Agriculture Handbook No. 60

**Comments:**

Jimmy R. Ferguson

**Report Number**
15-219-0295 **Page:** 2 of 7

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**Purchase Order :**
**Report Date :** 08/19/2015
**Date Received :** 08/06/2015

## *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94741
Sample Id : 37648

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Bulk Density , lbs/yd3 | 2630 | 18.0 | BULK DENSITY | 08/17/2015 09:29 | TAW |
| Soil Porosity , % | 0.21 | | SDA-HANDBOOK 60-6-39/ | 08/17/2015 09:00 | TAW |

**Method Reference:**
USDA Agricultural Handbook 60, Chapter 6 (38).
USDA Agriculture Handbook No. 60

**Comments:**

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**Report Number**
15-219-0295 **Page:** 3 of 7

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**Purchase Order :**
**Report Date :** 08/19/2015
**Date Received :** 08/06/2015

## *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94742
Sample Id : 37704

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Bulk Density , lbs/yd3 | 1780 | 18.0 | BULK DENSITY | 08/17/2015 09:29 | TAW |
| Soil Porosity , % | 0.05 | | SDA-HANDBOOK 60-6-39/ | 08/17/2015 09:00 | TAW |

**Method Reference:**
USDA Agricultural Handbook 60, Chapter 6 (38).
USDA Agriculture Handbook No. 60

**Comments:**

Jimmy R. Ferguson

**Report Number**
15-219-0295 **Page:** 4 of 7

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**Report Date :** 08/19/2015
**Date Received :** 08/06/2015

## *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94743
Sample Id : 37748

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Bulk Density , lbs/yd3 | 2020 | 18.0 | BULK DENSITY | 08/17/2015 09:29 | TAW |
| Soil Porosity , % | 0.22 | | SDA-HANDBOOK 60-6-39/ | 08/17/2015 09:00 | TAW |

**Method Reference:**
USDA Agricultural Handbook 60, Chapter 6 (38).
USDA Agriculture Handbook No. 60

**Comments:**

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**Report Number**
15-219-0295 **Page:** 5 of 7

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**Report Date :** 08/19/2015
**Date Received :** 08/06/2015

## *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94744
Sample Id : 38004

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Bulk Density , lbs/yd3 | 2430 | 18.0 | BULK DENSITY | 08/17/2015 09:29 | TAW |
| Soil Porosity , % | 0.14 | | SDA-HANDBOOK 60-6-39/ | 08/17/2015 09:00 | TAW |

**Method Reference:**
USDA Agricultural Handbook 60, Chapter 6 (38).
USDA Agriculture Handbook No. 60

**Comments:**

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**Report Number**
15-219-0295 **Page:** 6 of 7

**Account Number**
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**Report Date :** 08/19/2015
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## *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94745
Sample Id : 38048

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Bulk Density , lbs/yd3 | 1600 | 18.0 | BULK DENSITY | 08/17/2015 09:29 | TAW |
| Soil Porosity , % | 0.06 | | SDA-HANDBOOK 60-6-39/ | 08/17/2015 09:00 | TAW |

**Method Reference:**
USDA Agricultural Handbook 60, Chapter 6 (38).
USDA Agriculture Handbook No. 60

**Comments:**

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**Report Number**
15-219-0295 **Page:** 7 of 7

**Account Number**
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**Project :** Stuart Cohen

**Purchase Order :**
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## *REPORT OF ANALYSIS*

**Date Sampled :**

Lab Number: 94746
Sample Id : 380104

| Analysis | Result | Quantitation Limit | Method | Date and Time Test Started | Analyst |
|---|---|---|---|---|---|
| Bulk Density , lbs/yd3 | 2300 | 18.0 | BULK DENSITY | 08/17/2015 09:29 | TAW |
| Soil Porosity , % | 0.4 | | SDA-HANDBOOK 60-6-39/ | 08/17/2015 09:00 | TAW |

**Method Reference:**
USDA Agricultural Handbook 60, Chapter 6 (38).
USDA Agriculture Handbook No. 60

**Comments:**

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# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0621<br>Cust No: 14930<br>Date Printed: 08/07/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 1 of 3 |

**Lab Number :** 11335 **Field Id :** **Sample Id :** 37604

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 5.4 |
| Buffer pH | BPH | 6.87 |
| Phosphorus (P) | M3 | 11 ppm |
| Potassium (K) | M3 | 21 ppm |
| Calcium (Ca) | M3 | 221 ppm |
| Magnesium (Mg) | M3 | 41 ppm |
| Sulfur (S) | M3 | 9 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.5 ppm |
| Iron (Fe) | M3 | 99 ppm |
| Manganese (Mn) | M3 | 12 ppm |
| Zinc (Zn) | M3 | 0.8 ppm |
| Sodium (Na) | M3 | 6 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 1.9 % ENR 82 |
| Nitrate Nitrogen | NO3N | 2 ppm |

SOIL TEST RATINGS: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: **2.1** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 2.6 | 0.1 |
| Ca | 52.6 | 1.1 |
| Mg | 16.3 | 0.3 |
| H | 29.0 | 0.6 |
| Na | 1.2 | 0 |

K/Mg Ratio: 0.33

Ca/Mg Ratio: 3.23

| %Sand | %Silt | %Clay |
|---|---|---|
| 80.6 | 12.7 | 6.7 |

Textural Class: Loamy Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass/Bluegrass green **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | | 4-6 | 2.0 | 6.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Bentgrass Tee **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | | 3-4 | 2.0 | 5.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Nitrate-nitrogen analysis will detect levels no lower than 2 ppm nitrate-nitrogen. Results that indicate undetected levels of nitrate-nitrogen will display 2 ppm or 4 lb/acre.**

**Bentgrass/Bluegrass green**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.5 to 0.75 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. If necessary, apply 0.25 lb of N/1000 sq ft per month during the summer. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Bentgrass Tee**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.5 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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**SOIL ANALYSIS**

| Client : | Grower : | Report No: 15-218-0621 |
|---|---|---|
| Environmental & Turf Services, Inc. | Stuart Cohe | Cust No: 14930 |
| A/P | | Date Printed: 08/07/2015 |
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| Ste 227 | | PO: |
| Wheaton MD 20902 | | Page : 2 of 3 |

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**Lab Number :** 11335 **Field Id :** **Sample Id :** 37604

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

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# SOIL ANALYSIS

| Client : | Grower : | |
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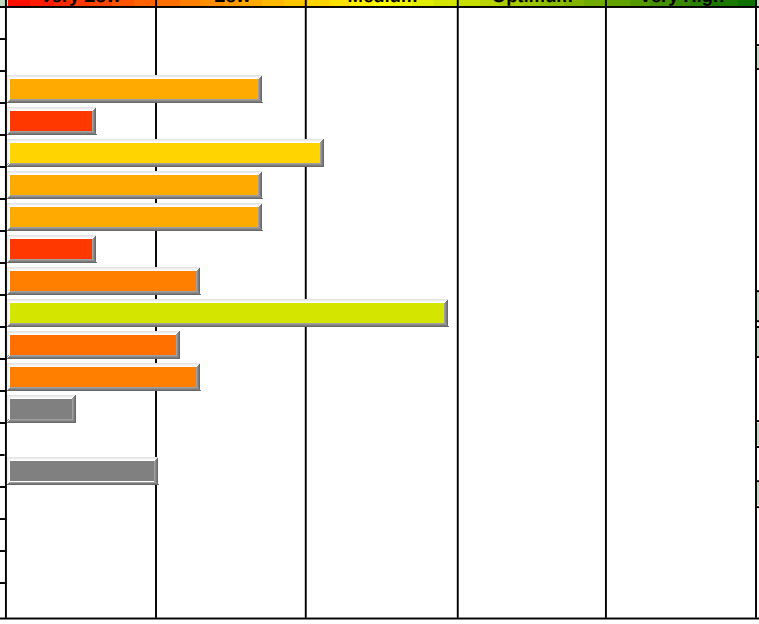
**Lab Number :** 11335 **Field Id :** **Sample Id :** 37604

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 5.4 |
| Buffer pH | BPH | 6.87 |
| Phosphorus (P) | M3 | 11 ppm |
| Potassium (K) | M3 | 21 ppm |
| Calcium (Ca) | M3 | 221 ppm |
| Magnesium (Mg) | M3 | 41 ppm |
| Sulfur (S) | M3 | 9 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.5 ppm |
| Iron (Fe) | M3 | 99 ppm |
| Manganese (Mn) | M3 | 12 ppm |
| Zinc (Zn) | M3 | 0.8 ppm |
| Sodium (Na) | M3 | 6 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 1.9 % ENR 82 |
| Nitrate Nitrogen | NO3N | 2 ppm |

**SOIL TEST RATINGS**




Calculated Cation Exchange Capacity: **2.1** meq/100g

**%Saturation**

| | %sat | meq |
|---|---|---|
| K | 2.6 | 0.1 |
| Ca | 52.6 | 1.1 |
| Mg | 16.3 | 0.3 |
| H | 29.0 | 0.6 |
| Na | 1.2 | 0 |

**K/Mg Ratio:** 0.33

**Ca/Mg Ratio:** 3.23

| %Sand | %Silt | %Clay |
|---|---|---|
| 80.6 | 12.7 | 6.7 |

**Textural Class**

**Loamy Sand**

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) LIME | (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | | 3-4 | 2.0 | 5.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Fescue Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 80 | | 3-4 | 2.0 | 5.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Bentgrass Fairway**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Fescue Fairway**

Limestone application is targeted to bring soil pH to 6.2.

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

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# SOIL ANALYSIS

| Client : | Grower : | |
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**Lab Number :** 11701 **Field Id :** **Sample Id :** 37648

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 6.4 |
| Buffer pH | | |
| Phosphorus (P) | M3 | 11 ppm |
| Potassium (K) | M3 | 19 ppm |
| Calcium (Ca) | M3 | 250 ppm |
| Magnesium (Mg) | M3 | 43 ppm |
| Sulfur (S) | M3 | 5 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.4 ppm |
| Iron (Fe) | M3 | 91 ppm |
| Manganese (Mn) | M3 | 16 ppm |
| Zinc (Zn) | M3 | 0.4 ppm |
| Sodium (Na) | M3 | 4 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 0.3 % ENR 48 |
| Nitrate Nitrogen | NO3N | 2 ppm |

SOIL TEST RATINGS: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: **1.8** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 2.7 | 0 |
| Ca | 69.4 | 1.3 |
| Mg | 19.9 | 0.4 |
| H | 9.2 | 0.2 |
| Na | 1.0 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 3.49

| %Sand | %Silt | %Clay |
|---|---|---|
| 90.6 | 4.7 | 4.7 |

Textural Class: Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass/Bluegrass green **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 4-6 | 2.0 | 6.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Bentgrass Tee **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 3-4 | 2.0 | 5.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Nitrate-nitrogen analysis will detect levels no lower than 2 ppm nitrate-nitrogen. Results that indicate undetected levels of nitrate-nitrogen will display 2 ppm or 4 lb/acre.**

**Bentgrass/Bluegrass green**

· MAINTENANCE: Apply 0.5 to 0.75 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. If necessary, apply 0.25 lb of N/1000 sq ft per month during the summer. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Bentgrass Tee**

· MAINTENANCE: Apply 0.5 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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**SOIL ANALYSIS**

| Client : | Grower : | Report No: 15-218-0631 |
|---|---|---|
| Environmental & Turf Services, Inc. | Stuart Cohe | Cust No: 14930 |
| A/P | | Date Printed: 08/10/2015 |
| 11510 Georgia Ave | | Date Received : 08/06/2015 |
| Ste 227 | | PO: |
| Wheaton MD 20902 | | Page : 2 of 37 |

**Lab Number :** 11701 **Field Id :** **Sample Id :** 37648

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# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
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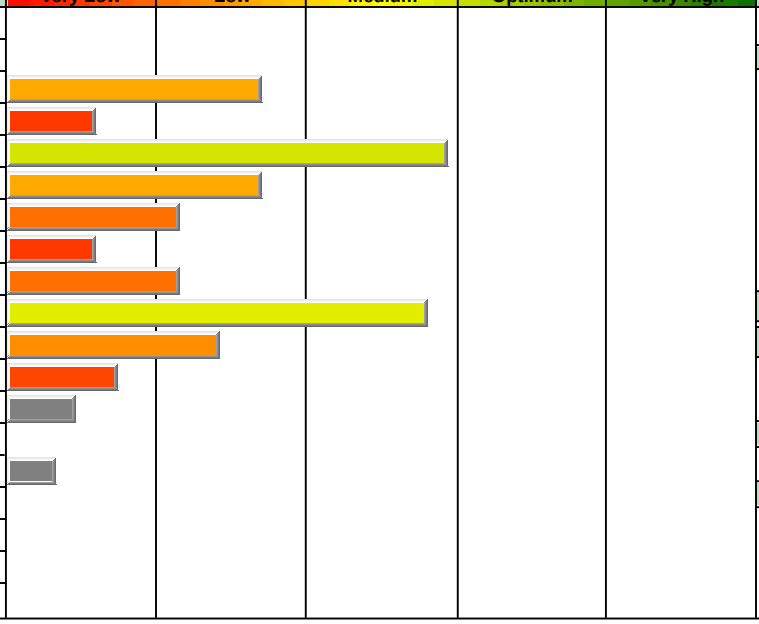
**Lab Number :** 11701 **Field Id :** **Sample Id :** 37648

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 6.4 |
| Buffer pH | | |
| Phosphorus (P) | M3 | 11 ppm |
| Potassium (K) | M3 | 19 ppm |
| Calcium (Ca) | M3 | 250 ppm |
| Magnesium (Mg) | M3 | 43 ppm |
| Sulfur (S) | M3 | 5 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.4 ppm |
| Iron (Fe) | M3 | 91 ppm |
| Manganese (Mn) | M3 | 16 ppm |
| Zinc (Zn) | M3 | 0.4 ppm |
| Sodium (Na) | M3 | 4 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 0.3 % ENR 48 |
| Nitrate Nitrogen | NO3N | 2 ppm |

**SOIL TEST RATINGS**




Calculated Cation Exchange Capacity: **1.8** meq/100g

**%Saturation**

| | %sat | meq |
|---|---|---|
| K | 2.7 | 0 |
| Ca | 69.4 | 1.3 |
| Mg | 19.9 | 0.4 |
| H | 9.2 | 0.2 |
| Na | 1.0 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 3.49

| %Sand | %Silt | %Clay |
|---|---|---|
| 90.6 | 4.7 | 4.7 |

**Textural Class**

Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 3-4 | 2.0 | 5.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Fescue Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | | 3-4 | 2.0 | 5.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Bentgrass Fairway**

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.
· Apply half of recommended phosphate in spring and again in fall.
· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.
· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Fescue Fairway**

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.
· Apply half of recommended phosphate in spring and again in fall.
· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.
· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

Waypoint ANALYTICAL
2790 Whitten Road, Memphis, TN 38133
Main 901.213.2400 º Fax 901.213.2440
www.waypointanalytical.com

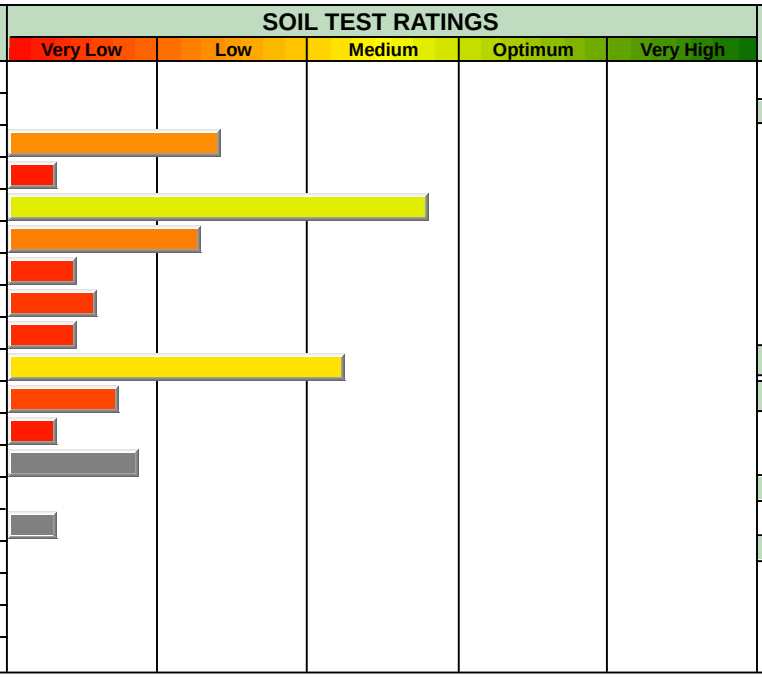
"Every acre...Every year."™

# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 4 of 37 |

**Lab Number :** 11702 **Field Id :** **Sample Id :** 376812

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 6.7 |
| Buffer pH | | |
| Phosphorus (P) | M3 | 8 ppm |
| Potassium (K) | M3 | 8 ppm |
| Calcium (Ca) | M3 | 79 ppm |
| Magnesium (Mg) | M3 | 23 ppm |
| Sulfur (S) | M3 | 2 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.2 ppm |
| Iron (Fe) | M3 | 60 ppm |
| Manganese (Mn) | M3 | 8 ppm |
| Zinc (Zn) | M3 | 0.1 ppm |
| Sodium (Na) | M3 | 3 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 0.5 % ENR 53 |
| Nitrate Nitrogen | NO3N | 2 ppm |




Calculated Cation Exchange Capacity: **0.6** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 3.4 | 0 |
| Ca | 65.8 | 0.4 |
| Mg | 31.9 | 0.2 |
| H | 4.9 | 0.0 |
| Na | 2.2 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 2.06

| %Sand | %Silt | %Clay |
|---|---|---|
| 94.6 | 2.7 | 2.7 |

Textural Class: Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass/Bluegrass green **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 4-6 | 2.0 | 6.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Bentgrass Tee **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 3-4 | 2.0 | 5.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Nitrate-nitrogen analysis will detect levels no lower than 2 ppm nitrate-nitrogen. Results that indicate undetected levels of nitrate-nitrogen will display 2 ppm or 4 lb/acre.**

**Bentgrass/Bluegrass green**

· MAINTENANCE: Apply 0.5 to 0.75 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. If necessary, apply 0.25 lb of N/1000 sq ft per month during the summer. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Bentgrass Tee**

· MAINTENANCE: Apply 0.5 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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**SOIL ANALYSIS**

| Client : | Grower : | Report No: 15-218-0631 |
|---|---|---|
| Environmental & Turf Services, Inc. | Stuart Cohe | Cust No: 14930 |
| A/P | | Date Printed: 08/10/2015 |
| 11510 Georgia Ave | | Date Received : 08/06/2015 |
| Ste 227 | | PO: |
| Wheaton MD 20902 | | Page : 5 of 37 |

**Lab Number :** 11702 **Field Id :** **Sample Id :** 376812

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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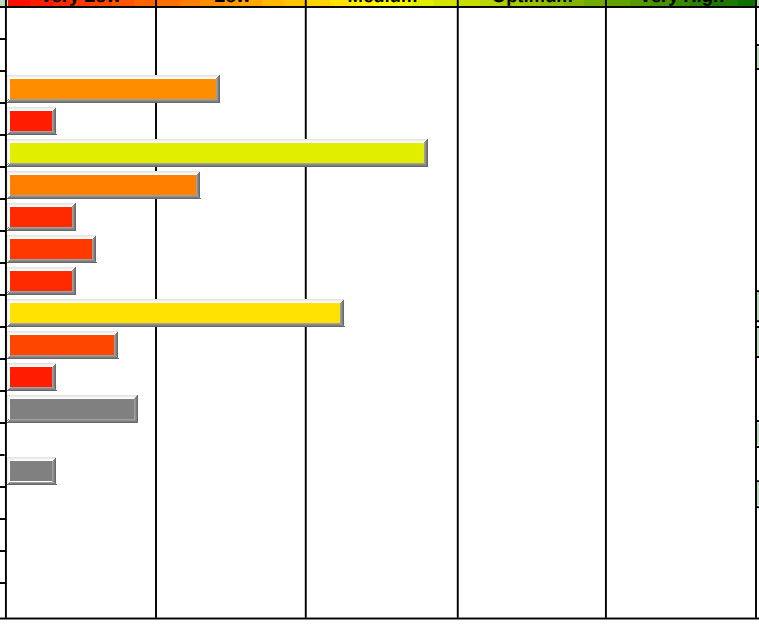
# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 6 of 37 |

**Lab Number :** 11702 **Field Id :** **Sample Id :** 376812

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 6.7 |
| Buffer pH | | |
| Phosphorus (P) | M3 | 8 ppm |
| Potassium (K) | M3 | 8 ppm |
| Calcium (Ca) | M3 | 79 ppm |
| Magnesium (Mg) | M3 | 23 ppm |
| Sulfur (S) | M3 | 2 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.2 ppm |
| Iron (Fe) | M3 | 60 ppm |
| Manganese (Mn) | M3 | 8 ppm |
| Zinc (Zn) | M3 | 0.1 ppm |
| Sodium (Na) | M3 | 3 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 0.5 % ENR 53 |
| Nitrate Nitrogen | NO3N | 2 ppm |




Calculated Cation Exchange Capacity: **0.6** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 3.4 | 0 |
| Ca | 65.8 | 0.4 |
| Mg | 31.9 | 0.2 |
| H | 4.9 | 0.0 |
| Na | 2.2 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 2.06

| %Sand | %Silt | %Clay |
|---|---|---|
| 94.6 | 2.7 | 2.7 |

Textural Class: Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME | (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | 3-4 | 2.0 | 5.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Fescue Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | 3-4 | 2.0 | 5.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Bentgrass Fairway**

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.
· Apply half of recommended phosphate in spring and again in fall.
· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.
· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Fescue Fairway**

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.
· Apply half of recommended phosphate in spring and again in fall.
· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.
· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 7 of 37 |

**Lab Number :** 11703 **Field Id :** **Sample Id :** 376124

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 6.5 |
| Buffer pH | | |
| Phosphorus (P) | M3 | 13 ppm |
| Potassium (K) | M3 | 6 ppm |
| Calcium (Ca) | M3 | 5 ppm |
| Magnesium (Mg) | M3 | 18 ppm |
| Sulfur (S) | M3 | 2 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.2 ppm |
| Iron (Fe) | M3 | 61 ppm |
| Manganese (Mn) | M3 | 10 ppm |
| Zinc (Zn) | M3 | 0.1 ppm |
| Sodium (Na) | M3 | 4 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 0.3 % ENR 48 |
| Nitrate Nitrogen | NO3N | 4 ppm |

SOIL TEST RATINGS: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: **0.2** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 7.7 | 0 |
| Ca | 12.5 | 0 |
| Mg | 75.0 | 0.2 |
| H | 8.4 | 0.0 |
| Na | 8.7 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 0.17

| %Sand | %Silt | %Clay |
|---|---|---|
| 94.6 | 2.7 | 2.7 |

Textural Class: Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass/Bluegrass green **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) LIME | (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 4-6 | 2.0 | 6.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Bentgrass Tee **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 3-4 | 2.0 | 5.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Bentgrass/Bluegrass green**

· MAINTENANCE: Apply 0.5 to 0.75 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. If necessary, apply 0.25 lb of N/1000 sq ft per month during the summer. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

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· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Bentgrass Tee**

· MAINTENANCE: Apply 0.5 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

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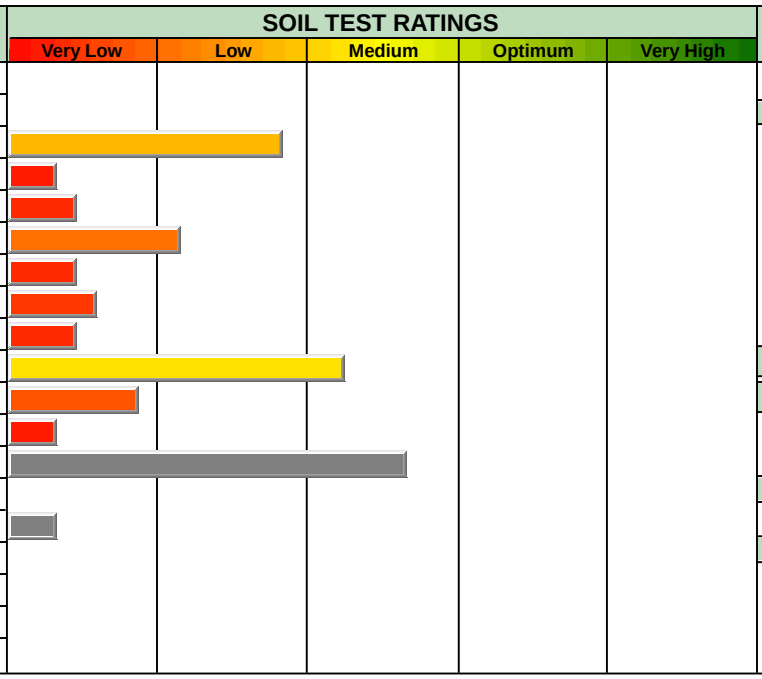
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 8 of 37 |

**Lab Number :** 11703 **Field Id :** **Sample Id :** 376124

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 6.5 |
| Buffer pH | | |
| Phosphorus (P) | M3 | 13 ppm |
| Potassium (K) | M3 | 6 ppm |
| Calcium (Ca) | M3 | 5 ppm |
| Magnesium (Mg) | M3 | 18 ppm |
| Sulfur (S) | M3 | 2 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.2 ppm |
| Iron (Fe) | M3 | 61 ppm |
| Manganese (Mn) | M3 | 10 ppm |
| Zinc (Zn) | M3 | 0.1 ppm |
| Sodium (Na) | M3 | 4 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 0.3 % ENR 48 |
| Nitrate Nitrogen | NO3N | 4 ppm |




Calculated Cation Exchange Capacity: **0.2** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 7.7 | 0 |
| Ca | 12.5 | 0 |
| Mg | 75.0 | 0.2 |
| H | 8.4 | 0.0 |
| Na | 8.7 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 0.17

| %Sand | %Silt | %Clay |
|---|---|---|
| 94.6 | 2.7 | 2.7 |

Textural Class: Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 3-4 | 2.0 | 5.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Fescue Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 3-4 | 2.0 | 5.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Bentgrass Fairway**

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.
· Apply half of recommended phosphate in spring and again in fall.
· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.
· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Fescue Fairway**

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.
· Apply half of recommended phosphate in spring and again in fall.
· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.
· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

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# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 9 of 37 |

**Lab Number :** 11704 **Field Id :** **Sample Id :** 37704

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 4.6 |
| Buffer pH | BPH | 6.88 |
| Phosphorus (P) | M3 | 7 ppm |
| Potassium (K) | M3 | 20 ppm |
| Calcium (Ca) | M3 | 23 ppm |
| Magnesium (Mg) | M3 | 28 ppm |
| Sulfur (S) | M3 | 3 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.3 ppm |
| Iron (Fe) | M3 | 105 ppm |
| Manganese (Mn) | M3 | 6 ppm |
| Zinc (Zn) | M3 | 0.3 ppm |
| Sodium (Na) | M3 | 6 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 2.6 % ENR 96 |
| Nitrate Nitrogen | NO3N | 3 ppm |

SOIL TEST RATINGS: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: **0.9** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 5.7 | 0.1 |
| Ca | 12.8 | 0.1 |
| Mg | 25.9 | 0.2 |
| H | 55.5 | 0.5 |
| Na | 2.9 | 0 |

K/Mg Ratio: 0.50

Ca/Mg Ratio: 0.49

| %Sand | %Silt | %Clay |
|---|---|---|
| 90.6 | 2.7 | 6.7 |

Textural Class: Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass/Bluegrass green **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) LIME | (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 120 | | 4-6 | 2.0 | 6.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Bentgrass Tee **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 120 | | 3-4 | 2.0 | 5.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Bentgrass/Bluegrass green**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.5 to 0.75 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. If necessary, apply 0.25 lb of N/1000 sq ft per month during the summer. Adjust N rate and timing to accomodate climatic conditions and management practices.

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· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Bentgrass Tee**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.5 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

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M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

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# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 10 of 37 |

**Lab Number :** 11704 **Field Id :** **Sample Id :** 37704

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 4.6 |
| Buffer pH | BPH | 6.88 |
| Phosphorus (P) | M3 | 7 ppm |
| Potassium (K) | M3 | 20 ppm |
| Calcium (Ca) | M3 | 23 ppm |
| Magnesium (Mg) | M3 | 28 ppm |
| Sulfur (S) | M3 | 3 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.3 ppm |
| Iron (Fe) | M3 | 105 ppm |
| Manganese (Mn) | M3 | 6 ppm |
| Zinc (Zn) | M3 | 0.3 ppm |
| Sodium (Na) | M3 | 6 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 2.6 % ENR 96 |
| Nitrate Nitrogen | NO3N | 3 ppm |

**SOIL TEST RATINGS**: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: **0.9** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 5.7 | 0.1 |
| Ca | 12.8 | 0.1 |
| Mg | 25.9 | 0.2 |
| H | 55.5 | 0.5 |
| Na | 2.9 | 0 |

K/Mg Ratio: 0.50

Ca/Mg Ratio: 0.49

| %Sand | %Silt | %Clay |
|---|---|---|
| 90.6 | 2.7 | 6.7 |

Textural Class: Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) LIME | (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 120 | | 3-4 | 2.0 | 5.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Fescue Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 160 | | 3-4 | 2.0 | 5.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Bentgrass Fairway**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Fescue Fairway**

Limestone application is targeted to bring soil pH to 6.2.

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 11 of 37 |

**Lab Number :** 11705 **Field Id :** **Sample Id :** 37748

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 4.7 |
| Buffer pH | BPH | 6.91 |
| Phosphorus (P) | M3 | 3 ppm |
| Potassium (K) | M3 | 11 ppm |
| Calcium (Ca) | M3 | 1 ppm |
| Magnesium (Mg) | M3 | 15 ppm |
| Sulfur (S) | M3 | 11 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.2 ppm |
| Iron (Fe) | M3 | 304 ppm |
| Manganese (Mn) | M3 | 2 ppm |
| Zinc (Zn) | M3 | 0.1 ppm |
| Sodium (Na) | M3 | 6 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 1.2 % ENR 68 |
| Nitrate Nitrogen | NO3N | 2 ppm |

SOIL TEST RATINGS: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: **0.4** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 7.1 | 0 |
| Ca | 1.3 | 0 |
| Mg | 31.3 | 0.1 |
| H | 47.0 | 0.2 |
| Na | 6.5 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 0.04

| %Sand | %Silt | %Clay |
|---|---|---|
| 84.6 | 6.7 | 8.7 |

Textural Class: Loamy Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass/Bluegrass green **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 110 | | 4-6 | 3.0 | 6.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Bentgrass Tee **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 110 | | 3-4 | 3.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Nitrate-nitrogen analysis will detect levels no lower than 2 ppm nitrate-nitrogen. Results that indicate undetected levels of nitrate-nitrogen will display 2 ppm or 4 lb/acre.**

**Bentgrass/Bluegrass green**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.5 to 0.75 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. If necessary, apply 0.25 lb of N/1000 sq ft per month during the summer. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Bentgrass Tee**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.5 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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Main 901.213.2400 º Fax 901.213.2440
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*"Every acre...Every year."™*

**SOIL ANALYSIS**

| Client : | Grower : | Report No: 15-218-0631 |
|---|---|---|
| Environmental & Turf Services, Inc. | Stuart Cohe | Cust No: 14930 |
| A/P | | Date Printed: 08/10/2015 |
| 11510 Georgia Ave | | Date Received : 08/06/2015 |
| Ste 227 | | PO: |
| Wheaton MD 20902 | | Page : 12 of 37 |

**Lab Number :** 11705 **Field Id :** **Sample Id :** 37748

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

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# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 13 of 37 |

**Lab Number :** 11705 **Field Id :** **Sample Id :** 37748

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 4.7 |
| Buffer pH | BPH | 6.91 |
| Phosphorus (P) | M3 | 3 ppm |
| Potassium (K) | M3 | 11 ppm |
| Calcium (Ca) | M3 | 1 ppm |
| Magnesium (Mg) | M3 | 15 ppm |
| Sulfur (S) | M3 | 11 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.2 ppm |
| Iron (Fe) | M3 | 304 ppm |
| Manganese (Mn) | M3 | 2 ppm |
| Zinc (Zn) | M3 | 0.1 ppm |
| Sodium (Na) | M3 | 6 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 1.2 % ENR 68 |
| Nitrate Nitrogen | NO3N | 2 ppm |

SOIL TEST RATINGS: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: **0.4** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 7.1 | 0 |
| Ca | 1.3 | 0 |
| Mg | 31.3 | 0.1 |
| H | 47.0 | 0.2 |
| Na | 6.5 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 0.04

| %Sand | %Silt | %Clay |
|---|---|---|
| 84.6 | 6.7 | 8.7 |

Textural Class: Loamy Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) LIME | (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 110 | | 3-4 | 3.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Fescue Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 150 | | 3-4 | 3.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Bentgrass Fairway**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Fescue Fairway**

Limestone application is targeted to bring soil pH to 6.2.

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 14 of 37 |

**Lab Number :** 11706 **Field Id :** **Sample Id :** 377812

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 5.4 |
| Buffer pH | BPH | 6.91 |
| Phosphorus (P) | M3 | 7 ppm |
| Potassium (K) | M3 | 18 ppm |
| Calcium (Ca) | M3 | 62 ppm |
| Magnesium (Mg) | M3 | 22 ppm |
| Sulfur (S) | M3 | 11 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.4 ppm |
| Iron (Fe) | M3 | 145 ppm |
| Manganese (Mn) | M3 | 6 ppm |
| Zinc (Zn) | M3 | 0.8 ppm |
| Sodium (Na) | M3 | 8 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 1.0 % ENR 64 |
| Nitrate Nitrogen | NO3N | 2 ppm |

SOIL TEST RATINGS: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: **0.8** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 5.8 | 0 |
| Ca | 38.8 | 0.3 |
| Mg | 22.9 | 0.2 |
| H | 28.6 | 0.2 |
| Na | 4.3 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 1.69

| %Sand | %Silt | %Clay |
|---|---|---|
| 84.6 | 8.7 | 6.7 |

Textural Class: Loamy Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass/Bluegrass green **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | | 4-6 | 2.0 | 6.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Bentgrass Tee **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Nitrate-nitrogen analysis will detect levels no lower than 2 ppm nitrate-nitrogen. Results that indicate undetected levels of nitrate-nitrogen will display 2 ppm or 4 lb/acre.**

**Bentgrass/Bluegrass green**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.5 to 0.75 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. If necessary, apply 0.25 lb of N/1000 sq ft per month during the summer. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Bentgrass Tee**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.5 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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**SOIL ANALYSIS**

| Client : | Grower : | Report No: 15-218-0631 |
|---|---|---|
| Environmental & Turf Services, Inc. | Stuart Cohe | Cust No: 14930 |
| A/P | | Date Printed: 08/10/2015 |
| 11510 Georgia Ave | | Date Received : 08/06/2015 |
| Ste 227 | | PO: |
| Wheaton MD 20902 | | Page : 15 of 37 |

**Lab Number :** 11706 **Field Id :** **Sample Id :** 377812

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

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# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 16 of 37 |

**Lab Number :** 11706 **Field Id :** **Sample Id :** 377812

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 5.4 |
| Buffer pH | BPH | 6.91 |
| Phosphorus (P) | M3 | 7 ppm |
| Potassium (K) | M3 | 18 ppm |
| Calcium (Ca) | M3 | 62 ppm |
| Magnesium (Mg) | M3 | 22 ppm |
| Sulfur (S) | M3 | 11 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.4 ppm |
| Iron (Fe) | M3 | 145 ppm |
| Manganese (Mn) | M3 | 6 ppm |
| Zinc (Zn) | M3 | 0.8 ppm |
| Sodium (Na) | M3 | 8 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 1.0 % ENR 64 |
| Nitrate Nitrogen | NO3N | 2 ppm |

SOIL TEST RATINGS: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: **0.8** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 5.8 | 0 |
| Ca | 38.8 | 0.3 |
| Mg | 22.9 | 0.2 |
| H | 28.6 | 0.2 |
| Na | 4.3 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 1.69

| %Sand | %Silt | %Clay |
|---|---|---|
| 84.6 | 8.7 | 6.7 |

Textural Class: Loamy Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Fescue Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 80 | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Bentgrass Fairway**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Fescue Fairway**

Limestone application is targeted to bring soil pH to 6.2.

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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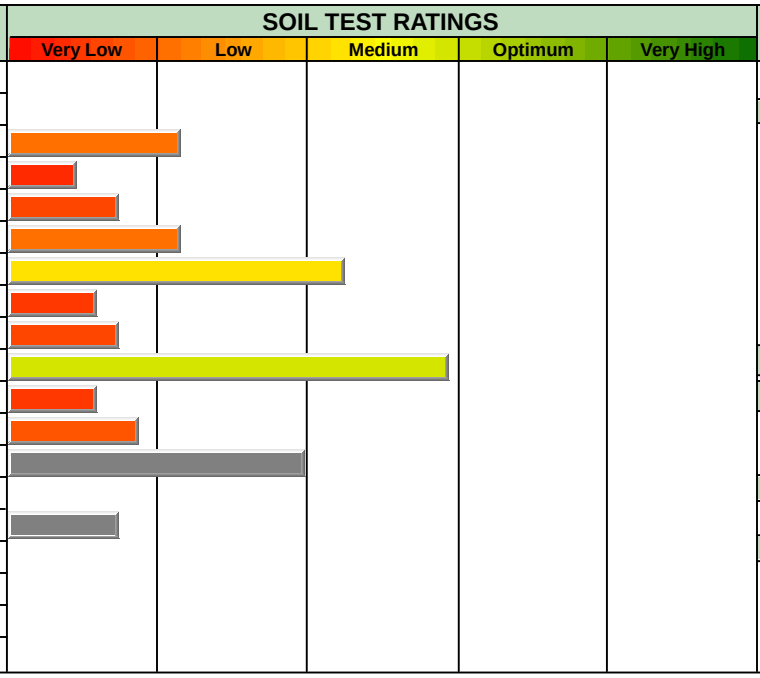
# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 17 of 37 |

**Lab Number :** 11707 **Field Id :** **Sample Id :** 377124

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 5.3 |
| Buffer pH | BPH | 6.92 |
| Phosphorus (P) | M3 | 5 ppm |
| Potassium (K) | M3 | 12 ppm |
| Calcium (Ca) | M3 | 11 ppm |
| Magnesium (Mg) | M3 | 16 ppm |
| Sulfur (S) | M3 | 13 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.3 ppm |
| Iron (Fe) | M3 | 95 ppm |
| Manganese (Mn) | M3 | 6 ppm |
| Zinc (Zn) | M3 | 0.5 ppm |
| Sodium (Na) | M3 | 4 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 1.3 % ENR 70 |
| Nitrate Nitrogen | NO3N | 2 ppm |




Calculated Cation Exchange Capacity: **0.3** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 10.3 | 0 |
| Ca | 18.3 | 0.1 |
| Mg | 44.4 | 0.1 |
| H | 35.4 | 0.1 |
| Na | 5.8 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 0.41

| %Sand | %Silt | %Clay |
|---|---|---|
| 38.6 | 32.7 | 28.7 |

Textural Class: Clay Loam

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass/Bluegrass green **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 50 | | 4-6 | 2.0 | 6.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Bentgrass Tee **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 50 | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Nitrate-nitrogen analysis will detect levels no lower than 2 ppm nitrate-nitrogen. Results that indicate undetected levels of nitrate-nitrogen will display 2 ppm or 4 lb/acre.**

**Bentgrass/Bluegrass green**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.5 to 0.75 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. If necessary, apply 0.25 lb of N/1000 sq ft per month during the summer. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Bentgrass Tee**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.5 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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**SOIL ANALYSIS**

| Client : | Grower : | Report No: 15-218-0631 |
|---|---|---|
| Environmental & Turf Services, Inc. | Stuart Cohe | Cust No: 14930 |
| A/P | | Date Printed: 08/10/2015 |
| 11510 Georgia Ave | | Date Received : 08/06/2015 |
| Ste 227 | | PO: |
| Wheaton MD 20902 | | Page : 18 of 37 |

**Lab Number :** 11707 **Field Id :** **Sample Id :** 377124

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

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# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 19 of 37 |

**Lab Number :** 11707 **Field Id :** **Sample Id :** 377124

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 5.3 |
| Buffer pH | BPH | 6.92 |
| Phosphorus (P) | M3 | 5 ppm |
| Potassium (K) | M3 | 12 ppm |
| Calcium (Ca) | M3 | 11 ppm |
| Magnesium (Mg) | M3 | 16 ppm |
| Sulfur (S) | M3 | 13 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.3 ppm |
| Iron (Fe) | M3 | 95 ppm |
| Manganese (Mn) | M3 | 6 ppm |
| Zinc (Zn) | M3 | 0.5 ppm |
| Sodium (Na) | M3 | 4 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 1.3 % ENR 70 |
| Nitrate Nitrogen | NO3N | 2 ppm |

SOIL TEST RATINGS: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: **0.3** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 10.3 | 0 |
| Ca | 18.3 | 0.1 |
| Mg | 44.4 | 0.1 |
| H | 35.4 | 0.1 |
| Na | 5.8 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 0.41

| %Sand | %Silt | %Clay |
|---|---|---|
| 38.6 | 32.7 | 28.7 |

Textural Class: Clay Loam

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 50 | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Fescue Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 90 | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Bentgrass Fairway**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Fescue Fairway**

Limestone application is targeted to bring soil pH to 6.2.

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 20 of 37 |

**Lab Number :** 11708 **Field Id :** **Sample Id :** 37804

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 6.2 |
| Buffer pH | | |
| Phosphorus (P) | M3 | 6 ppm |
| Potassium (K) | M3 | 6 ppm |
| Calcium (Ca) | M3 | 10 ppm |
| Magnesium (Mg) | M3 | 15 ppm |
| Sulfur (S) | M3 | 11 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.3 ppm |
| Iron (Fe) | M3 | 87 ppm |
| Manganese (Mn) | M3 | 4 ppm |
| Zinc (Zn) | M3 | 0.1 ppm |
| Sodium (Na) | M3 | 3 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 0.7 % ENR 58 |
| Nitrate Nitrogen | NO3N | 2 ppm |

**SOIL TEST RATINGS**: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: **0.2** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 7.7 | 0 |
| Ca | 25.0 | 0.1 |
| Mg | 62.5 | 0.1 |
| H | 13.9 | 0.0 |
| Na | 6.5 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 0.40

| %Sand | %Silt | %Clay |
|---|---|---|
| 88.9 | 4.5 | 6.6 |

Textural Class: Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass/Bluegrass green **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 4-6 | 2.0 | 6.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Bentgrass Tee **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Nitrate-nitrogen analysis will detect levels no lower than 2 ppm nitrate-nitrogen. Results that indicate undetected levels of nitrate-nitrogen will display 2 ppm or 4 lb/acre.**

**Bentgrass/Bluegrass green**

· MAINTENANCE: Apply 0.5 to 0.75 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. If necessary, apply 0.25 lb of N/1000 sq ft per month during the summer. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Bentgrass Tee**

· MAINTENANCE: Apply 0.5 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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**SOIL ANALYSIS**

| Client : | Grower : | Report No: 15-218-0631 |
|---|---|---|
| Environmental & Turf Services, Inc. | Stuart Cohe | Cust No: 14930 |
| A/P | | Date Printed: 08/10/2015 |
| 11510 Georgia Ave | | Date Received : 08/06/2015 |
| Ste 227 | | PO: |
| Wheaton MD 20902 | | Page : 21 of 37 |

**Lab Number :** 11708 **Field Id :** **Sample Id :** 37804

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 22 of 37 |

**Lab Number :** 11708 **Field Id :** **Sample Id :** 37804

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 6.2 |
| Buffer pH | | |
| Phosphorus (P) | M3 | 6 ppm |
| Potassium (K) | M3 | 6 ppm |
| Calcium (Ca) | M3 | 10 ppm |
| Magnesium (Mg) | M3 | 15 ppm |
| Sulfur (S) | M3 | 11 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.3 ppm |
| Iron (Fe) | M3 | 87 ppm |
| Manganese (Mn) | M3 | 4 ppm |
| Zinc (Zn) | M3 | 0.1 ppm |
| Sodium (Na) | M3 | 3 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 0.7 % ENR 58 |
| Nitrate Nitrogen | NO3N | 2 ppm |

SOIL TEST RATINGS: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: **0.2** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 7.7 | 0 |
| Ca | 25.0 | 0.1 |
| Mg | 62.5 | 0.1 |
| H | 13.9 | 0.0 |
| Na | 6.5 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 0.40

| %Sand | %Silt | %Clay |
|---|---|---|
| 88.9 | 4.5 | 6.6 |

Textural Class: Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME | (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Fescue Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Bentgrass Fairway**

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.
· Apply half of recommended phosphate in spring and again in fall.
· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.
· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Fescue Fairway**

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.
· Apply half of recommended phosphate in spring and again in fall.
· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.
· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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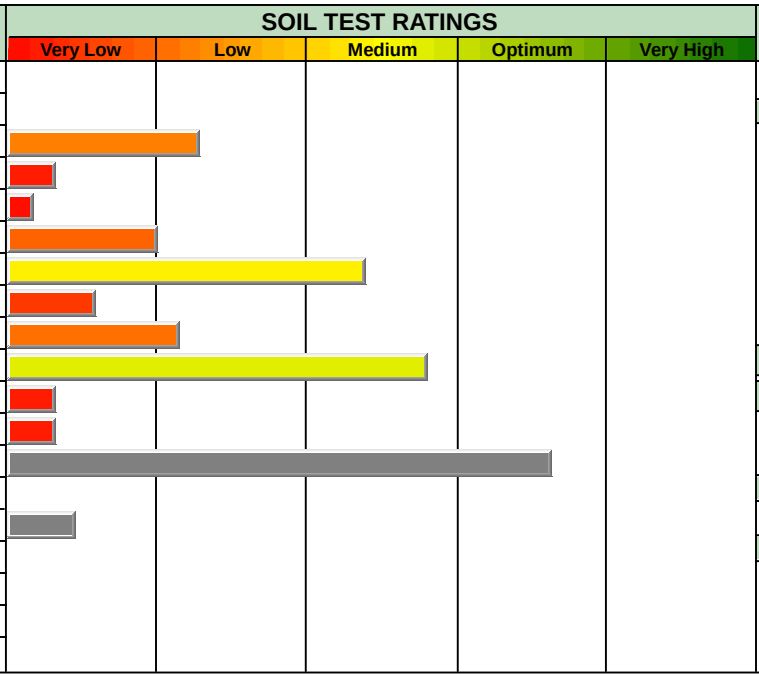
# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 23 of 37 |

**Lab Number :** 11709 **Field Id :** **Sample Id :** 37848

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 6.2 |
| Buffer pH | | |
| Phosphorus (P) | M3 | 7 ppm |
| Potassium (K) | M3 | 8 ppm |
| Calcium (Ca) | M3 | 1 ppm |
| Magnesium (Mg) | M3 | 14 ppm |
| Sulfur (S) | M3 | 15 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.4 ppm |
| Iron (Fe) | M3 | 91 ppm |
| Manganese (Mn) | M3 | 2 ppm |
| Zinc (Zn) | M3 | 0.1 ppm |
| Sodium (Na) | M3 | 6 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 0.6 % ENR 55 |
| Nitrate Nitrogen | NO3N | 2 ppm |




Calculated Cation Exchange Capacity: **0.2** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 10.3 | 0 |
| Ca | 2.5 | 0 |
| Mg | 58.3 | 0.1 |
| H | 11.5 | 0.0 |
| Na | 13.0 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 0.04

| %Sand | %Silt | %Clay |
|---|---|---|
| 88.9 | 4.5 | 6.6 |

Textural Class: Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass/Bluegrass green **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 4-6 | 2.0 | 6.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Bentgrass Tee **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Nitrate-nitrogen analysis will detect levels no lower than 2 ppm nitrate-nitrogen. Results that indicate undetected levels of nitrate-nitrogen will display 2 ppm or 4 lb/acre.**

**The sodium rating is high on this sample rather than optimum.**

**Bentgrass/Bluegrass green**

· MAINTENANCE: Apply 0.5 to 0.75 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. If necessary, apply 0.25 lb of N/1000 sq ft per month during the summer. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Bentgrass Tee**

· MAINTENANCE: Apply 0.5 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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**SOIL ANALYSIS**

| Client : | Grower : | Report No: 15-218-0631 |
|---|---|---|
| Environmental & Turf Services, Inc. | Stuart Cohe | Cust No: 14930 |
| A/P | | Date Printed: 08/10/2015 |
| 11510 Georgia Ave | | Date Received : 08/06/2015 |
| Ste 227 | | PO: |
| Wheaton MD 20902 | | Page : 24 of 37 |

**Lab Number :** 11709 **Field Id :** **Sample Id :** 37848

- If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

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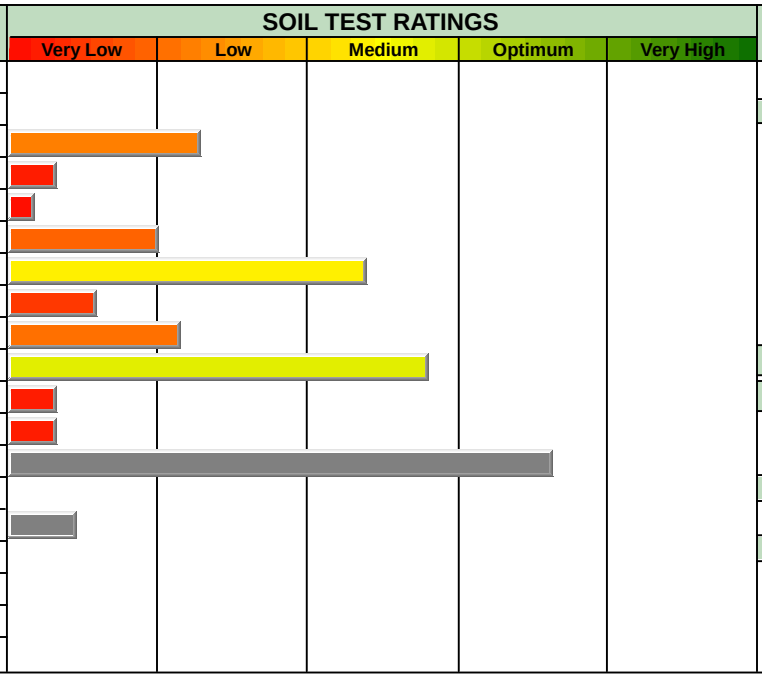
# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 25 of 37 |

**Lab Number :** 11709 **Field Id :** **Sample Id :** 37848

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 6.2 |
| Buffer pH | | |
| Phosphorus (P) | M3 | 7 ppm |
| Potassium (K) | M3 | 8 ppm |
| Calcium (Ca) | M3 | 1 ppm |
| Magnesium (Mg) | M3 | 14 ppm |
| Sulfur (S) | M3 | 15 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.4 ppm |
| Iron (Fe) | M3 | 91 ppm |
| Manganese (Mn) | M3 | 2 ppm |
| Zinc (Zn) | M3 | 0.1 ppm |
| Sodium (Na) | M3 | 6 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 0.6 % ENR 55 |
| Nitrate Nitrogen | NO3N | 2 ppm |




Calculated Cation Exchange Capacity: **0.2** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 10.3 | 0 |
| Ca | 2.5 | 0 |
| Mg | 58.3 | 0.1 |
| H | 11.5 | 0.0 |
| Na | 13.0 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 0.04

| %Sand | %Silt | %Clay |
|---|---|---|
| 88.9 | 4.5 | 6.6 |

Textural Class: Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Fescue Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Bentgrass Fairway**

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Fescue Fairway**

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 26 of 37 |

**Lab Number :** 11710 **Field Id :** **Sample Id :** 38004

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 4.2 |
| Buffer pH | BPH | 6.85 |
| Phosphorus (P) | M3 | 5 ppm |
| Potassium (K) | M3 | 25 ppm |
| Calcium (Ca) | M3 | 1 ppm |
| Magnesium (Mg) | M3 | 30 ppm |
| Sulfur (S) | M3 | 11 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.3 ppm |
| Iron (Fe) | M3 | 182 ppm |
| Manganese (Mn) | M3 | 1 ppm |
| Zinc (Zn) | M3 | 0.8 ppm |
| Sodium (Na) | M3 | 9 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 2.8 % ENR 100 |
| Nitrate Nitrogen | NO3N | 2 ppm |

SOIL TEST RATINGS: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: **1.2** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 5.3 | 0.1 |
| Ca | 0.4 | 0 |
| Mg | 20.8 | 0.3 |
| H | 69.6 | 0.8 |
| Na | 3.3 | 0 |

K/Mg Ratio: 0.33

Ca/Mg Ratio: 0.02

| %Sand | %Silt | %Clay |
|---|---|---|
| 88.9 | 8.5 | 2.6 |

Textural Class: Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass/Bluegrass green **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 160 | | 4-6 | 2.0 | 6.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Bentgrass Tee **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 160 | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Nitrate-nitrogen analysis will detect levels no lower than 2 ppm nitrate-nitrogen. Results that indicate undetected levels of nitrate-nitrogen will display 2 ppm or 4 lb/acre.**

**Bentgrass/Bluegrass green**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.5 to 0.75 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. If necessary, apply 0.25 lb of N/1000 sq ft per month during the summer. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Bentgrass Tee**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.5 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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Main 901.213.2400 º Fax 901.213.2440
www.waypointanalytical.com

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**SOIL ANALYSIS**

| Client : | Grower : | Report No: 15-218-0631 |
|---|---|---|
| Environmental & Turf Services, Inc. | Stuart Cohe | Cust No: 14930 |
| A/P | | Date Printed: 08/10/2015 |
| 11510 Georgia Ave | | Date Received : 08/06/2015 |
| Ste 227 | | PO: |
| Wheaton MD 20902 | | Page : 27 of 37 |

**Lab Number :** 11710 **Field Id :** **Sample Id :** 38004

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 28 of 37 |

**Lab Number :** 11710 **Field Id :** **Sample Id :** 38004

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 4.2 |
| Buffer pH | BPH | 6.85 |
| Phosphorus (P) | M3 | 5 ppm |
| Potassium (K) | M3 | 25 ppm |
| Calcium (Ca) | M3 | 1 ppm |
| Magnesium (Mg) | M3 | 30 ppm |
| Sulfur (S) | M3 | 11 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.3 ppm |
| Iron (Fe) | M3 | 182 ppm |
| Manganese (Mn) | M3 | 1 ppm |
| Zinc (Zn) | M3 | 0.8 ppm |
| Sodium (Na) | M3 | 9 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 2.8 % ENR 100 |
| Nitrate Nitrogen | NO3N | 2 ppm |

SOIL TEST RATINGS: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: **1.2** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 5.3 | 0.1 |
| Ca | 0.4 | 0 |
| Mg | 20.8 | 0.3 |
| H | 69.6 | 0.8 |
| Na | 3.3 | 0 |

K/Mg Ratio: 0.33

Ca/Mg Ratio: 0.02

| %Sand | %Silt | %Clay |
|---|---|---|
| 88.9 | 8.5 | 2.6 |

Textural Class: Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) LIME | (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 160 | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Fescue Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 200 | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Bentgrass Fairway**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Fescue Fairway**

Limestone application is targeted to bring soil pH to 6.2.

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 29 of 37 |

**Lab Number :** 11712 **Field Id :** **Sample Id :** 38048

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 5.5 |
| Buffer pH | BPH | 6.93 |
| Phosphorus (P) | M3 | 3 ppm |
| Potassium (K) | M3 | 6 ppm |
| Calcium (Ca) | M3 | 1 ppm |
| Magnesium (Mg) | M3 | 11 ppm |
| Sulfur (S) | M3 | 6 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.2 ppm |
| Iron (Fe) | M3 | 181 ppm |
| Manganese (Mn) | M3 | 1 ppm |
| Zinc (Zn) | M3 | 0.1 ppm |
| Sodium (Na) | M3 | 3 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 0.6 % ENR 55 |
| Nitrate Nitrogen | NO3N | 2 ppm |

SOIL TEST RATINGS: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: **0.2** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 7.7 | 0 |
| Ca | 2.5 | 0 |
| Mg | 45.8 | 0.1 |
| H | 22.0 | 0.0 |
| Na | 6.5 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 0.05

| %Sand | %Silt | %Clay |
|---|---|---|
| 92.9 | 4.5 | 2.6 |

Textural Class: Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass/Bluegrass green **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | | 4-6 | 3.0 | 6.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Bentgrass Tee **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | | 3-4 | 3.0 | 5.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Nitrate-nitrogen analysis will detect levels no lower than 2 ppm nitrate-nitrogen. Results that indicate undetected levels of nitrate-nitrogen will display 2 ppm or 4 lb/acre.**

**Bentgrass/Bluegrass green**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.5 to 0.75 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. If necessary, apply 0.25 lb of N/1000 sq ft per month during the summer. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Bentgrass Tee**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.5 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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**SOIL ANALYSIS**

| Client : | Grower : | Report No: 15-218-0631 |
|---|---|---|
| Environmental & Turf Services, Inc. | Stuart Cohe | Cust No: 14930 |
| A/P | | Date Printed: 08/10/2015 |
| 11510 Georgia Ave | | Date Received : 08/06/2015 |
| Ste 227 | | PO: |
| Wheaton MD 20902 | | Page : 30 of 37 |

**Lab Number :** 11712 **Field Id :** **Sample Id :** 38048

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 31 of 37 |

**Lab Number :** 11712 **Field Id :** **Sample Id :** 38048

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 5.5 |
| Buffer pH | BPH | 6.93 |
| Phosphorus (P) | M3 | 3 ppm |
| Potassium (K) | M3 | 6 ppm |
| Calcium (Ca) | M3 | 1 ppm |
| Magnesium (Mg) | M3 | 11 ppm |
| Sulfur (S) | M3 | 6 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.2 ppm |
| Iron (Fe) | M3 | 181 ppm |
| Manganese (Mn) | M3 | 1 ppm |
| Zinc (Zn) | M3 | 0.1 ppm |
| Sodium (Na) | M3 | 3 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 0.6 % ENR 55 |
| Nitrate Nitrogen | NO3N | 2 ppm |

SOIL TEST RATINGS: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: **0.2** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 7.7 | 0 |
| Ca | 2.5 | 0 |
| Mg | 45.8 | 0.1 |
| H | 22.0 | 0.0 |
| Na | 6.5 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 0.05

| %Sand | %Silt | %Clay |
|---|---|---|
| 92.9 | 4.5 | 2.6 |

Textural Class: Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) LIME | (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | | 3-4 | 3.0 | 5.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Fescue Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 70 | | 3-4 | 3.0 | 5.0 | 0.20 | 0.20 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Bentgrass Fairway**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Fescue Fairway**

Limestone application is targeted to bring soil pH to 6.2.

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 32 of 37 |

**Lab Number :** 11713 **Field Id :** **Sample Id :** 380812

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 5.4 |
| Buffer pH | BPH | 6.93 |
| Phosphorus (P) | M3 | 5 ppm |
| Potassium (K) | M3 | 8 ppm |
| Calcium (Ca) | M3 | 1 ppm |
| Magnesium (Mg) | M3 | 9 ppm |
| Sulfur (S) | M3 | 23 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.3 ppm |
| Iron (Fe) | M3 | 99 ppm |
| Manganese (Mn) | M3 | 1 ppm |
| Zinc (Zn) | M3 | 1.2 ppm |
| Sodium (Na) | M3 | 4 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 1.6 % ENR 76 |
| Nitrate Nitrogen | NO3N | 2 ppm |

SOIL TEST RATINGS: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: **0.2** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 10.3 | 0 |
| Ca | 2.5 | 0 |
| Mg | 37.5 | 0.1 |
| H | 23.5 | 0.0 |
| Na | 8.7 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 0.07

| %Sand | %Silt | %Clay |
|---|---|---|
| 88.9 | 6.5 | 4.6 |

Textural Class: Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass/Bluegrass green **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | | 4-6 | 2.0 | 6.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Bentgrass Tee **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Nitrate-nitrogen analysis will detect levels no lower than 2 ppm nitrate-nitrogen. Results that indicate undetected levels of nitrate-nitrogen will display 2 ppm or 4 lb/acre.**

**Bentgrass/Bluegrass green**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.5 to 0.75 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. If necessary, apply 0.25 lb of N/1000 sq ft per month during the summer. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Bentgrass Tee**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.5 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

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**SOIL ANALYSIS**

| Client : | Grower : | Report No: 15-218-0631 |
|---|---|---|
| Environmental & Turf Services, Inc. | Stuart Cohe | Cust No: 14930 |
| A/P | | Date Printed: 08/10/2015 |
| 11510 Georgia Ave | | Date Received : 08/06/2015 |
| Ste 227 | | PO: |
| Wheaton MD 20902 | | Page : 33 of 37 |

**Lab Number :** 11713 **Field Id :** **Sample Id :** 380812

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

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# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 34 of 37 |

**Lab Number :** 11713 **Field Id :** **Sample Id :** 380812

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 5.4 |
| Buffer pH | BPH | 6.93 |
| Phosphorus (P) | M3 | 5 ppm |
| Potassium (K) | M3 | 8 ppm |
| Calcium (Ca) | M3 | 1 ppm |
| Magnesium (Mg) | M3 | 9 ppm |
| Sulfur (S) | M3 | 23 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.3 ppm |
| Iron (Fe) | M3 | 99 ppm |
| Manganese (Mn) | M3 | 1 ppm |
| Zinc (Zn) | M3 | 1.2 ppm |
| Sodium (Na) | M3 | 4 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 1.6 % ENR 76 |
| Nitrate Nitrogen | NO3N | 2 ppm |

**SOIL TEST RATINGS**: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: **0.2** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 10.3 | 0 |
| Ca | 2.5 | 0 |
| Mg | 37.5 | 0.1 |
| H | 23.5 | 0.0 |
| Na | 8.7 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 0.07

| %Sand | %Silt | %Clay |
|---|---|---|
| 88.9 | 6.5 | 4.6 |

Textural Class: Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Fescue Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 80 | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Bentgrass Fairway**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Fescue Fairway**

Limestone application is targeted to bring soil pH to 6.2.

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

Waypoint ANALYTICAL
2790 Whitten Road, Memphis, TN 38133
Main 901.213.2400 º Fax 901.213.2440
www.waypointanalytical.com

"Every acre...Every year."™

# SOIL ANALYSIS

| Client : | Grower : | |
|---|---|---|
| Environmental & Turf Services, Inc.<br>A/P<br>11510 Georgia Ave<br>Ste 227<br>Wheaton MD 20902 | Stuart Cohe | Report No: 15-218-0631<br>Cust No: 14930<br>Date Printed: 08/10/2015<br>Date Received : 08/06/2015<br>PO:<br>Page : 35 of 37 |

**Lab Number :** 11714 **Field Id :** **Sample Id :** 380124

| Test | Method | Results |
|---|---|---|
| Soil pH | 1:1 | 5.3 |
| Buffer pH | BPH | 6.92 |
| Phosphorus (P) | M3 | 4 ppm |
| Potassium (K) | M3 | 5 ppm |
| Calcium (Ca) | M3 | 1 ppm |
| Magnesium (Mg) | M3 | 12 ppm |
| Sulfur (S) | M3 | 15 ppm |
| Boron (B) | M3 | 0.1 ppm |
| Copper (Cu) | M3 | 0.1 ppm |
| Iron (Fe) | M3 | 76 ppm |
| Manganese (Mn) | M3 | 1 ppm |
| Zinc (Zn) | M3 | 0.2 ppm |
| Sodium (Na) | M3 | 3 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 0.8 % ENR 60 |
| Nitrate Nitrogen | NO3N | 2 ppm |

SOIL TEST RATINGS: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: **0.2** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 6.4 | 0 |
| Ca | 2.5 | 0 |
| Mg | 50.0 | 0.1 |
| H | 29.4 | 0.1 |
| Na | 6.5 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 0.05

| %Sand | %Silt | %Clay |
|---|---|---|
| 88.9 | 6.5 | 4.6 |

Textural Class: Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass/Bluegrass green **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 50 | | 4-6 | 2.0 | 6.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Bentgrass Tee **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 50 | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Nitrate-nitrogen analysis will detect levels no lower than 2 ppm nitrate-nitrogen. Results that indicate undetected levels of nitrate-nitrogen will display 2 ppm or 4 lb/acre.**

**Bentgrass/Bluegrass green**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.5 to 0.75 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. If necessary, apply 0.25 lb of N/1000 sq ft per month during the summer. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Bentgrass Tee**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.5 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

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**SOIL ANALYSIS**

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| 11510 Georgia Ave | | Date Received : 08/06/2015 |
| Ste 227 | | PO: |
| Wheaton MD 20902 | | Page : 36 of 37 |

**Lab Number :** 11714 **Field Id :** **Sample Id :** 380124

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

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# SOIL ANALYSIS

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**Lab Number :** 11714 **Field Id :** **Sample Id :** 380124

| Test | Method | Results |
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| Buffer pH | BPH | 6.92 |
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| Copper (Cu) | M3 | 0.1 ppm |
| Iron (Fe) | M3 | 76 ppm |
| Manganese (Mn) | M3 | 1 ppm |
| Zinc (Zn) | M3 | 0.2 ppm |
| Sodium (Na) | M3 | 3 ppm |
| Soluble Salts | | |
| Organic Matter | LOI | 0.8 % ENR 60 |
| Nitrate Nitrogen | NO3N | 2 ppm |

SOIL TEST RATINGS: Very Low | Low | Medium | Optimum | Very High

Calculated Cation Exchange Capacity: **0.2** meq/100g

%Saturation

| | %sat | meq |
|---|---|---|
| K | 6.4 | 0 |
| Ca | 2.5 | 0 |
| Mg | 50.0 | 0.1 |
| H | 29.4 | 0.1 |
| Na | 6.5 | 0 |

K/Mg Ratio: 0.00

Ca/Mg Ratio: 0.05

| %Sand | %Silt | %Clay |
|---|---|---|
| 88.9 | 6.5 | 4.6 |

Textural Class: Sand

## SOIL FERTILITY GUIDELINES

**Crop :** Bentgrass Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| (lbs) | LIME | (tons) | N | $P_2O_5$ | $K_2O$ | Mg | S | B | Cu | Mn | Zn | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 50 | | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

**Crop :** Fescue Fairway **Yield Goal :** 1 Optimum **Rec Units:** LB/1000 SF

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 90 | | | 3-4 | 2.0 | 5.0 | 0.20 | 0 | 0.02 | 0.10 | 0.10 | 0.10 | |

Comments :

**Bentgrass Fairway**

Limestone application is targeted to bring soil pH to 6.0.

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

**Fescue Fairway**

Limestone application is targeted to bring soil pH to 6.2.

· MAINTENANCE: Apply 0.75 to 1 lb N/1000 sq ft in March, May, September, and November. Adjust N rate and timing to accomodate climatic conditions and management practices. If lower maintenance is desired, the May application can be eliminated.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index NO3N - Nitrate-N LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

# Appendix 14
# IMP for the Hills

## *Integrated Pest Management Plan: Hills at Southampton*

Integrated Pest Management Plans (IPM) set forth site specific goals and thresholds for pests that threaten the health of turfgrass and ornamental plantings. The Hills' ITHMP provide the management techniques to establish and maintain healthy dense turf. The IPM provides thresholds for insects, weeds and fungi presence and tolerable levels of damage that once exceeded results in the expected loss of turf.

Healthy, dense turf is the foundation of turf management goals set to reduce inputs, especially pesticides. There are several components to the Hills IPM strategies:

**Grow-in:** During the time period necessary to the establish golf course turf (grow-in period) turf areas are more susceptible to damage by biotic and abiotic factors, and recovery is much slower than older, mature turfs of like varieties. Furthermore there may be a correlation between the older turf's genetic responses to site specific conditions (light penetration, internal defense mechanisms to frequent pathogen attacks, population dynamics within the turf stand, etc.) that resulted in adaptations not found within a younger turf stand.

Therefore during grow-in the response to pest thresholds needs to be more flexible to provide conditions to permit the desired turf to survive and mature. It may not be feasible to predict the length of time required for plants to adapt, however a two-year growing season should provide an adequate turf root system and moderately good density.

Different areas of the golf course will exhibit various development stages during the grow-in period caused by shade, topography, planting date, planting methods, and golf course construction staging. One major issue may be weed control because imported soil amendments may not be weed free and on site native soils disturbed during construction will bring dormant seeds to the surface where germination is more likely.

Initially, insect damage is predicted to be less of a concern because there is currently no host turfs in the area. Post grow in this will change, with arrival of the more common pests: grubs, cut worms, sod worms, chinch bugs, and annual bluegrass weevil. A major concern within the preserved woodlands adjoining the course is the southern pine beetle and potential for significant and continued loss of pitch pine.

During the grow-in, the thresholds identified in Tables X-1 Weeds, X-2 – Insects AND X-3-Fungus will be used. The X-3 Fungus Table shows the response time expressed in hours that the golf course superintendent is required to analyze the turf problem and implement a cultural and mechanical method of treatment. The response times also establish a timeframe for the golf course superintendent to determine when an appropriate pesticide treatment is needed for control.

During the grow- in period, the list of pesticides available will be limited to the list provided in TABLE ___ of the ITHMP, with exception of pesticides listed with the USEPA as known carcinogens. The monitoring may be modified as dependent on pest life cycles and environmental conditions typically used in pest prediction and management (phenology, weather, season, models and sample analysis).

Priority of preventative and curative treatment pesticides will be

1. Biologicals (Bacillus, predatory nematodes, ) largely preventative
2. Category III pesticides.
3. Category II and Restrictive Use Category II pesticides, limited to fairways, tees and greens.
4. Category I pesticides for use as treatments to greens.

***Post Grow-in:***

Post grow-in IPM program monitoring, pest tolerance thresholds and treatment response times will remain the same as during the grow-in. The monitoring may be modified as dependent on pest life cycles and environmental conditions typically used in pest prediction and management (phenology, weather, season, models and sample analysis).
The priority of pesticide treatments will begin as:

1. Biologicals
2. Category III pesticides
3. Category II pesticides and Restrictive Use limited to greens and limited as spot treatments fairways and tees.
4. Category I pesticides limited to greens

The selection of pesticides will be further limited by excluding the following pesticides that were detected in groundwater samples collected at the Bridge and or Sebonack golf courses. The use of these pesticides will excluded from use on areas of tees, roughs and fairways:

Paclobutrazol
Triadimenol
Myclobutanil
Chlorothalonil,
Propiconazole-b
PCNB
Quinclorac (Not registered in NY)

Furthermore pesticides that have been classified as possible, probable, or likely carcinogenic to humans now or as classified in the future shall be avoided. This list includes:

| | |
|---|---|
| Bifenthrin | Pyrethroid insectide |
| Carbaryl | Carbamate insecticide |
| Tridiamefon | Fungicide |
| Propiconazole | Broad spectrum fungicide (DMI) |
| Iprodione | Broad spectrum fungicide |
| Prodiamine | Pre-emergent broadleaf control |
| Chlorthalonil | Broad spectrum fungicide |
| Etridiazole | Fungicide |

When no available control methods or treatments fail to provide results the golf course superintendent may consider the use of these products.

***Residential Areas:*** IPM programs within the common areas and residential lots provide for management using very low inputs with professional management by the golf course superintendent and course staff compared to the typical residential landscaper. The use of a Discovery Land formation of a Home Owner's Association permits management of turf and ornaments within residential home sites, common areas and undeveloped lands under established guidelines and covenants.

The developed sites will be monitored by the golf staff, and weekly inspections conducted to evaluate turf and ornamental plant conditions. The home sites landscape plans will include lawn areas comprised of endophytic tall fescues, Kentucky bluegrass/tall fescue mixes, planting beds with a mixture of native plants and cultivated ornamentals, and preservation of existing mature, healthy trees.

The IPM program, pest tolerance thresholds and treatment response times will remain the same as the golf course. The monitoring will be weekly depending on the pest life cycle and environmental conditions typically used in pest prediction and management (phenology, weather, season, models and sample analysis).
Residential and common areas will receive treatments in the following priority:

1. Biologicals
2. Category III pesticides

The non-golf low traffic areas will be established using endophytic tall and creeping fescues, maintained at an average height of 3-inches. Areas of high traffic and wear will be comprised of a mixture of Kentucky bluegrass, endophytic tall and creeping fescues, maintained at 3-inches.

The residential and common ground areas will use of pesticides that are USEPA Exempt (25 (b) FIFRA) weed control products for use at NYS school grounds and day care centers include:[1]

| **Pre-emergent:** | **Brand Names:** |
|---|---|
| Corn Gluten | Generic brands |
| | |
| **Post-emergent:** | |
| Cinnamon and cinnamon oil | Weed Zap |
| Citric acid | Burnot II |
| Citric acid, malic acid and clove oil | Phydura |
| Cloves and garlic oil | Matran EC |
| Eugenol | EcoSmart Weed & Grass Killer |
| Sodium chloride | Adios |
| 2- Phenethyl propionate | 2-Phenethyl propionate |

[2] Rossi, F. Grant, J. 2015-16 Cornell Pest Management Guidelines for Commercial Turfgrass, Cornell University, Ithaca, NY.

When the superintendent determines the residential and common areas require an "emergency treatment" the following reduced risk pesticides will be available:

| | |
|---|---|
| Citrus Oil (d-limonene) | Avenger |
| Iron HEDTA | Fiesta (selective broadleaf control) |
| Pelargonic acid | Scythe |
| Potassium salts of fatty acids | Safer Brand Fast Acting Weed & Grass Killer |

One concern with reduced risk herbicides and EPA exempt products is their inability to provide a selective control with exception of (Iron HEDTA). Each product requires the applicator to treat a specific plant or area to avoid phyto-toxicity on non-target plants.

**Nutrient Planning**

The Hills golf course will be a regulated activity pursuant to the Suffolk County 'Fertilizer Law" and specifically the following sections of the law pertaining to applications of fertilizer:

***Local Law NO. 41 -2007, Suffolk County, New York***
***A Local Law to Reduce Nitrogen Pollution by Reducing Use of Fertilizer in Suffolk County***

**Section 3. Prohibitions.**

A.) Fertilizer shall not be applied to County owned real property, except as authorized under Section 8 of this law.

B.) Fertilizer shall not be applied to any turf on any non-County owned real property any non-County owned real property by any person between November 1 and April 1 of every year, except as authorized by Section 8 of this law.

**Section 8. Exemptions.**

B.) Section 3(A) of this law shall not apply to:

i.) Golf courses, provided, however, that only the minimum amount of slow-release and organic fertilizer shall be used that is needed to sustain healthy turf on golf courses, and that fertilizer application rates shall be limited to 3 lbs. of nitrogen/1000 sq. ft. per year, over the golf course as a whole, consistent with the Organic Maintenance Plan adopted via Suffolk County Resolution No. 608-1998.

The Hills golf course will receive supplemental nitrogen from its irrigation water, which is calculated to contain 15 ppm of N. Based on an estimated use of 20 MG per year of irrigation applied to the playing areas of the golf course, the annual quantity of N derived from irrigation applied to the 78 acres of golf course managed turf area is 2,502 pounds, equivalent to 0.74 pounds of nitrogen per 1000 square feet of turf area (expressed as 0.74 # N/1000 SF).

In geographic areas where there is concern for nitrogen leaching and nitrogen laden runoff contamination to ground and surface water resources such as Suffolk and Nassau Counties in New York and Cape Cod and Martha's Vineyard, Massachusetts, regulations limit the annual nitrogen applications on turf to 3 #N/1000 SF.

At the Hills golf course this limit would be reduced to 2.26 #N/1000 SF because of the annual amount of applied irrigation water.

The maximum limits of applied nitrogen and sources are:

| Turf | Irrigation # N/1000 SF | Supplemental # N/1000 SF | Total # N per Year/1000 SF |
|---|---|---|---|
| Greens | 0.74 | 2.26 | 3.0 |
| Tees | 0.74 | 2.26 | 3.0 |
| Fairways | 0.74 | 2.26 | 3.0 |
| Roughs | 0.74 | 1.76 | 2.5 |
| Native Areas | 0.00 | 0.00 | 0.00 |

The supplemental nitrogen application rates will not exceed 0.5 #N/1000 SF in any single application. The greens will receive more frequent applications at low rates (0.25 # N/1000 SF or less). Tees will also receive frequent applications at low rates because of divot repairs especially to the par 3 holes. Fairways and roughs will receive higher rates, less frequently. A typical yearly application of nitrogen during the operating season can be described as:

Greens- 17 applications; Tees-10 applications; Fairways-4 applications; Roughs 4 applications.

Residential and non-golf common areas are expected to mimic golf course roughs fertilizer application frequency and rates. Liquid forms of fertilizers have become desirable for golf course turfs because applications of low rates are more accurately controlled through fertigation systems or by turf sprayer equipment. These types of application equipment can deliver other nutrients, plant bio-stimulants and turf inputs (auxins, amino acids, cytokinins, iron, soil microbes, humic acid, wetting agents, etc.).

Long term use of the fertigation system will be practical and desirable for the turf management because of the nitrogen supplied by the irrigation system and the ability to adjust the fertigation mixing tanks to deliver a more precise amount (calibrations to deliver 0.01 pounds nitrogen per 1000 SF is common) of supplemental nutrients than can be expected from rotary or drop spreaders using granular forms of plant nutrients.

***IPM TABLE 1 Pest Thresholds: The Hills at Southampton***

| ***Weeds*** | **Location** | **Threshold per 1800 SF** | **Monitoring Method(s)** | **Monitoring Frequency** | **Cultivation Treatment** | **Mechanical Treatment** | **Chemical Treatment** |
|---|---|---|---|---|---|---|---|
| ***Annul Bluegrass*** | Tees | 10 | Visual & Counts | Early Spring to Fall Daily | | Collect Seeds in Mower Baskets | Post Emerg Seedhead Controls |
| | Greens | 1 | Visual & Counts | Early Spring to Fall Daily | Reduce Water & P Hand Weed Use Dense Bentgrass | Collect Seeds in Mower Baskets | Post Emerg Seedhead Controls |
| | Bunkers & Fairways | 10 | Visual & Counts | Spring/Fall Twice Weekly | Solid Tine Aeartion Reduce Water | Spring-Collect Seeds in Mower Baskets | At Grow-in Pre & Post Emerg Seedhead Controls |
| | Roughs | 20 | Visual & Counts | Spring/Fall Once Weekly | Overseed with Fescue | Sweep Clippings after Mowing | |
| ***Barnyardgrass*** | Tees | 5 | Visual & Counts | Daily | Hand Weed Spot Seed | Collect Seeds in Mower Baskets | Post-Spot Treat |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed Spot Seed | Collect Seeds in Mower Baskets | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed Spot Seed | Use Hoover Mowers at Bunkers | Pre & Post Spot Treat |
| | Roughs | 10 | Visual & Counts | Weekly | Hand Weed | Raise Mow Height to Shade Out Weed | Post Spot Treat |
| ***Goosegrass*** | Tees | 5 | Visual & Counts | Late Spring To First Frost Twice Weeksly | Aerate & Hand Weed Spot Seed | Collect Seeds in Mower Baskets | Pre & Post Spot Treat |
| | Greens | 1 | Visual & Counts | Late Spring To First Frost Twice Weeksly | Aerate & Hand Weed Spot Seed | Collect Seeds in Mower Baskets | Post-Spot Treat |
| | Bunkers & Fairways | 10 | Visual & Counts | Late Spring To First Frost Twice Weekly | Increase Water, Maintain Nutrients, Aerate & Hand Weed Spot Seed | Use Hoover Mowers at Bunkers | Use Phenology for Pre Apps & Post Spot Treat |
| | Roughs | 20 | Visual & Counts | Late Spring To First Frost Twice Weekly | Aerate & Hand Weed Spot Seed | Raise Mow Height to Shade Out Weed | Pre & Post Spot Treat |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Green Foxtail*** | Tees | 5 | Visual & Counts | Daily | Hand Weed Spot Seed | Low Mow Height to Shear off Weed | Post-Spot Treat |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed Spot Seed | Raise Mow Height to Shade Out Weed | Pre & Post Spot Treat |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed Spot Seed | Raise Mow Height to Shade Out Weed | Pre & Post Spot Treat |
| ***Crabgrass*** | Tees | 5 | Visual & Counts | Daily | Aerate & Hand Weed Spot Seed | Improve Water Coverage | Post-Spot Treat |
| | Greens | 1 | Visual & Counts | Daily | Aerate & Hand Weed Spot Seed | | |
| | Bunkers & Fairways | 5 | Visual & Counts | Late Spring To First Frost Twice Weekly | Increase Water, Maintain Nutrients, Aerate & Hand Weed Spot Seed | Raise Mower Height - Improve Water Coverage | Use Phenology for Pre Apps & Post Spot Treat |
| | Roughs | 20 | Visual & Counts | Late Spring To First Frost Twice Weekly | Aerate & Hand Weed Spot Seed | Raise Mow Height to Shade Out Weed | Use Phenology for Pre Apps & Post Spot Treat |
| ***Purple Top*** | Tees | 5 | Visual & Counts | Daily | Hand Weed Spot Seed | Low Mow Height to Shear off Weed | Post Spot Treat |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed Spot Seed | Use Hoover Mowers at Bunkers | Pre at Grow-in & Post Spot Treat |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed Spot Seed | Raise Mow Height to Shade Out Weed | At Grow-in Pre & Post Spot Treat |
| ***Quackgrass*** | Tees | 5 | Visual & Counts | Daily | Aerate & Hand Weed Spot Seed | Improve Water Coverage | Pre-treat at Grow-in |
| | Greens | 1 | Visual & Counts | Daily | Aerate & Hand Weed Spot Seed | Collect Seeds in Mower Baskets | Pre-treat at Grow-in |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Increase Water, Maintain Nutrients, Aerate & Hand Weed Spot Seed | Improve Water Coverage | Use Phenology for Pre Apps & Post Spot Treat |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Small Crabgrass*** | Roughs | 20 | Visual & Counts | Weekly | Aerate & Hand Weed Spot Seed | Raise Mow Height to Shade Out Weed | Pre-treat at Grow-in |
| | Tees | 1 | Visual & Counts | Daily | Aerate & Hand Weed Spot Seed | Low Mow Height to Shear off Weed | Pre-treat at Grow-in |
| | Greens | 1 | Visual & Counts | Daily | Aerate & Hand Weed Spot Seed | Low Mow Height to Shear off Weed | Pre-treat at Grow-in |
| | Bunkers & Fairways | 5 | Visual & Counts | Weekly | Aerate & Hand Weed Spot Seed | Raise Mow Height to Shade Out Weed | Use Phenology for Pre Apps & Post Spot Treat |
| ***Timothy*** | Roughs | 10 | Visual & Counts | Weekly | Aerate & Hand Weed Spot Seed | Raise Mow Height to Shade Out Weed | Pre-treat at Grow-in |
| | Tees | 5 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| ***Yellow Foxtail*** | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Raise Mow Height to Shade Out Weed | |
| | Tees | 5 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Post Spot Treat |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | Post Spot Treat |
| ***Purple Nut Sedge*** | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Raise Mow Height to Shade Out Weed | |
| | Tees | 5 | Visual & Counts | Daily | Hand Weed & Spot Seed | Add Drainage | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | | Hand Weed & Spot Seed | Add Drainage | Spot Treat Post Emergent |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Edge Bunkers & Remove Runners | Apply Less Water Improve Drainage | Spot Treat Post Emergent |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Roughs | 50 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Raise Mow Height to Shade Out Weed | |
| ***Black Medic*** | Tees | 5 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Roughs | 50 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Raise Mow Height to Shade Out Weed | |
| ***Broadleaf Plantain*** | Tees | 3 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Raise Mow Height to Shade Out Weed | |
| ***Chickweed*** | Tees | 3 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Post Spot Treat |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | |
| ***Common Speedwell*** | Tees | 5 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | | Spot Treat Post Emergent |
| | Roughs | 50 | Visual & Counts | | Hand Weed & Spot Seed | Raise Mow Height to Shade Out Weed | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Clover*** | Tees | 3 | Visual & Counts | Daily | Maintain Nutrients, Aerate & Hand Weed Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Maintain Nutrients, Aerate & Hand Weed Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Maintain Nutrients, Aerate & Hand Weed Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Aerate & Hand Weed Spot Seed | Raise Mow Height to Shade Out Weed | |
| ***Curly Dock*** | Tees | 3 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Raise Mow Height to Shade Out Weed | |
| ***Dandelion*** | Tees | 3 | Visual & Counts | Daily | Hand Weed & Spot Seed | | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Lower Mow Height to Shear Off Weed | |
| ***Ground Ivy*** | Tees | 3 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Heal All*** | Tees | 5 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | | |
| ***Henbit*** | Tees | 5 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | |
| ***Knotweed*** | Tees | 5 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | |
| ***Lambsquater*** | Tees | 3 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | | | |
| ***Mallow*** | Tees | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Bunkers & Fairways | 5 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Roughs | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | |
| ***Mouse-ear Chickweed*** | Tees | 3 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | | |
| ***Nodding Spurge*** | Tees | 3 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Aerate, Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | |
| ***Oxalis*** | Tees | 5 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | |
| ***Pearlwort*** | Tees | 1 | Visual & Counts | Daily | Reduce Water, Hand Weed & Spot Seed | | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Reduce Water, Hand Weed & Spot Seed | | Spot Treat Post Emergent |
| | Bunkers & Fairways | 5 | Visual & Counts | Weekly | Hand Weed & Spot Seed | | Spot Treat Post Emergent |
| | Roughs | 10 | Visual & Counts | Weekly | | | |
| ***Plantain*** | Tees | 3 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Roughs | 15 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | |
| ***Poison Ivy*** | Tees | 1 | Visual & Counts | Daily | Spot Seed Post Control | Mow Off | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Spot Seed Post Control | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Bunkers & Fairways | 1 | Visual & Counts | Weekly | Spot Seed Post Control | Mow Off | Spot Treat Post Emergent |
| | Roughs | 5 | Visual & Counts | Weekly | Spot Seed Post Control | Mow Off | Spot Treat Post Emergent |
| ***Poison Oak*** | Greens | 1 | Visual & Counts | Daily | Spot Seed Post Control | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Tees | 1 | Visual & Counts | Daily | Spot Seed Post Control | Mow Off | Spot Treat Post Emergent |
| | Bunkers & Fairways | 1 | Visual & Counts | Weekly | Spot Seed Post Control | Mow Off | Spot Treat Post Emergent |
| | Roughs | 5 | Visual & Counts | Weekly | Spot Seed Post Control | Mow Off | Spot Treat Post Emergent |
| ***Purslane Speedwell*** | Tees | 3 | Visual & Counts | Daily | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | |
| ***Prostate Spurge*** | Tees | 3 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Prostate Pigweed*** | Tees | 3 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | | |
| ***Red Clover*** | Tees | 3 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Aerate & Maintain Nutrient Levels | Mow Off | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Raise Mow Height to Shade Out Weed | |
| ***Sheep Sorrel*** | Tees | 3 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 15 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Roughs | 30 | Visual & Counts | Weekly | Spot Seed Post Control | Mow Off | |
| ***Shepards Purse*** | Tees | 5 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | |
| ***Spotted Spurge*** | Tees | 3 | Visual & Counts | Daily | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | |
| ***Stichwort*** | Tees | 5 | Visual & Counts | Daily | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | |
| ***Yarrow*** | Tees | 3 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 10 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | |
| ***Yellow Wood Sorrel*** | Tees | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Greens | 1 | Visual & Counts | Daily | Hand Weed & Spot Seed | Low Mow Height to Shear off Weed | |
| | Bunkers & Fairways | 5 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | Spot Treat Post Emergent |
| | Roughs | 20 | Visual & Counts | Weekly | Hand Weed & Spot Seed | Mow Off | |

***IPM TABLE 2 Pest Thresholds: The Hills at Southampton***

| Insects | Area | Insect Density for Cultural Control | Insect Density for Curative Control | Monitoring Method | Comments |
|---|---|---|---|---|---|
| ***Annual Bluegrass Weevil*** | Greens/Tees<br>Fairways<br>Roughs | 3-5/SF<br>5-8/SF<br>5-8/SF | 6/SF<br>8/SF<br>8/SF | Phenology Visual Traps & Larve Counts<br>Watch for Activity in<br>Rough Edges At Fairway In Spring | Often Multiple Generations<br>Watch for Resistance |
| ***Ant Mounds*** | Greens/Tees<br>Fairways<br>Roughs | 1-2/SY<br>NA<br>NA | 3/SY<br>NA<br>NA | Visual | |
| ***Cutworms*** | Greens/Tees<br>Fairways<br>Roughs | 1-2/SF<br>2-3/SF<br>3-4/SF | 3/SF<br>4/SF<br>5/SF | Visual<br>Watch for activity on Greens Post Aeration | |
| ***Bluegrass Bill Bug Larve*** | Greens/Tees<br>Fairways<br>Roughs | NA<br>3-4/SF<br>4-8/SF | NA<br>6/SF<br>10/SF | Visual | |
| ***Hairy Chinch Bug*** | Greens/Tees<br>Fairways<br>Roughs | 10-15/SF<br>15-25/SF<br>26-30/SF | 12-16/SF<br>25-30/SF<br>30-35/SF | Visual | |
| ***Sod Worms*** | Greens/Tees<br>Fairways<br>Roughs | 1-2/SF<br>3-4/SF<br>5-6/SF | 3/SF<br>5/SF<br>7/SF | Visual | |
| ***Black Turfgrass Ataenius*** | Greens/Tees<br>Fairways<br>Roughs | 20-25/SF<br>30-35/SF<br>50-60/SF | 30/SF<br>40/SF<br>60/SF | Visual | |
| ***Japanese Beetle & Annual Grubs*** | Greens/Tees<br>Fairways<br>Roughs | 3-4/SF<br>5-8/SF<br>8-10/SF | 4/SF<br>8/SF<br>10/SF | Visual Below Turf Surface<br>Watch for Predator Damage | |

***IPM TABLE 3 Pest Thresholds: The Hills at Southampton***

| Pest | Area | Cultural Management | Chemical Control | Monitoring & Comments |
|---|---|---|---|---|
| ***Moss*** | Tees/Greens<br>Fairways<br>Roughs | Improve Drainage<br>Increase N<br>Reduce Water<br>Reduce Shade<br>Improve Air Circulation | Baking Soda<br>Cafentrazone<br>Spot Treat | Visual |
| ***Necrotic Ring*** | Tees/Greens<br>Fairways<br>Roughs | 24-48 hrs<br>24-48 hrs<br>48-72 hrs | Aerate Spot Treat | Visual |
| ***Nematodes*** | Tees/Greens<br>Fairways<br>Roughs | Sample Counts<br>Sample Counts<br>Sample Counts | Needle > 200/100 cc Soil<br>Lance> 200/100 cc Soil<br>Stunt> 800/100 cc Soil<br>Spiral> 3,000/100 cc Soil<br>Ring> 3,000/100 cc Soil | Lab Tests |
| ***Pink Patch*** | Tees/Greens<br>Fairways<br>Roughs | 24-48 hrs<br>24-48 hrs<br>48-72 hrs | Spot Treat<br>Preventative<br>Preventative | |
| ***Powdery Mildew*** | Tees/Greens<br>Fairways<br>Roughs | 24-48 hrs<br>24-48 hrs<br>48-72 hrs | Spot Treat<br>Spot Treat<br>Spot Treat | |
| ***Pythium Blight*** | Tees/Greens<br>Fairways<br>Roughs | Upon Detection<br>Upon Detection<br>24-48 hrs | Preventative<br>24-48 hrs<br>48-72 hrs | Improve Drainage<br>Reduce Water & Shade |
| ***Red Thread*** | Tees/Greens<br>Fairways<br>Roughs | 24-48 hrs<br>24-48 hrs<br>120 hrs | 72 hrs<br>96 hrs<br>Spot Treat | |
| ***Slime Mold*** | Tees/Greens<br>Fairways<br>Roughs | Upon Detetion<br>24-48 hrs<br>48-72 hrs | Spot Treat<br>Spot Treat<br>Spot Treat | |
| ***Snow Molds*** | Tees/Greens<br>Fairways<br>Roughs | Upon Detection<br>Upon Defaction<br>Rake Out | Preventative<br>Preventative<br>Spot Treat | Reduce Fall N<br>Improve Drainage |
| ***Summer Patch*** | Tees/Greens<br>Fairways<br>Roughs | 24-48 hrs<br>48-72 hrs<br>48-72 hrs | Spot Treat<br>Spot Treat<br>Spot Treat | |

| Pest | Area | Cultural Management | Chemical Control | Monitoring & Comments |
|---|---|---|---|---|
| ***Take All Patch*** | Tees/Greens | Upon Detection | Spot Treat | Reduce Stress |
| | Fairways | Upon Detection | Spot Treat | Raise Mow Height |
| | Roughs | Upon Detection | Spot Treat | |
| ***Anthracnose*** | Tees/Greens | Upon Detection | Spot Treat | |
| | Fairways | 48-72 hrs | 96 hrs | |
| | Roughs | 48-72 hrs | 96 hrs | |
| ***Bacterial Wilt*** | Tees/Greens | 24-48 hrs | 72 hrs | |
| | Fairways | 24-48 hrs | 96 hrs | |
| | Roughs | 48-72 hrs | 120 hrs | |
| ***Brown Patch*** | Tees/Greens | Upon Detection | Spot Treat | Preventative |
| | Fairways | 24-48 hrs | 72 hrs | Reduce N Use Resistant |
| | Roughs | 48-72 hrs | 96 hrs | Cultivars |
| ***Copper Spot*** | Tees/Greens | Upon Detection | Spot Treat | |
| | Fairways | 24-48 hrs | 72 hrs | |
| | Roughs | 48-72 hrs | 96 hrs | |
| ***Crown & Root Rot*** | Tees/Greens | Upon Detection | Spot Treat | Maintain Correct Water |
| | Fairways | 24-48 hrs | 72 hrs | Improve Drainage |
| | Roughs | 48-72 hrs | 96 hrs | |
| ***Dollar Spot*** | Tees/Greens | 24-48 hrs | Spot Treat | Remove Dew Use Biologicals |
| | Fairways | 24-48 hrs | 72 hrs | Reduce Shade |
| | Roughs | 48-72 hrs | 96 hrs | Top Dress & Roll |
| | | | | Civatas plus Fungicide |
| | | | | Maintain N |
| ***Downy Mildew*** | Tees/Greens | 24-48 hrs | Spot Treat | |
| | Fairways | 24-48 hrs | 72 hrs | |
| | Roughs | 48-72 hrs | 120 hrs | |
| ***Fairy Ring*** | Tees/Greens | 24-48 hrs | Spot Treat | Aerate Area prior to Treatment |
| | Fairways | 24-48 hrs | 96 hrs | |
| | Roughs | 48-72 hrs | 120 hrs | |
| ***Fusarium Patch*** | Tees/Greens | 24-48 hrs | Spot Treat | |
| | Fairways | 24-48 hrs | Spot Treat | |
| | Roughs | 48-72 hrs | 96 hrs | |
| ***Helminthosporium Leaf Spot*** | Tees/Greens | 24-48 hrs | Spot Treat | Reduce N Reduce Mowing |
| | Fairways | 24-48 hrs | Spot Treat | |
| | Roughs | 48-72 hrs | 96 hrs | |

| Pest | Area | Cultural Management | Chemical Control | Monitoring & Comments |
|---|---|---|---|---|
| ***Leaf Rust*** | Tees/Greens | 24-48 hrs | Spot Treat | |
| | Fairways | 24-48 hrs | Spot Treat | |
| | Roughs | 48-72 hrs | 96 hrs | |
| ***Melting Out*** | Tees/Greens | 24-48 hrs | Spot Treat | |
| | Fairways | 24-48 hrs | Spot Treat | |
| | Roughs | 48-72 hrs | Spot Treat | |

| *IMP TABLE 4 Insect Activity for Suffolk County* | *Jan* | *Feb* | *Mar* | *Apr* | *May* | *Jun* | *Jul* | *Aug* | *Sept* | *Oct* | *Nov* | *Dec* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Annual Bluegrass Weevil** | | | | | | | | | | | | |
| **Ants** | | | | | | | | | | | | |
| **Black Cutworm** | | | | | | | | | | | | |
| **Hairy Chinchbug** | | | | | | | | | | | | |
| **Bluegrass Sod Worm** | | | | | | | | | | | | |
| **Asiatic Garden Beetle** | | | | | | | | | | | | |
| **Large Sod Worm** | | | | | | | | | | | | |
| **Black Turfgrass Ataenius** | | | | | | | | | | | | |
| **Japanese Beetle** | | | | | | | | | | | | |
| **June Bug** | | | | | | | | | | | | |
| **Northen Masked Chafer** | | | | | | | | | | | | |
| **Oriental Beetle** | | | | | | | | | | | | |
| **Winter Grain Mite** | | | | | | | | | | | | |
| **Bluegrasss Billbug** | | | | | | | | | | | | |

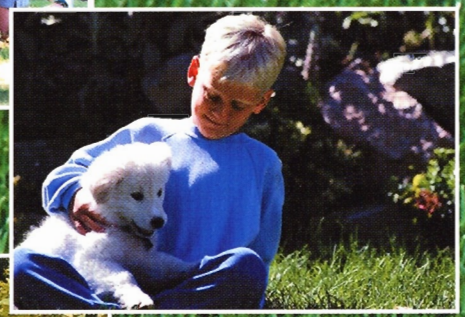
**Possible Occurance**

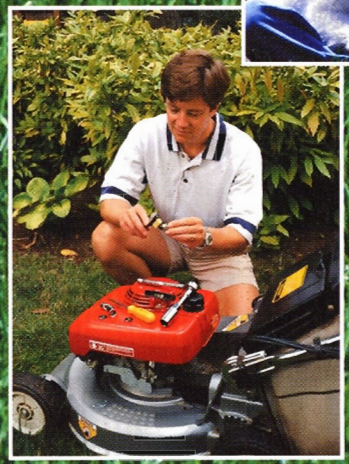
**Probable Occurance**

**Common Occurance**

Source: Golf at the Bridge DEIS

# Appendix 15
# Lawn Care without Pesticides, Rossi





Information Bulletin 248

# Lawn Care without Pesticides

Frank Rossi, Ph.D.

Cornell University
Cooperative Extension

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## Part I. Where to Start

# It Can Be Done

Chances are, you can grow a pretty good lawn without using insecticides, fungicides, or herbicides. You may even be able to do it using little or no chemical fertilizer, if that's your goal. Will your lawn look like a putting green? No. Will it stand up to wear and tear like a professionally managed soccer field? Not a chance. Will it stay emerald green through the dog days of summer? Probably not. But if you arm yourself with an understanding of what grasses need to thrive—and commit to a long-term plan to meet those needs—you can grow a perfectly acceptable lawn while foregoing lawn chemicals.

Even if you don't want to give up using lawn chemicals completely, this publication will help you get by with fewer pesticides. Either way, our goal is to help your lawn thrive because well-managed lawns are an environmental asset, not a liability (see "Why Lawns Matter," page 7).

Keep in mind, this publication was written with New York State lawns in mind. This approach can be adapted to areas with similar conditions, but the more your conditions differ from ours, the more important it is that you gather sound information. A good place to start is with your state's cooperative extension services. Chances are, there is an office in your county. Find your local office at **www.csrees.usda.gov/Extension**.

## Decide What You Want to Do

The main theme of this publication is that if you do everything possible to reduce the stress on your grass plants—help them thrive—you will have a better lawn. The grass plants will grow stronger, stand up better to weeds, and be more resistant to insects and diseases. Consequently, you will need fewer lawn chemicals. Or, if you don't use lawn chemicals at all, you will have a healthier, better-looking lawn.

But not all lawn chemicals are the same. The insecticides and fungicides used to control insect pests and fungal diseases will probably be easiest to give up. (Most insecticides applied to home lawns are either unneeded or ineffective anyway because they are applied at the wrong time or to the wrong pest.) In recent years, the more dangerous insecticides and fungicides have been taken off the market for homeowners. But some consumers have lingering concerns about the health and environmental effects of certain products that are still available.

In general, chemical fertilizers sold for use on lawns aren't as dangerous. (Caution: Some products are a mix of fertilizers and insecticides or herbicides and may pose more of a hazard than fertilizer alone.) True, many people use way too much fertilizer. And over-application or misapplication can result in fertilizers polluting waterways and wells in addition to weakening your grass. But smaller amounts of chemical fertilizer used judiciously can solve other problems by helping your grass outcompete weeds and resist pests and diseases.

Just as a little fertilizer can help grass thrive, a carefully timed herbicide application or an occasional spot spray in a trouble area may go a long way toward reducing weed problems in the long run. But you can easily do without these chemicals—as long as you don't expect to have a totally weed-free lawn.

So what exactly do you want to do? Turn your neglected lawn into a greener place? Eliminate all lawn chemicals and fertilizers immediately? Cut back on all of them gradually? Eliminate insecticides, herbicides, and fungicides but still use some fertilizers? How far you go is up to you. The principles and practices you learn from this publication will help no matter which chemicals you want to give up and how fast you want to do it.

If you rely on a lawn care service, talk with them after you read this publication and see if they can adapt their lawn program to fit your needs. If not, find one that can. Many larger urban areas have services that specialize in environmentally sound lawn care. Another alternative might be to hire a neighborhood youth who is willing to work under your direction.

## The Most Important Step

Read "How Grass Grows" (page 8) and understand these simple concepts. Everything you do (or avoid doing) is based on the fact that cool-season lawn grasses grow best when it's, well, cool. And they need to store energy and nutrients in their roots to get through winter and green up well in spring.

## Your First-Year Plan

Once you understand how grass grows, spend the first year adjusting how you take care of your grass so that you better meet its needs.

### 1. Mow correctly

Mowing takes more time than any other lawn care activity. It also has a tremendous effect on the health of your grass. If you mow high, mow often, and leave the clippings, your grass plants will be healthier and have stronger roots that can better withstand drought, outcompete weeds, and resist pests and diseases. (To find out how high, how often, and why clippings are good, see "Mowing," page 8.)

### 2. Patch small holes

Nature abhors a vacuum and will rush to fill bare earth with weeds. In early spring, inspect your lawn for small patches where the grass is dead or weak, and reseed them. (See "Repairing Small Spots," page 9.) To prevent weeds without using herbicides, don't let them get a start in these bare spots. Repair any lingering weak spots in late summer or early fall.

### 3. Wait before you renovate

Is your lawn is more weeds than grass? Take a deep breath and wait a year. Sometimes just changing the way you mow (high, often, leave clippings) will be enough to tip the balance toward the grass. But if after a year or two of mowing correctly the grass is still weak and the lawn is more than 50 percent weeds, your best option might be to start over and totally renovate your lawn. (See "Renovating and establishing a lawn," page 11.)

### 4. Choose the right grass

Whether you will be renovating or just patching small spots, choose grass species and varieties that help solve problems, not create more. Grasses differ in their susceptibility to insects and diseases, how much light they need, and how much traffic they can take. (See "Choosing Lawn Grasses," page 12.)

## 5. Do *not* focus on spring fertilization

Even if you don't plan to use chemical fertilizers over the long haul, applying a little bit can help boost grass growth while you are changing your mowing and management style. The key is not to apply nitrogen fertilizer to healthy turf in early spring. Doing so will encourage lush top growth at the expense of roots, and those roots need to go deep for moisture to outcompete weeds during the hot, dry summer months. One exception: If your turf is thin, a spring N application can help thicken it so that weeds don't gain a foothold in the thin spots. Be sure to do this along with reseeding bare spots. (See "Repairing Small Spots," page 9.)

## 6. *Do* focus on fall fertilization

For most low-maintenance lawns, a single application of nitrogen (1 lb. N/1,000 sq. ft.) between Halloween and Thanksgiving (about two weeks after your last mowing) is best. If you applied no nitrogen last fall, apply 1 lb. N/1,000 sq. ft. around Memorial Day. Then begin applying fertilizer in fall when it encourages strong root growth. (See "Fertilizing," page 9.)

## 7. Stop Watering

In many cases, watering your lawn can do more harm than good. (Sure, if you have a sandy soil that dries out quickly, you will need to water most years.) Improper watering can lead to more disease problems and shallow-rooted plants that are more vulnerable to drought and weed competition. If you do plan to water, make sure you do it right. (See "Watering," page 10.)

# Gather More Information

If you had been mowing your lawn too short, watering incorrectly, or applying too much or too little nitrogen fertilizer at the wrong times, you may notice some big differences in how your grass grows and looks after a year or two of doing it right. Hopefully, you now have a thicker sod, healthier grass, and fewer weeds. Your grass probably has deeper roots that help it stay green longer during dry spells without watering. And you've gotten used to your grass being a little higher and a little more uneven between mowings.

But you may still have spots where more weeds are growing than grass or where the grass doesn't grow as well as other places in the yard. Now it's time to focus your attention on these problem areas, do some detective work to find out what's wrong with them, and take action to resolve the problem:

### Test the Soil

The soil in these trouble spots may lack the nutrients your grass needs to grow well. Or perhaps the pH (acidity or alkalinity) of the soil is outside the range preferred by most lawn grasses (6.0–7.0). If you haven't done so already, take soil samples both from areas where your grass grows well and from where it grows poorly, have them tested, and compare the two. If there are major differences between these areas, chances are good that correcting the pH or nutrient deficiency will improve grass growth in the poor areas. Contact your county Cornell Cooperative Extension office (see "For More Information," inside back cover) for soil testing information. Adjust pH and follow fertilizer recommendations supplied with the soil test results.

### Observe Soil Conditions

Sometimes the condition of the soil rather than its fertility is the problem. Is your lawn weak in areas where water collects and drains slowly after it rains? Use a shovel to dig into the soil and see if it is compacted or if there is a hardpan (compacted layer) below the soil surface. You will be able to tell because the grass roots won't penetrate into these hard-soil areas.

Layering of soil is another problem to look for. This can occur after construction if only a thin layer of topsoil was added when the grass was replanted or when sandy topsoil was applied over clay topsoil. In either case, the result is often poor drainage and a poor lawn.

Fixing compacted or poorly drained areas might necessitate hiring a professional to regrade and renovate the area. Or you may be able to relieve the compaction by using a core aerator (available at rental stores). (For more information on core aeration, see "Relieving Thatch," page 15.)

If there are spots with little or no topsoil, a possible result of new construction, adding purchased topsoil and reseeding might be the solution. In areas that are chronically wet, grass may not be the best ground cover. Instead, consider planting certain species of shrubs or herbaceous perennials that thrive in saturated soils.

If your lawn has a history of high fertilization, compaction, and poor drainage, thatch (a build-up of dead and decomposing grass stems) might be the problem. (See "Relieving Thatch, page 15.)

### Watch the sun

Grass needs a minimum of four hours of direct sun daily. Even six hours a day is marginal. If your grass gets less than that, it probably can't compete with weeds that can get along with less sun. See "Coping with Shade" (page 16) for suggestions.

### Deal with high-traffic areas

Even if you use lawn chemicals, it's unlikely you will ever have a nice lawn under the swing set. Even the toughest grass will withstand only so much traffic. To keep weeds from invading and taking over (and then spreading to the rest of your lawn) where grass is weakened by foot traffic, consider establishing stone or gravel paths or other "hardscaping" solutions. Prevent and relieve salt damage adjacent to walks and driveways and damage from dog urine throughout the lawn. (See "Salt Damage," page 16.)

## Snuff Out Weeds

Despite your best efforts, some weeds probably remain, especially in high-traffic areas and next to pavement. Weeds are opportunists and will exploit bare spots or places where grass is weak to gain a foothold.

Perennial weeds (those that regrow from their roots every year) can spread and make a lawn unsightly. Examples include dandelions, plantain, ground ivy (creeping Charlie), and nutsedge. These weeds are particularly troublesome because even if you kill the tops, they will regrow from their roots.

Annual weeds (those that die at the end of the season and come back from seed the next year) can leave bare spots that are vulnerable to runoff. Examples include crabgrass, knotweed, and annual bluegrass. To get them under control you need to kill them before they set seed, and then improve the soil conditions to favor lawn grasses.

The first line of defense against all weeds is preventive practices. Before you start attacking weeds individually, make sure that you are following the steps starting on page 2, especially mowing correctly, reducing compaction, repairing bare spots, and fertilizing in fall. Here are some other strategies:

### Get to the root of the problem

Let the weeds be your guide. If weeds dominate an area, it's likely that something is wrong with either the growing conditions or your lawn practices. Dense stands of prostrate knotweed *(Polygonum aviculare)* are a good sign of soil compaction. Don't just pull out the weeds—relieve the compaction. Violets (*Viola* spp.) are a good sign of low light levels. One solution might be to seed shade-tolerant fine fescues. Ground ivy *(Glechoma hederacea)* often thrives where grass is cut too short. Red sorrel *(Rumex acetosella)* thrives in wet, acidic soil.

### Weed by hand

This is easiest when the soil is slightly moist. Check your garden center or catalogs for tools that help pull tough perennials, such as dandelions, out by their roots. Research shows that if you remove only the leaves above ground, you will have to repeat the process 8 to 10 times before the roots of some perennial weeds will die.

### Use other weeding "tools"

Lately, "natural" products have come onto the market as alternatives to chemical herbicides. Researchers at Cornell have tested one of them, corn gluten meal. When this product was applied in early spring, before crabgrass germinates, lawn grasses grew better than unfertilized plots and crabgrass was reduced somewhat. But the effect was not significantly different from using natural or chemical fertilizers to make the lawn grasses more competitive.

If you want to avoid using "nonselective" synthetic herbicides such as glyphosate (Round-Up), you have several alternatives. But keep in mind these share the same liability as broad-spectrum herbicides: They will kill good plants right along with the weeds, and they do not solve the problem that helped the weeds gain a foothold.

**Nonselective "natural" herbicides.** Like glyphosate, these herbicides will kill plants they come in contact with, but they use different active ingredients, including acetic acid (often derived from vinegar), ethanoic acid, pelargonic acid, fatty acids, and clove oil. These products usually work best on young annual weeds. Tough, established perennial weeds may require several applications. As with any herbicide, follow label directions precisely.

**Boiling water.** Weeds in cracks in pavement and other spots that are difficult to weed can be killed with boiling water. Use care not to burn yourself or plants you don't want to kill. Remember that this will probably kill only the tops and that perennial weeds will regrow. Commercial-scale machines that use steam to kill weeds are on the market, but few landscapers have them. Smaller versions may be available commercially in the future.

**Flame weeders.** Specially designed flame weeders—powered by propane or similar fuel—can be an effective nonselective weed killer. But you must use extreme care not to scorch plants or set mulch and other combustibles on fire.

# Manage Insects

Many insects live in lawns, but few of them are pests. Many are beneficial insects that help keep pests under control or perform other useful ecological roles. Most pesticides applied to home lawns are either unneeded or ineffective, and they kill beneficial insects along with the insect pests.

Chances are good that if you do everything you can to maintain a healthy turf, your grass will be able to tolerate modest insect pest infestations. But sometimes pests gain the upper hand and cause aesthetic damage to the lawn. If damage is heavy, they can kill enough grass to leave the soil vulnerable to soil erosion and invasion by weeds.

## "Scout" for insect pests

In the Northeast, white grubs are the most common lawn insect pests. Chinch bugs, billbugs, and sod webworms cause trouble only occasionally. Before deciding what to do about insect pests, you need to "scout" for them to find out what species are present and if there are enough to warrant treatment. You also need to time treatments for when they will be most effective. For more information about common insect pests—how to identify them, scout for them, and when treatment is justified—visit www.gardening.cornell.edu/lawn.

## Plant endophytic grass varieties

Some grass varieties are resistant to insects that feed above the ground, such as cutworms, sod webworms, chinch bugs, and bluegrass billbugs. If these insects are a problem, choose endophytic varieties of perennial ryegrass and fine-leaf and tall fescues. (Endophytes are beneficial fungi that live on the grass and discourage surface feeders.)

## Try using biocontrols

Several biological control products are on the market to control grubs (the larvae of Japanese beetles and similar insects that live underground and feed on grass roots). Studies in northern regions show that milky spore, a fungal pathogen that infects Japanese beetle grubs, usually does not reduce turf injury from grubs, so we do not recommend it. Soil temperatures are often lower than optimal for this pathogen, and many times the damage is caused by other grubs that aren't affected by milky spore.

The use of nematodes (microscopic worm-like organisms) to control grubs shows more promise. But effectiveness depends on matching the nematode species with the grub species causing the problem. Results also vary depending on temperature, moisture, and other environmental factors. Contact your county's Cornell Cooperative Extension office for more information on nematodes.

## Know where the pests are

### Insects

#### Surface damage

Insects suck juices from plants and cut or snip grass blades and stems above ground.

1. **Cutworms:** Gray-brown-black caterpillars that curl into a "C" when disturbed.
2. **Sod Webworms:** Young caterpillars that have black heads. Full-grown caterpillars are brown to green, have dark spots, and grow up to 3/4 inch long.
3. **Chinch Bug:** Adults up to 1/4 inch long, black with white wings that have a black triangle on them.
4. **Bluegrass Billbug:** Adults are 1/4 to 1/2 inch long, have snouts; can be seen on driveways and sidewalks migrating to the lawn in spring.

#### Subsurface damage

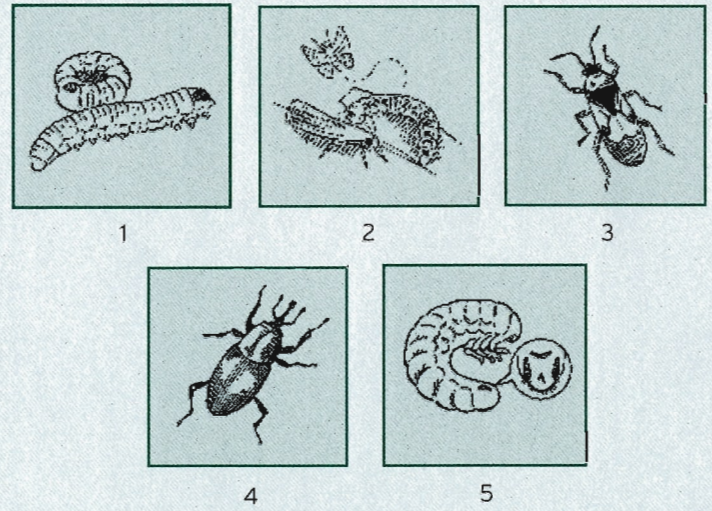
Root system is eaten and plant uptake is disrupted or prevented. Damage appears as wilted turf that does not revive when watered. "C"-shaped, cream to white grubs feed on roots of all grasses.

5. **Grubs:**

   **European Chafer:** Damage threshold 5 to 10 grubs per square foot.

   **Japanese Beetle:** Damage threshold more than 10 grubs per square foot.

   **Oriental Beetle:** Damage threshold 8 grubs per square foot.



## Prevent Diseases

By the time you see a lawn disease, it is too late to do much about it, at least in the short term. Lawn diseases are caused by plant pathogens, usually fungi. These fungi are almost always present, living off dead and decaying material in the soil but go unnoticed by humans because the grass usually fends them off. (They are not dangerous to humans.) But when environmental conditions are favorable (usually plenty of moisture and the fungi's favorite temperature) and your grass is stressed, the scale tips in favor of the pathogen. Infestations can range from barely noticeable to ugly to devastating. For information on identifying common lawn diseases, visit www.gardening.cornell.edu/lawn. If you haven't guessed by now, prevention is the best remedy. In particular, take the following steps:

- Keep grass leaves dry. If you water, do so early in the morning so that leaves dry quickly. Avoid watering at night.
- Don't overfertilize. Too much fertilizer can stress plants and leave them vulnerable to diseases.
- Plant disease-resistant grasses. Choose the right grass for the site.
- Improve drainage. Poorly drained low spots are particularly prone to disease.
- Increase air flow. Lawn diseases are more likely where stagnant air collects. Clear underbrush to improve air circulation.

Many products such as microbial inoculants, composts, and other biostimulants claim to prevent or control lawn diseases. While some research indicates that composts and inoculants can suppress certain diseases, most of these products have not been tested under controlled conditions. Until more research is done, it might still be worth testing the performance of a small amount of some of these materials on a limited area of your lawn. Overall, however, a healthy lawn, planted with a disease-resistant variety, is the best defense against turfgrass diseases.

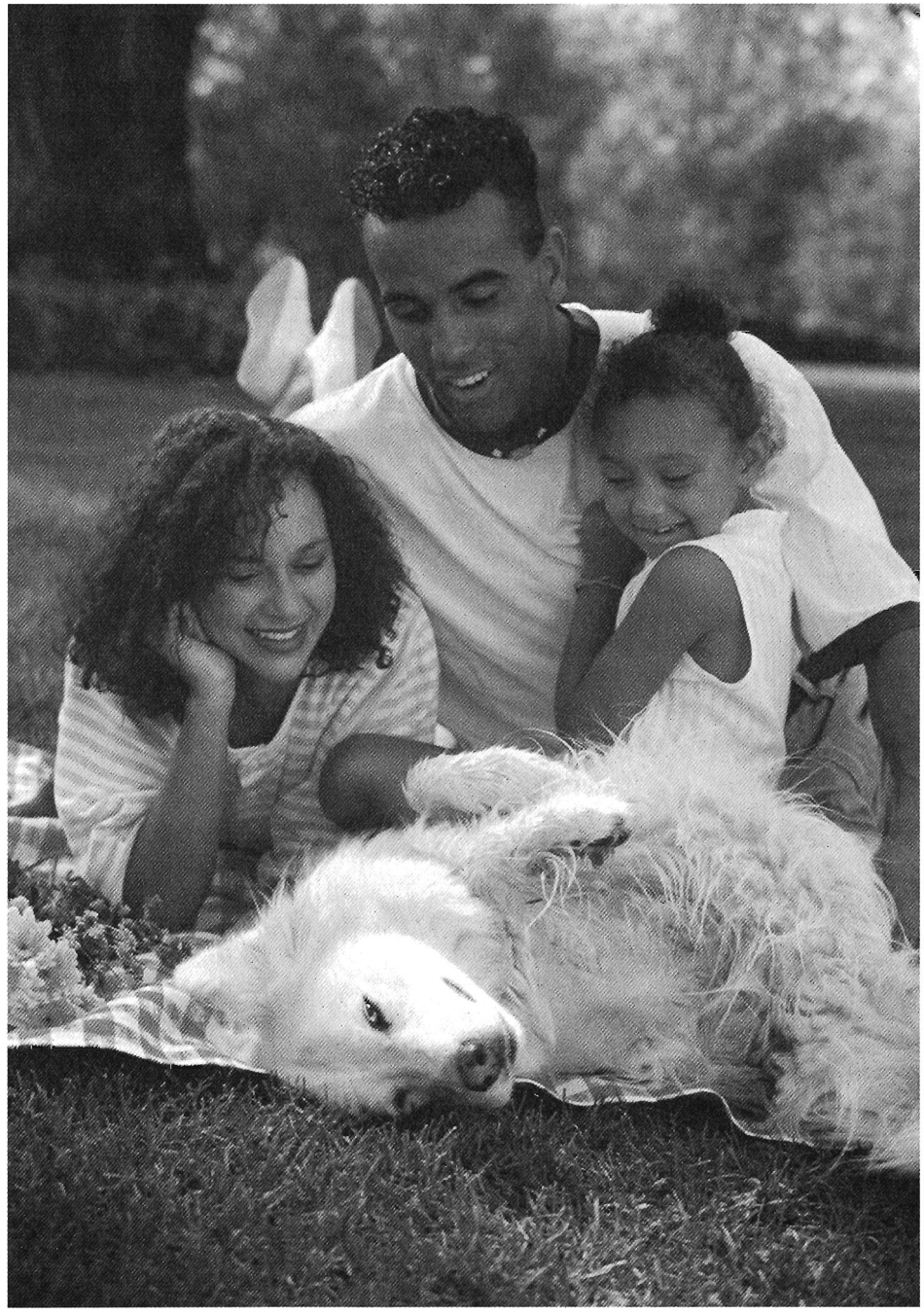
**Part II. The Details**

# Why Lawns Matter

**Properly managed lawns offer major benefits to people and the environment.**

Lawns have a bad reputation these days. Some people think they are sterile "ecological deserts" or, worse, sources of pollution or human health hazards. But well-managed lawns are an environmental asset. They can help protect or even improve water quality and control erosion. By contrast, lawns that are poorly managed—whether as a result of neglect or through the overuse of fertilizers and pesticides—can be an environmental liability.

What you and your neighbors do with your lawns matters. Collectively, you control about 900,000 acres of lawn in New York alone—75 percent of the managed turf in the state. Ensuring that your lawn helps enhance our environment means being aware that small acts (such as not washing grass clippings into the street or down sewer drains) can have a big impact on our streams and lakes.



### Healthy lawns provide many benefits

- Lower air conditioning bills. Moisture evaporating from grass leaves helps keep air temperatures cooler compared to paved surfaces.
- Less pollution. Lawns can help filter pollutants out of the air and reduce noise pollution, especially when used along with physical barriers.
- Higher property values. Attractive lawns contribute to the overall appearance of a community's landscape.
- A place to play. Grasses are the only plants that can withstand repeated recreational use.
- Better water quality. The thick sod formed by grasses helps water soak into the ground. This aids in reducing or eliminating runoff that can carry soil or other contaminants into waterways.

The good news is, you can reap most of these benefits without spending much money or taking more time than you are probably already spending on maintaining your lawn.

Explore this publication and you'll discover the hows and whys of growing a healthy lawn.

## How Grass Grows

### If you understand cool-season grasses, you can help them thrive

Most lawn grasses grown in New York (and areas that have similar conditions)—Kentucky bluegrass, perennial ryegrass, and fescues—are cool-season grasses. They grow best in spring and fall.

The major exception is zoysia grass, a warm-season grass occasionally grown in warmer areas downstate. Most ornamental garden grasses are warm-season grasses.

The roots of cool-season grasses grow best between 55° F and 65° F. Shoots grow best between 67° F and 75° F. In early spring, even before the grass starts to green up, the roots break dormancy and begin growing.

The combination of long days, cool temperatures, and adequate moisture produces a flush of growth in the spring. This sometimes makes it challenging to keep up with mowing. In a normal year, 60 percent of grass growth occurs during six weeks in spring.

As temperatures warm during summer, growth slows and lawns require less frequent mowing. Roots can be damaged when temperatures are above 85° F. During this "summer slump," warm-season weeds such as crabgrass (*Digitaria* spp.) thrive because they are more competitive in warm weather.

The combination of warm temperatures and lack of moisture can cause cool-season grasses to become dormant and turn brown during dry summers. In most cases, the grasses haven't died. They will green up and grow again in fall when cool weather returns and soil moisture is replenished.

Top-growth continues in fall until there are about 10 days with average daily temperatures below 50° F. Roots will continue to grow and take up fertilizer until the ground freezes.

## Mowing

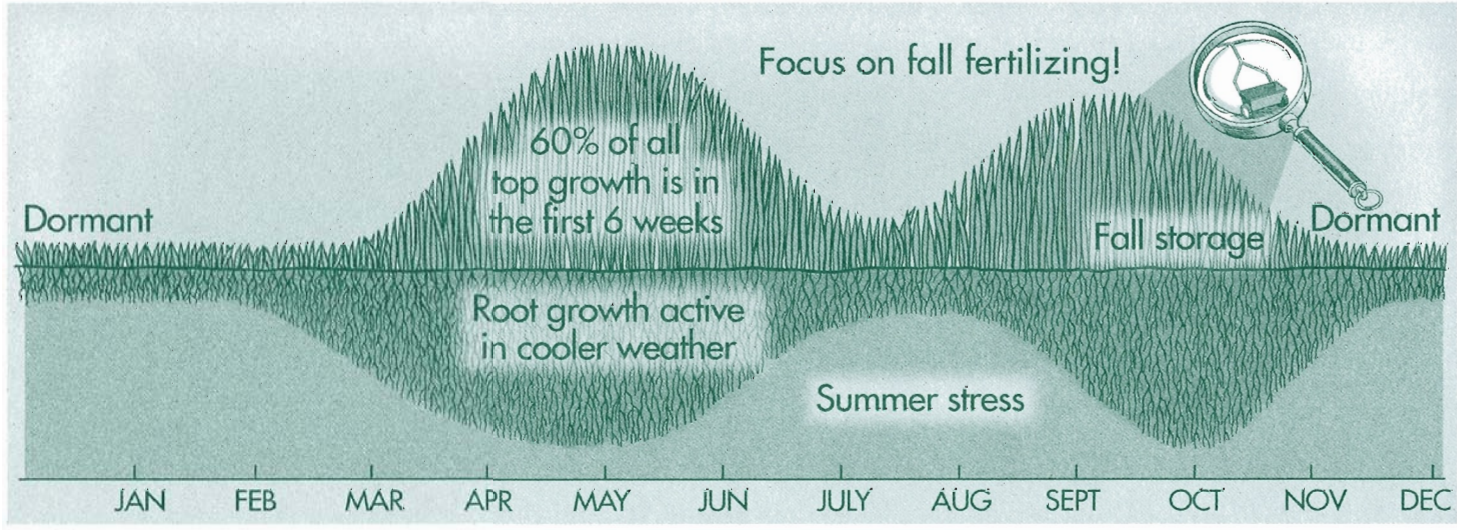
### Mow high, mow often, and leave the clippings

Proper mowing gives grass a competitive advantage over weeds and helps keep your lawn healthy. Over the course of the season, mowing is the single most time-consuming lawn care chore. You might as well do it right!

### How high?

For a healthy, low-maintenance lawn, set your lawn mower to trim grass to 3 inches or higher—likely the highest setting on your rotary lawn mower. (If you're not sure how high your mower leaves the grass, take a ruler and place the end on the soil surface and measure the grass after you mow.)

The reason to mow high is that the roots underground mirror the shoots on top. The shorter you mow, the smaller the root systems will be. Small root systems leave your lawn more vulnerable to drought, insects, and invasive weeds. Short lawns also require more frequent fertilization. Longer grass helps cool the soil surface, reducing water loss from the soil and decreasing competition from warm-season weeds such as crabgrass.



### How often?

It depends. Let the grass be your guide, using the one-third rule: never remove more than one-third of the grass blade when you mow. That means if you are cutting your lawn to a 3-inch height, you should mow before the grass is more than 4.5 inches tall. During the spring flush, you may need to mow every three to five days. During the summer slump, the interval may be two weeks or more. If you are cutting the grass shorter, you will need to mow more often to avoid violating the one-third rule.

### When to start?

Start mowing in spring when the one-third rule says it's time: when the grass reaches 4.5 inches if you are maintaining a 3-inch cut. Stop mowing in fall as growth slows, usually about the time the daily average temperature falls below 50° F for a week. Don't leave the grass more than about 4 inches long going into winter because it can mat down and encourage snow mold.

### What about the clippings?

Leave them. They do not cause thatch, contrary to popular belief. (Thatch usually occurs only when turf is excessively fertilized and soil is compacted, cool, and moist.) If you follow the one-third rule, the clippings won't smother the grass plants. They will dry out quickly and work their way down to the soil surface where earthworms will help incorporate them. Mulching mowers chop clippings finely to speed the process.

If the grass gets too tall and you end up with clumps of clippings, use a lawn rake to distribute them or rake them up so that they don't kill the grass underneath them.

Clippings return nutrients to the soil, so you can use less fertilizer. They can also cool the soil and help it retain water. Do not blow or leave clippings where they will wash into streets or sewer drains and end up polluting our waterways. Clippings are high in phosphorus, a major non-point source pollutant. If you have a lake, pond, or stream on your property, establish a natural buffer zone between your lawn and the water. Allow the vegetation to grow long in the buffer so that clippings don't get into the stream. The buffer can also filter out other potential pollutants.

### Anything else?

Keep your lawnmower blades sharp. Dull blades tear the grass instead of cutting it cleanly. The wounds cause the grass to lose more water, increasing irrigation needs or moisture stress, and also leave the plants more vulnerable to diseases.

## Repairing Small Spots

### Repairing small bare spots is one of the most important things you can do to keep weeds from invading your lawn

The best times to repair bare spots are in early spring and late summer or early fall, when temperatures start to cool and rains return (mid-August to late September or as late as mid-October in downstate New York and on Long Island).

Bare spots can be caused by foot traffic, compaction or salt damage next to a sidewalk or driveway, localized winter kill, or dog urine. Whatever the cause, the first step to repair the spot is to loosen the soil with a rake or similar tool.

Choose grass seed that matches your site. If the spot receives less than six hours of direct sun a day, select a shade-tolerant mix that includes tall fescue or fine-leaf fescue. (For more information, see "Choosing Lawn Grasses," page 12.)

To ensure even coverage on a small spot, try mixing 1 part seed with 3 parts topsoil, potting soil, or compost. Sprinkle the seed-soil mix evenly on the bare spot. Ideally, you should end up with about 15 to 20 seeds per square inch. More seed isn't necessarily better because crowding can weaken new seedlings.

Use your foot to firm the seed-soil mix. Close contact between the seed and the soil hastens sprouting. Keep the soil moist, but water only enough to moisten the surface without causing runoff. After seeds emerge, reduce watering to encourage deeper rooting.

You can leave the spot bare or, to help keep soil moist, lightly cover it with weed-free straw, marsh hay, or other mulching material. (Products made from a combination of pelletized newsprint, and water-absorbing gel, such as PennMulch, are also effective.) Make sure at least 30 percent of the soil is visible through the mulch. Start mowing when 60 percent of the grass reaches the recommended mowing height (at least 2 to 3 inches). Make sure your mower is sharp because dull blades can rip out young seedlings.

## Fertilizing

### Use only what you need, and avoid spring applications

Just like people, lawns need a balanced diet. If you fertilize them too much, too little, or use the wrong kind, they won't be healthy.

### Test your soil

A soil test will tell you how much phosphorus (P) and potassium (K) fertilizer your lawn needs, if any. Contact your county Cornell Cooperative Extension office for soil testing information. If tests indicate that no P or K is needed, use nitrogen fertilizers that contain few or none of these elements.

### Adjust pH if needed

Lawns should have a slightly acidic pH (6.0–7.0). If your soil tests fall outside this range, follow instructions included with the test results for adding lime or sulfur to bring pH into this range.

### Focus on fall

If phosphorus and potassium levels are adequate in the soil, nitrogen (N) is the most important nutrient for grass growth. Understanding how grass grows is important when making decisions about how much nitrogen fertilizer to use and when to apply it (see "How Grass Grows," page 8).

For most low-maintenance lawns, a single application (1 lb. N/1,000 square feet) between Halloween and Thanksgiving (about two weeks after your last mowing) is best. Do not fertilize during Indian summer, a warm period following hard frost. Fertilization at this time

can cause excessive top growth, reduce root storage, and increase winter kill. The best window for fall application is after top growth stops, usually after 10 days with average daily temperatures below 50° F. Roots will continue growing and taking up fertilizer until the ground freezes.

Organic nitrogen sources alone are not a good choice for fall fertilization because they require warm soil and microbial action to release nitrogen. Soluble nitrogen sources are readily available to the plant, but leaching may occur on sandy soils. A 50-50 or 70-30 mix of slow-release to quick-release N is less risky to the environment.

For higher-maintenance lawns, you can also apply 1 lb. N/1,000 sq. ft. around Labor Day and/or Memorial Day. (Neglected lawns or sods thinned by winter kill may benefit from 0.5 lb. N/1,000 sq. ft. after the soil has thawed and drained but before the grass greens up.) At least 50 to 75 percent of the nitrogen applied to any lawn annually should come between August and November.

Lawns that were not fertilized the previous fall or have suffered from winter injury may benefit from spring nitrogen applications. But wait until soil temperatures have warmed to at least 55° F before applying.

### Water it in

Give your lawn one-quarter to a one-half inch of water after spreading fertilizer to get the material into the ground where it can be used by plants.

### Consider the source

Most synthetic lawn fertilizers contain at least 40 percent slow-release nitrogen. Slow-release N becomes available to the plant over a period of time depending on soil moisture, temperature, and microbial activity. The balance of the N is water-soluble nitrogen, which is readily available for plant uptake.

Slow-release nitrogen sources have a lower risk of burning plants and a lower potential to pollute water than water-soluble N sources. The tradeoff is that slow-release N is usually more expensive.

Lawns grown on mostly sandy soils should rely more on slow-release nitrogen to reduce the possibility of rain or excessive irrigation leaching N out of the root zone. Research shows that nitrogen rarely leaches from lawns planted on soils containing silt and clay.

Natural organic fertilizers supply nitrogen in complex organic forms that are not immediately available to plants. The fertilizers require warm (higher than 65° F), moist soils for microbial activity to release nitrogen. Natural organic fertilizers are well suited for applications during warm summer months when the potential for burning plants with high-salt synthetic fertilizers is higher.

Topdressing (applying a thin layer on top of the grass) with organic soil amendments, such as composted animal manure, can help improve soil structure and break down thatch, especially if applied in conjunction with core aeration. (See "Relieving Thatch," page 15.) The combination of topdressing and coring can reduce fungal diseases in some situations.

Organic soil amendments should have a carbon-to-nitrogen ratio of less than 30 to 1 to prevent tying up soil nitrogen while they decompose. It is important not to apply too heavy a layer of soil or compost because these layers can prevent water from moving down into the soil. Compost applications should be light and frequent (perhaps every three to four weeks during the growing season, depending on growth and weather), no more than 0.1 to 0.2 inch at a time. Cut your grass slightly shorter than usual before topdressing so that the compost can more easily sift down to the soil and not bury the grass.

Using nitrogen from organic sources is almost always more expensive than using synthetic fertilizers. That's because organic sources contain less nitrogen, much of which is tied up in organic matter and not readily available to the grass. Theoretically, as the lawn matures it needs less nitrogen, and more nitrogen is gradually released from the organic matter you've been topdressing.

### Consider different needs

High-traffic areas usually require more fertilizer than low-traffic areas. Different species of grass have different needs, too. Kentucky bluegrass, for example, requires more nitrogen than do fine-leaf fescues. If bluegrass doesn't get enough nitrogen, it is less competitive against weeds and pests. If fine-leaf fescues (which normally grow slowly) get too much N, they produce lush, weak growth that is susceptible to pests.

### Apply with care

The idea is to get the right amount of fertilizer on the lawn and none into streams and lakes. Rotary spreaders cover a wide swath but can also hurl fertilizer into streets and driveways where the next rain carries it into storm drains and then on to waterways. A drop spreader may take a little longer, but it puts the fertilizer exactly where you want it. Use care when loading spreaders. Sweep up spills before they pollute.

## Watering

### Be careful—you can do more harm than good

Most lawns in New York rarely need watering, except possibly for a few weeks in summer. With careful advance preparation, it is possible to avoid watering even during these weeks and still have healthy turf.

If you choose to water, it's important to do so properly because poor watering practices can do more harm to your lawn than good, and water can carry pollutants out of your yard and into waterways.

### Never water at night

The best time to water is early morning, between 4:00 and 8:00 a.m. Evaporation is low at this time, so more of the water makes it into the soil. Leaves dry quickly in the morning sun, reducing the chances of diseases. Avoid watering on cloudy days.

### How much?

It depends on soil type, cutting height, lawn use, temperature, wind, and a host of other factors. In general, a healthy lawn loses about 1 inch of water per week during summer. (The process by which water is lost from the soil through the leaves and through the soil surface is

called evapotranspiration, or ET.)

If your lawn receives an inch of rainfall every week in the summer, it will probably come through with little moisture stress. If you get less rain than that, you can make up the difference with sprinklers or an irrigation system. Your water application rate should supplement what you receive as rain. If you get half an inch of rain one week, apply only another half-inch. (Use a rain gauge, coffee cans, or other containers to measure rainfall and supplemental water.)

It's also important to apply water no faster than your soil can soak it up (infiltration rate). When your irrigation rate (how fast you are putting it on with the sprinkler) exceeds the infiltration rate, puddling occurs on level areas. On slopes, the water will run off and can carry sediments and other pollutants with it. To avoid this, measure your soil's infiltration rate by cutting off both ends of a coffee can and inserting it several inches into the soil. Pour about 1 inch of water into the can and time how long it takes to soak in. Then measure your irrigation rate by placing a coffee can (with the bottom intact) in the area watered by your sprinkler and time how long it takes to fill the can with 1 inch of water. Your irrigation rate should not exceed your infiltration rate.

### What about drought?

It is normal for cool-season grasses to experience summer dormancy in response to lack of moisture. Studies show that as little as 1/10 inch of water over a three-week period can keep the sod from dying.

Under all but the most severe conditions, it is best to avoid lawn watering, especially if your watering system isn't precise. Too much or too little supplemental water can weaken plants, making them more susceptible to pest problems and less likely to recover when cool, moist conditions return. Of course, you should follow all local water restrictions during drought.

### What can I do to prevent water stress?

- Plant grass species, such as fescues, that require less water.
- Mow grass higher, encouraging larger root systems.
- Do not apply nitrogen fertilizer in spring.
- Leave grass clippings on the lawn.

## Renovating and Establishing a Lawn

### Late summer or early fall is the best time to get your turf in shape for next year

Before you decide to renovate your lawn, try using the best mowing, watering, fertilizing, and weed and pest management practices for a year or two. Pay special attention to problem areas and rake up and reseed bare or weed-infested spots.

If your lawn is still more than 50 percent weeds after a few years, it might be time to consider a complete renovation. Planning is critical because during renovation your soil is unprotected and can easily be washed away into surface waters.

Late summer or early fall is usually the best time to establish or renovate cool-season grass lawns in most of New York (August 15 to September 25 or as late as mid-October downstate and on Long Island). Temperatures are moderating, weeds are less competitive, and moisture is usually adequate.

### Follow these 12 steps carefully:

**1. Control perennial vegetation to keep other species from competing with your new grass**

The most effective way to eliminate existing weeds and turf is by using nonselective herbicides that contain the active ingredient glyphosate (e.g., Round-Up). Other nonselective herbicides include glufosinate (Finale) or the herbicidal soap formulation Scythe.

Nonselective herbicides are designed to kill any plant on contact but do not kill weed seeds. Once in contact with the soil they are inactivated. This allows the new lawn to be planted just five to seven days after spraying.

To ensure an effective kill, wait until the vegetation appears chlorotic (yellow). Then either till the vegetation into the soil or run a slicer or dethatching tool over the killed sod.

If you don't want to use herbicides, one alternative is to use a rotary tiller to kill the sod. It will probably take three or four tillings at about one-week intervals to kill the existing sod and weeds. Each time you till, new weed seeds will be brought to the surface, which you will kill with the next tilling. Tilling on slopes leaves soil very vulnerable to erosion. In this case using herbicides to kill the existing sod is probably more environmentally sound.

Another option is solarization. After mowing down the vegetation close to the ground to weaken it, spread clear plastic over the area and anchor it in place. In research on Long Island, this practice killed the existing vegetation in as little as three weeks when the weather was hot and sunny. Solarization can also kill some of the weed seeds in the soil.

**2. Protect and test soil**

Minimize cultivation and compaction to maintain good soil structure. If the site needs grading, this might mean removing and temporarily storing the topsoil.

Before establishing the final grade with the topsoil, have it tested by a reputable soil testing lab. The information the lab provides will tell you how much fertilizer, organic matter, and other amendments you need to add to establish a healthy new lawn. Allow two to three weeks for test results.

**3. Establish a rough grade**

Take care of grade problems before you replant. Now is the time to eliminate low spots and resolve other drainage problems. Gently grade steep slopes to make mowing easier. Fracture compacted subsoil layers to help water move down through the soil profile.

**4. Amend and grade topsoil**

Cover the subgrade with at least 4 inches of topsoil. Ideally, the interface between the subgrade and topsoil should be gradual, not abrupt. Till a few inches of topsoil into the subsoil, then add the remaining topsoil to the surface. If the topsoil is high in clay, add compost materials that are

good soil conditioners and have relatively high amounts of nitrogen and phosphorus. These include biosolid composts (e.g., Milorganite); brewery by-product composts (e.g., Allgro); animal manure and yard-trimming composts (e.g., Erthrite); paper mill by-product composts such as Glatco-lite.

Organic soil amendments should have a carbon-to-nitrogen ratio of less than 30 to 1 to prevent tying up soil nitrogen while they decompose. Although it might sound like a good idea, do not add sand to high-clay soils in an attempt to improve drainage. The amount of sand needed to improve drainage makes this too expensive, and adding just a little sand can worsen drainage problems. Avoid using uncomposted yard waste because it may carry weed seeds.

To improve the water- and nutrient-holding capacity of sandy soils, add the same kind of compost materials used to improve clay soils. Add high-phosphorus starter fertilizer with about 1 lb. N/1,000 square feet and/or pH modifiers such as lime or elemental sulfur based on information from your soil test.

**5. Choose the right grass**

The species and variety you choose will depend on:

- the quality of sod you expect.
- how much work you want to do to maintain it.
- how you plan to use it.
- the characteristics of the site, including the amount of sun.
- winter hardiness.
- resistance to insects and diseases.

For more information, see "Choosing Lawn Grasses," at right.

Planting seed costs less than sodding, but sod is preferable when rapid turf cover is needed such as on slopes that need to be protected from erosion. Most cool-season sods are improved Kentucky bluegrass varieties because their spreading rhizomes intertwine to form a strong sod. Use high-phosphate starter fertilizer when laying sod, just as you would with reseeding.

Keep sod in shade so it doesn't dry out, and install it as soon as possible. Lay it in a staggered brick-like fashion, matching the edges closely.

**6. Seed at the correct rate**

The larger the seed, the higher the seeding rate. Studies show that there is no benefit from seeding more than the recommended rate. Excessive seeding rates create too much competition between the seedlings. Seeding at the correct rate or slightly lower encourages tillering—lateral spreading of the grass plants. (Sometimes if conditions are less than ideal, a higher seeding rate may be justified.)

Use a drop spreader or rotary "spin" seeder calibrated to deliver half of the recommended seeding rate. Then apply the seed in two different directions at right angles to each other. This assures more uniform coverage. For more about seeding rates for different grass species, see "Choosing Lawn Grasses," at right.

**7. Rake lightly**

Mix the seed and soil so that the seed is covered no more than 1/16 to 1/8 inch deep.

**8. Firm the soil**

Light rolling assures good seed-to-soil contact needed for the seeds to take up water and germinate. (For small patches, just firm them with your feet.) Do not overfill the roller because it may crush seed and cause compaction. A properly rolled seed bed can reduce establishment time by as much as two weeks.

**9. Mulch**

Use weed-free straw or marsh hay to conserve moisture and help prevent erosion. (Avoid pasture hay because it is often loaded with weed seeds.) Other effective mulching materials include products made from wood fiber, excelsior, newsprint, and other erosion-control blankets. Products made from a combination of pelletized newsprint and water-absorbing gel, such as PennMulch, are also effective.

**10. Water**

Germinating seeds and young seedlings will die quickly if allowed to dry out. Keep seedbeds moist at all times until seeds emerge. Water only enough to moisten the surface. Do not overwater, which will cause runoff. Gradually reduce water after seedlings emerge to encourage deeper rooting. Once grass covers about 60 percent of the ground, allow the surface to dry.

**11. Fertilize**

About two to three weeks after seedlings emerge, apply about 1 lb. N/1,000 square feet. This will increase shoot density and the seedlings' ability to withstand diseases such as rust.

**12. Mow**

Once more than 60 percent of the grass reaches the recommended mowing height (at least 2 to 3 inches), start mowing. Mowing encourages lateral shoot development, increases stand density, and helps the turf out-compete weeds. Make sure your mower blade is sharp because dull blades will tear young seedlings from the soil.

# Choosing Lawn Grasses

## They're not all the same!

If you are renovating or reseeding your lawn, it's important to pick the right kind of grass for your situation. Each of the four most popular cool-season lawn grasses (profiled on the following pages) has its strengths and weaknesses.

Consider the following before you choose which grass will work best for different areas of your lawn. (See chart, bottom of page 13 for summary.)

## Shade tolerance

Grasses need a minimum of four hours of direct sun a day. Areas that receive a lot of traffic require at least six hours of direct sun. If your light is marginal, plant fescues, which tolerate shade better than bluegrass or ryegrass.

## Drought tolerance

If you don't plan to water during summer droughts, or your soil doesn't retain much water, fescues are the best choice.

## Wear tolerance

Fine fescue does not stand up well to traffic. Choose another species for lawn areas that take a lot of wear and tear.

## Establishment

Perennial ryegrass is quick to germinate and protect the soil, which is an important consideration on slopes that are vulnerable to erosion. Kentucky bluegrass is the slowest to germinate, while the fescues fall between these two.

## Growth habit

Kentucky bluegrass spreads by underground stems called rhizomes. It forms a tough sod. When damaged, the rhizomes can creep back in to cover the bare spot. The other grasses are bunch varieties that don't spread as well or form as dense a sod.

## Leaf texture

Fine fescue has very thin, fine leaves. The leaves of tall fescue are coarse. Ryegrass and bluegrass fall in between.

## Maintenance

The fescues are good choices for low-maintenance lawns that don't require frequent fertilization or close mowing.

At the other end of the spectrum, Kentucky bluegrass makes a fine-looking lawn but requires more careful management to stay healthy. For a Kentucky bluegrass lawn to look its best, you need to fertilize it three or four times a year. Keep in mind that it is more susceptible to drought and pests.

## Seed mixes

Grass seed is often a mixture of several species. Read the label to find out what's in the bag before buying it. "Variety not specified" on the label means "buyer beware." Try not to purchase a mix that is more than 20 percent perennial ryegrass. Because it germinates quickly, ryegrass will overwhelm the other species if there is too much in the mix. (Also avoid annual ryegrass. It will germinate and grow quickly, but usually dies over winter.)

### Typical mixes matched for different situations

**Sunny, medium- to high-maintenance lawn:**

- 65% Kentucky bluegrass blend (several different varieties)
- 15% perennial ryegrasses
- 20% fine fescues

*Seed at 3 to 4 pounds per 1,000 square feet.*

**Sunny, low-maintenance lawn:**

- 65% fine fescue blend
- 15% perennial ryegrasses
- 20% Kentucky bluegrass blend

*Seed at 4 to 5 pounds per 1,000 square feet.*

or

- 100% tall fescue blend

*Seed at 7 to 10 pounds per 1,000 square feet.*

**Shady areas:**

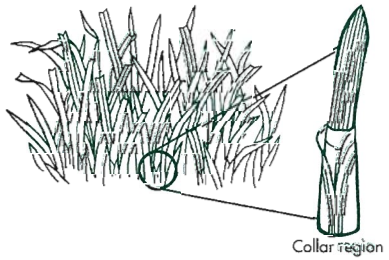
- 100% fine fescue blend

*Seed at 4 to 5 pounds per 1,000 square feet.*

### Summary of cool-season lawn grasses

| | *Kentucky Bluegrass* | *Perennial Ryegrass* | *Tall Fescue* | *Fine Fescue* |
|---|---|---|---|---|
| **Shade tolerance** | Poor | Poor | Good | Excellent |
| **Drought tolerance** | Poor | Poor | Some | Some |
| **Wear tolerance** | Good | Good | Good | Poor |
| **Establishment (days)** | Slow 30 to 90 | Fast 14 to 21 | Average to Fast 21 to 30 | Average 21 to 50 |
| **Growth habit** | Rhizomatous | Bunch | Bunch | Bunch |
| **Seeding rate** *(lb./1000 sq. ft.)* | 1 to 2 | 5 to 9 | 5 to 9 | 3 to 5 |
| **Nitrogen fertilizer** *(lb. N/1,000 sq. ft./year)* | 3 to 4 | 2 to 6 | 2 to 4 | 1 to 2 |

## Fine fescues




The fine fescues are comprised of a group of lawn grasses that includes

- creeping red fescue *(Festuca rubra)*
- chewings fescue *(Festuca rubra var. commutata)*
- hard fescue *(Festuca longifolia)*
- sheep fescue *(Festuca ovina)*

The fine-leaf fescues are the most shade tolerant of the lawn grasses. Their leaves are medium to dark green and narrow, almost needle-like. They are primarily bunch-type grasses, except for creeping red fescue, which can produce rhizomes. Fine-leaf fescues are often favored as low-maintenance grasses because they grow very slowly and require little or no fertilizer. Fine fescues should be mowed at least 2 inches or higher.

These grasses are well adapted to infertile, acidic soils and tolerate shade better than other cool-season grasses. They are not good for high-traffic areas because they do not tolerate abrasion,

and like other bunch grasses they are slow to fill in damaged spots.

Thatch can become a significant problem if not managed properly because fescues are the most aggressive thatch producers of the cool-season grasses. (This is primarily because fescue's leaf stems are high in lignin, which is slow to break down.)

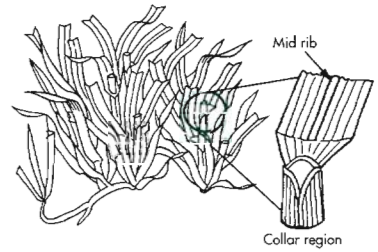
Traditionally, fescues are used in mixtures with Kentucky bluegrass and/or perennial ryegrass. However, growing interest in low-maintenance lawns has made blends of fine-fescue cultivars increasingly popular.

If you use fescue blends as part of a low-maintenance strategy, you need to lower your quality expectations. Fescues do not hold up to traffic as well as other species, and they often take on a "brown haze" appearance under full sun and dry conditions. These are the tradeoffs you need to weigh against the benefit of reduced mowing and fertilizer applications.

Sheep and hard fescues are more adapted to the low-maintenance approach, whereas chewings and red fescue perform better in traditional lawn mixtures that will receive regular fertilizer applications.

Fescues have few major pest problems. Under wet conditions however, red thread and leaf spot can attack them. Similar to the ryegrasses, certain fescue cultivars have endophytes to repel surface-feeding insects but are susceptible to white grub infestations.

## Kentucky bluegrass




Kentucky bluegrass is the predominant high-quality lawn grass for northern climates. It is a well-adapted, perennial species that spreads by underground lateral stems called rhizomes. This enhances its ability to form sod and recover from traffic damage.

Kentucky bluegrass is most successful in full sun and well-drained, fertile soil. It should be fertilized regularly and requires irrigation to avoid summer dormancy associated with warm, dry conditions.

The major diseases associated with Kentucky bluegrass include fungal diseases such as leafspot, dollar spot, and necrotic ringspot. Pest problems include surface- and root-feeding insects such as white grubs and billbugs.

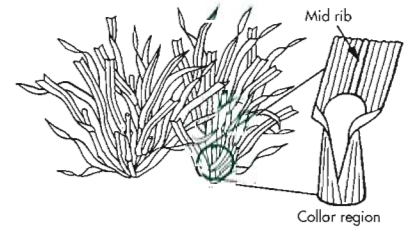
There are many improved cultivars of Kentucky bluegrass bred for close mowing (less than 1 inch), high-traffic areas, disease resistance, and extremely dark green color.

Kentucky bluegrass requires more than two weeks to emerge from seed sown in the soil and can take up to eight weeks to produce a dense sod. This limits its use in overseeding and renovation when a mature lawn is needed in a short time.

This grass also is less competitive with fast-germinating weeds and other lawn grasses such as perennial ryegrass during establishment. Studies show that as little as 30 percent perennial ryegrass mixed with 70 percent bluegrass will result in 80 percent perennial ryegrass three years after establishment. To establish stands of Kentucky bluegrass, you need to use mixes with less than 20 percent fast-germinating species.

The drawback of Kentucky bluegrass's aggressive, sod-forming rhizomes is that they can contribute to excessive thatch development. Under high fertility and cool, moist soil conditions, thatch may have to be removed physically, or core cultivation (aerification) can be used to mix soil particles with the thatch layer.

## Perennial ryegrass




Perennial ryegrass has become a popular component of lawn seed mixtures in the United States as a result of improvements in color, texture, and disease resistance. It is used widely because it establishes quickly and competes well. Ryegrass will germinate from seed in just two to four days and will provide a uniform lawn within two weeks.

Perennial ryegrass is a bunch-type grass that does not produce lateral growth in the form of rhizomes or stolons. Rather it spreads from the base by small shoots called tillers. This makes ryegrass plants less competitive in a lawn with regular traffic that injures the plant and leaves open spaces.

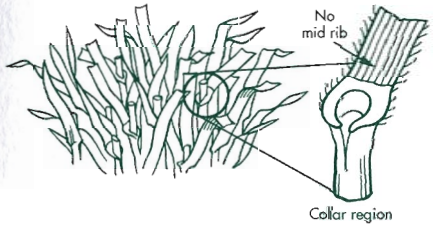
In high-traffic situations, Kentucky bluegrass is more competitive, producing rhizomes that can refill damaged spots. With ryegrass, weeds can often fill in open spaces before the grass can recover. While ryegrass tolerates abrasion better than Kentucky bluegrass, it does not recover adequately. Overseed regularly to maintain a competitive stand.

Perennial ryegrass is most successful in full sun with well-drained, fertile soil. It can tolerate mowing down to three quarters of an inch, but does best at 2.0 to 2.5 inches or more.

Ryegrass is not well adapted to shade and drought, and vigorous growth can cause thatch to accumulate. Major disease problems include fungal diseases such as red thread, rust, brown patch, and Pythium blight. This is most likely a result of reduced growth from low fertility and environmental conditions conducive to fungal growth.

Ryegrass breeders have developed varieties that contain endophytic fungi. These beneficial fungi live in the leaf sheath and produce chemicals that deter surface-feeding insects such as chinch bugs and sod webworm. Unfortunately, they have no effect on white grubs or other subsurface feeders.

### Tall fescue




Turf-type tall fescue is a bunch-type grass with substantially wider leaves compared to the fine-leaf fescues. It has very deep roots that help it weather drought conditions better than other cool-season lawn grasses.

The wide blade makes tall fescue inappropriate for lawn mixtures with other cool-season grasses (such as bluegrass and ryegrass) unless it is greater than 90 percent of the mixture. Breeders have developed exceptionally dark green cultivars that are extremely tolerant of heat and drought.

Tall fescue is more shade tolerant than bluegrass or ryegrass but not as tolerant as the fine fescues. It requires regular fertilization and should not be mowed closer than 2 inches.

Tall fescue is tolerant of abrasion, but because it is a bunch-type grass that doesn't spread much it requires regular seeding to stay competitive in a heavily trafficked lawn.

As a result of its "forage grass" heritage (it is commonly grown in pastures), tall fescue has a very rapid leaf extension to replace leaves grazed by animals. This trait has persisted even though the mower has replaced the cow. As a result, tall fescue requires more frequent mowing under ideal growing conditions compared to other cool-season grasses. Thatch is usually not a problem.

Tall fescue is susceptible to brown patch and Pythium. Similar to the ryegrasses it has suffered recently from rust. Proper nitrogen fertilization is vital to avoid and manage these diseases.

Tall fescue is most successful when established from seed in early August (several weeks before the best date for establishing other cool-season grasses) because it is less winter-hardy in the seedling stage. While generally not recommended, spring establishment can be successful when soils warm and seeding rate is increased slightly to compete with weed growth.

## Relieving Thatch

### Don't blame clippings

Thatch is a layer of dead and decomposing plant tissue that forms above the soil. A thin layer (1/2- to 3/4-inch) is beneficial because it protects plant crowns and reduces compaction.

But if the layer gets too thick, water, air, and fertilizer can't get through to the soil and grass roots. Runoff increases and dry spots appear. When it's wet, thatch can remain saturated and suffocate roots.

Leaving grass clippings on the lawn when you mow does not cause thatch. Clippings break down quickly in most cases. Thatch is made up mostly of stems and roots that decompose more slowly.

Thatch usually occurs on turf that has been heavily fertilized, and it is most common on poorly drained, compacted, and acidic soils. Of the species of lawn grasses, fine fescues are most prone to thatch problems.

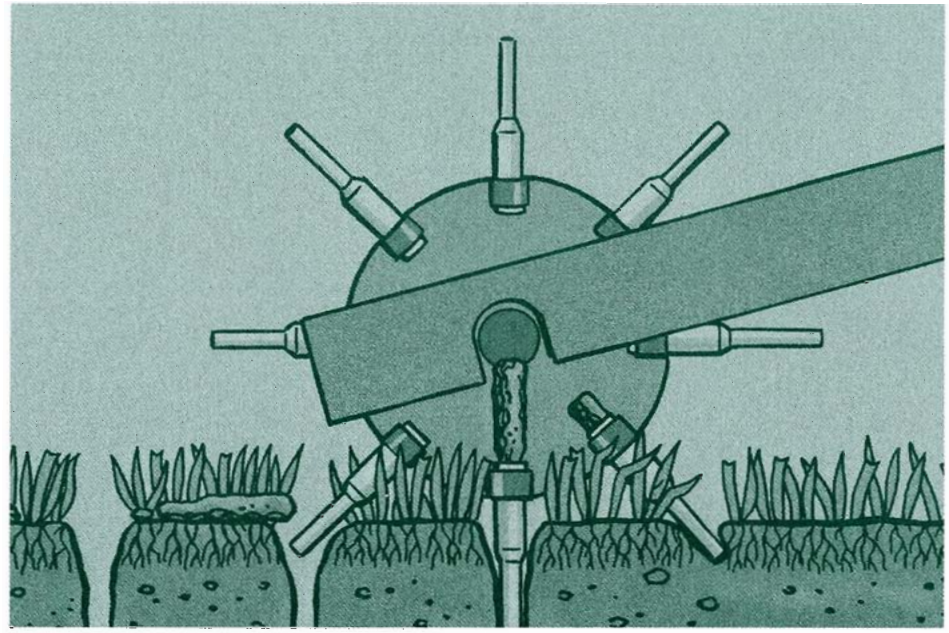
### Try core aeration

The best way to relieve thatch problems is by core aeration. Contract with a local landscape company for service or check with your local equipment rental center.

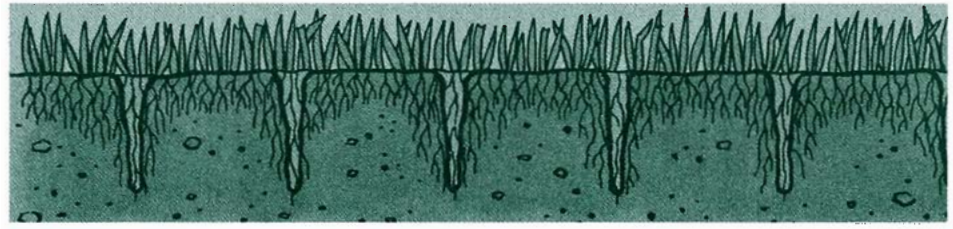
Core aerators punch small holes in the lawn, pull out the cores, and leave them on the surface. Core aeration is most effective in late summer when temperatures are starting to cool and the soil is only slightly moist.

After aeration, air and moisture can penetrate the thatch through the holes. Leave the soil cores on the surface to dry. Then rake them to distribute the soil down through the grass to mix with and dilute the thatch. Don't allow the cores to wash away and pollute surface water.

The mixing action of core aeration is similar to that provided by earthworms. Core aeration can also help increase water infiltration on compacted soils.



*The lawn is perforated during core aeration*



*Core aeration improves infiltration on compacted soils*

# Coping with Shade

Most grasses are sun-loving plants. For healthy growth, lawn grasses need at least four hours of direct sun a day. Grasses that receive much traffic or wear and tear need a minimum of six hours.

In addition to being weak from lack of sun, grass in shady areas can suffer more diseases because of cool, moist conditions and lack of air circulation. Poor grass stands in shady areas are vulnerable to erosion, which can carry sediments and other pollutants into surface water.

## Options for coping with shady areas

### Choose the right grass

In spots that receive marginal light, plant fine fescues, which are more shade tolerant than other lawn grasses.

### Grow other ground covers

Grass isn't your only choice. Consider attractive and vigorous shade-loving ground covers such as hostas, pachysandra, lily of the valley, English ivy, periwinkle, epimedium, sweet woodruff, and lamium.

### Plant a shade or woodland garden

There are hundreds of herbaceous perennial flowers and foliage plants that will thrive in shade as well as annuals such as impatiens.

### Mulch around trees

If you don't have the energy to maintain a shade garden, consider using about 3 inches of wood, bark, or stone mulch around the base of trees. (Don't pile mulch against the base of the tree trunk.)

### Build paths

If grass grows fine in your shady areas except where people walk, put in a stone, gravel, or other path to concentrate wear and tear in one area.

### Mow high

Grass in shady areas should be allowed to grow taller than grass in direct sun. Do not mow closer than 3 inches.

### Fertilize and water less

Grass in shady areas grows slowly and needs less fertilizer and water.

### Let in more light

Remove lower branches and selectively prune other branches or remove entire trees to let in more light.

# Salt Damage

## Look for damage along walks, driveways, and roads

Sodium chloride (salt) used for deicing may cause bare spots or give an edge to salt- and compaction-tolerant weeds along sidewalks, driveways, and roadsides. Soil is sometimes covered with white or yellow crust.

Salt damage is often compounded by compaction from foot traffic, auto tires, and piled snow. Even if the damage doesn't kill sod, it increases stress on the grass, making it more prone to diseases and weed competition. Weak turf in these areas is especially vulnerable to runoff into storm sewers and surface waters.

Kentucky bluegrass is very sensitive to salt damage. Perennial ryegrass, fine fescues, and tall fescue are more tolerant.

To prevent salt damage, avoid plowing or shoveling salt-laden snow onto turf. Apply only enough salt to do the job after you remove the snow. Calcium chloride–based deicing salts don't cause as much damage as sodium chloride.

Even though they are often suggested, do not use urea or other fertilizers as deicing salts. They can run off when snow melts and pollute surface and ground waters.

Spring rains may leach salts from the soil if drainage is adequate. If it's dry, you may need to water by hand to flush them out. If soil is poorly drained, improve it by mixing in organic matter to a depth of 6 inches, or remove soil and replace it with fresh topsoil and reseed. Improve soil before reseeding because salt can prevent germination and damage seedlings.

**Dog urine** causes similar damage to salt and is often mistaken for disease problems. Salts in dog urine can kill grass. Look for dead spots with greener grass around the edges. Female dogs and dry, infertile soil make problems worse.

To reduce damage, flush with water immediately after dogs urinate or train them to go elsewhere. Rake up feces to prevent them from smothering and killing grass, providing an opening for weeds to get a foothold.

# For More Information

## Local information

Contact your local Cooperative Extension Office. In New York State: www.cce.cornell.edu. For all other states: www.csrees.usda.gov/Extension.

## Online resources

**Lawn care**
Department of Horticulture, Cornell University
www.gardening.cornell.edu/lawn

**Home gardening**
Explore Cornell
www.explore.cornell.edu/homegardening

**Weeds and your lawn**
New York State IPM Program
www.nysipm.cornell.edu/publications/weedslawn

**Grubs in your lawn**
New York State IPM Program
www.nysipm.cornell.edu/publications/grubs

This publication is issued to further Cooperative Extension work mandated by acts of Congress of May 8 and June 30, 1914. It was produced with the cooperation of the U.S. Department of Agriculture; Cornell Cooperative Extension; and College of Agriculture and Life Sciences, College of Human Ecology, and College of Veterinary Medicine at Cornell University. Cornell Cooperative Extension provides equal program and employment opportunities. Helene Dillard, Director.

IPM **New York State Integrated Pest Management Program**

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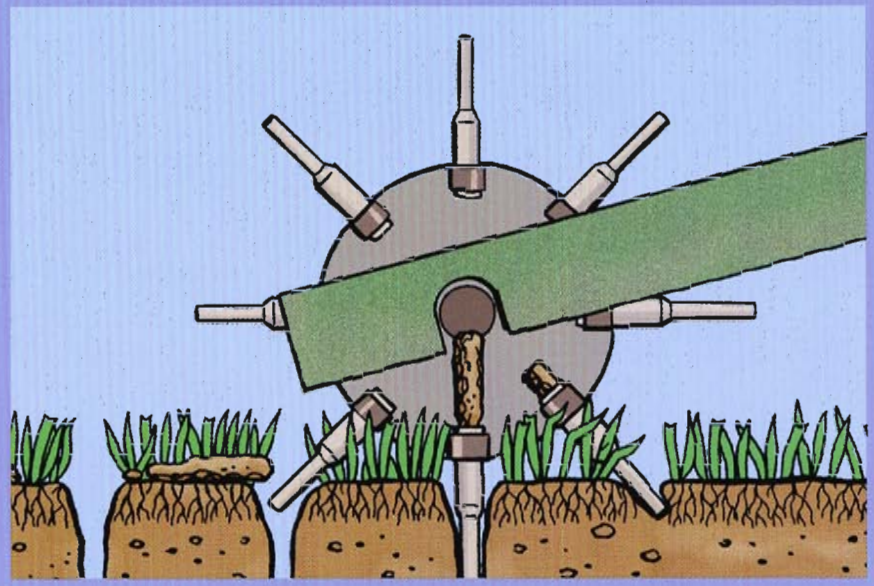
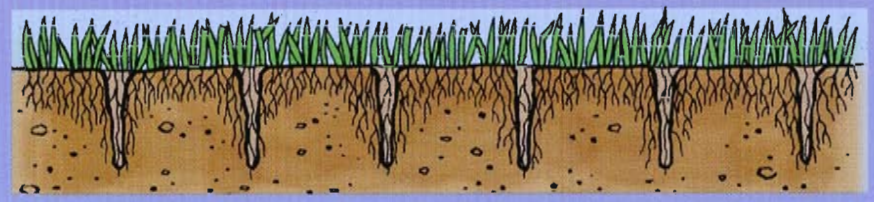
This essential text focuses on reducing environmental stressors on your grass plants as the key to a lush, beautiful, and thriving lawn. If you understand how grass grows, why lawns matter, and do everything possible to reduce stress, your lawn will grow stronger, stand up better to weeds, and be more resistant to insects and diseases. Consequently, you will spend less time and less money on lawn chemicals, and quite possibly never use pesticides on your lawn again. The key is how far you want to go. The principles and practices you learn in this publication will help no matter which chemicals you want to give up and how fast you want to do it.

***Lawn Care without Pesticides*** begins with a seven-step first-year plan. Patience and careful attention to important indicators of lawn health during the first year may not result in a perfect lawn immediately but will go a long way toward achieving your goals. During the first year make sure you also gather information about your lawn: test your soil, observe soil conditions, watch the sun, and note high-traffic areas. Now it's time to roll up your sleeves and actively snuff out weeds, manage insects, and prevent diseases based on your observations. In addition to learning effective practices for achieving a beautiful lawn, you will learn why lawns matter; how grass grows; best mowing, watering, and fertilizing practices; and how to repair small bare spots, renovate and establish lawns, choose grasses for your lawn, relieve thatch, cope with shade, and deal with salt damage.

Adorned with helpful diagrams and tables throughout the text, as well as a page devoted to additional lawn care information, ***Lawn Care without Pesticides*** will find a special place reserved among other classic Cornell Cooperative Extension bulletins as a true homeowner's and gardener's reference.





IPM New York State Integrated Pest Management Program

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# Perfect Earth Project

## Toxin-Free Lawn & Landscape Manual

## 2015

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# PART ONE: Culture and Pests

## KINDS OF COOL SEASON TURF

**Kentucky Bluegrass**: Wear tolerant, recuperates well, excellent traction, cold tolerant, slow to establish so wait minimum 180 days for intensive use, most are sun only. Can have major disease issues. With 80% Kentucky bluegrass 20% rye mix, intensive use is okay in 90 days.

**Perennial Rye**: Good wear tolerance, tough root system, compaction tolerant, can be enhanced with endophytes for disease and surface insect resistance, best choice for overseeding worn or diseased areas due to rapid germination and fill in, sun only.

**Fine Fescue**: Cannot take foot traffic, best choice for dry shade, tolerates acid soil, does not tolerate high fertilizer and wants only half the normal rate of fertilization, extremely drought tolerant, (excess irrigation thins fine fescue), can be enhanced with endophytes for disease and surface insect resistance, tight growth habit helps to exclude weeds, best choice for infrequent mowing, may take on bronze color in full sun.

Types of Fine Fescue:
Creeping Red Fescue: Dense turf, with weak rhizomes
Strong Creeping Red Fescue: Less dense turf, better rhizomes, spreads well
Chewings Fescue: No rhizomes, very dense, not as temperature extreme tolerant but considered most attractive of the fine fescues
Hard Fescue: No rhizomes, better disease and drought resistance than creeping fescue, slow growing and well adapted to shade and poor soils
Sheep Fescue: Used for soil stabilization, makes a clumpy turf; very drought tolerant and does well on gravelly or sandy soil; does not need to be fertilized

**Tall Fescue**: Best grass for Long Island, deep fibrous root system, excellent drought tolerance once established. Include 5-10% Kentucky bluegrass in tall fescue mix for fill in of divots. Disease tolerant unless overwatered, moderate shade tolerance, can be endophyte enhanced for disease and surface insect resistance, grub resistant. Tall fescue grows rapidly, so must be mowed frequently. Frequent mowing also helps it remain drier with less humidity in the canopy, stimulates dormant buds, and helps turf remain denser. Mowing once a week or more is best.

**Poa trivialis**: Very shade tolerant grass for chronically wet sites only. Has a very shallow root system so will only work in moist areas. The least heat tolerant and wear resistant of cool season grasses.

## HOW TURF GROWS

- Rhizomatous (Kentucky bluegrass): Spreads laterally BELOW ground, fills in well.
- Stolons (Poa Trivialis): Spreads laterally ABOVE ground, bentgrass.
- Bunch (perennial rye, tall fescue, fine fescue): Does NOT spread laterally, therefore must have tight overseeding, reseed damage immediately

**TIP**: Always have about 10% bluegrass in the mix, in full sun, to help fill in holes that develop in the lawn. Rye and most Kentucky bluegrass are shade intolerant.

**SEED MIXES AND RATES**
In lbs/1000 sqft, the Seeding Rate Rules are roughly:
KENTUCKY BLUEGRASS: 2lbs/1000
POA TRIVIALIS: 1-2lbs/1000
FINE FESCUES: 5lbs/1000

- Chewings: 3.5-5
- Hard: 3-4.5
- Meadow: 7-10
- Red: 3.5-5
- Sheep: 3-4.5

TALL FESCUE: 8-12lbs/1000
PERENNIAL RYE: 7-10lbs/1000
KENTUCKY BLUEGRASS/PERENNIAL RYEGRASS MIX in percent by weight: 80-20 to 90-10: 2-4lbs/1000
KENTUCKY BLUEGRASS/TALL FESCUE mix: 10-90 to 20-80: 7-10lbs/1000
KENTUCKY BLUEGRASS/FINE FESCE mix: 30-70 to 50-50: 2-5lbs/1000
KENTUCKY BLUEGRASS/PERENNIAL RYEGRASS/FINE FESCUE mix: 45-5-50 to 60-10-30: 3-5lbs/1000

**Typical Mixes or Blends for Specific Conditions**
Sunny, medium to high maintenance
65% KENTUCKY BLUEGRASS, several different varieties
15% PERENNIAL RYEGRASS
20% FINE FESCUES
Seed at 3-4 lbs/10000

Sunny, low maintenance
65% FINE FESCUE blend
15% PERENNIAL RYEGRASS
20% KENTUCKY BLUEGRASS
Seed at 4-5lbs/10000

OR

100% TALL FESCUE blend, Seed at 7-10 lbs/1000

Shady, dry areas
100% FINE FESCUE blend
Or shade tolerant TALL FESCUE

Shady, wet areas
100% POA TRIVIALIS

**Blending Your Own Seed Mix**
To produce the number of pounds of a particular grass you want in a mix, use this formula: % of seed suggested, decimal placed in front **X** number of pounds total seed mix desired. For example, if you want to make 25lbs of seed mix total, 10% Kentucky bluegrass, then: 0.10 bluegrass X 25lbs = 2.5lbs of bluegrass in your 25lb mix.

**Recommended Varieties of Cool Season Turfgrass**
Check the National Turfgrass Evaluation Program, www.ntep.org, to find well-performing varieties for our climate. Use data generated at Rutgers University in New Jersey; their climate is most similar to Long Island.

New varieties that have done well:

- Tall fescue: Bonanza, Phoenix, Taurus, Rebell II, Finelawn
- Kentucky Bluegrass: Bristol, A-34, Ram I, Chateau, Kenblue, Midnight, Georgetown
- Fine Fescue: Aurora, Scaldis, Spartan, Reliant, Valda Waldina, Spartan
- Perennial Rye: Allaire, Pennant, Patriot II; Palmer

**TIP**: Fertilization at establishment can influence types of grass in future seasons.
If you have a mix of Kentucky bluegrass and rye, and turf receives heavy N (Nitrogen) shortly after rye germinates, rye will take over the stand. Kentucky bluegrass is slower and can't compete. This is also related to percent of rye originally in the seed mix. A mix of Kentucky bluegrass and fescues given high N causes Kentucky bluegrass to dominate. Give the mix low N, fescues dominate.

**TIP**: Fertilizer composition used the year after establishment can affect turf growth. The year after seeding when using a regular fertilizer, the proportion of N to P (Phosphorous) to K (Potassium) affects the amount of grass growth. We will see more no P fertilizer combinations due to new laws. You may be able to manipulate ratios for better results:

- No P, low N formulation: Make sure K is also very low or you will have less turf growth.
- No P with moderate to high N levels: K level is not as important.
- No P with very high N: K will improve growth.

**ENDOPHYTIC GRASSES**
Endophytes are good guy fungi that grow within certain turfgrass plants like fescues and ryes, but not in Kentucky bluegrass. You can buy endophyte-enhanced seed, but not all endophyte-enhanced turf seeds are alike. Look for the term "enhanced" and a percentage associated with it; the higher the better. It is not enough to say endophyte "infected," or "enhanced," without the percentage. Endophytic fungi produce alkaloid compounds that confer resistance to turf against surface feeding insects like chinch bugs, some resistance to drought, and some resistance to diseases like red thread. These alkaloids are not translocated to the roots, so there is no resistance conferred for grubs. Overseeding with endophytes for a couple of seasons can get rid of chinch bug infestations.

**TURF SUNLIGHT REQUIREMENTS**
EVALUATING LIGHT: Turf needs 4 hours of sun daily to survive, 6 hours to thrive. Given this constant, grade your site for turf growth potential in the following way:
Grade A = 8 or more hours of light
Grade B = 6-8 hours
Grade C = 4-6 hours
Grade D = 2-4 hours
Grade F = less than 2
Heavy shade = less than 25% daily sun.
Shade above 85% just can't grow turf.

**MOWING AND GRASS CLIPPINGS; SPECIAL EVENTS**

Turf should be kept at a height of 3" all season.

- When grass approaches a height of 4" mow it back to 3".
- If you are currently mowing at less than 3" every 1/8" of grass blade added increases leaf surface area by 30%.

Short grass (under 2.5") equals short roots. There is not enough food to go around to roots and blades. Short grass means hotter, drier soil, with few roots to pull water through the plant for cooling. This means greater risk of crown damage, which means thinner grass, which means weeds.

<u>If you need to mow low for an event, try several weeks of 0.25" height reductions</u>.

- Once you reach desired height; mow three times a week to encourage new buds from the crown to maintain density.
- As soon as the event is over, raise mowing height immediately.
- Avoid heavy fertilizer applications to make a turf stand green for a party, especially if turf has been mowed low. Instead, spray liquid iron to darken turf and make it more uniformly green for visual purposes. This will mow off after about a week. Be careful of concrete; it can be stained by these products. (Cosmetic use of iron is much healthier for turf and environment than a heavy hand with nitrogen.)

**FERTILIZERS**

Use 2lbs of actual nitrogen per 1000sqft/year to grow decent rye, Kentucky bluegrass, or tall fescue. Fine fescue will cope with 1lb of actual nitrogen per 1000sqft/year.

<u>To determine how much of any fertilizer product will give 1lb of actual nitrogen per 1000sqft:</u>
Divide the number 100 by the N number from the N-P-K ratio on the fertilizer package. This tells you the amount of fertilizer product for 1lb actual nitrogen per 1000sqft of turf.

<u>To determine how quickly your product choice releases its nitrogen</u>:
Divide the number corresponding to the slow release nitrogen portion as listed on your package by the N number from the NPK ratio.

- An answer below 0.15 indicates a fast release product.
- An answer above 0.29 indicates a slow release product.
- The recommended level for slow release products for turf is between 0.5-0.7 (50-70%) for best results during the turf growth cycle.

**Fertilizer Application Times and Schedules**

If your fertilizer has more than 30% slow release nitrogen, the following timing options apply.

To reach your total goal of actual nitrogen for the year:

- Three applications: Third week of April, last week of August, second week of October.
- Two applications: Third week of April, second week of September.
- One application: Second week of September.
- "Spoon feed:" Use 1/4-1/8lb per week April 15-October 30.

**NATURAL FERTILIZERS** Byproducts or waste products of plants or animals.

- Bat guano: Nitrogen contents fast or slow release, depending on source. pH slightly alkaline; no value as soil amendment, useful as quick-acting early growth stimulant.
- Blood meal: No value as soil amendment. pH slightly acid, excess will burn foliage.
- Raw bone meal: Has a variable NPK analysis and is a slow release source of nutrients.
- Steamed bone meal: Slow-moderate release of nutrients, no value as soil amendment.
- Chicken manure: Moderate-fast release; it can burn your plants. pH tends to be alkaline. Water it in; good for moisture retention in sandy soils.
- Cotton seed meal: Acidic pH, provides good moisture retention as soil amendment. Slow to decompose.
- Cow manure: Dairy cow preferable to beef cow; less weed seeds and lower salts. pH generally alkaline, medium release rate. Improves soil texture and organic matter.
- Fish meal: Has a lot of slow release nitrogen. pH is acidic, but does not improve soil.
- Oyster Shells: No fertilizer value but strongly alkaline and can improve drainage. Must be washed well or can lead to excess salt.

**HOW MUCH IRRIGATION FOR YOUR TURF**

Where does the convention, 1-1½" of water per week, on a deep and infrequent basis, originate? It comes from the amount of water needed to penetrate the entire soil profile depth surrounding your turf root system.

If you figure the very best turf root system should go down about a foot, then we apply the constant: 1" of water applied in a single application penetrates to a depth of about a foot as well. 1½" of water insures a consistently moist, 1ft profile. By contrast, light and frequent irrigation can result in a dry pocket of soil between surface and deeper water in the soil profile.

Questions:
On a very rough basis, how long does it take your sprinkler system to water a 6-9" root system, the average on less than perfect turf growth sites? How does your soil texture figure into this?

To wet soil 6-9" in depth:

| If in 15 min. your system applied: | Sandy Soil | Intermediate | Clay Soil |
|---|---|---|---|
| 1/8" | 30 minutes | 60 minutes | 120 minutes |
| 1/4" | 15 minutes | 30 minutes | 60 minutes |
| 3/8" | 10 minutes | 20 minutes | 40 minutes |

If we wet soil to a 9" depth, using the chart this means we have applied ¾" (0.75). For most soil types, if we do this twice a week, separated by 3-4 days, this should top off the soil column around the roots and keep roots consistently, but not overly, hydrated. Install a rain sensor and use a rain gauge to compensate for natural precipitation. The best irrigation is not "set it and forget it," but manual operation based on natural precipitation and weather conditions.

**TIME OF DAY TO IRRIGATE YOUR TURF**
Turf is naturally wet from dew during the period between midnight and 8AM. Irrigation should correspond to this time period. Watering during the day does no harm, but accelerated evaporation caused by wind and sunshine means turf will not get as much water as you think you are delivering.

Watering between 4PM and midnight CAN harm your turf. Prolonged leaf wetness overnight can enhance or promote disease, much in the way constantly wet feet can lead to foot fungus. This is particularly true for dollar spot disease.

**DOES THE TURF HAVE ENOUGH WATER?**
Footprint Test: Stomp on the turf so you can see your footprints. Leave for 30 minutes and come back. Are the prints are still clearly visible? If so, the turf needs more water.

Screwdriver Test: After watering, push a screwdriver into soil to a depth of 6-9". If the barrel feels powdery when withdrawn, more water is needed. If it is smeary, less water is needed.

**LOCALIZED DRY SPOTS AND WATER REPELLANT SOILS**
Water Droplet Test: To determine if soil is water repellent, remove intact cores with a soil probe. Allow to air-dry several days. Water repellency is determined by placing small drops at increments of 0.5" on the surface of the core starting at the soil surface.

**WETTING AGENTS**
These are used for improving wetting of LDS, improving drainage in layered soil profiles, improving drainage in heavy traffic areas, increasing product efficacy, and increasing water efficiency. This leads to reduced irrigation costs and speeds root growth under dry conditions. ALWAYS use non-ionic wetting agents: esters, ethers, alcohols.

**THATCH**
Thatch can result in localized dry spots, and is unlikely to be found in high traffic areas. Measure a thatch layer by slicing through the soil and looking at the layer of material between the crown of the grass and where white, active roots are located. A normal thatch layer may have one part that is crumbly and decomposing; ignore this. Measure the part that resembles a woven, intact carpet of dead brown roots. If less than ½" of this material is present, leave the turf alone. It acts as a "carpet pad" for the turf crowns, the heartbeat of the plants.

Thatch is composed of dead and dying roots that collect faster than they can be broken down by soil microbes. Usually this is due to acid pH, in which case liming may help. Core aeration to increase oxygen to soil microbes and to bring microbes into contact with the thatch layer is better than using a dethatching machine.

Dethatching machines bring crabgrass and annual bluegrass seed to the surface and in spring provide gaps for weeds. If you dethatch in fall, you provide gaps where moss can take hold. Moss lifecycles are different than turf; moss will thrive and invade in winter when turf is weakened by dormancy or stresses like dethatching.

## IS THE TURF REALLY DEAD AND WILL IT RECOVER

1. In area you suspect is dead (brown leaf blades) pull some of the blades out.
2. Where blades were removed, look closely for signs of new growth from crown located at ground level.
3. If crown is pale green or white, plump, and juicy it is still alive. New turf will emerge shortly.
4. If crown is brown and rotted, it is dead. It is time to overseed. For rye and tall and fine fescues, reseed dead spots larger than 3" in diameter. For Kentucky bluegrass, reseed dead spots larger than 6" in diameter.

If you are still not sure if turf is alive: Bring a piece inside, place it in a sealable plastic bag, and treat it like a houseplant. Within a week, you should know.

## COMMON REASONS TURF THINS & FAILS WITHIN FIRST YEAR OF ESTABLISHMENT:

- Poor quality soil.
- Lack of planning for water draining from roof/sidewalks, foot traffic from pets/people, seed selection based on amount of sun, compost to amend entire turf area properly, etc.
- Improper soil preparation: Till at least 6" deep, preferably 8-10" or even 12". Raking lawn to a final grade is critical, especially for sodded lawns, so uneven pockets do not sink and leave roots dangling in empty air under the turf canopy where they will die. Remove old sod with a sod cutter rather than coarsely chopping up the old lawn and turning it into the soil. REMEMBER: The bucket of a skid-steer loader is not the proper tool for creating the seedbed before seeding or sodding!
- Wrong date of seeding: August and September are the best seeding months. Other seeding dates are doable, but more attention and labor will be needed for success.
- Poor choice of seed: No rye in shade, tall fescue with about 10% Kentucky bluegrass in sun, fine fescue best for dry shade, Poa trivialis for always wet, compacted shade.
- No irrigation after seeding: Usually you will need to irrigate 2-4 times/day to keep the seedbed moist. If new seedlings dry out even once they will die. They do not have roots to fetch moisture deeper in the soil profile.
- Failure to re-fertilize when turf reaches about 2" in height 4-6 weeks after sprouting. This follow up fertilization is REQUIRED for maximum establishment. Seedling turf is likely to run out of food and become very susceptible to damping off unless application of 0.5-1lb of actual nitrogen is made, in accordance with local/state fertilizer laws.
- Bad mowing practices: Mow as soon as the first few plants reach 3" and weekly after that. Most wait too long to mow.
- Crabgrass and bentgrass: Crabgrass will outcompete newly seeded areas, especially those that are hot and dry. Make sure you have chosen the correct grass for the site and there are no gaps in the turf into which crabgrass can grow. Bentgrass will outcompete other grasses in shade, in wet areas, and at the bottom of slopes. Bentgrass is also encouraged by close mowing, high fertilizer, and frequent irrigation.
- Failure to core aerate a sodded lawn can result in sod failure within 6-7 months. Core aeration about 4 weeks after sod is laid is recommended to permit roots to grow through aeration holes into soil, under sod, and into layer of soil sod was brought in. It also opens up channels for air and water exchange and prevents disastrous formation of a perched water table.
- Failure to mulch after seed application to help keep moisture and humidity around germinating grass, promote seed to soil contact, and help keep seed in place during irrigation or rain events. Use about 2 bales/1000sqft of straw mulch. You can also lightly dust seed with soil to keep it in contact with the soil it is planted in.

**What is an Unexpected Reason for New Turf to Thin & Fail Within a Year?**
Failing to COVER the site once turf renovation is initiated. Heavy rain can cause water movement off adjacent areas onto the turf site. This typically carries and deposits silt and clay, forming a seal on the soil surface difficult for turf seed or sod to root through. A lens of water is also created on the surface that can act as a mini perched water table, leading to algae, moss, and disease, and encouraging run off of fertilizers and washing away of seed. If contamination by particles from off site happens, dig up the surface to reestablish soil air and water exchange, and remove the "crust" from the top.

**ISSUES WITH TURF IN WET CONDITIONS**

- There is no oxygen in soil for roots; it has been replaced in pore space by water.
- Turf slips against wet soil underneath when pressure is applied.
- Crown tissues are crushed and roots dislodged.
- Wet soils that heat up cause the plant to use more oxygen when there is already very little in the soil.
- If amount of water in roots is lower than amount of water in soil, guttation takes place. Guttation fluid is pushed out of turf tips when soil is too wet, a result of root pressure pushing water up from the root. (When you see drops of liquid at the tips or along the edges of leaves, you are witnessing guttation.) This typically occurs at night when stomata are closed and transpiration is over for the day. While dew covers the entire surface area of the leaf, guttation occurs only at the tip or along the edges. Guttation fluid is high in sugars and minerals used by turf fungi like dollar spot.
- Turf roots are short because of root rot, dysfunctional in taking up water and nutrients, and in cooling the plant off.

**Caring for Turf in Wet Sites**

- To minimize tracks, set blades to highest mowing height to reduce clipping clumping.
- Make sure blade is sharp; turf in habitually wet conditions is weak and tears off its root system easily when tugged at by dull blades.
- Clear residual clippings from previous sites from under mower deck for a cleaner cut.
- Do a second cut shortly after first in a different pattern to alter track path and minimize tracks in lawn.
- 72" decks seem to handle wet grass better.
- Soil under wet turf is often compacted. It may be causing surface wetness if there is a perched water table. Wetting agents may help water penetrate and move off surface.

**Seeding or Reseeding a Muddy Lawn**

- Spread straw BEFORE you seed, 1-2 bales/1000sqft. You should see ½ straw, ½ dirt. This will provide a little substrate to walk on, or roll lightweight seed spreader across.
- Seed from a diagonal, so you will not have to walk over any area twice.
- A hand crank seeder may work best in really wet conditions.
- If conditions are super wet and the area is small, seed, then cover with cheesecloth. (You will not have to remove it and it will help to soak up water.)
- You may not need to water for part of the establishment process. You may need to increase seed by 20% to adjust for rot.
- KEEP TRAFFIC OFF: Use walk behind mowers.

**Fertilizing a Wet Lawn**
Spoon feed. With water saturation a constant issue, roots are likely to be SHORT. No heavy fertilization. Depending on how wet conditions are, possibly no watering during application, or you'll get top growth roots can't support, and fertilizer pushed past where roots can get to it. Excess fertilizer + water = disease; especially brown patch (Rhizoctonia). Try a fertility schedule that spoon feeds 1/8lb of actual nitrogen/1000sqft, weekly from mid-April to end of October.

**TIP:** Fine fescues do not tolerate consistently wet soils.

**CARING FOR TURF IN SHADE**
It is always better to use an alternative in shade, but if you must have grass, try Poa trivialis. (Rough stalk bluegrass.)

Shade performance of other cool season grasses:
Fine fescue > bentgrass (undesirable) > rough stalk bluegrass > tall fescue
Kentucky bluegrass (shade tolerant) > Kentucky bluegrass (shade intolerant) > rye

**Symptoms of Too Much Shade**
- Shortened roots
- Reduced wear tolerance
- Reduced shoot density (thinning)
- Decreased vigor
- Elongated, skinny stems
- Increased disease

**To Improve Grass Growth in Shade**
- Prune interior tree branches to strive for dappled light
- Blow off leaves/debris rather than raking. Turf has shallow roots/thin leaves in shade.
- Use a full inch higher mowing height. (4")
- Use open, rather than solid, fencing so light can penetrate. (Especially in winter.)
- DO NOT USE RYE IN SHADE; it will always die out yet is so aggressive it will crowd out other more tolerant grasses.
- Morning light is better than afternoon sun.
- Keep the mowing height of this grass at 2.5", or it tends to flop over and mow poorly.

Growing Grass under Trees:
Best: Birches, gingkoes, and locusts
Worst (heavy shade and/or shallow root systems): Maples, oaks, magnolias, elms, poplars, sweet gums, and willows

**Fertilizing in Shade**
For most turf stands, it is recommended to fertilize at half the normal rate unless you have heavy traffic, which should be minimized in shade due to shallow root systems and low recuperative ability. Make sure turf has sufficient water as there is competition from tree roots, and canopies can shed water like an umbrella; resulting in a dry zone inside the drip line. Grass will probably need to be renovated every five years or so.

**HEAT STRESSED TURF**
Cool season grasses hate summer. This means all of our lawns hate summer!

In nature, cool season grasses naturally go dormant during the greatest periods of summer stress, but we artificially keep our lawns going with irrigation. The grass that best tolerates summer conditions on Long Island is tall fescue; the least tolerant grass is Kentucky bluegrass.

What you can expect when certain temperatures are reached:
**90°** Shoot growth ceases
**77°** Root growth ceases
**70°** Max temp. for useful root growth. Ideal temp. to plant grasses other than tall fescue, which prefers it warmer.
**60-75°** Optimum for shoot growth
**50-65°** Optimum for root growth

For established turf:
If temps are 90° or higher, or if there is high wind for more than half the day, set sprinkler system to go off multiple times between 11AM and 2PM, in addition to regularly scheduled watering.

- This provides cooling of the grass crown as water evaporates, protecting against "heatstroke" in the crown (the heartbeat) of the turf.
- A heat-damaged crown cannot draw water through the roots and up through the leaves of the turf for evaporative cooling, causing further heat damage and decline.
- Tall fescue has a larger root volume and is superior in drawing water to keep the plant cool.

**What Makes Heat Stress Worse?**
If turf was on a regimen of light, frequent irrigation before heat stress hit, there will be few functional roots remaining alive in the shallow moist zone created. Once heat stress hits, these roots must work twice as hard to take up enough water to supply the plant for growth, activity, and cooling.

If the roots cannot keep up, heat damage will occur and the plant may die. This creates thin turf, which means no shading of the soil, and even hotter conditions.

**What Helps Grass Recover from an episode of Heat Stress?**

- Try kelp based amendments.
- Keep mowing height at 3".
- Overseed with tall fescue enhanced with endophytes.
- Your turf now has a limited root system; it is essential to keep damaged areas cool so crowns can be kept viable by the limited ability of roots, or artificially by syringing.
- Try wetting agents to help spread water around.
- To help trap and hold moisture, treat heat-damaged turf as you would new seedlings or grub-damaged turf and mulch with straw: 1 bale/1000sqft. Or apply 1/8" compost top dressing, and/or an artificial "pontoon" to keep water ponded in damaged area.

**TURF IN MEDIANS**

- Tall fescue: Best choice, stays greener longer under dry conditions.
- Fine fescue: Poor choice, conditions are too arid.
- Rye: Poor choice due to heavy concentration of road deicing salts.

Roots will be shorter because of soil compaction, so adjust irrigation accordingly. Spoon feed fertilizer, so it will not be lost by runoff or through leaching past short roots. If frustrated by seeding failures in medians, hydromulching is very helpful. Covering seed with cheesecloth is helpful to keep seed from moving offsite. (The cheese cloth will rot away.) You can also use polyester spun fabric, but this must be removed.

For establishing grass seed in early spring, dusting seed with compost or soil may help it to stay in place. Try seeding with 20% more to compensate for seed that falls or is washed over the side.

**DOGS AND TURF**

Dog urine damage is a bright green ring with a brown spot in the center, while turf disease is usually just a brown spot, or green in the center with a brown ring. Dog urine damage is essentially a salt burn, so treat it as you would a fertilizer burn.

The remedy is watering to dilute urine before 8 hours have passed. If you delay watering for 12 hours or more, burns will progressively worsen. Kentucky bluegrass is most susceptible to dog damage, because it is most sensitive to salt. Tall fescue is least susceptible because it has the highest salt tolerance.

**RUTS IN TURF**

The first step for most is to tamp down soil surrounding ruts like a bubble in carpet. DO NOT TAMP. Instead, stand perpendicular to the rut and loosen soil with a spading fork pushed into it at a 45° angle. Slowly, push depressed soil in rut UPWARD to 1-2" ABOVE the surrounding area. As it settles, it will be level with surrounding turf, with no compaction from tamping.

<u>For deep ruts of more than 4"</u>

- Use an edger or spade to make a parallel cut in the bottom of the rut.
- Use a sod lifting tool or spade to lift each side of the flap and fold it back.
- Loosen the soil in the rut, leaving it 1-2" higher than undisturbed soil.
- Add more soil from an area at the same site if necessary.
- Replace flaps, roll lightly, water well.

It takes about half an hour to go 150ft this way, but it saves the time and uncertainty of procuring topsoil from an outside site and reseeding. The regrowth will be a better match for the existing stand, whereas reseeding often leaves a very visible rut-shaped patch.

**TURF TRAFFIC GUIDELINES**

When turf is used by 50 or more people each day, there will be damage. After 10 uses per week, allow turf to rest and recover. Minimize use during periods of rain or irrigation. Do not allow play on the thawed surface of frozen turf. The turf will be ruined; the crown crushed and abraded. Grass needs to recover from winter dormancy before use in late winter/early spring.

Is there a better way to oversee turf use and planned activities?
Yes! A single contact person should be responsible for scheduling. There should be a grounds committee to establish a rotation plan, the importance and uses of each turf area, and differences in priority of use by daily users (like students or campers) vs. visitors. This committee should estimate extent of use in each area before it must be rested. Be sure to include soil type and irrigation availability in your committee's plans. Members should visit each turf site at least twice a year.

**SEEDING AND OVERSEEDING**
All seed should be evaluated for how much of the product is actually alive. It takes just a moment and will save you money and weed pressure. All you need is the seed label. If the seed does not have a seed label, run the other way!

Calculating Pure Live Seed

- Multiply % purity by % germination for each component of seed mix.
- Add sums together.
- Multiply new number by pounds of seed recommended for over seeding 1000sqft.
- Subtract this number from number of pounds recommended for the overseeding rate.
- Add this amount to the recommended overseeding rate per 1000sqft to compensate for seed that will never germinate.

For example: Recommended overseeding rate is 5lbs/1000sqft.
Look at the SEED LABEL and you find a seed mix is composed of:

| | Percent Purity | Percent germination | % Purity X %Germination |
|---|---|---|---|
| Red fescue | 11% | 76% | 0.11 X 0.76 =0 .08 |
| Kentucky bluegrass var 1 | 35% | 89% | 0.35 X 0.89 =0.31 |
| Kentucky bluegrass var 2 | 38% | 87% | 0.38 X 0.87 =0.33 |
| Perennial ryegrass | 16% | 90% | 0.16 X 0.90 =0.14 |
| | | | 0.86 |

0.86 X 5lbs overseeding rate = 4.3lbs of seed that will germinate, out of 5lbs total.
To get 5lbs of seed that will germinate: 5-4.3=0.7
ACTUAL OVERSEEDING RATE IS: 5+0.7=5.7lbs.

**HYDROSEEDING**
A popular, improved method of quick coverage. Try using a fan type nozzle (50° angle tip is best) for optimal soil surface coverage. Apply flexible growth media to soil surface from opposing directions to reduce shadow effects and ensure minimum 95% soil surface coverage.

**Seeding Around New Construction**
Wait until grading/plowing has subsided for at least 48 hours, or soil will settle and bury seed too deeply to germinate effectively.

**Seeding Other Times of the Year?**
Dormant seeding by honeycomb seeding is better done mid-February through late March. Divide seed into 3-4 lots and sow on 3-4 different days, early in morning when still-frozen soil is expected to thaw midday. Cracking and moisture embeds the seed in the soil. Increase seed by 50% for dormant seedings to compensate for bird predation and rot.

Rye seeded by October 1 provides about 60% cover by December 1. Rye needs a soil temp of at least 45°, and like tall fescue, needs a soil temp of 55°+ for best results.
Dormant seeding of Kentucky bluegrass on Dec. 1 outperformed spring seedings on April 1 and May 1, and performed almost as well as a September seeding in one study. Kentucky bluegrass, with its slow germination, is the best turf type for the cold temperatures of dormant seeding. It germinates best when temperatures are below 35°.

**How Late Can You Seed?**
20-30 days before first expected killing frost is safest. Ideal soil temp for fall establishment is 73-76° at a 4" depth. It is risky to seed later, and you may run into the Suffolk County Fertilizer Blackout Law, which could prevent follow up fertilizations that make healthier establishment possible. The old rule is: Seed by Labor Day, you'll be ready for play by Memorial Day.
Every week seeding is delayed beyond Labor Day costs two weeks of full turf use after Memorial Day.

**RENOVATION: SEED AND SOD**
The best time of year to renovate is late August through mid-September.

1. Do not bring in soil from a remote site. It causes layering/drainage issues or cement -like soil as finer particles mix with larger.
2. Never use sand to amend clay or clay to amend sand. Work with soil you have and improve it with organic matter.
3. Reserve power equipment in advance.
4. Have soil amendments like compost on hand or delivered in advance to get a pH.
5. Get a pH of existing topsoil so you know how much lime to amend with, if any.
6. A final pH of 6.3-6.8 is crucial for soil structure and nutrient uptake by grass.
7. Do a phytotoxicity test on compost by attempting to sprout cucumber seeds in several small pots: some of compost, some of soil you know has no problem. If seeds sprout, turn yellow, and die before developing true leaves, your compost has problems; possibly too much salt.
8. If you have limited time, rent a sod cutter to strip off old turf for disposal. Set sod cutter on lowest setting to get as much of old root system as possible.
9. Once you have removed old grass, spread organic amendment on surface, using 2-3" depth of material, or 6 cubic feet per 1000sqft of lawn area.
10. Spread starter fertilizer on soil, using 40lbs of 5-10-5 or 5-10-10 NPK or its equivalent per 1000sqft. Spread lime as recommended by your soil pH test.
11. Fire up the rototiller. Plow organic and other amendments in to a depth of 6-8".
12. Do not over rototill. This will break down soil structure and cause compaction and drainage problems. You want soil clumps the size of a pea to the size of a golf ball.
13. If you have a slope, don't plant it to grass. Install a low-maintenance ground cover.
14. Holes/dips in landscape should NOT be filled in with pure organic matter or topsoil brought in. Instead, mix equal parts organic matter and topsoil shaken from turf removed from your site and use this mix to fill in depressions.
15. Rake seedbed to remove root clumps and stones over 2". Rake again to smooth.
16. Apply a light fertilization, about 1/3 amount applied prior to incorporation of amendments.
17. Put seed in freezer for 48 hours to crack seed coat and halve germination time.
18. Allow bed to settle for 24 hours.
19. Rake a final time for levelness.
20. Seed with a mix of grasses appropriate for your site, at rates appropriate for the type of grass you have selected.
21. Divide seed mixture in half. Sow each half in opposite directions for good overlap.
22. Compensate for unviable seed by calculating the pure live seed rate.
23. Mulch with straw to conserve moisture around seed. Use 1½ bale of straw /1000sqft. You will not need to remove this unless applied too thickly. (Don't use hay; it contains a lot of weed seeds.) You should see 50% bare ground, 50% straw.

**Watering**
This is one time light, frequent waterings are recommended. (Mature turf is watered differently.) Make sure waterings are gentle; seed is easily washed away. Initially water to a depth of 5-6", then lightly several times a day. Maintain until grass is at least 1.5" long!

**TIP:** Light and frequent means, enough to keep the upper 1" of soil moist. You can decrease irrigation to once a day at the level of 0.25" depth of water once turf is 2". Maintain this level for 3-5 days. THEN skip a day between irrigations, applying 0.3-0.5" depth of water to wean the turf off light frequent irrigation. Do this for 1.5-2 weeks, and then continue to provide deep, infrequent irrigation as you would for mature turf.

**Turf Renovation Continued**
When grass height reaches 4", mow it back to 3", and weekly after that. Poor mowing practices after renovation are a major reason for failure. Most wait too long to mow!

For maximum establishment, fertilize with: 0.5-0.75lbs N/1000sqft, 4-6 weeks after seeding.

This usually means, perform post-emergence fertilization when new grass has reached 1.5-2". Use starter fertilizer. Plan wisely; county fertilizer law prohibits fertilization November 1-April 1.

**TIP:** If you do not fertilize newly seeded turf, you run the risk of disease (damping off), which can completely destroy your new turf stand.

**TIP:** The year after establishment, if you use:
No phosphorous, low N formulation: Make sure K is also very low, or you will have less growth.
No phosphorous with moderate to high N: K level does not matter.
No phosphorous with very high N: Get more growth with more K.

**The "Don'ts" of Turf Renovation**
People love to top existing soil with a 1-2" layer of sand, organic matter, or loam in an effort to improve their lawns. This practice rarely succeeds, and can result in a layering effect that impedes water and fertilizer movement into soil, and restricts grass' ability to root. Avoid skid steer renovation, it causes compaction. When water hits seed on compacted soil, it follows the path of least resistance, causing spotty take of turfgrass seed, and rivulets of bare soil with sand on top where crabgrass will thrive.

**INSTALLING SOD**
Prepare sod bed the same as seedbed. The worst mistake you can make is to lay sod over existing turf, or to only scratch the area lightly; you are asking for sod not to take. You MUST core aerate 4-6 weeks after installation to provide a channel for roots to get beyond the soil on the sod at installation.

Most sod is grown on fine textured soils, so when placed over sandy soils, you get a perched water table and sod roots rot. Core aerate 4-6 weeks after installation, when sod gets to a root depth of 2" to reduce risk of layering. When installing sod you still need to incorporate pre-plant fertilizer, then starter fertilizer. Follow the seeding regimen! Lightly roll sod with an empty roller to get rid of air pockets that later become dead spots.

Looking ahead:

- Sod will root in 1-2 weeks, and must have rooting depth of at least 4" for play.
- New sod needs at least 1" of water 30-minutes after installation. Soil beneath should seem sopping wet. A screwdriver barrel should have moisture at least 4" along it; if not water more.
- Keep soil wet for at least two weeks after sodding.
- For 0.25"/day or more, perform light and frequent irrigation; sod roots are short.
- Until roots grow down, use a screwdriver barrel to confirm water is penetrating beyond the layer of soil brought in on the sod. Push screwdriver through sod, into soil about 4". It should travel easily into the soil. When you pull the screwdriver out, you should be able to feel moisture along the first 3-4" from the blade. Use this technique as sod roots or as you water other plants to determine how deep water is going.
- Dry areas are likely to occur at corners, edges, and around buildings due to reflected heat and poor irrigation distribution. You may need to hand water these areas.

**TIP:** If water runs off rather than continues to soak in, shut down water, wait 30 minutes, and resume. You may have to do this several times depending on slope and soil conditions.

You will need to provide LIGHT FREQUENT IRRIGATION FOR APPROXIMATELY THREE WEEKS until sod has rooted below a depth of 1.5". Water several times a day, at about ¼" depth. Determine how long you need to reach ¼" with an inexpensive rain gauge to measure irrigation system output. If conditions are arid or windy, you may have to water more frequently to prevent sod from drying out.

**SOD SURVIVAL TIP**

If temperatures are 90° or higher, or if there is high wind for more than half the day, set sprinkler system to go off multiple times between 11AM and 2PM to provide a light sprinkling in addition to regularly scheduled watering. These light sprinklings are designed to cool off the crown of the grass by evaporation in order to prevent "heatstroke" in the turf, which really means keeping the crown cool so no permanent damage occurs.

**DEALING WITH GRUBS**

By the time you see damage, reseeding is the best option.

**How Should You Fertilize if You Have Grubs?**

Heavy nitrogen fertilization in spring and summer will decrease root growth, increase turf stress, and accentuate damage caused by grubs during September and October. Use of milorganite fertilizer at this time of year may also deter grub predators.

For turf attacked by grubs, spoon feeding with liquid fertilizer may the best option. It is easy to flush nutrients past roots that are very short and damaged. Small amounts of liquid fertilizer have a better chance of being taken up to help with regrowth.

Try feeding at the rate of 1/8lb per week for 8 weeks, (or until the fertilizer law blackout point has been reached), or ¼lb every two weeks for 8 weeks, or until roots have grown back. Avoid high salt fertilizer; this will make the potential for physiological drought around the limited roots worse. Avoid heavy nitrogen, fast-release products; you will push top growth that cannot be supported by the limited roots.

**How should you irrigate if you Have Grubs?**
Irrigation during drought periods in August and September will usually reduce turf damage caused by grubs, whereas frequent irrigation in June and July can attract egg-laying females and increase egg survival. Withhold irrigation as much as possible in June and July. If grub damage occurs in late August and September, water frequently. If grubs are present, you may have to combine light, frequent irrigation with deep, infrequent irrigation for "hydroponic turf."

When grubs attack the root system of turf, its ability to absorb water and nutrients is reduced, leading to turf losses. Proper irrigation can provide enough moisture for survival, even with a reduced root mass. This is why irrigated turf can tolerate higher numbers of grubs per sqft than unirrigated turf.

Consider using wetting agent; chewed up turf tends to get hydrophobic as does soil underneath.

A grub hit watering regimen should be light, frequent irrigation. Treat the area like a newly seeded or sodded area. Light, frequent waterings must continue until grass roots are at least 1.5" in the sodded area. Water enough to keep the upper 1" of soil moist. You can decrease irrigation to once a day at the level of 0.25" depth of water once turf no longer lifts easily by hand. Keep this level up for 3-5 days, THEN skip a day between irrigations, applying 0.3-0.5" depth of water to wean the turf off light, frequent irrigation. Do this for about 1.5-2 weeks then provide deep, infrequent irrigation as you would for mature turf.

**Is There a Link Between Soil pH and Grubs?**
Make sure soil is not in acid range. This can encourage grubs or make grass less able to withstand them. Grubs average 2.2-6.0/sqft at a pH less than 5 vs. 0-0.6/sqft in neutral to alkaline soils. Make sure fertilizer is not sabotaging liming efforts by making the soil more acidic.

**What are the Best Management Practices for Reducing Grub Damage?**
Establish tall fescue turf. Although grubs feed on the roots, it is seldom damaged. During the mid-August and September feeding period, tall fescue usually is able to replenish its root system at a rate sufficient to counteract grub feeding. During the same feeding period, Kentucky bluegrass roots are NOT re-growing.

Reduce heat during a grub hit. Your turf has a limited root system with a grub attack, so it is essential to keep damaged areas cool. Help keep crowns viable through the limited ability of roots by artificially cooling them with syringing or wetting agents to help spread water. You can also use straw at a rate of 1 bale/1000sqft, it helps to trap and hold moisture. Again, you are treating the damaged turf like a newly sprouted seedling until the root system can regrow. 1/8" compost top dressing can be used to hold moisture and to mulch crowns. Or, use an artificial "pontoon" to keep water ponded in the area of damage (Looks like the draft doggie for the bottom of doors in winter.)

Scout for grubs. The area at greatest risk has more than 60% Kentucky bluegrass and less than 30% shade. The threshold for grubs is 8-10/sqft. Well-watered turf can cope with 30/sqft. Grub distribution is spotty, so sample in a grid pattern with about ten paces between shovelfuls. If there are two consecutive shovelfuls with a grub(s), it is a hot spot for further sampling.

**Nematodes, Chromobacter subtsugae and Milky Spore**
The best time of year to apply entomopathogenic nematodes is mid-August through end of September. When it is hot and dry, grubs will move 4-8" deeper into the soil profile so apply ½" of irrigation before applying nematodes and then ½" after applying nematodes. This encourages grubs to move back into the root zone and moves nematodes down into the soil zone where the grubs are for better contact and efficacy. Commercial milky spore is ONLY for Japanese Beetles; we have mostly oriental beetles on Long Island. To use milky spore for Japanese Beetles, use 1tsp on 4ft centers. Chromobacter subtsugae (Grandevo) should be applied to first instar August 10, and to second instar August 21.

**DEALING WITH CHINCH BUGS**
Chinch bugs are tiny true bugs that suck turfgrass juices with a straw-like mouth part. A chinch bug has a triangular head and bright red eyes. The adult is about the size of a sesame seed, 1/5" long, with a black and white X pattern on the back. Adult chinch bugs are inactive during the winter. Reproduction begins after the appearance of warm weather in spring. Juvenile chinch bugs look like tiny bright orange and white candy corn.

Chinch bug saliva is toxic to the turf. Damage looks like disease or drought injury, and can develop rapidly, especially in sunny locations during hot, dry weather.

First signs of chinch bugs:
- Expanding, irregular patches of dead/stunted grass surrounded by halo of yellowing, dying grass.
- Lots of starlings feeding on turf.
- Grass turns yellow to red-brown, looks drought stressed but water doesn't help.

**How can I find out if I have chinch bugs?**
- Part grass on margin of where it is damaged and still green; inspect leaf litter for presence of larvae and adults.
- Remove both ends of 1lb coffee can. Pound can about 1" into ground between damaged and green grasses. Fill with solution of one gallon water + one ounce lemon dish detergent. If can drains, fill again. Wait 10 minutes for chinch bugs to float to top.
- Use watering can to apply water + detergent solution to margin between damaged and green grass in 2sqft area. Lay sheet of white flannel on top. Wait 10 minutes or so, then peel back the flannel and look for chinch bugs clinging to underside of cloth.

Start to sample at 115 GDD (growing degree days) and again at 850 GDD.

Chinch bugs like all grasses. Often the greatest numbers will occur in weedy lawns with lots of bents, fescues and thatch. They favor full sun, and all but northern slopes or faces. You are most likely to see damage in June with droughty conditions.

The best option for chinch bug reduction is to overseed with endophyte enhanced grasses in fall. Endophyte enhanced grasses have a fungus that grows within the grass plant and can reduce and eliminate chinch bug feeding after several consecutive overseedings. Ryes and fescues can be purchased with endophytes.

**What is the Threshold for Treating Chinch Bugs?**
The threshold is 15-20 chinch bugs/sqft. More than 20 floaters/coffee can means action should be taken to avoid loss of turf.
Visual Threshold: More than 10 chinch bugs found in a 60-second search of 1sqft and 20-30/sqft in a detailed search.

**Why Would Chinch Bugs Show Up in Different Places Each Year?**
Heat accumulation can change from year to year. Extra heat means a greater chance for chinch bug problems.

Heat accumulation can result from:
- Sand top dressing
- Pavement edging
- Loss of shade from tree or shrub removal
- Dethatching
- Pavement changes
- Reduced mowing height
- Use of different equipment that radiates more heat.

**Monitoring Tips for Turf Insects**
- 1 ounce of lemon soap in a gallon of water sprinkled onto surface of turf should bring insects to surface in 5-6 minutes, provided sample area has been mowed low.
- Starlings are an indicator of caterpillar pests.
- Tiny tufts of grass pulled out are an indicator of insects in turf.
- Dead patch with yellow border, soil firm, in sun: chinch bugs.
- Dead patch without yellow border, soil firm, in sun: caterpillars.
- Dead patch, loose, soil spongy, in sun: grubs.
- "Pencil-holes" in turf: caterpillars or bird pecks.
- Mounds with granular materials: ants or worms. (turf damaged but not discolored)

**Weather Considerations for Turf Insects**
- Cool wet springs: Natural fungal epidemics in turf insects.
- Hot dry weather: More chinch bugs, may decrease grubs, or grubs may show up later.
- Warm spring: Caterpillar pests may show up earlier than usual.
- Cool summer: Late blooming grubs.
- Worst case scenario for grubs: Hot dry summer and fall, followed by cool wet spring.
- Dry conditions also reduce the natural spread of caterpillar diseases.

**Watering Considerations for Turf Insect Management**
- Grubs move 4-8" DEEPER when hot and dry.
- Water top 2" of soil (0.25-0.5" volume) 24-36 hours prior to treating, grubs move back into root zone, thus better contact and efficacy: VERY IMPORTANT FOR NEMATODES.
- Water AGAIN after treatment to keep grubs in root zone.
- 1" volume = 622 gallons of water/1000sqft.
- Caterpillars are at surface; don't push treatment beyond where they are.
- Caterpillars are nocturnal, so delay putting treatment out until early evening.

**INDICATOR WEEDS**

Low soil fertility: Cinquefoils, common mullein, mallow, moss, wild carrot

Low nitrogen: Chickweed, clover species

Too dry: Bird's foot trefoil, crabgrass, quackgrass, silvery and other cinquefoils, rabbit foot clover, pigweed, speedwell, leafy spurge, prostrate spurge, yarrow, yellow woodsorrel, goosegrass, curly dock

Too wet or poor drainage: Algae, (also indicates pythium root and crown), nutsedge, barnyard grass, rushes, false green kylinga, smartweed, creeping bentgrass, buttercups, corn chamomile, coltsfoot, docks, lady's thumb, plantains

Mowing too low: Annual bluegrass, chickweeds, speedwell, moss, creeping bentgrass, purslane, crabgrass, dandelions, ground ivy

Shade: Moss, mouse ear and/or common chickweed, creeping speedwell, violets, ground ivy

Compaction: Prostrate knotweed (with bluish green leaves), goosegrass, pineapple weed, corn speedwell, annual bluegrass, broadleaf plantain, prostrate spurge, aujuga, moss, chickweed, crabgrass, ground ivy, pineapple weed

Excessive surface moisture: Algae, moss, creeping bentgrass, annual bluegrass, cinquefoils

Low pH: Moss, sheep sorrel, rabbits foot clover, coltsfoot, docks, English daisy, wild strawberry, hawkweeds, knawel, lady's thumb, common mullein, wild parsnip, wild radish, foxtail spp., mallow

**DANDELIONS**

Dandelions are effective competitors with turf when:

- Turf is mowed low.
- Calcium levels are low.
- Fertility is low.
- pH is out of whack.

Increase calcium levels via gypsum or other to reduce dandelion and other weed competition if calcium soil test levels are low.

Since Dandelions effectively out-compete grass at LOW nitrogen, look at your fertility program or other factors that may be affecting nitrogen availability (such as pH). Avoid fertilizers with excess potassium, especially if you apply more than what your soil test recommends. Long-term studies in the United Kingdom found potassium fertilizers increased dandelion densities up to twenty-fold.

Ironically, excess potassium can also increase snow mold disease exponentially, yet many biostimulants are particularly rich in potassium. Use your soil test as a guideline for applications and pay attention to potassium levels in both location and in products.

Seed germination occurs at or very near the soil surface. Light increases germination. Beware dethatchers, scattering cores from core aeration, and disturbing the surface in spring! Dandelions are suppressed by mulch mowing in fall.

**CRABGRASS**
Crabgrass seed contains a pigment that stimulates germination when exposed to light and heat. Crabgrass is a warm season annual grass. If cool season grasses are present, they will have already established when crabgrass germinates.

This tells us three things:

- We do not want to expose crabgrass seed to heat or light.
- We do not want gaps in cool season turf where dark, bare soil can absorb heat and light and allow crabgrass to get going.
- Crabgrass, a warm season summer annual, will out-compete cool season turf during warm weather by virtue of its tolerance for heat and drought, and by occupying hot compacted areas like the edges of lawns, near concrete, by the side of the road, etc.

Steps to take in an organic program to reduce crabgrass and its competitive behavior:

- Make sure spring turf is thick as it can be, and any bare spots are dormant seeded to avoid open gaps for crabgrass.
- Stop edging lawns, this exposes crabgrass seed to heat and light, while damaging, desiccating, and overheating turf crowns and roots.
- Apply slow release fertilizers early; second to third week of April, so they have time to be released by warming soil microbial activity, to be most useful to turf and least useful to crabgrass. Waiting until late May means, by the time nutrients are released, cool season turf is shutting down for summer, leaving crabgrass to use all the nutrients.
- Make sure areas of heavy crabgrass activity are renovated in fall; otherwise dead crabgrass will weather away over the winter leaving a large bare area of soil with crabgrass seed on top just waiting for spring sun.
- Do not core aerate in spring and then break up and scatter cores across the surface; you are scattering crabgrass seed right where it wants to be. The same is true for using dethatching machines.
- Make sure irrigation practices are not contributing to crabgrass issues. Light frequent irrigation encourages turf thinning because of dry zones that develop deeper in the soil profile. This thinning encourages crabgrass, as does over watering. The naturally shallow root system of crabgrass is not affected by constant saturation.
- Make sure mowing height is at least 3". The lower the height, the shallower the root system, the hotter and often drier the site, and the more potential for crabgrass germination and take over. In one study, 6-8 weeks AFTER forsythia flowers begin to drop, crabgrass was reduced by 50% by increasing mowing height to 3.5-4".

**TIP:** For cracks and crevices in driveways, sidewalks, and tennis courts, or where you feel you must edge, install a line of felt weather stripping by pushing the felt in tight to the cracks or against the edged turf. Water to help settle the stripping.

This will prevent crabgrass seed from germinating and the areas from filling in with crabgrass at the rate unprotected sites would experience. The felt is biodegradable, and keeps edges of turf moist and protected from the reflected heat and dryness of the sidewalk.

**WILD ONION AND WILD GARLIC**
Frequent, low mowing early in spring before grass has broken dormancy can help to severely weaken the plants. Never allow aerial bulblets to form; they will shatter and spread everywhere.

## UNDERSTANDING ANNUAL BLUEGRASS

Typical Annual Bluegrass Cycles: At the first dry spell in spring, overnight there are yellowing pockets of grass with seedheads. A few weeks later, their dead space is taken over by crabgrass. Even though there is technically an annual and a perennial biotype, all annual bluegrasses are considered winter annuals. This is important from a control standpoint. Winter annuals' seeds germinate in late summer and fall. That means the plants mature in fall and live through winter. Seed can live for up to six years in the soil.

### Conditions

Weather: Annual bluegrass is quite susceptible to winter damage and may be killed by direct freezing of the crown, and by extended periods under ice cover. Annual bluegrass ALSO invades any opening in the turf. So if you have a bad winter, and the annual bluegrass is killed or thinned leaving an open space, crabgrass will happily fill in any gaps. If moisture dries up in late spring causing annual bluegrass to die out, crabgrass again has the advantage because it is tolerant of such conditions.

Aerification: Time aerification and plug scattering wisely. It is important to NOT drag cores back in spring. You will drag crabgrass seed and annual bluegrass seed over the surface where it can take advantage of the extra light to stimulate germination. The peak germination period for annual bluegrass in most regions is late summer and fall, which means aerification in mid to late August will ALSO bring seed to the surface for germination.

Irrigation: Irrigation frequency and depth of penetration can either encourage or discourage annual bluegrass. Annual bluegrass has a very shallow root system so it prefers wet conditions, especially if it can live in a lens of moisture caused by surface compaction. Light frequent irrigation and over watering on compacted soil encourages annual bluegrass. Withholding water until desirable turfgrass species exhibit initial drought stress symptoms can help reduce soil moisture for potential annual bluegrass infestations. It is especially important NOT to over water early in season to discourage annual bluegrass. Over watering, especially in shady areas, may predispose the site to annual bluegrass invasion.

Fertility: Discourage annual bluegrass by keeping phosphorus applications LOW, allowing mature turf to take its phosphorus from underlying soil. Annual bluegrass may also be encouraged by high nitrogen levels. Fertilizing dormant turfgrasses when annual bluegrass is actively growing may also exacerbate infestations and should be avoided. In fact, nitrogen fertilization should be reduced during peak annual bluegrass germination and periods of vigorous growth.

Unfortunately, peak germination occurs during late summer and fall; the timeframe most important for fertilizing desirable turf species. The best option is to use slow release products with moderate nitrogen levels so annual bluegrass is not favored. High nitrogen at these times encourages annual bluegrass spread and survival into winter and spring. In addition to limiting P application, applying sulfur to acidify soil is suggested to decrease annual bluegrass density. However, acidification can favor undesirable bentgrass, so manipulation of fertility plus other cultural connections may be a better bet.

Mowing: Low mowing (especially in condominium common areas), coupled with high irrigation, high fertility, and compaction is a recipe for LOTS of annual bluegrass. As previously mentioned, annual bluegrass has a strong light requirement for seed germination compared to Kentucky bluegrass and creeping bentgrass. Thus a dense stand of turf which shades the soil surface is capable of preventing annual bluegrass seed germination and invasion. This means, simply, mow high for less annual bluegrass. In areas of high concentration of annual bluegrass, collecting clippings with seed heads during seed head formation is also a management strategy until changes can be implemented to the site or to cultural practices.

Compaction: Renovation, especially with skidsteers, can result in focal compaction in multiple areas; conditions perfect for annual bluegrass takeover. Water applied to a compacted renovation site follows the path of least resistance, leaving fingers of heavier sand particles behind, plowing smaller particles into little humps over compacted soil where annual bluegrass will thrive. Look for fingers of bright green surrounded by fingers of crabgrass or poor growth.

Thin Turf: Openings in the turf from disease damage, divots, or similar adverse stress conditions will permit light penetration to the surface. The result is rapid germination of existing annual bluegrass seeds followed by seedling growth and invasion of the area.

**TIP:** Seed with 50% more than recommended for dormant seedings in shade and other areas to compensate for rot and bird predation, or annual bluegrass may fill in these areas. In consistently wet soil, fine fescue will not grow, and annual bluegrass will take over.

**UNDERSTANDING BENTGRASS**

Bentgrass grows differently from other cool season turfgrasses. Its growth point is much closer to the ground, allowing it to be grazed or mowed very low with less damage. When mowed at the proper height for other cool season turfgrasses (2.5-3"), some varieties develop a long stringy stem with a witch's broom of green growth at the top. This growth habit often causes the grass to flop over and form what almost looks like a crop circle appearance. Other varieties of bentgrass will also flop over, particularly during periods of high heat and humidity, when often the bent will appear to die out altogether each year during the summer.

Bentgrass is highly competitive in wet areas, like the bottom of slopes / swales, in the shade / along shade lines, in seaside areas, and in wet areas that are compacted. Bent was once included in seaside grass seed mixtures due to its tolerance of these conditions. The seed is extremely fine, allowing it to blow in from adjacent areas as a contaminant.

Bentgrass tolerates acid soil better than other cool season turfgrasses. Making sure pH is between 6 and 7, ideally 6.3-6.8, can help other grasses be more competitive.

The design of a property is also important, for instance, if wind is blocked on three sides and thus holds in moisture, bent will thrive. If the site is extremely wet and this is contributing to the problem, cut back on irrigation. Try twice a week at only 0.5" at each application, between midnight and 8AM. You can also install more dry well drainage to pull water out of swales. A sod cutter can be used to cut out contiguous areas of bentgrass.

**UNDERSTANDING NUTSEDGE**

Nutsedge is not a grass.

- It has three-sided leaves and stems and is often found in wet habitats.
- It can be introduced to a site in compost or by birds.
- Nutsedge particularly likes light, sandy soils with high moisture.
- In turf, it grows more rapidly than desirable grasses and is readily apparent 2-3 days after mowing.
- Hand removal is laborious, expensive, and usually unsuccessful due to buried tubers, unless soil is removed to a depth of 3ft and replaced with tuberless soil.
- Since most reproduction is by means of tubers rather than seeds, control should be directed at tuber management.
- Since tuber production is correlated to light, increasing shade by as little as 30% can promote a corresponding drop in tuber production, although it never stops it completely.

If you want to dig out the nutsedge before more tubers are produced, early spring is best. Start about 10" away from the perimeter of the problem and go 10" deep. Refill area with clean soil.

Once again, watch that irrigation!

- Drainage is a best bet for containment.
- Monitor irrigation systems; a sudden surge of nutsedge in an area that has not been disturbed recently and has never had nutsedge before might signal a break in the irrigation head or line.
- Cultivation can help to control nutsedge outbreaks in areas where it is practical, and before plants have reached the 5-7 leaf stage. Shallow cultivation permits desiccation but is not a sure cure.
- Cultivation should NOT be done when soils are wet, moving wet soils contributes to spread.

**QUACKGRASS**

Quackgrass is easily identified, as it is the only perennial weedy grass that spreads by rhizomes.

- It is very salt tolerant, so hot, dry sites exposed to deicing salts or overwash are particularly vulnerable.
- Using organic contact herbicides on quackgrass is problematic because up to 95% of lateral buds on the rhizomes are dormant, though the plant is actively growing. After about 7 days, the dormant lateral buds will start to grow new shoots.
- It may take more than one application of organic herbicide to completely eradicate quackgrass.
- Nitrogen fertilizer will break lateral bud dormancy. The plant will begin to poke up again, and you can now use your contact product to exhaust the quackgrass' reserves.

Using this strategy to exhaust the plant may be particularly effective during springtime. Rhizome carbohydrate reserves are quickly depleted in spring as rapid shoot growth occurs.

**ALGAE**

Surface algae is usually a sign of a lens of compaction just below the soil surface on which moisture sits and warms, allowing algae to proliferate on the surface. The resulting semi-anaerobic conditions are perfect for pythium root and crown infection and in fact the dark, slimy presence of an algae layer almost always goes hand in hand with the disease. Reduce phosphorous fertilizers and aerate to break through the layer, and avoid sand top dressings.

**CLOVER**

Dry conditions a previous season enhance clover germination in the current season. White clover can access nitrogen from the atmosphere, making it very successful where turf is thin from poor fertilization. Dry conditions in fall mean poor fertility utilization and thin lawns in spring. Clover therefore has niches to occupy, and a germination advantage.

- Clover begins to germinate in fall when soil temperatures are 50°-60°. Germination continues throughout winter and early spring.
- Clover seed has a hard, heat-tolerant seed coat. Composting and solarization are not as effective in reducing its seed viability as they are with other weed species. The hard seed coat also allows seeds to survive longer in soil than many other weed seeds; clover seeds can germinate over many years, making control an ongoing effort.
- White sweet clover germinates at minimum 41°, but the best germination occurs when soils are 64-68° degrees. Spring is the optimum time for germination. White clover requires moist soil and cool ambient temperatures.

<u>If you WANT clover:</u> Do not fertilize or seed in thin areas of turf in spring. Clover is beneficial for its nitrogen fixing abilities and its pollinator friendly flowers.

<u>If you do NOT want</u> clover: Change your fertility or fixing soil so nitrogen is optimally available, and overseed turf so it is not thin.

**SPRING SEEDING TIP**: Seeding in spring is dicey because of competition from summer annual weeds. If you have to do it, research has shown seeds applied just before soil temps reached 50° provided 20% more cover by mid-June for Kentucky bluegrass, and 10% more for perennial ryegrass. Tall fescue prefers warmer temps, spring seed in late May or early June. Newly seeded areas need water until there is at least 60-70% cover.

**MOSS**

Moss tends to occur in areas that are: thin, disturbed, have low fertility, are salty, are compacted, have acidic soils, have endured an oil spill, and/or are shaded.

Mosses thrive in areas of: turf injury from disease, insects, chemicals or cultural practices, especially dethatched areas.

Repeated dethatching can encourage moss populations from year to year. Fertilizers that acidify the soil, or turf areas with naturally acidifying additions like pine needles or oak leaves will be subject to moss. Moss is more likely in areas of soil with potassium deficiency, with high calcium to magnesium ratio, or on heavy soil.

<u>Controlling Moss:</u>

- Two applications of a soap product labeled for moss control, two weeks apart, generally achieves a high level of control. Excessive damage may occur to turf if soap applications are followed by frost. To minimize turf scorching after soap applications, rinse turf within an hour of application.
- Moss can also be removed by using a sod cutter.
- A simple change in pH to 6-6.5, and to a less acidifying fertilizer, plus passing on dethatching, may make all the difference in permanent moss reduction.

**TURF DISEASES**

**Damping Off**: Death of seedling turf caused by fungus, before or just after it has sprouted. Damping off can kill seedling turf virtually overnight.

Pre-emergence damping off: Occurs prior to new plant breaking through soil, meaning, the seed actually rots.

Typical damping off: The stem and roots form, but the plant is girdled at the soil line. The seedlings yellow, the plants become floppy, and the whole stand of new grass collapses and dies, often with a bunch of fungal threads visible in the canopy. This is seen more often than pre-emergence damping off.

Both types of damping off are favored by a poor seedbed:

- Too wet.
- Seeds planted too deep. (never plant more than 1/8")
- Too much fertilizer applied.
- TOO MUCH SEED! When you spread seed thickly, you set it up for high competition for light, (leading to spindly plants with thin cuticles), and you increase humidity leading to rot and extreme competition for water and nutrients.
- Soil should be fine and firm.

All of this leads to weak grass, and opportunistic diseases are going to move in. Typical damping off organisms are the same that produce disease in mature turf, e.g., Pythium, Fusarium, and Rhizoctonia, and they stick around from year to year.

The most important thing is proper seedbed preparation:

- Freeze seed pre-planting for 24-48 hours to crack the seed coat and speed germination. This gives an advantage over fungus-induced pre-emergence damping off in cool soils.
- Fertilize with a 1/2lb actual nitrogen/1000sqft in the form of starter fertilizer about 4-6 weeks after establishment.
- Water in AM and early afternoon so soil can dry before nightfall.
- Mow as soon as seedlings reach a mowable height to keep canopy drier and less humid, less conducive to damping off.

**Pythium Root Rot (on seedling turf AND mature turf)**

- Can I see it with the naked eye? No.
- Is it obvious? No.
- What kinds of grass get it? Bluegrasses, bents, rye.
- What kind of weather? Cool, wet. (Pythium blight occurs in hot, wet weather).
- What do I look at first? The entire turf stand, the roots, the soil to a depth of 6".
- What do I see? Thin, off-color turf, yellowed areas, roots short and off-color in areas of poor drainage and shade, or in low spots near surface water. If soil has been amended with topsoil or sod laid you may have what look like two or more discrete layers. This can make for very poor drainage and predispose turf to pythium root rot. Wherever you see algae growing on surface of soil or grass, you are likely to see pythium.
- What do I do? Don't over irrigate! Improve air circulation and drainage. Use slow release fertilizers, avoid excessive watering, avoid compaction, top dress with compost. Amend with composted poultry litter.
- Will the grass die? Yes. The pathogen attacks the roots.

**The problem is largely cultural due to poor drainage. Fixing the drainage problem should eliminate fungus issues. Another fungus is available as a biological control for pythium.**

**Dollar Spot:** If you have dollar spot issues on your lawn, mow the good area first, then the bad. If you mow lawns commercially, mow them early and wash down mowers prior to moving on to later lawns. Any afternoon or evening watering must be changed. You can also set irrigation systems to syringe early every morning (4AM) to knock guttation fluid off. Dew removal between 4AM and dawn can provide 70-80% reduction in dollar spot severity.

Look for the disease from April through December. Conditions are perfect for dollar spot when there is heavy dew, extended leaf wetness, temperature bounces, and nitrogen runs out. (When disease begins it is a signal to FERTILIZE!) Dragging to remove dew is just as good as fungicide, and mowing is just as effective. Rolling also helps dry things out. Wetting agents for dew and guttation management work well, and get mowed off in 7-10 days. Make a couple of wetting agent applications in hot spots to control dollar spot without fungicide.

Endophytes help to decrease dollar spot by enhancing vigor, but this only helps in areas planted with fescues or rye. Biocontrols can be used with low disease pressure but require multiple applications. Dollar spot is capable of producing root-inhibiting toxins. Combined with high salt fertilizers, you have a recipe for turf disaster. The high nitrogen in the fast release salt fertilizers encourages juicy top growth, which attracts dollar spot. The salts coupled with toxins difficult to break down in soil spell disaster and failure for roots. Dollar spots take FOREVER to grow out, PLUS there is always new inoculum moving in. This leaves a depression in turf ripe for moss if grass is in shade, compacted, or acid conditions; and for crabgrass if it is in the sun.

Dollar spot can develop during late spring/early summer or late autumn, but early autumn drought brings the severest outbreaks, especially when salt is involved. Salt build-up in SPRING will probably be found in the area driest the previous fall, or where nutrients were run off or washed through, or where salty snow was piled up. This is where you will likely see your first outbreaks.

Drought-stressed turf is particularly susceptible to infection but free water, high relative humidity, and/or heavy dew is necessary for disease development. WATCH OUT FOR FERTILIZER TO RUN OUT THIRD WEEK OF AUGUST: this is correlated with a dollar spot jump. Temporary drought stress during the day will make grass more susceptible to dollar spot!!

**Dollar Spot**

- Can I see it with the naked eye? YES!!
- Is it obvious? Yes!!
- What grasses get it? Bents, bluegrasses, rye, fine fescue, Zoysia. (Can be very severe.)
- What kind of weather? Warm temps, high humidity, cool nights, persistent drought.
- What do I look at first? Leaves.
- What do I see? Hourglass shaped spots with brown edges, irregular straw-colored patches, tip blighting, "cobwebs" on lawn in AM (actually fungal threads), dime-quarter sized pits in low mown turf. Do not confuse with ball marks.
- What do I do? Reduce compaction, raise mowing height, DO NOT water late afternoon and evening, avoid light frequent sprinkling, reduce shade, increase air circulation, use natural organic fertilizers, animal and plant meal amendments.
- Will the grass die? Yes. Fortunately, only small areas are usually affected initially. May cause decline of new roots.
- Dollar spot is easily spread on mowers, shoes, and other objects.

**Summer Patch:** Root pathogen that sets up infection where it penetrates the roots. Poa annua shows earliest symptoms of root dysfunction, because it already has such a shallow root system.

Summer Patch presents first in areas the size of a basketball, (if the area is larger, it is often something else), BUT BASKETBALLS WILL COALESCE. There may be "frog eyes" of green grass surrounded by a tan ring, or serpentine swirling tan patterns in the turf. Kentucky bluegrass is favored as a host. The summer months are most common for visible symptoms.

To test for Summer Patch, take a sample and incubate in a sealable bag on a sunny windowsill:

- Summer patch makes no fuzz.
- Rhizoctonia (brown patch) fuzzes mid-canopy or on top of the sample.
- Fairy ring fuzzes on the side.

Roots begin to be infected about mid-April, but symptoms do not appear until it begins to get hot and dry, and damaged roots can no longer pull water up through the plant to keep the crown cool.

- Mow at 3.5" to reduce visible disease symptoms.
- Reduce pH to 5.5 to 6.2.
- Ideal pH for significant reductions in disease is 6.0 in the upper 2"of soil, where fungus is most active.
- Every 1/10 of a pH unit drop below 6.5 provides some reduction of summer patch.
- Avoid nitrate nitrogen or urea.
- If you are going to skimp on fertility, do it early in season.

Companion biofungicide (Bacillus subtilis) is excellent for summer patch.

- Start treatment with Companion EARLY to control the disease: apply mid-April through Labor Day.
- Put Companion in 5 gallons of water per 1000sqft, so it gets drenched into root zone but not pushed beyond.
- Trim grass back to 2" before treating and apply just after mowing so you have a ratio of more product to less surface area.

Manganese deficiency will make the disease worse.
Add 6-8lbs/acre/year using manganese sulfate. This also helps to drive pH down to 5.5-6. You may need to do this yearly, since the disease actually metabolizes manganese.

Syringing

- Syringe newly planted areas susceptible to summer patch if temps approach 80°, or if there are high winds for more than half the day under hot, dry conditions.
- Syringing does NOT replace regular irrigation, just cools turf down to reduce desiccation and root death from heat accumulation.
- Syringing can reduce temperatures 1-2 degrees for up to 2 hours, so it is a crutch to get through a hot day.
- Syringe areas that have the most abrasion. Summer patch usually occurs in the hottest part of the lawn.
- Look for roots that are tan and brittle.

**Summer Patch**

- Can I see it with the naked eye? Possibly.
- Is it obvious? Possibly.
- What grasses get it? Bluegrasses, bents, rye, fine fescues.
- What kind of weather? Infection occurs in cool, wet weather. You won't SEE symptoms until it gets hot and dry, and grass is stressed. Less likely in cool, wet summers.
- What do I look at first? The turf stand in general and the roots.
- What do I see? Look for wilting, frog eyes, swirls, or browned out areas in hottest part of lawn. Roots will be tan or brittle. Grass will change color from wilted blue, to reddish, to tan, to straw. Spots may occur in same place year after year, and will first reappear where disease was active the year before. Prevalent near sidewalks, buildings, and southern slopes.
- What do I do? Maintain 5.8-6.0 pH in root zone, raise mowing height in hot weather, avoid fluctuation in soil from wet to dry, try slow release fertilizers rather than soluble, core aerate to improve layering. Cool down areas routinely attacked by summer patch; damage is worst in soil 5-10° warmer than surrounding areas. Remove excess thatch.
- Will the grass die? Yes. The pathogen attacks the roots.
- Time your first preventative applications of biological control like Bacillus subtilis for around tax time. Once you see symptoms, the grass is already dead.

**Necrotic Ringspot**: A root pathogen very similar to summer patch, but tends to occur in new turf stands. Like summer patch, it occurs in the hottest part of the lawn, but you will tend to see it either prior to June or from mid-August on. Any treatment should still be in mid-April. Favored hosts are fescue and Kentucky bluegrass; it DOES NOT AFFECT RYE. This is also a disease made worse by manganese deficiency.

Most importantly, avoid over watering. It is tempting to irrigate lawns with a history of NRS more frequently, but this will enhance the disease. Water to 6-8" infrequently as possible, usually no more than twice a week, without creating water stress. Check irrigation heads are working properly, and limit overlapping sprays that may create puddles. **Prepare site before sodding or seeding.** Necrotic ring spot is more severe on sites with compacted soils and poor soil drainage.

**Necrotic Ringspot**

- Can I see it with the naked eye? Possibly, or only see swirly area of browned out grass.
- Is it obvious? Possibly, or it may be a diffuse thinning or browning.
- What grasses get it? Bluegrasses, bents, fine fescues.
- What kind of weather? Mild weather in fall and spring.
- What do I look at first? The entire turf stand, the roots.
- What do I see? Frog eyes (tan circles with apparently healthy grass growing in center), or sunken bronzed patches in lawns less than four years old. Roots discolored dark brown or black.
- What do I do? Overseed with resistant varieties, avoid serious fluctuations in soil moisture, use slow release fertilizers, avoid excessive watering, avoid compaction, top dress with compost.
- Will the grass die? Yes. The pathogen attacks the roots.
- Time your first preventative applications of biological control like Bacillus subtilis for around tax time. Once you see the symptoms, the grass is already dead.

**Anthracnose**: Anthracnose commonly occurs in conjunction with other diseases like summer patch, Rhizoctonia (brown patch) and Pythium blight. There is a strong association between summer patch and anthracnose. Anthracnose infected grass heats up quicker because turf is thinner, so this may also be the first place you see symptoms of summer patch.

Two types of Anthracnose:

- Foliar: Presents as black bristles on the leaf. Present at 61-90°, optimal is 81-91°.
- Black basal rot: Begins to really affect plants at around 59°.

The more foliar anthracnose present, the more crown rot anthracnose.

70% of a current season's disease is from over-wintering disease to healthy grass once SOIL temperatures hit 65°. Look for bright yellow leaves surrounding central green leaf. PURPLISH areas are a warning to water and add nitrogen. Yellowish spots mean failing plants. Avoid abrasive practices and spoon feed with about 0.116lbs of actual nitrogen per week through season, and then catch up with the rest of the fertility through fall.

**Anthracnose**

- Can I see it with the naked eye? Yes, using a hand lens.
- Is it obvious? Usually.
- What grasses get it? Bluegrasses, bents.
- What kind of weather? Warm temperatures, excessive moisture, stress.
- What do I look at first? Leaves.
- What do I see? Elongated reddish brown spots that eventually become small, black, hairy dots on dead and dying leaf tissue. May see yellow outer leaves, while still green center leaf detaches easily like a rotted tooth. Check for water soaked crowns. Common with excessive moisture, combining with factors that slow grass growth. More common on annual bluegrass, but also seen on bents. May see in conjunction with leafspots.
- What do I do? Increase mowing height, decrease compaction, core aerate, no heavy N applications especially during drought or heat wave (spoon feed instead), reduce traffic.
- Will the grass die? On a golf course during hot weather YES. Try to fix stress factors to improve chances for survival.
- Symptoms will be worse during hot weather.

**Rhizoctonia/Brown Patch**: There are different species present at different times of the year, as different Rhizoctonia occur at different temperatures:

- 45-65° for R. cerealis
- 60-85° for R. solani
- 85-100° for R. zea, which attacks grass crowns and sheaths

As temperatures warm, brown patch may first infect ROOTS, then stolons, then leaves; but the MOST susceptible place for entry is the cut ends of the grass. Just like dollar spot, the mycelium can bridge plant to plant and uses nutrients in guttation fluid. Worm casts are a source of inoculum. Early AM hosing, poling, or dragging of turf reduces Rhizoctonia; results improved if before 7:00AM. Look for reddish winter color, the higher the percentage, the more likely to develop Rhizoctonia during the course of the following season. Look at emerging roots and new roots in these areas: they will become necrotic and die at 0.5-1" when correlated with Rhizoctonia. In rye, usually see this onset between 200-300 Growing Degree Days.

Treatment for Rhizoctonia/ Brown Patch

Compost supplemented with an organic N source like blood meal may reduce incidence of disease indirectly. When applied as a topdressing or topdressing mix amended with plant and animal meals, composted animal manures, plant debris, or composted turkey litter may also help. Use of urea may enhance brown patch. Do not irrigate in late afternoon or evening.

**Brown Patch (Rhizoctonia)**

- Can I see it with the naked eye? Probably not. You may see irregular brown lesions, tip blighting or smoke rings on closely mowed turf.
- Is it obvious? Sometimes.
- What grasses get it? Bents, bluegrasses, rye, fescue, Zoysia.
- What kind of weather? Cool wet or warm wet (75-95° AM, 70° PM)
- What do I look at first? Leaves.
- What do I see? Smoke rings on golf turf, or circular areas that appear a different color than surrounding areas. There may be blight or die back from leaf tips. May see brown patches with darker border, especially in AM. Kentucky bluegrass may appear to have reddish blades or whitish spots with red margins (a bit like dollar spot). In warm weather, the size of the patch affected may increase rapidly over a day or two. Blighting of leaf tips may last 1-3 weeks.
- What do I do? Improve drainage, reduce compaction, DO NOT over-fertilize, avoid excess soluble nitrogen, irrigate deeply and infrequently, DO NOT water every day, mow early in AM to speed leaf drying, remove excess thatch, use organic amendments like composted poultry litter, compost, or animal and plant meal.
- Will the grass die? Possibly. Brown patch affects roots and crowns. Bring Extension a sample for confirmation.
- Root health and turf density can be seriously affected.

Monitoring Tip: Activities or organisms that injure roots INCLUDING Rhizoctonia can be seen before the actual appearance of brown grass. Reduced root systems and attendant water stress cause this MAJOR CLUE: areas infected have NO guttation fluid or dew early in the morning while surrounding grass is covered. Infected areas also don't grow as quickly after mowing, meaning, they heat up quicker, and thus are areas first hit by anthracnose.

**Red Thread:** Most grass outgrows symptoms with weather change. Grass may take on an overall bleached appearance, but no real harm is done unless the disease persists steadily for 3-4 weeks. Composted poultry litter may help grass outgrow it. A more permanent solution is to overseed with endophytic fine fescues, which can reduce disease incidence dramatically.

**Red Thread**

- Can I see it with the naked eye? Yes.
- Is it obvious? Yes
- What kinds of grass get it? Bents, bluegrass, fescues, rye.
- What kind of weather? Cool, wet.
- What do I look at first? Leaves.
- What do I see? Red or pink strands near tips of leaves binding them together, or fuzzy pink on dead leaves. Infected leaves turn straw color.
- What do I do? Fertilize properly, reduce compaction, irrigate, use organic amendments.
- Will the grass die? Probably not.

**Rust:** Usually an indicator of weak, dry, or undernourished turf and, like red thread, comes and goes with weather. Rust is mostly seen from about mid-October until frost, often during "Indian Summer." The incorporation of compost as a top dressing or in new turf plots may reduce rust by providing a bit of moisture retention, and nutrition can make a big difference in the level and persistence of the disease.

**Rust**

- Can I see it with the naked eye? Yes!!
- Is it obvious? Yes!!
- What kinds of grass get it? Bluegrasses, rye, Zoysia (Can be serious.)
- What kind of weather? Cool, wet weather, moisture for 10-12 hours, fog.
- What do I look at first? Leaves.
- What do I see? Yellow, orange, or red lesions surrounded by green, yellow, brown borders depending on age and susceptibility of grass; severely affected grass has red or yellow cast, may be huge clouds of spores which turn shoes and clothing orange.
- What do I do? Mow frequently, avoid prolonged drying, irrigate, reduce compaction, increase light and air circulation.
- Will the grass die? No.

**Leaf Spot:** A symptom of stress, often attacks plants in shade or receiving improper irrigation.

**Leaf Spot (excluding gray leaf spot)**

- Can I see it with the naked eye? Yes!
- Is it obvious? Yes!
- What kinds of grass get it? Bents, bluegrasses, rye, fine fescues, rye, Zoysia.
- What kind of weather? Cool wet weather for spots; hot wet weather for major damage.
- What do I look at first? Leaves.
- What do I see? Browning. Thinning. Circular to elongated purple with brown, red, white tan, straw centers. Leaf blotch, tiny red or purple spots on blades and sheaths. Seedlings are most susceptible and often die. Zoysia dies back from tip during hot, wet weather. Look for first signs of leaf spot on bluegrass; may look like dull mower injury on bents. You may see tip blighting or a reddish brown to black crown root rot, and few, shallow, or lacking feeder roots. Older leaves are more susceptible than young. In warm weather, leaf spot is restricted to roots and crowns. Kentucky bluegrass is susceptible when sugar is low, i.e., overcast weather, or succulent growth.
- What do I do? Avoid planting grass in shade; leaf spot appears first on shaded grass. Mow high, leaf sport is worst on closely mowed turf. Reduce thatch, don't over fertilize, improve drainage, try not to mow or irrigate when disease is active, irrigate deeply and infrequently, apply higher rates of nitrogen in fall than spring. For fine fescue, don't over irrigate or keep wet; avoid all light frequent irrigation. Avoid soluble fertilizers like urea or ammonium nitrate. DON'T sprinkle in early evening; the more often the grass is wet or remains wet, the greater chance of establishment, and once there, it's always a problem. Avoid use of plant growth regulators. Increase air circulation.
- Will the grass die? Leaf spot will attack roots and crowns. In hot windy weather, yes; this is known as melting out. Discrete spots seen in spring and fall will not kill the plants.
- Most varieties of grass are now somewhat leaf spot resistant. If you do use a fungicide, only contact fungicides are useful against leaf spots.

**MUSHROOMS IN THE LAWN**
Often arise from remnants of old roots in soil. May be more prevalent after several days of light sprinkling.

**Fairy Ring**
- Can I see it with the naked eye? Yes.
- Is it obvious? Yes.
- What kinds of grass get it? Most.
- What kind of weather? Infection occurs all year during periods of high humidity.
- What do I look at first? Fairy rings are actually fronts of fungus infesting the soil. Take a sample of soil; break it apart to see if it smells moldy.
- What do I see? Look for a strange green arc or ring, or an arc/ring of mushrooms, or if it is really bad, death of turf in a circular pattern.
- What do I do? Use a wetting agent to try to ensure soil does not become hydrophobic.
- Will the grass die? Usually not.
- Should I use a fungicide? No. Fungicides are ineffective against fairy ring. The fairy ring usually resolves itself. You can try using a little nitrogen to mask the darker color.

**VOLES**
Voles, also known as meadow mice, have plump bodies, short hairy tails, and small eyes and ears in proportion to the head. Fully grown, they are about 7" long and have rather coarse hair. They eat a variety of grasses, broad-leaf weeds (every pest has a plus), seeds, tubers, bulbs and rhizomes. They also eat tree bark including that on roots. They do not hibernate and remain active all year, mostly during the day. They can produce a new generation in about 60 days. Like moles, their population fluctuates from year to year. Fortunately, many are consumed by natural predators, and the mortality rate of the young is more than 80% prior to reaching one month. The lifespan of the vole is short, from 2-16 months.

- Moles have greatly enlarged front feet with prominent claws for digging.
- Shrews have long, pointed snouts and needlelike front teeth.
- Voles have blunt snouts with chisel-like front teeth.

There are two prevalent types of vole:
The meadow vole usually has a run at the surface in ground cover and a long tail.
The pine vole is tougher to control, has a shorter tail, and tends to damage plant root systems and even to girdle plants.

These are both incidental to turf problems; they may use the abandoned tunnels of moles for transport. On ornamentals they area serious problem. Look for tiny 1-2mm wide tooth marks and scratch marks where bark is removed. Reducing grounds covers helps to reduce meadow vole populations; weed fabric is especially favored by voles because they can travel along beneath it. Switch to mulch that will not hold its shape during vole tunneling, such as large bark chunks. Finely shredded mulch, which tends to pack, is perfect for them to create a tunnel in.

Voles can be caught with live capture traps or any kind of mouse trap, with an overhead tent of roofing shingles, or an upturned 5 gallon bucket. Use a bait of 1 slice of apple under a shingle to survey. If 5% of the slice is missing for areas around immature trees and shrubs, control them. If 10% is missing for mature trees and shrubs, control them.

**MOLES**

There are two kinds of mole: Star-nosed and Eastern.

They are not rodents; they are in the same group of mammals as shrews. Moles are considered beneficial for their insect eating and aeration abilities. Moles eat more than grubs and are primarily carnivorous so they do not damage plants by feeding.

Once the moles have moved on, you can expect your grass to thrive better than before, thanks to the effect of tunneling aeration.

Moles are mostly nocturnal, and do not resemble mice at all.

- The head and body range from 4.3 to 6.7" in length.
- They have thick fur that ranges in color from silver to black to copper.
- The short round tail ranges from ¾-1½" in length and is almost hairless.
- There are no external eyes or ears.
- They have very poor eyesight, and can only see light vs. dark.
- Their large, almost hairless front feet have webbing between the toes.
- They are powerful diggers, having been clocked at a rate of 14.8ft per hour, or 101.8ft per day!!
- Their major food source is earthworms.
- Their tunnels are on two levels, with upper tunnels used for transportation, lower for living space.
- Moles are known to seek well-irrigated lawns during dry spells just for the moisture.
- Moles are mostly solitary, mating in spring.
- They are very territorial; two moles at the most are doing all the tunneling in an average location.
- Mole populations are not constant. Extra rain will cause a temporary increase in numbers, and possibly in activity since it will also cause grubs to stay near the surface.

Eastern moles prefer well-drained, loose soil in lawns and gardens. They are not found in rocky soil or clay.

Star-nosed moles prefer wet areas in woods, fields, or swamps. Presence of star nosed moles indicates you may be over irrigating.

Moles get a bad name for damaging turf which, when disturbed by tunneling, may shrivel up and die during hot weather. If you are disturbed by the presence of mole tunnels, you can roll the area lightly and water the area. The mounds shouldn't interfere with mowing unless you have you mower blade set too low, which isn't good for the grass anyway. If you have multiple tunnels, even them off with a shovel and top dress with the excess.

Harpoon traps set under a five-gallon pail are effective, or you can try castor oil deterrent products available commercially. Irrigation or rain will leach the repellent decreasing its effectiveness. Otherwise, the application can remain effective for 30-60 days. To find best places to trap, stomp the tunnels, and then look for which are reactivated in the next 24-48 hours.

## PART TWO: Soil Testing

### HOW TO SOIL SAMPLE

- When: Early enough to get soil test results back.
- How: 2-3" depth for turf, 4-6" other plantings.
- Where: Take multiple samples at same depth removing any large objects, mix in plastic container for composite sample.
- Sample separately each area with different liming or fertility practices.
- Each area to be sampled should be represented by 10-15 soil core sub-samples.
- Homogenize sub-samples in plastic container. (Do not use metal.)
- Submit 2/3 pint of composite sample from each separate area with different liming or fertility practices.

### Caveats for Soil Sampling

- Except for deeply rooted trees and shrubs, use only the surface horizon for soil testing. Otherwise, your results may not reflect the true nature of the zone where root growth occurs and where you are interested in making changes or marking values.
- Seasonal variation: phosphorous and potassium may be lower in spring and late summer.
- The pH of coarse textured soils is often reduced by 0.5 pH (a lot in a log scale) by recent addition of acidifying fertilizer.
- Microbial activity, growth of plant roots, and increases in soil temperature can also result in a REDUCTION in soil pH.
- For frequently tilled areas sample to a depth of 6-9", for lawns to a depth of 2-3", for trees and fruits use two samples: one from 0-8" and another from 8-24".
- Do not sample when extremely wet or when soil is frozen.

**Why Soil Tests Disagree**: When we send tests out to separate labs, (a local option for soil tests is the Cornell Cooperative Exchange Horticultural Diagnostic Lab,) we get reports that are completely different. This is influenced by several factors:

- The kind of test performed
- A difference in type of units reported (these can be converted)
- The type of plant indicated as the crop for that location.
- Or in the case of phosphorous, the type of soil tested.

Lime recommendations will be different depending on if the lab has figured in buffering capacity, and depending on soil type. pH tests can also differ based on method used. If something seems off, ask questions.

### What is Included in a Typical Soil Test?

- Soil pH
- Lime requirements as a function of buffering capacity
- Soluble salts
- Levels of Phosphorous (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Manganese
- (Mn), Iron (Fe), and Zinc (Zn)

**WHAT IS PH?** pH is a measure of the soil's acidity. The lower the pH, the more acid the soil. When pH is low, lime is added to increase or "sweeten" the soil. The pH scale is a logarithm, so a pH of 5 is ten times more acid than a pH of 6, 100 times more acid than a pH of 7, etc.

**How Does pH Affect Fertility and Fertilizer Availability?**

- If pH is 4.5, about 75% of applied fertilizer may be unavailable to plants
- If pH is 5, about 54% of applied fertilizer may be unavailable to plants
- If pH is 5.5, about 33% of applied fertilizer may be unavailable to plants
- If pH is 6.0, about 20% of applied fertilizer may be unavailable to plants
- If pH is 7.0, about 0% of applied fertilizer should be unavailable to plants

pH is like the bank teller that tells your plants if they can make a nutrient withdrawal, since plants cannot access certain nutrients when the pH is too high or too low. Most plants prefer a pH between 6 and 7 with optimal a 6.5. Turf does best with a pH between 6 and 7

**Lime Recommendations:** Lime incorporated pre-plant should be done to a depth of at least 6". Lime applications should never exceed 50lbs/1000sqft in a single application. Often you will have to split a greater amount recommended into 2 or even 3 apps, by season. If applying to established plantings without incorporating, never apply more than 50lbs/1000sq.ft./application.

**Soil Buffering Capacity in Relation to pH**

The buffering capacity of the soil is its ability to withstand rapid pH fluctuation. The greater the buffering capacity of the soil, the greater quantity of acid or base that must be incorporated into the soil to alter its pH.

- Soil types with LOW buffering are sandy soils with little clay or organic matter.
- Soil types with HIGH buffering are those with greater amounts of clay or organic matter; these will need more lime or acidifying product to effectively change pH.

**When do Lime Recs take into account Buffering Capacity of Soil?**

Some soil tests refer to the lime index which = buffer pH; the value is reported without a decimal point to distinguish it from the regular soil pH. The lime recommendation is then based on a calculation of the difference between the soil pH and the lime index. A higher lime index indicates soil is more susceptible to changes in pH.

PRE-PLANT LIMING RATE: LBS LIME/1000 SQFT (TO RAISE PH TO 6.5)
INCORPORATED INTO TOP 6LBS LIME/1

| PH | SAND | LOAM | CLAY |
|---|---|---|---|
| 4.0 | 300 | 125 | 165 |
| 4.5 | 100 | 125 | 235 |
| 5.0 | 75 | 85 | 175 |
| 5.5 | 50 | 50 | 110 |
| 6.0 | 25 | 21 | 60 |

Application amount is dependent on soil texture. Always base lime applications on soil tests.

**How long does it take Lime to become Chemically Active in Soil once Applied?**

3-6 months. Do a pH test about 6 months pre planting so lime amendments have time to work.

**What is the Difference between Calcitic and Dolomitic Limestone?**
CALCITIC Limestone has less than 5% magnesium.
DOLOMITIC Limestone has more than 5% magnesium. (Pure magnesium carbonate is known as dolomite.)

**What kinds of Liming Materials may I choose from?**

- Pulverized: Fine, dusty, fairly fast acting.
- Granular: Slow acting, inexpensive.
- Pelletized: Fast acting, easy to spread, more expensive.

**WAYS TO JUDGE HOW GOOD YOUR LIME IS**
Effective neutralizing value - All lime is not created equal

- Look on label for the ENV. (Effective Neutralizing Value.)
- Divide 100 by this number.

The result is the amount of lime needed to provide one unit of 100% effective neutralizing value, which gives you true measure of cost to get the right amount to reach desired pH.

This can save you money!

For example:
Lime #1 has an ENV of 70. 100 divided by 70 =1.42. So for every pound of lime they recommend you put down, you actually have to put down 1.42 pounds!

Lime #2 has an ENV of 89.7. 100 divided by 89.7 =1.11. Even though Lime #1 is cheaper by the pound, it will cost more to treat your property because you ultimately have to buy more!

**Calcium Carbon Equivalent (CCE): Another way to Judge Lime Value**
Recommended liming rate/calcium carbon equivalent X 100
=actual amount of liming material to apply

**TIP**: Do not sabotage your liming efforts with acidic fertilizers.

**What to do about High pH**

- Sulfur (S) will be recommended if pH EXCEEDS 7.5.
- Depending on plant sensitivity, never apply more than 1-5lbs S/1000sqft/app.
- Apply S to turf ONLY in spring and fall.
- You can also use iron sulfate at 8.7lbs/1000sqft to acidify a high pH.
- Sample soil frequently at 1-2" and at 2-6" to make sure you are not acidifying just a shallow surface zone.
- Most of us are working with soils that tend to be acid. (Too low.)
- If your soil's pH tends to be TOO HIGH (alkaline), one solution is to add elemental S to acidify (lower) the pH.
- If you have a lot of free carbonates in soil, it is practically impossible to use S in this manner. Try this test: Take a soil sample, dry down a bit, add vinegar. If you get foaming, carbonates are present and it will be difficult to reduce soil pH using sulfurs.

**To Reduce Soil pH add the following lbs of Elemental Sulfur/1000sqft**

| Existing pH | Desired pH | Sandy Loam | Loam | Clay |
|---|---|---|---|---|
| 8 | 7.0 | 4.0 | 8 | 11 |
| | 6.5 | 5.7 | 11.3 | 15.7 |
| 7.5 | 7 | 1.7 | 3.3 | 4.7 |
| | 6.5 | 3.3 | 6.7 | 9 |
| 7 | 6.5 | 1.7 | 3.3 | 4.7 |

**MACRONUTRIENTS**

**TIP:** Nitrogen is constantly changing in soils, so soil tests for nitrogen are of very limited value for predicting nitrogen needs. On many soil tests, no tested values for nitrogen appear.

| Nutrient | Low lbs/acre | Medium lbs/acre | High lbs/acre |
|---|---|---|---|
| Phosphorous | 0-3 | 4-8 | Greater than 9 |
| Potassium | 0-150 | 150-300 | Greater than 300 |
| Magnesium | Less than 65 | 66-100 | Greater than 100-199 |
| Calcium | Less than 3,500 | 3,500-5,200 | Greater than 5,200 |

**Why would I have a Soil Test with High Calcium Levels?**

Extractable levels increase with clay content. The Ca levels of poorly drained, loamy sand, or sandy soils are likely to be higher because a clay type soil or one with more organic matter has more charge to hang onto the Ca. Or you may have concrete leaching or street sweepings as a component of manufactured soils.

**MICRONUTIENTS**

| Nutrient | Normal range in lbs/acre |
|---|---|
| Manganese | 60-80 |
| Iron | 20-50 |
| Zinc | 0-1 |
| Aluminum | 20-80 |

**WHAT IS A CATION?**
A cation is an ion with a positive charge that will stick to things with a negative charge, such as water, clay particles, and organic matter.

The collective ability of a soil to hold on to cation nutrients is called cation exchange capacity (CEC).

**What is Cation Exchange Capacity (CEC)?**
Clay and organic matter have negative charges, so CEC capacity is a measure of a soil as water, to hold exchangeable cations like Ca ++, Mg++, K++, Cu++, Mn++, Zn++, and Fe++.

The higher the CEC, the larger the fertilizer application of cations has to be in order to fill up all the binding sites.

Soils with lower CEC need smaller, more frequent fertilizer applications to keep binding sites filled. Nutrients with negative charges are repelled by cation exchange complexes so therefore easily leach with excess water, which has both a positive and negative charge on its molecules. These include nitrate NO3-, chloride (cl-)2, sulfate (so4-2) and borate (Bo3-3).

Thus even moderate amounts of organic matter provide a great deal of CEC.

**Typical CEC Ranges**

| Soil Texture | Common CEC Ranges |
|---|---|
| Sand to sandy loam | 0-12 |
| Sandy loam to silty clay loam | 8-30 |
| Silty clay loam to clay | 20-40 |

Sometimes amount of nutrients will be listed as a function of what is held on the CEC complex. Below are acceptable ranges:

| Available P | 115-2.3lbs/1000sqft |
|---|---|
| Exchangeable K | 7-11.5lbs/1000sqft |
| Exchangeable Ca | 46-138lbs/1000sqft |
| Exchangeable Mg | 5.8-23lbs/1000sqft |

**What is Base Saturation in relationship to Cations?**
While there are many negatively charged sites for positively charged cations to bind with in soil, they are not all filled all the time. There is an optimal range for percentages of sites to be filled:

- Ca++ 50-70%
- Mg++ 8-20%
- K+ 1-9%
- Na less than 4%

If you get readings lower than this, you may end up with a somewhat higher application recommendation. Readings may not correlate well with nutrient content in plant tissues, or growth in the field.

**WHAT IS EXCHANGE ACIDITY?**
Sometimes your soil report will have "exchange acidity" on it if your pH is below 6. This is a measure of the number of H+ ions stuck to soil that can be replaced by Ca++ or Mg++ on cation exchange sites to help neutralize soil acidity and will be given in milliequivalents per 100 grams of soil (ME/100g).

**SOLUBLE SALTS**
Cornell soil tests for soluble salts and reports values in mmho/cm:

- 0-25 mmho/cm is low: do nothing.
- 25-75 mmho/cm is medium: still to do nothing.
- 75-100 mmho/cm is HIGH: recommendation is heavy watering and fertilizers with low salt index. (Listed on bag, the closer the value is to 100, the greater the salts hazard.)
- +100 mmho/cm is EXCESSIVE: recommendation is heavy watering, and to use salt tolerant species.

**What About Using Gypsum when Soluble Salts are High?**
In the case of a saltwater overwash such as we had in Hurricane Sandy, leach with 1" of water every other day for 20 days. Or, in combination with this leaching regimen ONLY, apply gypsum at a rate of 46-138lbs/1000sqft, with more positive effect seen on less sandy soils.

**Gypsum Test for Potential Soil Benefit**

- Take two, 4oz soil samples from affected site using a soil corer, dry and crush until largest particles are sesame seed sized.
- Mix generous ½ tsp of gypsum (we would standardize this in grams using a digital scale) with sample of crushed soil.
- Take a second sample of crushed soil without added gypsum.
- Prepare two empty cans with both metal ends removed.
- Cover one open end of each can with fine screening (e.g., window screen) so water may drain but soil cannot fall through.
- Place each soil sample in a can; each can should be about 3/4 full.
- Tap cans approximately ten times on a hard surface to settle soil.
- Place cans over separate collection containers and fill to brim with water carefully so as not to disturb soil.
- Add the same amount of water to each can.
- Compare the amount of water collected when cans finish draining
- If less than half as much water has passed through the soil that was not mixed with gypsum, the addition of gypsum may help to improve drainage in the location from which the soil was obtained.

# PART THREE: Understanding Soils

### THE MEANING OF SOIL COLOR

- Dark soil is associated with organic matter.
- Brown-red soil is associated with adequate air and good drainage.
- Yellow soil is associated with imperfect drainage.
- Mottling/streaking of the soil is associated with seasonal periodic water problems.
- Mottled blue green / gray soil is associated with poor drainage. Dig into the soil for a depth of 12-15" to find underlying drainage issues. You will usually encounter foul odor and/or reddish streaks of chemical change known as "gley."

### WHEN SHOULD YOU HAVE PHYSICAL TESTS OF SOIL DONE?

- On new construction sites.
- During construction projects to insure quality control of new soil loads.
- To check for contamination of old soil loads.

Cover soil loads to prevent contamination from material blown in or arriving in runoff. For soil that is already on site, take undisturbed samples from problem areas and evaluate physical condition.

### COMMON SOIL PHYSICAL TESTS

- Particle size analysis: percent sand silt and clay, DEFINING soil types, textures
- Bulk density
- Saturated hydraulic conductivity = infiltration rate
- Porosity/water retention: occupation of air after free drainage vs. occupation of water after free drainage

### Determine your Soil Type: Texture by Ribbon Test

1. Place 2tsp of the soil in your palm and drip water onto it, kneading until it forms a ball.
2. Does the soil remain in a ball when squeezed? If not, you have mostly sand.
3. If the ball forms, squeeze it between your thumb and forefinger into a ribbon of sorts.
    - Loam: Weak ribbon less than 1" before breaking.
    - Silty Loam: Ribbon holds together and appears to be "ruffled" or has cracks in it.
    - Clay Loam: Medium ribbon 1-2" before breaking.
    - Clay: Strong ribbon 2"+ before breaking, may explain drainage problems.

### Determine Soil Type, Texture by Jar Test (rough estimate)

Fill half a jar with soil; add water until full, shake one minute, let settle:

- Gravel and sand settle to bottom
- Clay and silt are next layer
- Dark layer on top = organic matter

### Specifications for soil texture

Soil particle size is the mineral fraction of the soil divided into sand silt and clay. The way they hang together is called an **aggregate.** Sizes for various particles:

Gravel: greater than 2mm
Very coarse sand: 2-1mm
Coarse sand: 1-0.5mm
Medium sand: 0.5-0.25mm
Fine sand: 0.25-0.1mm
Very fine sand: 0.1-0.05 mm
Silt: 0.05-0.002 mm
Clay: less than 0.002 mm

**FORMAL SAND DEFINITIONS**

Sand does not have to be 100% sand; in fact it is any soil material at least 85% sand.

- Taken backwards, a sand is any soil material where the percentage of silt + 1.5 times the percentage of clay does not exceed 15. 85+15=100.
- The official abbreviation is Sa.
- Squeeze sand dry and it falls apart. Squeeze it wet, it forms a ball but immediately falls apart when disturbed in any way.
- Sand is defined as 25% or more very coarse + coarse + medium (0.5-0.25mm) sand and less than 50% fine sand (0.25-0.1mm) or very fine sand (0.1-0.05mm).

Coarse sand is 1-0.5mm in size, and is defined as 25% or more very coarse/coarse sand, and less than 50% of any other single grade of sand.

Very coarse sand is 1-2 mm in size.

Fine sand is defined as 50% or more of fine sand OR less than 50% very fine sand.

Very fine sand is 50% or more of very fine sand.

Sand by definition will form a cast when wet, crumbles easily and, this is very important, 100% will pass through a 2mm sieve, because the largest particle, very coarse sand, is 1-2mm. It does NOT make a ribbon.

Loamy sand has two limits, an upper and a lower:

- Upper limit loamy sand has 85-90% sand. The percentage of silt + 1.5 times the percentage of clay will never be less than 15.
- Lower limit loamy sand will not contain less than 70-85% sand and the percentage of silt + twice the percentage of clay will NOT exceed 30.

The official abbreviation is Lsa. Loamy sand is 25% or more very coarse, coarse, and medium sand + less than 50% of any other single grade of sand. By definition, loamy sand will NOT form a ribbon, will form a cast when wet, and sand grain can be felt when rubbed between your fingers.

Loamy coarse sand is 25% or more very coarse and coarse sand + less than 50% of any other single grade of sand.

Loamy fine sand is 50% or more of fine sand OR less than 25% very coarse, coarse, and medium sand + less than 50% very fine sand.

Loamy very fine sand is 50% or more very fine sand.

**Why sand shape is important:** Sands that are very spherical may be unstable. Sands that are flat and angular may pack excessively, even though the size distribution is favorable.

**TIP**: Uniformity Coefficient (Cu)
Very few labs report this, but it is very important: the acceptable range is 2-4; optimum range is 2-3. The higher the value, the less uniform the sand or soil mix, the GREATER THE POTENTIAL FOR PACKING, which can mean compaction troubles.

Sands with Cu less than 1 may not pack at all, resulting in unstable surfaces during grow in and beyond.

**What is the difference between Sandy Loam and Loamy Sand?**
Sandy loam is a soil material that contains 20% or less of clay, the percent of silt + two times the percent of clay exceeds 30, AND has 52% or more of sand.

A second definition of sandy loam is a soil material of less than 7% clay, less than 50% silt and a sand range of 43-52%. The official abbreviation is SaL.

Coarse sandy loam has 25% or more very coarse and coarse sand + less than 50% of any one other grade of sand.

True sandy loam has 30% or more of very coarse, coarse and medium sand, BUT less than 25% very coarse sand and less than 30% fine sand or very fine sand.

Fine sandy loam has 30% or more fine sand and less than 30% very fine sand OR 15-30% very coarse, coarse, and medium sand.

Very fine sandy loam is 30% or more very fine OR greater than 40% fine and very fine sand, at least half of which is very fine sand AND less than 15% very coarse, coarse, and medium sand.

**TIP**: Uniformity of a sand will influence physical properties of a sand-based mix:

- Sands that fall into two ADJACENT size categories and are uniform or uniformly graded, will have good compaction resistance and maintain a fairly uniform pore size between sand grains.
- If you have sand with particles falling across several size fractions, these are lacking uniformity (widely graded) and tend to pack tightly, producing small pores between sand grains.

**TIP**: Uniformity of sand affects bulk density.
Low uniformity = tight packing = higher bulk density = greater compaction potential

**TIP**: By definition, sandy loam less than 10% clay will be slightly plastic. Sand grains can be seen and felt between the fingers when rubbed together after being lightly dampened, and will feel gritty. The ribbon test length is 0-0.75". A sandy loam that is 10-20% clay feels similar, only more plastic, but the ribbon formed is three quarters to an inch and a half. Sandy loam, if squeezed when moist, forms a ball that will not break when dropped into an open hand.

**Loam**
This is the Cadillac of soils, a material that contains 7-27% clay, 28-50% silt and less than 52% sand. By definition loam is somewhat gritty, but less so than sandy loam and forms a ribbon that is a quarter to one and a half inches long. The official abbreviation is L.

Silt loam has 50% or more silt and 12-27% clay OR 50-80% silt and less than 12% clay. It will feel smooth, slippery, and velvety between your fingers. The official abbreviation is SiL.

- When silt loam is dry, it feels soft and floury, and forms clods easily pulverized. The 0-1.5" ribbon will have ruffles or cracks readily apparent.
- When wet, it has a smooth doughy feel.
- When moist it can form long ribbons that can be freely handled without breaking. When moist and smeared firmly between thumb and finger, it will have a broken appearance rather than a shiny rubbed surface.

Silt all by its lonesome is defined as soil material with 80% or more silt and less than 12% clay.

Sandy clay loam is soil material with 20-35% clay, less than 28% silt, and 45% or more sand. It is somewhat gritty and although quite resistant to ribboning, can actually form a ribbon of 1.5-2.5" length. The official abbreviation is SaCL.

Clay loam has a 27-40% clay to 20-45% sand ratio. It is moderately resistant to forming a ribbon, but in the end also makes 1.5-2.5" ribbon that is smooth and shiny. The official abbreviation is CL.

Silty clay loam soil has 27-40% clay but a sand content of less than 20%. Although slippery, this soil is dull, and will ribbon more easily into a long, thin ribbon of 1.5-2.5" that is both plastic and gritty. The official abbreviation is SiCL.

**Clay**
Is not pure clay, but is a soil material that contains 40% or more clay, less than 45% sand and less than 40% silt. It can make a ribbon exceeding 2.5" that is smooth and shiny. The ribbon will be long and thin, perhaps even threadlike. The official abbreviation for clay is C. It forms hard lumps or clods when dry, and is plastic and sticky when wet. Pinch it, and forms a long, thin, flexible ribbon that does not break easily.

**TIP**: Soils that have 25% clay or less are good for plant growth.

**Gravel**
Will pass a .75mm sieve but be retained on a 2mm sieve. All soil types when mixed with greater than 15% gravel can be designated as:
Gravelly (15-35% gravel)
Very gravelly (35-60%)

This designation is usually expressed before the soil texture name, e.g., gravelly clay loam.

**IMPORTANT FACTS ABOUT SOIL TEXTURE**

Texture changes for every topsoil source, and for every few inches deeper you go into the soil.

Use other senses besides touch. For instance, observe bare ground after a rain to see how much sand or silt washes out.

Clayey soils have sand-sized granules of soil and make a thin or cloddy crust that cracks apart quickly after rains.

Loamy and silty soils form thicker crusts with smooth surfaces.

Sandy loams and sandier soils leave lots of loose, clean sand grains in any low spots where water runs over the surface.

**TIP**: Always estimate rock volume of a soil prior to purchase.
To estimate % volume of gravel or small rocks, use a 1lb coffee can, or a 3lb can for soils with cobbles or bigger rocks.

- Fill can to top, packing soil in as you fill.
- Pour soil out onto a tarp; clean most of dirt off rocks. (Bigger than 1/8" is a rock.)
- Discard rocks and pour soil back into can, packing as before.
- Measure down to top of packed soil. Volume of rocks is amount of air space left at top of can.

For example:
Can is 5.5" tall but measurement to top of soil is 2.5" after rocks are discarded.
Rock volume then = 2.5/5.5 or 45%.

Do you really want to pay for this?

**SOIL AGGREGATION**

Soil structure = arrangement of texture particles into aggregates.

How do we know if these aggregates are stable?

- Good stability: Small, friable, "sugary" aggregates, no significant clodding, many tiny spaces (macropores) between and within aggregates, lots of roots.
- Moderate stability: Significant quantities of the above type of aggregates, with significant coarse, firm clods, significant reduction of soil macropores, and moderate numbers of roots.
- Poor stability: Dominant is coarse, firm to very firm clods, with far fewer small sugary aggregates, no soil macropores visually apparent, few roots.

Poor aggregation: A very dense, hard soil which would show fragile, twisted roots at only a depth of 1.5-2", clod-like soil structure with few vertical pores, and roots in a dense "mat" only an inch or two deep, as though grown on a glass plate.

**TIP**: Aggregate formation is dependent on freezing, thawing, wetting drying, root growth and soil organism activity to push particles together; these must be stabilized in some way. Under ideal conditions, aggregates are cemented in place by fungal byproducts, and decomposed organic matter which acts as "support pantyhose" to keep structure stabilized.

**TIP**: SOIL STRENGTH does NOT equal AGGREGATE STRENGTH. Soil strength is a measure of resistance to penetration. Compacted soils are defined as having greater resistance to penetration and higher bulk density.

**Aggregate Stability Test**

- Pass air-dried soils through a 2mm mesh and retain on 1mm mesh.
- Place sieved soil in small, open container with fine screen at bottom.
- Place container in distilled water for 5 minutes.
- Raise basket out of water and lower to bottom 5 times for about 1 second each time.

Stability is as follows:

| Stability Class | Criteria |
|---|---|
| 0 | Soil falls through sieve, too unstable to sample |
| 1 | 50% of structural integrity lost within 5 seconds of insertion into water |
| 2 | 50% of structural integrity lost within 5-30 seconds of insertion into water |
| 3 | 50% of structural integrity lost within 30-300 seconds after insertion or less than 10% of soil remains on sieve after five dipping cycles |
| 4 | 10-25% of soil remaining on sieve after five dipping cycles |
| 5 | 25-75% of soil remaining on sieve after 5 dipping cycles |
| 6 | 75-100% of soil remaining on sieve after 5 dipping cycles |

**BULK DENSITY: WHY IS IT IMPORTANT?**

Bulk Density is used as a measure of soil wetness, volumetric water content, and porosity. Factors that influence the measurement include: organic matter content, porosity of soil, and soil structure. These factors in turn control hydraulic conductivity.

**Bulk Density (p) = Mass of oven dried soil / Total volume**

The bulk density of the soil can provide indication of the porosity and structure of the soil, which will govern O2 and $H_2O$ movement in the soil. It is also a measurement of the degree of compaction of the soil. If the soil has a high bulk density (compaction), grass seed will be restricted in emergence and root growth, which will affect total plant growth and yield.

**TIP**: Type of equipment tires will directly affect soil's bulk density causing extreme compaction, especially if soil is wet.

**Minimum Bulk Density (in grams/cc) at which Root Restriction will Occur:**

- Coarse, medium, and fine sand, and loamy sands other than loamy very fine sand = 1.8
- Very fine sand and loamy very fine sand =1.77
- Sandy loams = 1.75
- Loam and sandy clay loam = 1.7
- Clay loam = 1.65
- Sandy clay = 1.6
- Silt and silt loam = 1.55
- Silty clay loam = 1.5
- Silty clay = 1.45
- Clay = 1.4

**Ideal Bulk Densities**

| Soil Textures | Ideal Bulk Densities |
|---|---|
| Sands, loamy sands | Less than 1.6 g/cc |
| Sandy loams, loams | Less than 1.4 g/cc |
| Sandy clay loams, loams, clay loams | Less than 1.4 g/cc |
| Silt, silt loams | Less than 1.3 g/cc |
| Sandy clays, silty clays, partial clay (35-45% clay) loams | Less than 1.1 g/cc |
| Clays (greater than 45% clay) | Less than 1.1 g/cc |

**INFILTRATION RATE**
The ability of a root zone mix to conduct water under saturated conditions. Infiltration rate is reported in inches/hour, and may also be called: saturated hydraulic conductivity, ksat, or percolation (perc) rate.

**GRAVITATIONAL WATER**
Water that moves through the root zone under saturated conditions is called gravitational water; gravity is the driving force. After the water drains through a percentage of the pores, these pores will then be filled with air. This is called aeration porosity.

Aeration Porosity is necessary for root growth. If filled with water all the time (anaerobic activity), roots suffocate and drown.

Capillary Porosity is the percentage of pores filled with water after gravitational drainage.

Field Capacity is the amount of water held in a soil type's pores.

**TIP**: Ideally, at field capacity 50% of pores are filled with air, 50% are filled with water.

**Available & Unavailable Water**
Available water is the portion of water that can be sucked out by plant roots in the root zone. Unavailable water is the fraction that remains too strongly bonded.

**Permanent Wilting Point** is reached when you get down to only that water too strongly bonded to be absorbed by the root system.

**TEXTURE, PARTICLE SIZE, AND INFILTRATION**
The particle size of a soil/sand based root zone mix influences the size of voids or pores between soil particles.

Smaller particle size = smaller pore void.

Pores formed between clay particles are very small and absorb water with so much energy; it is often unavailable to plants. Pores formed between sand particles are typically large enough for water to drain via the force of gravity. Pores between silt particles retain water against gravity, but plants can still absorb this water.

**TIP**: For soils, size of sand fraction becomes increasingly important as percentage of sand in soil increases. Best size choices for a sand-based mix are medium and coarse sized fraction.

Adhesion: Water molecules stick to each other.
Cohesion: Water molecules stick to soil or organic matter.

**TIP**: The deeper the profile, the more suction created to pull air down through the profile. Shallow profiles stay wet, deep profiles drain more thoroughly.

**INFILTRATION**

Process of water entering soil. Rate of infiltration is the maximum velocity at which water enters the soil surface. Healthy soil has continuous pores to soil surface, which allows water to enter unimpeded during a rain or irrigation event.

Low infiltration rate is often produced by surface seals. Surface seals are caused by weakened soil structure and clogged or discontinuous pores from oily deposits and/or compaction of incompatible soil layers. (Such as sod laid over a different soil type with no core aeration.)

**Classic Percolation Test**

- Dig a pit 1ft deep.
- Fill with water, allow to drain completely.
- Refill, measure depth of water, note time.
- After 15 minutes, note depth of water and calculate rate of drainage in inches/hour.

Poorly drained: less than 4"/hour
Moderately drained: 4-8"/hour
Excessively drained: more than 8"/hour

**Factors Influencing Soil Infiltration**

Texture: Sandy has greater infiltration rate than clay.

Crust: Soils that have many large surface connected pores have higher intake rates than soil with only a few pores. Water hitting bare soil over focal compaction can result in a crust which seals pores and restricts water entry. Crust can also be covered with algal mat or result in a lens of water that encourages annual bluegrass.

Compaction: Leads to ponding or run off.

Aggregation and structure: Soils with stable, strong aggregates such as granular or blocky soils have a higher infiltration rate than massive soils or platey soils.

Frozen surface: Greatly slows or prevents water entry.

Organic matter: Plant material dead or alive increases the process of infiltration by protecting soil aggregates from breaking down during impact of raindrops. If soil aggregates break up on impact of precipitation, those particles that are broken off clog pores and seal the surface thus decreasing infiltration during precipitation.

Pores: Discontinuous pores may retard flow of water due to entrapment of air bubbles. Earthworms increase amount of pores and assist process of aggregation that enhances water infiltration.

Water content of soil: Infiltration rate is higher when soil is initially dry, then decreases as soil becomes wet. As pores and cracks become filled with water, soil with clay will also swell. As soils wet, they slow in infiltration rate to the rate of permeability of the most restrictive layer.

| Hydrological Soil Group | Infiltration Rate (inches/hr) |
|---|---|
| A: Low runoff potential and high infiltration rate = Sands and gravel | 1-8.3 |
| B: Moderate infiltration rate when completely wetted = Sandy loam with moderately fine to moderately coarse textures | 0.5-1 |
| C: Slow infiltration rate when thoroughly wetted = Silty loam soils with an impeding layer or soils with moderately fine to fine texture | 0.17-0.27 |
| D: Clay soils with high swelling potential, soils in a permanent high water table and shallow soils over nearly impervious material | 0.02-0.10 |

**STEADY INFILTRATION RATES FOR GENERAL SOIL TEXTURES**

| Soil Type | Steady Infiltration Rate (inches/hour) |
|---|---|
| Sands | Greater than 0.8 |
| Sandy and silty soils | 0.4-0.8 |
| Loams | 0.2-0.4 |
| Clayey soils | 0.04-0.2 |
| Sodic clayey soils | Less than 0.04 |

**TIP**: Ways to Increase Infiltration

- Decrease compaction and crust formation by maintaining turf cover.
- Increase organic matter.
- Decrease or eliminate tillage operations. (Raking and leaf blowing are a kind of tillage, and increase surface rooting via compacting soil surface through organic material removal and soil packing.)

## PART FOUR: Topsoil Suitable for Landscape Use

Never buy soil without inspecting it first. In many cases it is easier and less expensive to improve existing soil than to buy topsoil.

### Considerations for Bringing in Topsoil

If you MUST bring in soil, it is important to consider:

- Soil texture
- Organic matter content
- pH
- Soluble salts

THERE IS NO OFFICIAL OR LEGAL DEFINITION FOR WHAT IS COMMONLY REFERRED TO AS TOPSOIL. A practical definition is the top 6-10" depth to which soil is plowed or cultivated. This layer differs from those beneath by having higher organic matter content, darker color, better tilth, high biological activity, and possibly less compaction.

**TIP**: Fertility can always be fixed. This is not always true of physical properties.

### Desirable Ranges and Textures for Sand, Silt and Clay in Purchased Topsoil

- Sand: 40-65%
- Silt: 25-60%
- Clay: 5-20%
- Gravel content: less than 10%

Examples of soil textural classes that are desirable are: sandy loams, silt loams, and loams.

### Organic Matter Values for Desirable Topsoils

- Sandy loam: 1.25-3% OM
- Silt loam: 2.5-5 % OM
- Loam: 2.5-5% OM

### Salt Levels for Desirable Topsoils

Quality topsoil should have less than 0.5 mmhos/cm for a soluble salts test using a 1:2 soil to water ratio.

### ASTM Standards for Topsoil

- 2% by weight of fine textured stable organic material and no greater than 6%.
- Not less than 20% fine textured material passing through the #200 sieve and not more than 15% clay.
- Relatively free of stones over 1.5" in diameter, and less than 10% gravel by volume. (With no noxious weeds.)
- Do not use topsoil with greater than 500ppm soluble salts.
- Distribute to a uniform depth and NOT over partly frozen, muddy, or frozen slopes or over ice, snow, or standing water puddles.
- Topsoil placed and graded on slopes steeper than 5% shall be promptly fertilized, seeded, mulched, and stabilized by tracking with suitable equipment.

| Site Conditions | Intended Use | Minimum Topsoil Depth |
|---|---|---|
| Deep sand or loamy sand | Mowed lawn | 6″ |
| | Tall legumes, unmowed | 2″ |
| | Tall grass, unmowed | 1″ |
| Deep sandy loam | Mowed lawn | 5″ |
| | Tall legumes, unmowed | 2″ |
| | Tall grass, unmowed | none |
| 6″ or more: silt loam, loam, silt | Mowed lawn | 4″ |
| | Tall legumes, unmowed | 1″ |
| | Tall grass, unmowed | 1″ |

**TIP**: For ANY addition of soil, after areas are brought to grade: prior to dumping and spreading topsoil, loosen subgrade soil by discing or scarifying to a depth of at least 2″ to permit bonding of topsoil to subsoil.

**IMPROVING SOIL STRUCTURE THROUGH AMENDMENT**

Organic matter is the best structural improvement for soil.

- You want to maintain 4-5% OM by dry weight in your soil.
- Increasing OM in an acre of topsoil by just 1% requires 40-50 cubic yards of amendment (or 460lbs/1000sqft for a 7″ profile of topsoil.
- You need to have soil tested by a lab to determine OM. They burn it off and measure the levels by before and after weights.

Organic matter is important because it increases water holding capacity of soil. Organic matter holds up to 4-6 times its own weight in water. Since many nutrients are dissolved in water, this means nutrient holding capacity increases as well.

**TIP**: Completely broken down organic matter is humus: the stable end product that has a negative charge which holds onto and exchanges positively charged cations like potassium, calcium and magnesium.

This acts as glue for soil aggregates, the fibrous support hose that keeps air and water exchange going for better drainage, root penetration, and development. It serves as home and food for microbial populations involved in mineralization, nitrogen fixation, and disease control.

**Ideal Levels of Organic Matter**

As a goal, most soils should be managed to maintain organic matter levels of at least 4-5% dry weight. Increasing organic matter in an acre of soil by just 1% requires the addition of 20 thousand pounds of humus or 40-50 cubic yards of material. 5.5-8% is ideal. Soil with 5% organic matter holds 1.88 gallons of plant available water in every cubic foot of soil.

**TIP**: When you are spec'ing out a manufactured soil, stay away from high organic silt loam or similar soils. While they LOOK like straight organic matter, they actually have 20-60% organic matter rather than 85% or greater. This means fine soil particles that clog up soil pores.

**ADDING COMPOST**

Addition of 10-30% by volume of compost to a soil will increase organic matter 2-5% by weight. Ideally this is mixed in offsite or rototilled in to a depth of 8-10".

**Compost as Organic Amendment**

Always do a phytotoxicity test. Compost may have contamination issues such as salts (of particular concern with Kentucky bluegrass), and it may have gone anaerobic, which leads to very low pH and toxic compounds.

Phytotoxicity Test:

- Try growing tomato, cucumber, or watercress seeds in some of the compost using 5 or 6 trial cups.
- Compare these to seeds grown in identically treated cups with soil you know is okay.
- If seedlings reach the two-leaf stage, then suddenly yellow and shrivel in your compost test cups, you know something is wrong.

**GUIDELINES FOR IDENTIFYING HIGH QUALITY COMPOST**

- Color: Brown to black
- Odor: Earthy or moldy (never vinegary or like a cow burp)
- Moisture: 15-25%
- Water holding capacity: 150-200%
- Bulk Density: 0.2-0.6 g/cc
- Organic matter: 25-80%
- pH: 5.5-7.5
- Ash: 20-65%
- Nitrogen: 0.4-3.5%
- Phosphorous: 0.2-1.5%
- Potassium: 0.4-1.5%
- C:N ratio 25-30:1
- CEC: 50-150 meq/100 g

Ranking Compost by C:N Ratio: When organic matter is added to soil, a C:N ratio of 15:1 to 30:1 is preferred. If you have a C:N ratio of LESS than 15:1, this suggests a compost not finished and/or presence of ammonia.

**WHAT ARE THE CAUSES OF SOIL COMPACTION**

- Normal use
- Excessive use (not enough area for number of users)
- Improper soil for intended use of site
- Poor construction techniques
- Poor mixing
- Poorly drained sites / outlets for drainage
- Excessive use while soil is wet
- Deep compaction during construction (big equipment syndrome)

Hallmarks of Compacted Soil: Look for platy or weak structure, massive clods, greater penetration resistance, higher bulk density, restricted plant rooting, and flattened, turned or stubby plant roots.

**TIP: Important Compaction Facts**

- Compaction may extend to 20" deep.
- Deep compaction affects smaller areas than shallow compaction, but persists because shrinking, swelling, freezing, and thawing affect it less.
- Machinery with axel loads of more than 10 tons may cause compaction below 12".

Effects of Compaction on Soil Pores: Discontinuities in air and water inhibit roots from growing uniformly and may often FAIL to penetrate downward through a layer of contrasting texture even if that layer is less than 1". Thus it is important to core aerate 4-6 weeks after putting down sod.

**KINDS OF AERATION**

- Spiking: Short-lived, least surface disruption (slicing/spiking are NOT aeration)
- Solid tine
- Hollow tine
- Deep tine
- Shatter tine: Fractures hardpan subsoil, promotes deep watering and active root growth

The best results are achieved when plugs are not dragged back in. This is especially true for aeration in autumn, when freezing and thawing over the winter will decompact soil further. It is important to NOT drag cores back in spring, this will also drag crabgrass seed and annual bluegrass seed over surface. Turf takes 2 weeks to recover.

**TIP**: Best timing: September and April, or once before and once after high traffic season.
**TIP**: The best aeration removes soil when making hole.
**TIP**: The best time to core is one day after a normal rainfall or irrigation.
**TIP**: Most compaction is in the top 1-3", keep core holes open as long as possible.
**TIP**: If soil is very hard, core aerate, irrigate, repeat.

**Aeration Must Be Combined With TOPDRESSING**

- Remediate with organic matter to change soil structure.
- Compost is the best topdressing, it can increase infiltration of clay soils by tenfold.
- Use 1/4" to 1/8", 4 or more times per year.
- Never jump up to ½", this will cause yellowing and density loss.

**SOIL LAYERING, STRATIFICATION, AND COMPACTION BY LAND LEVELING**

If subsoil restricting layers are present before leveling, they will be shallower in cut areas and deeper in fill areas. To prevent a bathtub from occurring, rip layers before leveling.

The leveling process can cause stratification, because materials of varying textures are brought in to make the fill. The fill then becomes compacted because of the large amount of wheel traffic running over it.

For this reason, after final grade is achieved, deep tillage by ripping, slip plowing, disc, or moldboard plowing in some combination should be used to loosen compacted soil and mix stratified areas.

**Effects of Compaction**
The most serious effects of soil compaction are usually found between the surface and 15" deep, or up to 24". Large moldboards, disc plows, rippers and chisels all move soil to a depth of 18-24" and should provide relief, if moisture is such that soil crumbles rather than clods.

Remember, loosened soil is especially prone to recompaction if equipment is driven over it. If possible, freshly plowed soil should not be disturbed for several weeks. Alternate wetting and drying, especially by rainfall, will allow soil to settle gradually and help strengthen its structure.

**Ripper and Chisel Specs**
- For loosening compaction, you want a depth capability of 2ft.
- Curved or parabola shaped shanks are effective.
- Rippers pull more easily through moist soils, but do a less effective job of loosening.
- Ripping dry soils usually results in more effective loosening.
- Shank spacing should be equal or less than the depth of ripping.
- Ripping never breaks the soil straight across between the points of adjacent shanks; there is always a hump between two channels.
- The further apart the shanks, the higher the hump.
- Cross ripping lowers the hump. Parallel ripping at narrow shank spacing is more efficient than ripping and cross ripping at a wider spacing.

**Soils with Natural Restricting Layers**
- Usually these layers are DEEP, so require special equipment. Make sure you are not inadvertently creating restricting layers by monkeying with soil. Deep restrictive layers usually only need to be remediated once.
- Shallow restrictive layers will probably need multiple remediations because they tend to reform due to human practices.

**Causes of Natural Stratification**
Natural Stratification is: Layers of different soil textures with abrupt boundaries between layers caused by speed of movement of floodwaters.

Rapidly moving water deposits coarse sand and gravel

Slowly moving water deposits fine sand and silt

Still water deposits clay.

Precipitation does not move uniformly downward in stratified soils. Think of pouring brandy on a layered cake; how does it penetrate through the layers?
- Fine layers under coarse layers slows rate of water movement so it remains ponded in the coarse layer above. This is a perched water table, resulting in poor aeration of plant roots in the coarse layer above the fine layer.
- The same result is achieved if the fine layer is above the coarse layer. The tiny pores hold on to the charge on water and the water molecules hold on to each other's charges

**How to Proceed if you have Natural Stratification**
Deep plowing with a moldboard blow or disc plows will break up and mix stratified layers. Best to do twice, but may not be able to get in immediately after first plowing so may have to wait a year. These two methods penetrate 18-30"

To go deeper, use a slip plow to go 5-6ft. This only mixes soil in the trench it has made. 15% of total soil profile gets mixed, and not as well as with the mold board or disc.

Best management practices include the slip plow followed by moldboard or disc plowing.

**TIP:** Poorly drained soils are more prone to compaction due to the lubricating effect water has between soil particles.

**DRAINAGE**
Surface drainage: Needed to prevent puddles forming on soil surface, and that which has already percolated through the soil.
Subsurface drainage: Needed when water percolates through topsoil faster than natural subsoil drainage will allow, causing a perched water table.

**TIP**: You can tell if you need surface drainage or subsurface drainage simply by walking into a puddle. If it is firm underfoot, the problem is surface drainage. If you sink to your ankle, it's a sub-surface issue.

You can also do a test boring. If water infiltrates from the sides; it's a surface drainage problem. If you have a high water table, subsurface drainage makes sense. More often what happens is formation of a perched water table at a depth where it will impact the turf roots. (I.e. the upper 10.) This is primarily a subsurface compaction issue.

**Drainage and the Perched Water Table**
If you have coarse soil over fine soil: Water moves through the coarse layer quickly, hits the slower draining fine layer below, and begins to back up into the coarse layer.

If you have fine soil over coarse soil: Water moves very slowly through the fine layer and cannot get to the coarse layer, until the fine layer is completely wet up. Only then can it overcome the attractive charges between water molecules and the sides of the small pores, and between the water molecules themselves.

**TIP**: A common thought is: you need a firm base, and then a "drainage" layer. So you use "select fill", i.e. gravel and road material compacted to 100%, and put 4" of "best quality" topsoil atop that. THAT IS A PERCHED WATER TABLE RECIPE!! START OVER!!

**Common Signs of Trouble in the Root System**
- Layering in soil profile
- Inconsistent blending of soil amendments
- Uneven soil depth
- Black layering
- Compaction
- Poor root development

**Evaluating Drainage:** The worst drainage and erosion problems are from November-April. Selection of planting or building site and water control systems should be based on this "wet season." Do test borings from your site that are from 3-5ft deep during the wet season. Take these borings at the highest elevation on the plot, in depressions, and at the bottom of abrupt slope changes. If you see obvious ponded or spongy areas, take borings in these areas as well.

A soil with good internal drainage has a high proportion of sand or gravel, and will NOT have distinct layers but will show a gradual color change from dark to light at 3ft depth. You should see no free water during excavation. Plants will have a deep, uniformly distributed root system.

**Dealing with Roof Runoff so it does not ruin your Planting Plan**

1. Deflect away from foundation, spread on lawn if there is enough slope to prevent ponding.
2. Start a rain garden.
3. Connect downspouts directly to a footing drain or storm sewer.
    - Best choice is to have excess water go to a gravity outlet to a storm sewer or drainage ditch.
    - Second choice is a drainage system that has gravity flow to a sump or reservoir where water can be pumped elsewhere.
    - Dry wells are the worst choice for getting rid of excess water in soils with restricted internal drainage.

**TIP:** In an area with GOOD drainage, if area of lawn is at least 10 times area of roof or other paved areas, you don't have to connect downspouts to an underground drainage system.

**Recognizing Bad Drainage**

A soil profile with abrupt color changes and mottling within 3ft of the surface indicates a restrictive soil layer, which inhibits downward movement of water. Soil will look densely packed and free water will accumulate in test boring holes of less than 3ft if bores are taken during wet season. Water will look like it is oozing into holes near the densest looking layers.

**TIP**: Restricted internal drainage occurs on slopes of 10% or greater as well as on flat surfaces.
**TIP**: Surface wet spots often appear at the base of slopes and will remain wet until mid-summer. Particles roll down hill.

**Recognizing REALLY Bad Drainage**

- Restricted vs. poor internal drainage
- Dark surface soil with an abrupt change to light gray or brown mottling
- Usually seen in natural depressions or in flat areas
- May also see in areas with seepage or runoff from higher elevations
- See large populations of sedges, willows, alders, red maples
- If you dig a test hole in wet season, hole rapidly fills with water and may not dry until late summer.
- This is the area to install your pond or wildlife marsh.

**Drainage Indicator Plants**

- Indicator of poor drainage sites: Willow, pin oak, swamp white oak, tupelo
- Indicators of moist soils: Sycamore and tulip trees
- Indicators of well-drained sites: Sugar maple, red oaks, hickories

**Troubles with Bedrock**

- Bedrock close to surface can cause drainage problems. (Shallow vs. deep profile and gravity-suction effect.)
- Bedrock below 8-10ft generally causes no problems.
- Bedrock at less than 8ft generally causes the soil profile to dry out rapidly so it is hard to maintain turf and other ornamentals.
- Free water flows along natural cracks in rock. If there is an abrupt change in slope get seepage on the land below the rock outcropping.
- Look for nearby road cuts to show you the local depth of bedrock or use soil survey.

**Improving Surface Drainage**

Grading or crowning. (Be careful; compaction, compaction, compaction.)
Crowning, for example, on a football field: 12-18" crown (1-2% sloping uniformly) from center to sidelines where tile lines are placed with open catch basins to remove surface runoff.
Vertical trenching to improve surface drainage: Dig trenches 12-18" deep and 3" wide on 10-15ft centers. If a slope exists in the area, run trenches ACROSS to remove runoff. Trenches should be sloped 0.5-1% to a terminal outlet which can include already existing drain tile. Use 2" ID slitted drain tubing in the bottom of the trench, then backfill to overflow with WASHED SAND. (Be careful of dirty or disreputable sand.)

- Herringbone and lateral drainage designs are common subsurface drain patterns.
- Drainage tiles are normally placed 2ft under turf with 15-20ft spacings.
- Trenches should be 6-8" wide with a minimum of 0.5% grade.
- Place a 2" layer of pea gravel in trench then level to grade for tile placement.
- Place 3-4" corrugated drain tiles into the prepared trench.
- Cap blind ends and secure all joints to prevent influx of soil particles into drain.
- Backfill trenches with a 2-4" layer of pea gravel over tile and fill remainder of trench with the soil mix you will use as your final growth media.
- AVOID filling trench with pea gravel to within 4" of surface, this will actually reduce draw of the tile leaving the surface wet.
- NO DRAIN FABRIC!!!!! Plugging and particle migration is a disaster.

**TIP:** If no drain tile is available, the trench can be terminated with a surface drain where you end the slitted tubing with a T joint set vertically. Extend the opening to the soil surface to allow outflow of excess water.

**TIP**: You don't need subsurface drainage unless you have a several days persistent water table after precipitation, or soil is continuously saturated, or if said water table is more than 3ft below root zone.

**French Well for Drainage** Impermeable layers sometimes overlie permeable. By placing a vertical or French well through the layer you can speed drainage. Dig a hole with a 12" auger through the impermeable layer and backfill to soil surface with pea gravel.

**Cambridge System for Drainage** Basically a lateral system, an overlain grid pattern of sand filled trenches connected to subsurface drains. Requires a special contractor with the right equipment to install subsurface drains and vertical sand filled slits cut into surface.

**PART FIVE: The Menace of Manufactured Soils**

Manufactured soils are blends of soil, soil components and soil-like material used in horticulture/landscape applications and site restoration. Using manufactured soils allows for "tailoring" of soil properties to specific needs. For example, a potting mix for seedlings may need to be light and well drained to accommodate seedling roots and reduce transport costs. In contrast, a landscape blend may need to be heavier and have a larger mineral component to provide long-term support and nutrition for trees/shrubs.

The theory: Take sub-soils, sand, and composts to generate a soil that performs equal to or better than native topsoils. Components of manufactured soils range widely. Typical components include: Compost, sub-soil, dredge, sand, shredded bark, and other organic materials. All bagged topsoils and gardening soils sold in commercial establishments are manufactured soils.

**How do we classify Manufactured Soils?**

Manufactured soils can broadly be divided into two categories consisting of:

1. Topsoil mixes (planting soils)
2. Structural soils.

The specifications for these soil blends are usually provided by the landscape architecture firm that designed the urban garden. These special soil blends are commonly created from non-local soil materials blended with manufactured or processed inorganic ingredients, such as sand or expanded shale. Ideally, they include a certain percentage of native soil salvaged on site or harvested from a nearby location.

**Structural Soils**

Structural soils differ from topsoil mixes in that they are designed to provide an engineering function as well as support plant growth. They typically consist of a blend of mineral soil with a coarse aggregate (stone) and thereby form a highly porous (30–35%) matrix with a high load-bearing capacity and rapid infiltration rate that also allows root growth and development.

- They are designed to provide structural support (i.e., load-bearing soils) beneath paved areas like sidewalks, streets, plazas, and parking lots while at the same time providing additional rooting space for trees beyond the traditional planting "pit" or "cutout."
- The structural component of these manufactured soils can consist of crushed stone, as in the Cornell University (CU) soil, or a light-weight heat-expanded shale or slate.
- CU soil is a mixture containing 80% (v/v) crushed granite or limestone rock and 20% clay loam soil.
- Another structural soil has been created by blending Carolina Stalite heat-expanded slate with a sandy clay soil at an 80:20 ratio.
- Increased strength and permeability in structural soils are achieved at the cost of diminished water and nutrient holding capacity.

**What happens when you add Manufactured Soil to an Existing Soil Site?**

Technosol: A class of human-impacted soils generally considered urban soils. We use the term urban soils to encompass use of natural, modified, or manufactured growth substrates in urban and suburban landscapes highly influenced by human activities.

**Urban Soil**

One of the most significant impacts of anthropogenic activities on urban soils is a change in the soil's physical functions. Urban soils often display a high degree of horizontal and vertical profile variability commensurate with the level of human disturbance. As a result of disturbance, the horizons of urban soils do not always run parallel to the soil surface, as observed in their natural or slightly modified counterparts.

Construction is the predominant human activity leading to truncated soil development and creation of discontinuous layers in urban soil profile because it usually involves scraping, cutting, filling, and spreading of soil.

Urban renewal and greening projects, more common near city centers, typically face degraded onsite soil conditions. Plans to modify/replace onsite soil must be on a case-by-case basis.

Physical compaction resulting in increased bulk density is a widespread problem with urban soils. As in agricultural soils, compaction destroys the natural structure of urban soils, resulting in reduced porosity with fewer or no macropores. Compaction also limits the movement of water through the soil profile, which can contribute to increased storm water runoff.

**Use of Manufactured Soils: Urban Settings**

The practice of making major modifications to available soil resources or manufacturing soil blends is almost exclusively an urban phenomenon. In these situations, the basic principles of soil science, including the concept that soil inputs should improve or sustain soil quality and long-term productivity, are usually NOT a major consideration.

**Onsite Manufacture of Soils**

Manufactured soils are generally used where there is no onsite soil or the onsite soil is unsuitable for use due to physical or chemical contamination.

Topsoil mixes are usually made by mechanically blending a mineral base like subsoil or sand, with organic materials like compost or peat, sometimes with the addition of lime and fertilizer.

Blending can be accomplished in situ by tilling a 5-15cm layer of organic matter into the existing soil, by mixing the ingredients in a tub mixer, or by folding together materials with front-end-load tractors.

In some cases, the onsite soil has to be significantly modified by mixing with various amendments to restore ecological functions and create a site-specific property, such as rapid infiltration and drainage.

Drainage is a very important concern in urban landscapes due to the pervasiveness of impervious surfaces.

In most urban situations, the existing onsite soils do not have the ability to drain at rates that help mitigate storm water runoff, therefore, organic and inorganic amendments are added to "manufacture" a soil with the desired property.

## APPENDIX

## MAINTAINING LOW MAINTENANCE, LOW INPUT LAWNS

The essentials to reduce turf stress and to commit to a low input lawn:

- Keep grass at a 3" height.
- Switch to endophytic and/or best grass for your site.
- Remove grass where it simply cannot grow in a low input situation (shade, severe compaction, tree roots, etc.) Switch to something that can grow, or a mulch.
- Implement recommended irrigation changes or updates, and know irrigation outputs on a zone by zone basis. Understand the system and any limitations.
- Leave clippings on lawn.
- Eliminate edging of lawn.
- Allow leaves to be mulched into lawn as much as possible.
- Routinely test pH.
- Know soil texture and organic matter level.
- Routinely supplement to keep pH and organic matter in correct range.
- Never expect 100% green.

**If you do not wish to do these things, low input lawn care may not be for you!**

## SCOUTING BY THE CALENDAR

### January/February

- Test pH and soil texture, apply lime IF NECESSARY depending on test results.
- Scan site for bare areas and dormant seed. (Rye germinates at soil temp of 45°, tall fescue at 55°. Measure soil temp with standard meat thermometer.)
- Check for areas of snow build-up over unfrozen ground. Remove to lessen chances of snow mold.
- Rake out chickweed and dormant seed.
- Check that you have a minimum 4″ of existing topsoil covering the subgrade: this may vary over the field.
- Scan for areas of poor drainage and note for further observation.

### March

- Look to see which areas green up first---these may be localized areas of compaction. To test, use a screw driver (not right after rain) and see how far into the soil the hilt will easily go. Core aerate focal areas of compaction rather than the whole lawn to avoid spring weeds, and top dress with 1/8" of compost. Remove cores.
- On first mowing, MOW LOW ONCE and reset mower for 3″. This initial low mowing will speed soil warming and spring green up. Mow early to also remove unsightly wild garlic/wild onion tops without disturbing actively growing grass.
- Check dormant seeded areas for germination, if necessary re-seed. Check for new areas that may need spot seeding due to weather or wear from early play.
- Check for signs of pink snow mold (circular gray or salmon colored spots) and rake out to hasten drying; usually a self limiting disease if precautions are taken in the fall.
- Look for areas with signs of leaf spot and record for further observation later on in the season, check the areas for thatch build up and record findings.
- Check for pythium root rot in thin, diffusely yellowed, stunted turf occurring in areas of poor drainage or recently sodded spots. Dig a sample 4" wide by 3" deep and check for layering and root quality. If layering or poor roots, aerate these spots only and top dress with 1/8"compost or amend soil with reed sedge peat or composted brewery sludge which has some protective effect against pythium root rot. Pythium root rot causes massive decrease in volume and vigor of roots.
- Start checking soil temps mid-month in preparation for activity of annual bluegrass weevil.
- Look for yellow, circular areas which may indicate cool season brown patch. It is important to try to decrease moisture in affected areas.
- First crabgrass seedlings out with soil temps of 54-58° for 3 consecutive days, major emergence at soil temps of 68°.

**April**

- Look for areas invaded by weeds and be ready with a mix of fast sprouting rye seeds and compost for sunny areas.
- Perennial weeds will be coming up now, including dandelion, clover (more following a dry year, but it is shallow rooted and so is easily raked out), bent grass (more following a wet year), ground ivy (shallow rooted), oxalis, plantain, wild garlic, quackgrass, speedwell, and mugwort.
- Look for perennial nutsedge next month and into June.
- Quackgrass treated with an organic herbicide may need to be treated again, but before you do this, fertilize the quackgrass to push lateral buds out of dormancy and then hit it with your product again to get better kill. This is especially effective in springtime.
- Clover may be reduced by limiting excess phosphorous, but find out if clients can live with clover since it is good for the soil.
- If quackgrass or mugwort are problems, don't till an infested area because it will spread the problem. If you are using organic herbicides for quackgrass control, fertilize the quackgrass following treatment to stimulate dormant buds, treat again to weaken the plant. Both mugwort and quackgrass may respond better to treatment in October than in April.
- Check for red thread outbreaks in areas with pinkish, straw, or reddish color; this is usually a self-limiting disease and proper fertility can reduce the incidence. The best amendment for red thread is composted poultry litter.
- Mid-April should see prophylactic treatment of areas prone to summer patch or necrotic ring spot by tax time.
- Continue to monitor for pythium root rot, leaf spot and cool season brown patch and use suggested strategies to combat; leaf spot is very common this month due to wet weather but again it is self-limiting unless dealing with a few varieties of bluegrass that may go on to melting out.
- Scout areas of turf preferred by birds, for grub activity. Do NOTHING about grubs at this time since they are not in a susceptible life stage and do comparatively little feeding at this stage, but note what areas of the yard they were in so you can re-scout those in the second and third weeks of August.
- Scout now for germinating summer annual weeds like crabgrass, goosegrass, purslane, spurge, blackmedic and knotweed. Pull or treat, remove, re-seed.
- Check for crabgrass emergence when soil temperatures are 54-58° for 3 consecutive days. USE A MEAT THERMOMETER.

**May**

- Scout for presence of progressive leaf spot decline (look closely at dead leaves in thinned out areas for signs of spots, especially in areas of rye exposed to deicing salts), for smut, for red thread, which may come and go (overseed in fall with resistant varieties), and pythium root rot. If pythium root rot suddenly becomes a problem, check for changes in drainage due to compaction or grading.
- Now that trees are leafed out, evaluate shade: grass needs 6 hours of at least 50% sunlight to thrive; try to get rid of grassy areas that don't receive this; shady areas should receive half the normal amount of fertilizer to limit disease UNLESS it is a high traffic area.
- Necrotic ring spot in new turf can be improved using uncomposted animal or plant meals or composted poultry litter.
- Turf is under greater stress where shading occurs in winter, for example objects on north side of turf cast long shadows, turf never really dries out.
- Take photos of problem areas through the season. You may be surprised at what the shadows can tell you.
- Plant growth regulators may improve turf appearance in shady areas but will also make turf more disease-prone
- Need at least 50% sunlight (minimum 4 hours daily) for turf to survive, 6 hours to thrive, morning light is better.
- Shade tolerance: Cool season: ff>bentgrass>rough stalk blue grass>KBG shade tolerant (eclipse, bensun, birka, bristol, glade, nugget, touchdown)>TF>KBG intolerant>PRG.
- Check turf under trees for water stress because the tree canopy excludes rainfall and the water that makes it through is used by tree roots.

**June**

- Monitor for chinch bugs in sunny or sandy areas using 1 ounce lemon dish soap to 1 gallon water overlain with a 1ft square piece of nappy white flannel. If found in concentrations about 1 nymph/square inch or 125/sqft consider treating. A permanent solution is to overseed areas affected by chinch bugs with endophytic fine fescue or ryegrass in September.
- Start monitoring summer patch; look for frog eyes or swirly areas of tan grass.
- Continue post emergence pursuit of weeds; look to see if mowing high has reduced previous history of prostrate weeds and annual bluegrass.
- Dollar spot is a common turf disease easily spread on mowers and shoes. Lesions are easy to see with the naked eye; they look like hourglasses. You can overseed with resistant varieties; but check for thatch buildup in areas prone to dollar spot. Core aerate these areas well in the fall; increase air circulation. You may need to remove clippings from seriously affected areas in order to prevent spread to other sections of the turf.
- In areas hit hard on a yearly basis; best amendments for dollar spot include uncomposted animal and plant meals and composted poultry litter.
- Monitor for Aschochyta leaf blight which may provide some silvering of grass tips which turn inward and take on a pointed appearance; the disease is self limiting and is often the result of over fertilization; regular compost may have some protective effect if applied as a light topdressing.
- In late June begin to look for sod web worms, although they are unlikely to be a problem on turf with plenty of ants to act as predators, or turf in shade.
- Look for the beginnings of anthracnose, especially when it turns hot and dry.
- Look for algae.
- Continue to monitor for leaf spot melting out, red thread early in month, if pythium root rot or nutsedge appears, check irrigation for leaks as well.
- Look for presence of adult beetles flying around, look for Japanese beetles, European chafers, Asiatic garden beetles, oriental beetles; several of these are attracted to light so recently installed outdoor lights may jump up your populations.
- Post emergent weed problems should be handled as before.
- Moles may be repelled using castor oil products; multiple applications may be necessary.

**July**

- July is a major disease month under the correct environmental conditions.
- Although red thread will usually fade from the scene you can add brown patch, fairy ring, and anthracnose to your monitoring list.
- Brown patch will usually subside as soon as PM temperatures drop below 65°, but for a particularly susceptible lawn, amendment with uncomposted animal and plant meals or with composted poultry litter may suppress the disease by 75%, coupled with improvement of drainage. (I.e., core aerate the area in fall.)
- Try very limited amts of oak sawdust as soil amendment to reduce brown patch.
- Areas in early AM where no dew has formed may have brown patch.
- Adult beetles should be subsiding by mid-month; continue to monitor for chinch bugs and sod web worms in wilted or browned areas or areas aggressively picked at by birds.
- Moles can sometimes be repelled using castor oil products.
- Tap rooted weeds such as dandelions grow better in compacted soil.
- If you see green algae on leaf blades it indicates poor drainage.
- Bird, skunk, or raccoon damage early in month especially near or under trees is likely due to cicada nymphs underground, as it's too early for grubs to be present. Reseed or re-sod areas.

**August**

- Mid-August is grub scouting time; look for areas that appear to have drought stress or are being aggressively picked at by birds.
- How to scout for grubs: take 3″ wide by 3″ deep samples about every 10ft in a grid pattern, map findings. Wherever you have 1 or more grubs in two adjacent plugs you have a hot spot. Sample further around the hot spot, spot treat as recommended below.
- If grubs are present, identify what kind they are and sample to find exact margins of trouble spots and that you have reached a threshold of 10 grubs/sqft.
- If you need to treat, pre-water site with ½″ of irrigation and then post-water the site with ½″ after you have applied, to push the product down. Continue to monitor for sod web worms and chinch bugs. Adult sod web worms don't necessarily indicate a problem because of efficient predation on eggs. They will also never reach populations high enough for damage if turf is in the shade. Adults don't cause feeding damage.
- Begin to evaluate lawn for possible renovation at end of the month or beginning of September; if the area contains at least 50% turf, you can overseed. More than 50% weeds means total renovation.
- Diseases to monitor for are the same as in July.
- Scout now for germinating winter annuals like chickweeds, Italian rye, and annual blue grass. These weeds have shallow roots and can easily be removed.
- Look for spread of moss.

**September**

- Diseases: Time for red thread to come back, along with rust, which while unsightly is usually a self limiting disease. Increase air circulation to reduce rust. Dollar spot will persist through this month as well.
- Note where crabgrass is now, map locations for overseeding now or in spring.
- This is a good month to overseed and renovate.

**October**

- Scout areas that have not filled in from last month's overseeding or renovation. These will fill in with weeds next spring, so either reseed them early in October, or mark them for dormant seeding in late February and early March.
- Diseases to scout for include red thread, leaf spot, and rust, especially along sides of buildings or in areas with low light intensity and poor air circulation.
- Scout for sprouting biennial weeds early in the month, such as curly dock and Queen Anne's lace. Use a weed popper or soap or vinegar based product for removal.

**November**

- Core aerate one week before last mowing, leave aeration holes open, take away cores, topdress with a ¼" of compost; this will help decrease weeds the following season.
- Cut grass short on last mowing around last week of November to prevent grass lying over and inviting snow mold.
- If you have a problem with snow mold, reduce amount of fast release nitrogen used at final fertilization; this is also better for the ground water. Also reduce potassium applications, this also makes snow molds worse
- Use seaweed based products according to labeled rates as drought conditioner for following year. Potassium in these products may also help deter diseases.

**December**

- You can dormant seed bare areas. Use 50% more seed to compensate for bird predation and rot.
- Mark out areas that went into winter dormancy thin, or areas you can see crabgrass skeletons: these will be areas to target for dormant seeding in February and March, the first areas to get crabgrass, and if compacted, annual bluegrass the following spring.

# Appendix 16
# Suffolk County Fertilizer Law

Intro. Res. No. 2117-2007 Laid on Table 11/7/2007
Introduced by Presiding Officer, on request of the County Executive and Legislators Losquadro, Romaine, Horsley, D'Amaro and Stern

**RESOLUTION NO. 1369 -2007, ADOPTING LOCAL LAW NO. 41 -2007, A LOCAL LAW TO REDUCE NITROGEN POLLUTION BY REDUCING USE OF FERTILIZER IN SUFFOLK COUNTY**

**WHEREAS**, there was duly presented and introduced to this County Legislature at a meeting held on November 7, 2007, a proposed local law entitled, **"A LOCAL LAW TO REDUCE NITROGEN POLLUTION BY REDUCING USE OF FERTILIZER IN SUFFOLK COUNTY"** and said local law in final form is the same as the amended copy filed with the Clerk of this Legislature on December 3, 2007 and presented to this Legislature on December 3, 2007; now, therefore be it

**RESOLVED**, that said local law be enacted as follows:

**LOCAL LAW NO. 41 -2007, SUFFOLK COUNTY, NEW YORK**

**A LOCAL LAW TO REDUCE NITROGEN POLLUTION BY REDUCING USE OF FERTILIZER IN SUFFOLK COUNTY**

**BE IT ENACTED BY THE COUNTY LEGISLATURE OF THE COUNTY OF SUFFOLK,** as follows:

**Section 1. Legislative Intent.**

This Legislature hereby finds that overapplication and/or misuse of fertilizer products has led to the degradation in the local water quality, and has harmed groundwater, drinking water, and wetlands and surface waters within the County of Suffolk.

This Legislature further finds that excess nitrogen in drinking water can threaten human health, as fertilizer leachate has contaminated groundwater and groundwater is the sole source of drinking water on Long Island.

This Legislature also finds that nitrogen contamination trends in groundwater are worsening, in that 17% of Upper Glacial public water supply wells in the Upper Glacial Aquifer now exceed 6 milligrams/liter (mg/l) nitrogen (degraded), an increase from 9% in 1987.

This Legislature further finds that in 2006, 15 community public water supply wells, and nearly 10% of private wells in Suffolk County were found to violate the 10 mg/L Maximum Contaminant Level (MCL) set for nitrates to ensure safe drinking water.

This Legislature further finds that various factors may cause excess leaching of fertilizer nitrogen, including use of quick-release fertilizer, percentage of nitrogen in fertilizer, labeling which results in excess application rates of fertilizer, organic/inorganic/polymer formulations, soil types, lawn type and condition, timing of application, and total nitrogen applied per year.

This Legislature further finds that fertilizers are responsible for approximately 50% of the total nitrogen loads to groundwater in the Peconic Estuary and throughout medium-density residential land uses in Suffolk County.

This Legislature further finds that groundwater is, by far, the largest local source of nitrogen to estuaries, and nitrogen loadings to the Peconic Estuary have increased by more than 200% since the 1950s, due to fertilizers and sanitary systems.

This Legislature also determines that excess nitrogen inputs result in depressed dissolved oxygen (hypoxia), harming aquatic life, causing excessive algal blooms, and diminishing water clarity to further impair habitat for aquatic plants.

This Legislature further finds that numerous Suffolk County waterbodies have been added to New York State's list of impaired waterbodies due to nitrogen over-enrichment, including the sensitive, westernmost areas of the Peconic Estuary, and eelgrass, a critical habitat, has substantially disappeared west of Shelter Island in the Peconics.

This Legislature further finds that more than half of Long Island Sound suffers from hypoxia every summer, that several areas of the South Shore Estuary Reserve are also seeing effects of eutrophication, and that several fish kills have been reported throughout Suffolk County due to low dissolved oxygen.

This Legislature further finds that fertilizer should not be applied to turf when ground is likely to be frozen, or when grass is not actively growing, so that fertilizer use on turf should be banned in cold-weather months, and public education and outreach should be utilized to prevent application during periods of summer dormancy.

This Legislature also determines that the Homestead A-Syst Task Force (Suffolk County Resolution No. 544-2006) sought to address this problem by establishing public education programs and holding public hearings, and that various other educational programs exist through agencies and estuary programs, but these efforts can be coordinated, refined, and expanded.

This Legislature further finds that current information regarding the use of fertilizers is confusing to consumers, and leads to the misapplication of fertilizer and contamination of groundwater, drinking water, and estuaries.

This Legislature also determines that the quality of our water should be considered a higher priority than the aesthetics of lawns, and that high maintenance lawns require more nitrogen and are more likely to leach excess nitrogen, so that high maintenance lawns should be discouraged.

This Legislature also determines that Suffolk County has already begun implementing programs to reduce nitrogen pollution, and those programs should continue to be refined and formalized as County policy, to serve as a model for residences, the private sector, and other levels of government.

This Legislature also determines that, based on the Peconic Estuary Program Comprehensive Conservation and Management Plan a goal of 10% to 25% fertilizer reduction is a reasonable initial target for existing residential fertilizing programs.

Therefore, the purpose of this law is to cause a reduction in the amount of nitrogen released into the groundwater by eliminating the use of fertilizers where practicable on lawns and on County property, decreasing the overall use of fertilizer, and optimizing the use of fertilizers when they are applied.

**Section 2. Definitions.**

As used in this law, the following terms shall have the meanings indicated:

A.) **"COMMISSIONER"** shall mean the Commissioner of the Suffolk County Department of Environment and Energy.

B.) **"DEPARTMENT"** shall mean the Suffolk County Department of Environment and Energy.

C.) **"ESTABLISHMENT"** shall mean a store or person located within Suffolk County that sells or offers fertilizer for sale.

D.) **"FERTILIZER"** shall mean any organic or inorganic material of natural or synthetic origin which is added to soil, soil mixtures, or solution to supplement nutrients and is claimed to contain one or more essential plant nutrients. The term "fertilizer" does not include unmanipulated animal and vegetable manure and agricultural liming materials used to reduce soil acidity.

E.) **"PERSON"** shall mean any individual, firm, partnership, corporation, company, society, association, or any organized group of persons whether incorporated or not.

F.) "**TURF**" shall mean any area of earth principally vegetated by grass.

**Section 3. Prohibitions.**

A.) Fertilizer shall not be applied to County owned real property, except as authorized under Section 8 of this law.

B.) Fertilizer shall not be applied to any turf on any non-County owned real property any non-County owned real property by any person between November 1 and April 1 of every year, except as authorized by Section 8 of this law.

**Section 4. Requirements.**

A.) An establishment shall conspicuously post a sign and informational brochures on fertilizers and turf management, which shall be furnished by the Department, within ten (10) feet of the establishment's fertilizer display area. If an establishment has more than one fertilizer display area, and the display areas are not substantially contiguous, then signs and brochures must be displayed within ten (10) feet of each display area.

B.) The Department shall prepare a report, no later than July 1 of each year, which presents information on fertilizers sold in the preceding year. This report will be based on records available from the New York State Department of Agriculture and Markets. If the Commissioner deems that additional information is needed, the Commissioner is authorized to promulgate rules and regulations necessary to implement a Suffolk County reporting system on fertilizer sales for establishments.

**Section 5. Education and Reporting.**

A.) The Department shall work in conjunction with other persons and organizations to expand educational programs already in place regarding the risks of fertilizers for retailers, consumers and landscapers. These organizations include, but are not limited to:

i.) Cornell Cooperative Extension (CCE);
ii.) Grassroots Healthy Lawn Program (GHLP);
iii.) Neighborhood Network;

iv.) Homestead A-Syst Task Force, as created by Suffolk County Resolution No. 544-2006;
v.) United States Environmental Protection Agency (USEPA);
vi.) Nassau Suffolk Landscape Gardeners Association (NSLGA);
vii.) Long Island Sound Study;
viii.) South Shore Estuary Reserve;
ix.) Peconic Estuary Program
x.) Turfgrass Science Program, Cornell University
xi.) Cornell University New York State Integrated Pest Management (NYSIPM) Program
xii.) Suffolk County Water Authority (SCWA)
xiii.) Such other organizations as deemed appropriate by the Commissioner of the Department.

B.) The Department, in consultation with the Suffolk County Department of Health Services, shall develop, within one year of the effective date of this law, information regarding the risks of fertilizer related to turf and suggested guidelines to delineate which types of fertilizers, fertilizer application methods and best management practices support healthy vegetation, while posing the least harm to the environment. Best management practices may include such practices as low-maintenance lawns and landscaping, proper mowing, and modification of fertilizer application rates or times. In developing the guidelines, the Department shall consider factors which may contribute to excessive and unnecessary degradation of local water quality by nitrogen pollution, including harm to groundwater, drinking water, wetlands and surface waters. Factors considered shall include, but not be limited to:

i.) Nitrogen content and formulation of fertilizers;
ii.) Rate of nitrogen release and leaching potential;
iii.) Soil type, soil conditions, land use, lawn age, and lawn condition;
iv.) Weather or temperature conditions;
v.) Impact on aquatic organisms and vegetation;
vi.) Definitions of fertilizer label terminology;
vii.) Information about proper application techniques, including, but not limited to, timing, total nitrogen per application and total cumulative nitrogen applied per year;
viii.) Impact on sensitive groundwater and surface water; and
ix.) Such other factors as deemed appropriate by the Suffolk County Department of Environment and Energy.

C.) The Department shall establish, within one year of the effective date of this law, an interactive website concerning turf and fertilizer-related issues. The website shall present educational materials on fertilizers and County law and policy, including advisory signage and brochures, the prohibition on usage of fertilizers on turf from November 1 to April 1, landscaper training, and the guidelines developed pursuant to section 5(B). The website may also include a simple computer-based method of determining the amount of fertilizer required for a specific site. Links to other related educational resources shall also be provided.

**Section 6. Annual Report and Program Evaluation Reports.**

A.) The Department shall prepare an annual report summarizing information received pursuant to Section 4 of this law and the report shall show, at a minimum, the total quantities of fertilizer sold in Suffolk County. The report shall also analyze this data

with respect to factors deemed to be significant by the Department, which may include, but not be limited to, nitrogen and phosphorus content of fertilizers, slow-release vs. quick-release fertilizers, and organic content of fertilizers. This report shall be completed no later than July 1 of the given year, shall be filed with the Clerk of the Legislature within 15 days of completion, and shall be made available to the public.

B.) The Department shall also prepare a report, every five years, beginning in 2014, which evaluates the effectiveness of this law, in terms of fertilizer sales information, environmental impact data, and any other information the Commissioner deems necessary. This report shall be completed no later than September 30 of the given year, shall be filed with the Clerk of the Legislature within 15 days of completion, and shall be made available to the public.

**Section 7. Signs and Brochures.**

The Department, in consultation with the Suffolk County Department of Health Services, shall develop, within one year of the effective date of this law, the signs and brochures referred to in section 4(A). The signs and brochures shall be written in a clear and simple manner and shall contain the suggested guidelines referred to in Section 5(B).

**Section 8. Exemptions.**

A.) Section 3 of this law shall not apply to land used in farm operations, as defined in the N.Y. Agricultural and Markets Law Section 301.

B.) Section 3(A) of this law shall not apply to:

i.) Golf courses, provided, however, that only the minimum amount of slow-release and organic fertilizer shall be used that is needed to sustain healthy turf on golf courses, and that fertilizer application rates shall be limited to 3 lbs. of nitrogen/1000 sq. ft. per year, over the golf course as a whole, consistent with the Organic Maintenance Plan adopted via Suffolk County Resolution No. 608-1998.

ii) The Suffolk County Farm; provided, however, that the Suffolk County Farm shall be subject to a goal of nitrogen reduction. The Suffolk County Departments of Planning and Health Services, in consultation with the Department, shall establish strategies to achieve this goal. Recommendations made in the following document shall be considered in developing the strategies:

> A Strategy to Develop and Implement the Suffolk County Agricultural Stewardship Program – A Report to the Agricultural Environmental Management Task Force for Nitrogen and Pesticides Load Reduction – Final Report (May 26, 2004).

iii) Athletic fields, provided, however, that the County department with jurisdiction of the fields shall develop and comply with an annual plan containing best management practices to reduce use of fertilizer and avoid fertilizer leachate. The plan shall be submitted to the Department for review and approval.

iv) Newly-seeded or planted landscapes and newly-seeded or newly-sodded areas.

C.) Any reporting requirement which is promulgated by Suffolk County pursuant to Section 4B shall not apply to an establishment selling less than one thousand (1000) pounds of fertilizer in total during the preceding calendar year.

**Section 9. Waivers.**

Upon written application to the Department by a person utilizing County-owned property, a waiver of the prohibition in Section 3(A) of this law may be granted upon such terms and conditions as deemed appropriate at the Commissioner's sole discretion. The decision to grant a waiver shall be based upon the following factors:

A.) Whether the waiver application is in general conformity with this law;

B.) Whether the uses of groundwater, surface water and drinking water supplies will be impaired;

C.) Whether the application conforms to a comprehensive management plan and/or well accepted best management practices, and;

D.) Whether the proposed use can be modified so that the project will not require a waiver.

**Section 10. Enforcement.**

The Suffolk County Department of Health Services shall enforce the prohibitions and requirements of Section 3 and 4 of this law, in accordance with the enforcement procedures established by Suffolk County Sanitary Code Article II, §§ 760-202 through 760-220.

**Section 11. Penalties.**

A.) Any violation of Sections 3 and 4 this law shall be subject to a civil penalty, in an amount not to exceed $1,000.00 per violation.

B.) Each day of continued violation shall constitute a separate additional violation.

**Section 12. Rules and Regulations.**

The Department, in consultation with the Suffolk County Department of Health Services and Suffolk County Office of Consumer Affairs, shall issue and promulgate such rules, regulations and standards as deemed necessary and appropriate to carry out the provisions of this law.

**Section 13. Amendment.**

Section 345-17 of Article II of Chapter 345 of the Suffolk County Code is hereby amended as follows:

**ARTICLE II**
**Home Improvement Contractors**

* * * *

**§ 345-17. License required.**

* * * *

F.) Every person applying under this Chapter for a license to engage in, or applying for the renewal of a license to engage in, home improvement contracting, as that term is used in this Chapter, and who applies any fertilizer in the operation of such home contracting business, shall take a turf management course approved by the Commissioner of the Department of Environment and Energy, pursuant to rules, regulations and standards to be promulgated by the Department of Environment and Energy.

[F] G.) * * * *

**Section 14. Reverse Preemption.**

This law shall be null and void on the day that Statewide or Federal legislation goes into effect, incorporating either the same or substantially similar provisions as are contained in this law, or in the event that a pertinent State or Federal administrative agency issues and promulgates regulations preempting such action by the County of Suffolk. The County Legislature may determine via mere resolution whether or not identical or substantially similar statewide legislation has been enacted for the purposes of triggering the provisions of this section.

**Section 15. Applicability.**

Sections 3, 4 and 13 of this law shall apply to all actions occurring on or after January 1, 2009.

**Section 16. Severability.**

If any clause, sentence, paragraph, subdivision, section, or part of this law or the application thereof to any person, individual, corporation, firm, partnership, entity, or circumstance shall be adjudged by any court of competent jurisdiction to be invalid or unconstitutional, such order or judgment shall not affect, impair, or invalidate the remainder thereof, but shall be confined in its operation to the clause, sentence, paragraph, subdivision, section, or part of this law, or in its application to the person, individual, corporation, firm, partnership, entity, or circumstance directly involved in the controversy in which such order or judgment shall be rendered.

**Section 17. SEQRA Determination.**

This Legislature, being the lead agency under the State Environmental Quality Review Act, N.Y. Envtl. Conserv. Law Art. 8 ("SEQRA") and Chapter 279 of the Suffolk County Code, hereby determines that this local law constitutes a Type I action, pursuant to 6 N.Y.C.R.R. §617.4. This Legislature further finds and determines that implementation of this action will not have a significant impact on the environment for the following reasons:

1. The proposed action will not exceed any of the criteria in Section 617.7 of Title 6 NYCRR, which sets forth thresholds for determining significant effect on the environment, as demonstrated in the Environmental Assessment Form;

2. The proposal does not appear to significantly threaten any unique or highly valuable environmental or cultural resources as identified in or regulated by the Environmental Conservation Law of the State of New York or the Suffolk County Charter and Code; and

3. The action will have significant beneficial impacts by minimizing nitrogen leachate to groundwater and surface waters, which will minimize hazards to drinking water and human health, while alleviating cultural eutrophication stresses to surface waters.

In accordance with Section 279-5(C)(4) of the Suffolk County Code, the Suffolk County Council, on Environmental Quality is hereby directed to prepare and circulate any appropriate notices or determinations in accordance with this resolution.

**Section 18. Effective Date.**

This law shall take effect immediately upon filing in the Office of the Secretary of State.

[ ] Brackets denotes deletion of existing language
___ Underlining denotes addition of new language

DATED: December 18, 2007

APPROVED BY:

/s/ Steve Levy
County Executive of Suffolk County

Date: January 16, 2008

After a public hearing duly held on January 15, 2008
Filed with the Secretary of State on January 31, 2008

# Appendix 17
# Selected Turf Products

CIVITAS

TURF DEFENSE™

Pre-M1xed

# Fungicide and Insecticide for turf on golf courses, sports and athletic fields

***Year-Round Applicability***
***(subject to limitations of extreme temperatures)***

**Keep from freezing**

| | By Weight |
|---|---|
| **ACTIVE INGREDIENT:** | |
| Mineral Oil* | 88.80% |
| **OTHER INGREDIENTS:** | 11.20% |
| TOTAL: | 100.00% |

*Contains petroleum distillates

Patent(s): www.suncor.com/patents

**KEEP OUT OF THE REACH OF CHILDREN**

**CAUTION**

**See inside booklet for additional Precautionary Statements and Directions for Use**

**EPA REG. NO. 69526-17** **EPA EST. NO. 79693-CAN-001**

OMRI LISTED For Organic Use

**MADE IN CANADA**
**(MAY CONTAIN IMPORTED PARTS) FOR:**

**Intelligro,**
**a Suncor Energy business**
2310 Lakeshore Road West, Mississauga, Ontario, Canada L5J 1K2

intelligro™

™Trademark of Suncor Energy Inc. Used under license.

- **Easier to use than the 2-Pack CIVITAS Turf Defense™ Ready-2-Mix**
- **Use CIVITAS TURF DEFENSE™ Pre-MIxed as part of your Overall Turf Management Program**
- **Fungicide that controls over 10 turfgrass pathogens**
- **Controls Surface Insects as listed on the label**
- **Fungicide and Insecticide for turf on golf courses, sports and athletic fields**
- **Shake well before using**
- **For Use in Both Conventional and Organic Turfgrass Management**

| FIRST AID | |
|---|---|
| **If swallowed:** | • Immediately call a poison control center or doctor.<br>• Do not induce vomiting unless told to by a poison control center or doctor.<br>• Do not give any liquid to the person.<br>• Do not give anything by mouth to an unconscious person. |
| **If on skin or clothing:** | • Take off contaminated clothing.<br>• Rinse skin immediately with plenty of water for 15-20 minutes.<br>• Call a poison control center or doctor for treatment advice. |
| **HOTLINE NUMBER**<br>**Have the product container or label with you when calling a poison control center or doctor or going for treatment. To reach a U.S. POISON CONTROL CENTER, call 1-800-222-1222. You may also contact Intelligro, a Suncor Energy business: 403-296-3000, or CANUTEC Canadian Transport Emergency Centre: 613-996-6666.** | |
| **NOTE TO PHYSICIAN:** Contains petroleum distillate. Do not induce vomiting since vomiting may induce aspiration pneumonia | |

# PRECAUTIONARY STATEMENTS

## HAZARDS TO HUMANS AND DOMESTIC ANIMALS

Avoid contact with eyes, skin, or clothing.

**Personal Protective Equipment (PPE)**

Some materials that are chemical resistant to this product are listed below. If you want more options, follow the instructions for category E on an EPA chemical resistance category selection chart.

**Applicators and other handlers must wear:**

- Long sleeved shirt and long pants;
- Chemical-resistant gloves made of: Barrier laminate or Nitrile rubber, Neoprene rubber or Viton;
- Shoes plus socks

Follow manufacturer's instructions for cleaning and maintaining PPE. If there are no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry. Discard clothing and other absorbent materials that have been drenched or heavily damaged by this product's concentrate. Do not reuse them.

**User Safety Recommendations**

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet;
- Remove clothing and/or PPE immediately if pesticide gets inside and then wash thoroughly and change into clean clothing;
- Remove PPE immediately after handling this product. As soon as possible, wash thoroughly and change into clean clothing.

## ENVIRONMENTAL HAZARDS

Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment wash waters or rinsate. Apply this product only as specified on the label. Drift and runoff may be hazardous to aquatic organisms in water adjacent to treated areas.

# DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Do not apply this product through any type of irrigation system. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation. Aerial application of this product is prohibited.

This product is registered only for use on turf on golf courses, sports and athletic fields.

**NON-AGRICULTURAL USE REQUIREMENTS**

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard for agricultural pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses. Keep children and pets out of the treated area until sprays have dried.

## STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.

**PESTICIDE STORAGE:** Keep out of reach of children and animals. Store in original containers only. Store in a cool, dry place and avoid excess heat. **Keep from freezing.**

**Shake well before using** (see mixing instructions). Carefully open containers. After partial use, replace lids and close tightly. Do not put concentrate or dilute material into food or drink containers. Keep containers closed to prevent entry of water.

In case of spill, avoid contact, isolate area and keep out animals and unprotected persons. Confine spills. To confine spill: If liquid, dike surrounding area or absorb with sand, cat litter or commercial clay. If dry material, cover to prevent dispersal. Place damaged package in a holding container. Identify contents.

**PESTICIDE DISPOSAL:** Dispose of wastes resulting from use of this product on site or at an approved waste disposal facility.

**CONTAINER DISPOSAL:**
Non-refillable container. Do not reuse or refill this container. Offer for recycling, if available. Clean container promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container ¼ full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. If recycling is unavailable, puncture and dispose of container in sanitary landfill, or by incineration, or if allowed by state and local authorities, by burning. If burned, stay out of smoke.

## PRODUCT INFORMATION

CIVITAS TURF DEFENSE Pre-Mlxed should be applied to healthy, growing turf. CIVITAS TURF DEFENSE Pre-Mlxed should be applied prior to the onset of disease symptoms. CIVITAS TURF DEFENSE Pre-Mlxed may be used in combination with other fungicides. Application rates toward the higher end of the ranges specified on this label and/or inter-application intervals toward the shorter end of the specified ranges should be used when conditions are favorable for disease development and in the absence of environmental stressors, including high heat or low temperatures. Combinations of CIVITAS TURF DEFENSE Pre-Mlxed with registered fungicides may be necessary when disease pressure is high.

CIVITAS TURF DEFENSE Pre-Mlxed may be used on cool-season grasses and warm-season grasses if applied in accordance with the requirements and specifications of this label.

Except when temperatures are, or are expected to be, very high (above 90° F) or low (40° F or below), CIVITAS TURF DEFENSE Pre-Mlxed may be applied repeatedly throughout the growing season, at the intervals and rates specified on this label.

Turf may show a luster after having been sprayed with this product.

## USE RESTRICTIONS

CIVITAS TURF DEFENSE Pre-Mlxed may only be used on turf on golf courses – including tees, greens, and fairways, sports and athletic fields to control the types of insects and fungi identified in the tables in the **DIRECTIONS FOR USE** section.

**Do not apply this product during or immediately prior to times when temperatures are expected to be 40°F or lower or above 90°F, or when rain or other unsuitable weather conditions are predicted.**

**Do not over-spray or double-spray.**
Ensure CIVITAS TURF DEFENSE Pre-M1xed is applied prior to line painting on sports and athletic fields. Wait until product has thoroughly dried prior to re-entry to avoid staining.

## USE PRECAUTIONS

Reduce the use of CIVITAS TURF DEFENSE Pre-Mlxed during periods of severe environmental stress, like high heat and humidity (including high soil temperatures at the roots), by using the longer specified inter-application intervals and/or the lower specified application rates in combination with cultural practices to reduce stresses on turf. Under such conditions, use the product with caution on *Poa annua* and do not apply this product during mid-day.

This product has not been tested on all species or varieties of plants. Before treating a large area, treat a small area and observe it for damage for several days prior to making full scale applications.

Plants should be sprayed only when in vigorous condition and when moisture conditions are suitable.

## SPRAY DRIFT MANAGEMENT

A variety of factors including weather conditions (e.g., wind direction, wind speed, temperature, and relative humidity) and method of application (ground) can influence pesticide drift. The applicator and grower must evaluate all factors and make appropriate adjustments when applying this product.

### Wind Speed

Do not apply at wind speeds greater than 15 mph at the application site.

### Temperature Inversions

If applying at wind speeds less than 3 mph, the applicator must determine if (a) conditions of temperature inversion exist, or (b) stable atmospheric conditions exist at or below nozzle height. Do not make applications into areas of temperature inversions or stable atmospheric conditions.

### Release Height

Apply using a nozzle height of no more than 4 feet above the ground.

### Droplet Size

Apply as a medium or coarser spray (ASABE standard 572), and the minimum volume mean diameter (VMD) for spinning atomizer nozzles.

## INTEGRATED PEST MANAGEMENT (IPM)

This product can be used in resistance management strategies or in integrated pest management (IPM) programs. Consult with your local Cooperative Extension Specialist on using this product for resistance management and using it in an IPM program.

## MIXING DIRECTIONS

Use only in equipment with sufficient agitation to keep contents thoroughly mixed. Provide sufficient agitation during mixing and application to maintain a uniform emulsion. Before mixing or using this product, make certain that the tank is clean and free of sulfur residues.

**DO NOT USE THIS MATERIAL IF IT DOES NOT EMULSIFY.**

1. Carefully calculate the quantity of CIVITAS TURF DEFENSE Pre-M1xed needed before mixing. Refer to the DIRECTIONS FOR USE ON TURF tables for controlling specific pests.
2. **CIVITAS TURF DEFENSE Pre-M1xed MUST BE SHAKEN WELL BEFORE USE.** Phase separation can occur during storage. Shake firmly for 30 seconds, or until the liquid has a uniform consistency and color.
3. With agitator running to provide vigorous mixing, start filling tank with water until it gets to about ½ full.
4. Add any powders or granular products that are to be used, and be sure that they are completely dissolved before other products are added.
5. Add CIVITAS TURF DEFENSE Pre-M1xed to the mixture. An initial green bloom indicates emulsification. Continue agitation. Do not proceed further until the spray mix has a uniform opaque dark green color.
6. Add any other products that are to be part of the spray mix and fill the tank completely with water.
7. Apply directly following mixing. **Continue agitation during mixing and application.**
8. Prepare only enough spray mix for the current day's use. Do not store spray mix.

Protect surfaces and objects from overspray to avoid discoloration. Clean up any spills containing CIVITAS TURF DEFENSE Pre-M1xed immediately with warm water and soap to help avoid persistent staining.

### Tank Mixes

Follow all directions, precautions, and limitations on labeling of all products used in tank mixes. Observe the most restrictive of the labeling limitations and precautions of all products used in the mixture. Tank mixtures or other applications of products referenced on this label are permitted only in those states in which the referenced products are registered.

DO NOT combine CIVITAS TURF DEFENSE Pre-M1xed in the spray tank with pesticides, surfactants, or fertilizers, unless your prior use or "jar compatibility test" has shown the combination to be physically compatible and non-injurious under your conditions. USE WITH CAUTION and test on a small area prior to broad application, especially in the following combinations:

- CIVITAS TURF DEFENSE Pre-M1xed combined in a tank-mix with both propiconazole and chlorothalonil may cause phytotoxicity when applied to colonial bentgrass under high temperatures and humidity
- CIVITAS TURF DEFENSE Pre-M1xed combined with DMI fungicides may cause phytotoxicity when applied to stressed turf especially to *Poa annua* and bermudagrass under high temperatures and humidity
- CIVITAS TURF DEFENSE Pre-M1xed combined with high rates of certain iron-containing products may cause potential turf discoloration
- DO NOT combine CIVITAS TURF DEFENSE Pre-M1xed with high label rates of chlorothalonil on ryegrass as phytotoxicity may result from the combination under high temperatures
- DO NOT combine CIVITAS TURF DEFENSE Pre-M1xed with PCNB as phytotoxicity may result from the combination when applied to turf

## APPLICATION PROCEDURES

CIVITAS TURF DEFENSE Pre-M1xed may be applied using the types of spray equipment commonly employed for ground applications. Note requirements for SPRAY DRIFT MANAGEMENT. Ensure that sufficient agitation is provided and maintained, either through use of mechanical mixing equipment or thorough circulation.

Apply CIVITAS TURF DEFENSE Pre-M1xed mixed in water as indicated above with 1-5 gal of total spray volume per 1000 $ft^2$ of turf area to be treated. Apply CIVITAS TURF DEFENSE Pre-M1xed in a volume of water sufficient for adequate coverage and canopy penetration. All applications must be consistent with the requirements and specifications indicated in the **DIRECTIONS FOR USE** and the rest of this label.

## DIRECTIONS FOR USE ON TURF*

* CIVITAS TURF DEFENSE Pre-M1xed should be applied to healthy, growing turf.
* Apply CIVITAS TURF DEFENSE Pre-M1xed according to the interval range identified for the specific disease throughout the whole growing season, prior to the onset of disease symptoms.
* CIVITAS TURF DEFENSE Pre-M1xed and any tank mix combinations should be tested on a small area prior to broad application.
* On greens and tees, use application rates toward the lower end of the specified range. On fairways, use application rates toward the upper end of the specified range.
* Refer to Tank Mix section for compatibility cautions.

### Turf Disease Control

| Target Disease | Application Interval (Days) | Total Application Volume with water (gal per 1,000 sq. ft.) | Application Rates (Fluid Ounces CIVITAS TURF DEFENSE Pre-M1xed per 1,000 sq. ft.) | Comments |
|---|---|---|---|---|
| Anthracnose *(Colletotrichum cereale)* | 7-14 days | 1-5 gal. | 8.5 to 17 fl. oz. | |
| Brown Patch *(Rhizoctonia solani)* | 14-21 days | 1-5 gal. | 8.5 to 17 fl. oz. | When disease pressure is high, CIVITAS TURF DEFENSE Pre-M1xed should be used in combination with an appropriate, registered fungicide. |
| Crown Rust | 14-21 days | 1-5 gal. | 17 fl. oz. | When disease pressure is high, CIVITAS TURF DEFENSE Pre-M1xed should be used in combination with an appropriate, registered fungicide. |
| Dollar Spot *(Sclerotinia homoeocarpa)* | 7-21 days | 1-5 gal. | 8.5 to 17 fl. oz. | When disease pressure is high, CIVITAS TURF DEFENSE Pre-M1xed should be used in combination with an appropriate, registered fungicide. |

| Target Disease | Application Interval (Days) | Total Application Volume with water (gal per 1,000 sq. ft.) | Application Rates (Fluid Ounces CIVITAS TURF DEFENSE Pre-M1xed per 1,000 sq. ft.) | Comments |
|---|---|---|---|---|
| Fusarium patch *(Microdochium nivale)* | 14-21 days | 1-5 gal. | 17 fl. oz. | When disease pressure is high, CIVITAS TURF DEFENSE Pre-M1xed should be used in combination with an appropriate, registered fungicide. |
| Gray Leaf Spot *(Pyricularia grisea)* | 14 days | 1-5 gal. | 8.5 to 17 fl. oz. | CIVITAS TURF DEFENSE Pre-M1xed should be used in combination with an appropriate, registered fungicide. |
| Large Patch of Zoysia *(Rhizoctonia solani)* | 2 applications in the early Fall. (September, October) It is critical to apply before the plant has become dormant. | 1-5 gal. | 17 fl. oz. | CIVITAS TURF DEFENSE Pre-M1xed should be used in combination with an appropriate, registered fungicide.<br>Application in early Spring may be necessary where disease pressure is high. |
| Leaf Spot / Melting-out *(Drechslera spp. and/or Biopolaris spp* | 14 days | 1-5 gal. | 8.5 to 17 fl. oz. | |
| Necrotic Ring *(Leptosphaeria korrae)* | 14 days | 1-5 gal. | 17 fl. oz. | |
| Powdery Mildew *(Erysiphe graminis)* | 14 days | 1-5 gal. | 17 fl. oz. | |
| Red Thread (Laetisaria fuciformis) | 14 days | 1-5 gal. | 17 fl. oz. | |

| Target Disease | Application Interval (Days) | Total Application Volume with water (gal per 1,000 sq. ft.) | Application Rates (Fluid Ounces CIVITAS TURF DEFENSE™ Pre-MIxed per 1,000 sq. ft.) | Comments |
|---|---|---|---|---|
| Snow Mold, Gray *(Typhula ishikariensis, Typhula incarnata)* Pink *(Microdochium nivale)* | Apply clean-up spray 14-21 days before final spray. Must apply final spray before the plant has become dormant. | 1-5 gal. | 17 to 34 fl. oz. | CIVITAS TURF DEFENSE Pre-MIxed should be used in combination with an appropriate, registered fungicide. |
| Southern Blight | 14 days | 1-5 gal. | 8.5 to 17 fl. oz. | |
| Spring Dead Spot *(Ophiosphaerella korrae)* | 2 applications in the early Fall. (September, October) Must apply before the plant has become dormant. | 1-5 gal. | 17 fl. oz. | CIVITAS TURF DEFENSE Pre-MIxed should be used in combination with an appropriate, registered fungicide. When CIVITAS™ is used in a tank mix with fenarimol the turfgrass should be irrigated with 0.5 inch of water following application. |
| Summer Patch *(Magnaporthe poae)* | 7 days | 1-5 gal. | 8.5 fl. oz. | CIVITAS TURF DEFENSE Pre-MIxed should be used in combination with an appropriate, registered fungicide. |

## Turf Pest Control

| Target Pest | Application Interval (Days) | Total Application Volume with water (gal per 1,000 sq. ft.) | Application Rates (Fluid Ounces CIVITAS TURF DEFENSE Pre-Mlxed per 1,000 sq. ft.) | Comments |
|---|---|---|---|---|
| Annual Blue Grass Weevils<br>Banks Grass Mites<br>Mealybugs<br>Mites<br>Cutworm<br>Sod Webworm<br>Fall Armyworm | 7-21 days | 1-5 gal. | 8.5 to 17 fl. oz. | Do not make spot applications.<br><br>Treat the entire area where exposure (or infestation) occurs.<br><br>Insecticidal effect of CIVITAS TURF DEFENSE Pre-Mlxed can also be achieved when CIVITAS TURF DEFENSE Pre-Mlxed is combined with other compatible control methods as part of an integrated pest management (IPM) program. |

## CONDITIONS OF SALE AND LIMITATIONS OF WARRANTY AND LIABILITY

It is impossible to eliminate all risks inherently associated with the use of this product. Crop injury, ineffectiveness, or other unintended consequences may result because of such factors as weather conditions, presence of other materials, or the manner of use or application, all of which are beyond the control of Intelligro, a Suncor Energy business, the manufacturer or seller. To the extent consistent with applicable law neither Intelligro, a Suncor Energy business, the manufacturer or seller shall be liable for consequential, special or indirect damages resulting from the use or handling of this product. All such risks shall be assumed by the buyer. Except as warranted by this label, Intelligro, a Suncor Energy business, the manufacturer or seller makes no warranties, guarantees, or representations of any kind, either express or implied, or by usage of trade, statutory or otherwise, with regard to the product sold, including, but not limited to, merchantability, fitness for a particular purpose, use or eligibility of the product for any particular trade usage. To the extent consistent with applicable law, buyer's or user's exclusive remedy, and Intelligro, a Suncor Energy business, the manufacturer's or seller's total liability, shall be for damages not exceeding the cost of the product.

CIVITAS

TURF DEFENSE™

Pre-M1xed

# Fungicide and Insecticide for turf on golf courses, sports and athletic fields

| ACTIVE INGREDIENT: | By Weight |
|---|---|
| Mineral Oil* | 88.80% |
| OTHER INGREDIENTS: | 11.20% |
| TOTAL: | 100.00% |

*Contains petroleum distillates

## KEEP OUT OF REACH OF CHILDREN

## CAUTION

• Keep from freezing • Year-Round Applicability (subject to limitations of extreme temperatures)

EPA REG. NO. 69526-17 EPA EST. NO 79693-CAN-001

Patent(s): www.suncor.com/patents

**See inside booklet for additional Precautionary Statements and Directions for Use**

**MADE IN CANADA (MAY CONTAIN IMPORTED PARTS) FOR:**

**Intelligro, a Suncor Energy business**

2310 Lakeshore Road West, Mississauga, Ontario, Canada L5J 1K2

## FIRST AID

| | |
|---|---|
| **If swallowed:** | • Immediately call a poison control center or doctor.<br>• Do not induce vomiting unless told to do so by a poison control center or doctor.<br>• Do not give any liquid to the person.<br>• Do not give anything by mouth to an unconscious person. |
| **If on skin or clothing:** | • Take off contaminated clothing.<br>• Rinse skin immediately with plenty of water for 15-20 minutes.<br>• Call a poison control center or doctor for treatment advice. |

**HOTLINE NUMBER**

Have the product container or label with you when calling a poison control center or doctor or going for treatment. To reach a U.S. POISON CONTROL CENTER, call 1-800-222-1222. You may also contact Intelligro, a Suncor Energy business: 403-296-3000, or CANUTEC Canadian Transport Emergency Centre: 613-996-6666.

**NOTE TO PHYSICIAN:** Contains petroleum distillate. Do not induce vomiting since vomiting may induce aspiration pneumonia.

## PRECAUTIONARY STATEMENTS

**HAZARDS TO HUMANS AND DOMESTIC ANIMALS**

Avoid contact with eyes, skin, or clothing.

## STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.

**PESTICIDE STORAGE:** Keep out of reach of children and animals. Store in original containers only. Store in a cool, dry place and avoid excess heat. **Keep from freezing.**

**Shake well before using** (see mixing instructions). Carefully open containers. After partial use, replace lids and close tightly. Do not put concentrate or dilute material into food or drink containers. Keep containers closed to prevent entry of water.

In case of spill, avoid contact, isolate area and keep out animals and unprotected persons. Confine spills. To confine spill: If liquid, dike surrounding area or absorb with sand, cat litter or commercial clay. If dry material, cover to prevent dispersal. Place damaged package in a holding container. Identify contents.

**PESTICIDE DISPOSAL:** Dispose of wastes resulting from use of this product on site or at an approved waste disposal facility.

**CONTAINER DISPOSAL:**

Non-refillable container. Do not reuse or refill this container. Offer for recycling, if available. Clean container promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container ¼ full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. If recycling is unavailable, puncture and dispose of container in sanitary landfill, or by incineration, or if allowed by state and local authorities, by burning. If burned, stay out of smoke.

OMRI LISTED For Organic Use

intelligro™

641017/2 ESL031615 REV041415

NET CONTENTS: ☐ 2.5 GAL (9.5 L) ☐ 2 x 2.5 GAL (2 x 9.5 L)

# EcoGuard™-GN

## BIOFUNGICIDE

roots®

xxxx-xxxx-0307

**For use on**

**Ornamental Plants**

**Active Ingredients:**

*Bacillus licheniformis* SB3086* .....1.26% (w/w)

Indole-3-butyric Acid** .....0.002755% (w/w)

**Other Ingredients:** .....98.737245% (w/w)

**Total** .....100.00%

*Contains 9.0 x $10^9$ Colony Forming Units (CFU)/ml

**A non-fungicidal plant growth regulating ingredient shown to improve the overall growth and health of turf and ornamental plants.

**Keep Out of Reach of Children**

## CAUTION

See back panel for additional Precautionary Statements.

## NET CONTENTS 2.5 GAL (9.46 L)

novozymes®

For information on product use, availability or MSDS requests, please contact
**Novozymes Biologicals, Inc.**
5400 Corporate Circle • Salem, VA 24153 • 1-800-342-6173
www.novozymes.com/roots

EPA Reg. No. 70127-3 EPA Est. 70127-VA-001

U.S. Patent No. 6,569,425

back booklet - outside(visible) panel

# PRECAUTIONARY STATEMENTS:

## Hazards To Humans and Domestic Animals - CAUTION:

**Personal Protective Equipment (PPE):** Applicators and other handlers must wear:

- Long-sleeved shirt and long-pants
- Shoes plus socks
- For handling activities use a non-powered air purifying NIOSH approved respirator with any N, P, R, or HE filter.

Follow the manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

**USER SAFETY RECOMMENDATIONS** Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

**Environmental Hazards:** Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high-water mark. Do not contaminate water when disposing of residual product or equipment washwaters. Do not use this product on plants intended for food or feed. Do not feed treated plants to livestock or domestic animals.

# DIRECTIONS FOR USE:

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Do not apply this product when weather conditions, cultural practices, extreme moisture conditions or other environmental conditions are outside of the ranges that are generally recognized as conducive to good growing practices. Do not apply with solutions containing strong acids, bases, oxidizing agents, or solvents.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

**AGRICULTURAL USE REQUIREMENTS**

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), notification to workers, and restricted-entry interval. The requirements in this box apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted-entry interval (REI) of 4 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is: coveralls and shoes plus socks and protective eyewear.

## INCLUSION IN PEST MANAGEMENT PROGRAM:

**EcoGuard-GN** also works well as part of an Integrated Pest Management (IPM) program, especially to help reduce the occurrence of disease resistance to other fungicide products. In addition, during times of high disease pressure, such combinations may provide optimal pest management while reducing overall yearly pesticide application amounts. Such an integrated program may be achieved by regular rotation of the treatments using **EcoGuard-GN** with treatments of other fungicides. Another approach is to apply **EcoGuard-GN** until the onset of high disease pressure, then to substitute another fungicide (at standard application rates) for a brief period (1-4 treatments) followed by a return to standard applications of **EcoGuard-GN**.

## Product Description:

**EcoGuard-GN** is a concentrated suspension of the bacterial spores of the organism *Bacillus licheniformis* SB3086 (U.S. Patent No. 6,569,425), which has been found effective as a natural inhibitor of a variety of agronomically important fungal disease species.

## Product Use Sites:

**EcoGuard-GN** is applied as a directed spray or soil drench on ornamental plants at the following sites: greenhouses, nurseries, and ornamental gardens. **EcoGuard-GN** is a preventative or curative treatment for the fungal diseases *Rhizoctonia solani* and *Phytophthora drechsleri*.

## Ornamental Plants including Greenhouse Applications, and Nursery and Ornamental Garden Uses:

Apply as a drench or directed spray using hand held, mechanical or motorized spray equipment after seeding or sticking of cuttings or after transplanting to beds, containers, pots, or trays. Thoroughly soak the growing media. Apply every 7-14 days for adequate crop protection. Rotate with other approved fungicides if disease conditions last for several months

| Disease | Crops | Oz./100 gals. |
|---|---|---|
| *Rhizoctonia solani* | Vinca, Zinnia, Geranium, Impatiens | 64 |
| *Phytophthora drechsleri* | Poinsettia, Marigold, Petunia, Impatiens | 64 |

## Irrigation Application:

**EcoGuard-GN** is a liquid concentrate that can be used through various irrigation systems such as drip (trickle), flood (basin) or sprinkler systems. **EcoGuard-GN** can be used on annual and perennial flowers, bedding and foliage plants, ground cover crops and trees and shrubs for indoor and outdoor landscaping.

**EcoGuard-GN** is compatible with fertilizers and pesticides. It is recommended that a jar test should be done if there is any questions about compatibility. If a soil sterilant or strong oxidizer is used, **EcoGuard-GN** should be applied after the recommended time for replanting.

| Injector Ratio | 1:100 | 1:200 |
|---|---|---|
| EcoGuard-GN | 64 oz. | Direct Siphon |

**Open for Continued Use Directions** ➔

# back booklet - inside panel

### Direct Siphon:

When using **EcoGuard-GN** with a high ratio (1:200), a siphon can be drawn directly out of the original container without dilution.

### Soil Drench Application:

**EcoGuard-GN** can be used on annual and perennial flowers, foliage crops, and ground cover crops as a drench or directed spray by various mechanical or automated equipment. For drench or directed spray **EcoGuard-GN** may be applied using hand held, mechanical or motorized spray equipment. Direct spray applications may also use sprinkler irrigation systems. **EcoGuard-GN** applications should begin before or shortly after initial seeding, planting of cutting, or after transplanting to propagation beds, containers, pots or trays. Drench the planting media thoroughly. Apply every 7-28 days through the growing season or the part of the season where the plant is most susceptible to disease pressure.

**EcoGuard-GN** Direct Drench

| Crop | EcoGuard-GN concentration | Application interval |
|---|---|---|
| Annual Flowers | 64 fl. oz./100 gals. water | 7-14 days |
| Perennial Flowers | - or - | 14-28 days |
| Foliage | | 14-28 days |
| Ground Cover | 0.5 oz. / gal. water | 14-28 days |

Apply this product only through sprinkler including solid set, or hand move; flood (basin); furrow; border or drip (trickle) irrigation system(s). Do not apply this product through any other type of irrigation system.

Crop injury, lack of effectiveness, or illegal pesticide residues in the crop can result from non-uniform distribution of treated water.

If you have questions about calibration, you should contact State Extension Service specialists, equipment manufacturers or other experts.

Do not connect an irrigation system (including greenhouse systems) used for pesticide application to a public water system unless the pesticide label-prescribed safety devices for public water systems are in place.

A person knowledgeable of the chemigation system and responsible for its operation or under the supervision of the responsible person, shall shut the system down and make necessary adjustments should the need arise.

**Chemigation Systems Connected to Public Water Systems:**

1. Public water system means a system for the provision to the public of piped water for human consumption if such system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year.

2. Chemigation systems connected to public water systems must contain a functional, reduced-pressure zone, back flow preventer (RPZ) or the functional equivalent in the water supply line upstream from the point of pesticide introduction. As an option to the RPZ, the water from the public water system should be discharged into a reservoir tank prior to pesticide introduction. There shall be a complete physical break (air gap) between the flow outlet end of the fill pipe and the top or overflow rim of the reservoir tank of at least twice the inside diameter of the fill pipe.

3. The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection.

4. The pesticide injection pipeline must contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.

5. The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops, or in cases where there is no water pump, when the water pressure decreases to the point where pesticide distribution is adversely affected.

6. Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock.

7. Do not apply when wind speed favors drift beyond the area intended for treatment.

Light agitation is recommended in the pesticide supply tank directly after adding **EcoGuard-GN** to the tank. If using direct siphon method, the container should be shaken well before beginning the siphon.

**EcoGuard-GN** is to be applied continuously for the duration of the water application. Always shake **EcoGuard-GN** container well before metering out to the pesticide supply tank.

**Sprinkler Chemigation:**

1. The system must contain a functional check valve, vacuum relief valve, and low pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from back flow.

2. The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection.

3. The pesticide injection pipeline must contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from b eing withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.

4. The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops.

5. The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.

6. Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock.

7. Do not apply when wind speed favors drift beyond the area intended for treatment.

Light agitation is recommended in the pesticide supply tank directly after adding **EcoGuard-GN** to the tank. If using direct siphon method, the container should be shaken well before beginning the siphon.

**EcoGuard-GN** is to be applied continuously for the duration of the water application. Always shake **EcoGuard-GN** container well before metering out to the pesticide supply tank.

### Floor (Basin), Furrow and Border Chemigation:

1. Systems using a gravity flow pesticide dispensing system must meter the pestsicide into the water at the head of the field and downstream of a hydraulic discontinuity such as a drop structure or weir box to decrease potential for water source contamination from back flow if water flow stops.

2. Systems utilizing a pressurized water and pesticide injection system must meet the following requirements:
   a. The system must contain a functional check valve, vacuum relief valve, and low pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from back flow.
   b. The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.
   c. The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.
   d. The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops.
   e. The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.
   f. Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock.

Light agitation is recommended in the pesticide supply tank directly after adding **EcoGuard-GN** to the tank. If using direct siphon method, the container should be shaken well before beginning the siphon.

**EcoGuard-GN** is to be applied continuously for the duration of the water application. Always shake **EcoGuard-GN** container well before metering out to the pesticide supply tank.

### Drip (Trickle) Chemigation:

1. The system must contain a functional check valve, vacuum relief valve, and low pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from back flow.

2. The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection.

3. The pesticide injection pipeline must contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.

4. The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops.

5. The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.

6. Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock.

Light agitation is recommended in the pesticide supply tank directly after adding **EcoGuard-GN** to the tank. If using direct siphon method, the container should be shaken well before beginning the siphon.

**EcoGuard-GN** is to be applied continuously for the duration of the water application. Always shake **EcoGuard-GN** container well before metering out to the pesticide supply tank.

### Tank Mixing:

Due to the nature of this microbial product (contains live spores), tank mixing of **EcoGuard-GN** with solutions containing strong acids, bases, oxidizing agents, or solvents should be avoided.

## STORAGE AND DISPOSAL: Do not contaminate water, food or feed by storage and disposal.

**Pesticide Storage: EcoGuard-GN** is a stable suspension of microbial spores. For best results, store within the recommended storage temperature range of 40° F - 95° F (4° C - 35° C). Avoid longer-term storage at warmer temperatures or in direct sunlight. This product can also be stored at lower temperatures (<40° F) for up to 2 weeks as freezing will not affect its usefulness. Store product in original container in a secure location. **Pesticide Disposal:** Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. **Container Disposal:** Triple-rinse (or equivalent) then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incineration, or if allowed by state and local authorities, by burning. If burned, stay out of smoke.

**WARRANTY:** The Directions for Use of this product reflect the opinion of experts based on field use and tests. The directions are believed to be reliable and must be followed carefully. Novozymes Biologicals warrants that at the time of the first sale of this product it conforms to the chemical description on the label and when used according to the label directions under normal growing conditions is reasonably fit for the purposes referred to above. Buyers/Users of this product assume full risk for any use contrary to the specified directions. If this product does not perform as warranted above and to the extent consistent with applicable law, customer's sole remedy for breach of warranty shall be replacement of the product or refund of the purchase price paid, at the option of Novozymes Biologicals. **EXCEPT AS PROVIDED ELSEWHERE IN WRITING CONTAINING AN EXPRESS REFERENCE TO THIS WARRANTY AND LIMITATION OF DAMAGES, SELLER MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OR GUARANTY TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, INCLUDING ANY OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS OR OF MERCHANTABILITY, AND NO AGENT OF SELLER IS AUTHORIZED TO DO SO.**
**Prompt Notice of Claim**: To the extent consistent with applicable law, Novozymes Biologicals must have prompt notice as soon as Buyer or User has reason to believe they may have a claim (not to exceed twenty-one days from date of application) so that an inspection of the affected property and growing crops may be made. Unless Buyer and User(s) shall promptly notify Novozymes Biologicals of any claims, the manufacturer does not intend to pay any damages.

**Novozymes Biologicals, Inc.** • www.novozymes.com/roots
5400 Corporate Circle • Salem, VA 24153 • 1-800-342-6173

roots®

SPECIMEN LABEL

# ENDORSE® WP

*FUNGICIDE*

For use on Turf and Ornamentals

**Prohibited for Any Food or Feed Use**

**GROUP 19 FUNGICIDE**

**ACTIVE INGREDIENT:**

Polyoxin D zinc salt (1:1)[1],

Zinc 5-[[2-amino-5-O-(aminocarbonyl)-2-deoxy-L-xylonoyl]amino]-1-(5-carboxy-3,4-dihydro-2,4-dioxo-1(2H)-pyrimidinyl)-1,5-dideoxy-ß-D-allofuranuronate..... 2.5%

**OTHER INGREDIENTS** ..... 97.5%

**TOTAL** .....100%

[1] Equivalent to 2.2% polyoxorim and 0.3% metallic zinc

**KEEP OUT OF REACH OF CHILDREN**

## CAUTION

## FIRST AID

- **IF ON SKIN OR CLOTHING:** Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.
- **IF IN EYES:** Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.
- **IF SWALLOWED:** Call poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told so by the poison control center or doctor. Do not give anything by mouth to an unconscious person.
- **IF INHALED:** Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible. Call a poison control center or doctor for further treatment advice.
- **HOTLINE NUMBER** Have the product container or label with you when calling a poison control center or doctor, or going for treatment.

  **FOR 24-HOUR EMERGENCY MEDICAL ASSISTANCE: CALL PROSAR AT 1-866-303-6952 OR 1-651-632-8946 IF CALLING FROM OUTSIDE OF THE U.S.**

## PRECAUTIONARY STATEMENTS

**HAZARDS TO HUMANS AND DOMESTIC ANIMALS.**

- **Caution** – Harmful if absorbed through skin, swallowed or inhaled. Causes moderate eye irritation. Avoid breathing dust or spray mist. Wash thoroughly with soap and water after handling. Remove and wash contaminated clothing before reuse. Wear the appropriate Personal Protective Equipment (PPE).

**PERSONAL PROTECTION EQUIPMENT (PPE):**

All mixers, loaders, applicators and other handlers must wear:

- Long-sleeved shirt and long pants
- Socks
- Shoes
- Chemical-Resistant gloves made of any waterproof material

**USER SAFETY REQUIREMENTS:** Follow the manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables are available, use detergent and hot water. Keep and wash PPE separately from other laundry.


**CLEARY CHEMICAL CORPORATION**
178 RIDGE ROAD, SUITE A
DAYTON, NJ 08810-1501

**EMERGENCY PHONE NUMBERS:**
M-F 9AM-5PM ET
800-524-1662 • 732-329-8399
24 Hour CHEMTREC
800-424-9300



Version: 03.01.07
Accepted: 02.27.07
EPA Reg. No. 66330-41-1001 Replaces: 08.13.03

**USER SAFETY RECOMMENDATIONS:**

- Users should wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Users should remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Users should remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

**ENVIRONMENTAL HAZARDS**

This product is moderately toxic to aquatic invertebrates and fish. For terrestrial uses: Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters or rinsate. Do not allow runoff into lakes, streams, ponds or public waterways. Drift and runoff may be hazardous to aquatic organisms in water adjacent to treated areas.

# DIRECTIONS FOR USE

IT IS A VIOLATION OF FEDERAL LAW TO USE THIS PRODUCT IN A MANNER INCONSISTENT WITH ITS LABELING. Carefully read and understand the Directions for Use and restrictions before applying this product. **Do not** apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the State or Tribe responsible for pesticide regulation.

## AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling, and the Worker Protection Standard, 40 CFR part 170. This standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions on this label about personal protective equipment (PPE) notification to workers, and restricted-entry interval. The requirements in this box **only** apply to uses of this product that are covered by the Worker Protection Standard.

**Do not** enter or allow entry into treated areas during the restricted entry interval (REI) of 4 hours unless wearing appropriate PPE.

**Personal Protective Equipment** PPE required for early entry into treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is: coveralls, socks, shoes, chemical resistant gloves made of waterproof material.

## NON-AGRICULTURAL USE REQUIREMENTS

The requirements in this box apply to uses of this product that are **NOT** within the scope of the Worker Protection Standard for agricultural pesticides (40 CFR part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries or greenhouses.

Keep children and pests out of treated area until sprays have dried.

## GENERAL INFORMATION:

**ENDORSE® WP Fungicide** is not for use on turf grown for commercial seed production.

**ENDORSE WP Fungicide** is a systemic foliar applied fungicide for use in controlling or suppressing certain diseases on golf courses, residential lawns, parks and commercial and institutional grounds composed of cool and warm season grasses such as bluegrass, bentgrass, fescue, ryegrass, zoysiagrass or their mixtures. **ENDORSE WP Fungicide** is also for use on ornamentals.

Apply **ENDORSE WP Fungicide** as a preventive or curative treatment in conjunction with good turf and ornamental management practices.

## RESISTANCE MANAGEMENT DIRECTIONS

**ENDORSE WP Fungicide** contains a Group 19 fungicide. Fungal isolates with acquired resistance to Group 19 may eventually dominate the fungal population if Group 19 fungicides are used repeatedly in the same field or in successive years as the primary method of control for targeted species. This may result in partial or total loss of control of those species by **ENDORSE WP Fungicide** or other Group 19 Fungicides.

To delay fungicide resistance, consider:

- Avoiding the consecutive use of **ENDORSE WP Fungicide** or other target site of action Group 19 fungicides that have a similar target site of action, on the same pathogens.
- Using tank-mixtures or premixes with fungicides from different target site of action Groups as long as the involved products are all registered for the same use and are both effective at the tank mix or prepack rate on the pathogen(s) of concern.
- Basing fungicide use on a comprehensive IPM program.
- Monitoring treated fungal populations for loss of field efficacy.
- Contacting your local extension specialist, certified crop advisors, and/or manufacturer for fungicide resistance management and/or IPM recommendations for specific crops and resistant pathogens.

## MIXING AND APPLICATION:

When tank mixing **ENDORSE WP Fungicide** with other products, observe all precautions and limitations on each separate product label. It is always advisable to conduct a spray compatibility test when you plan to mix this product with other products. To determine the physical compatibility of this product with other products, use a jar test. Using a quart jar, add the proportionate amounts of the products to approximately one quart of water with agitation. Add dry formulations first, then flowables, then emulsifiable concentrates last. After thorough mixing, allow this mixture to stand for 5 minutes. If the combination remains mixed or can be readily remixed, it is physically compatible. Once compatibility has been proven, use the same procedure for adding required ingredients to the spray tank. Use combinations on a small number of plants to check for phytotoxicity and disease control before treating large areas. Do not use the combination if adverse affects are observed.

Do not apply this product through any type of irrigation system.

Mixing instructions for **ENDORSE WP Fungicide**:

- Fill spray tank to ¾ of the intended final volume.
- Start spray tank agitation.
- Add the appropriate amount of product to the tank (refer to Rate and Schedule section of label). Follow the directions above for mixing other products in the spray tank.
- Agitate to ensure thorough mixing while adding the remaining required water.
- DO NOT allow the spray mixture to stand without agitation.

Mix only the amount of spray solution needed to treat the desired area.

For optimum control of labeled diseases, apply **ENDORSE WP Fungicide** with sufficient water to provide a thorough coverage.

With the exception for treatment of fairy ring, irrigation or rainfall soon after treatment with **ENDORSE WP Fungicide** will decrease disease control. For best control, do not irrigate for 12 hours after treatment.

For best results, apply after mowing.

**TURF GRASSES**

| Disease | Rate | Application Notes |
|---|---|---|
| **Control:**<br>**Brown Patch**<br>**Large Patch** | 11 lbs/acre (0.275 lb ai/acre in a minimum of 44 gallons of water) | –Repeat treatment on a 7-14 day schedule where environmental conditions are conducive to development of diseases.[1]<br>–When symptoms are present, best control will be achieved by using a shorter interval.<br>–For best results apply after mowing. |
| **Aids in Control:**<br>(Except California)<br>**Cool Weather Brown Patch (Yellow Patch)**<br>*(Rhizoctonia cerealis)*<br>**Foliar** and **Basal Anthracnose**<br>*(Colletotrichum graminicola)*<br>**Gray Snow Mold**<br>(*Typhula ishikariensis and Typhula incarnata*)<br>**Leaf Spot/Melting Out**<br>(*Dreschlera poae*)<br>**Pink Snow Mold**<br>(*Microdochium solani*)<br>**Red Thread**<br>(*Laetisaria fuciformis*)<br>**Rhizoctonia Damping Off**<br>(*Rhizoctonia solani*)<br>**Zoysia Patch**<br>(*Rhizoctonia solani*) on cool and warm season turf grasses | | |
| **Aids in Suppression**<br>(Except California)<br>**Gray Leaf Spot**<br>(*Pyricularia grisea*) | | |
| **Suppression and Short Term Control:**<br>**Fairy Ring** (including *Marasmius* spp., *Lepiota*, spp. and *Agarius* spp.) | 4 ozs/1000 square feet in minimum of 2 gallons of water (0.275 lb ai/acre in a minimum of 88 gallons of water) | –Make two-three applications on a 7-day interval schedule.<br>–Use a penetrating wetting agent. Immediately following application, water in the treatment with sufficient irrigation (0.5-1") to wet the active root zone. |

Notes:

– Use in alteration with fungicides that have different modes of action.

[1] Consult your local extension agent or local recommendations for information relating to proper timing for control of these diseases.

**ORNAMENTALS**

| Foliar Disease Control | Rate | Application Notes |
|---|---|---|
| **Botrytis blight**<br>*(Botrytis cinerea)* | 1.1–2.2 lb/ 100 gal/acre (0.03–0.06 lb ai/ 100 gal/acre) | •Apply as a foliar spray every 7–10 days.<br>•Apply prior to disease development and when conditions are conducive for disease.[1] |
| **Alternaria blight**<br>(*Alternaria panax*) | 2.2 lb/100 gal (0.06 lb ai/100 gal/acre) | |
| **Root and Crown Diseases** | **Rate** | **Application Notes** |
| **Rhizoctonia root** and **crown rot**<br>(*Rhizoctonia solani*) | 1.1–2.2 lb/ 100 gal/acre (0.03–0.06 lb ai/ 100 gal/acre) | •Apply as a drench every 14–28 days. |

Notes:

- Use in alternation with fungicides that have different modes of action.

[1] Consult your local extension agent or local recommendations for information relating to proper timing for control of these diseases.

## STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal.

**PESTICIDE STORAGE:** Store in dry place away from food or feed.

**PESTICIDE DISPOSAL:** Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

**CONTAINER DISPOSAL:** Completely empty bag into application equipment. Then dispose of empty bag in a sanitary landfill or by incineration, or, if allowed, by State and local authorities, by burning. If burned, stay out of smoke.

**FOR 24-HOUR CHEMICAL EMERGENCY ASSISTANCE: Spill, leak, fire, exposure or accident, call CHEMTREC at 1-800-424-9300 or 1-703-527-3887 if calling from outside the U.S.**


**WARRANTY AND DISCLAIMER STATEMENT**

1. Cleary Chemical Corporation ("Cleary") warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in accordance with the Directions for Use under normal conditions of use. This warranty does not extend to the use of this product contrary to label instructions, or under abnormal use conditions, or under conditions not reasonably foreseeable to Cleary. CLEARY DISCLAIMS ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY. TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, SELLER SHALL NOT BE LIABLE FOR CONSEQUENTIAL SPECIAL OR INDIRECT DAMAGES RESULTING FROM OR IN CONNECTION WITH THE MANUFACTURE, SALE, DELIVERY, USE, HANDLING OR STORAGE OF THIS PRODUCT. TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, SELLER'S LIABILITY SHALL BE LIMITED TO THE REFUND OF THE PURCHASE PRICE. CLEARY DOES NOT AUTHORIZE ANY AGENT OR REPRESENTATIVE TO MAKE ANY OTHER WARRANTY, GUARANTEE OR REPRESENTATION CONCERNING THIS PRODUCT.
2. Critical and unforeseeable factors beyond the control of Cleary prevent Cleary from eliminating all risks in connection with the use of this product. Such risks include, but are not limited to, damage to plants and crops to which product is applied, lack of complete control, and damage caused by drift to other plants or crops. Such risks occur even though the product is reasonably fit for the use stated on the label and even though label directions are followed. Except as stated in 1 above, to the extent consistent with applicable law, by purchasing, accepting and using this product, the buyer and user acknowledge and assume all risks and liabilities resulting from handling, storage and use of this product.

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# SUSTANE 16-0-6

## Sustâne®16-0-6 with UMAXX® Zero-Phosphorus, Premium Turf Fertilizer.

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**Made with Sustâne® Organic Compost and UMaxx® Stabilized Nitrogen**

## Description:

Sustâne 16-0-6 combines a high quality leaf litter and food waste compost with plant nutrients to create an effective turf fertilizer without the risk of phosphorus runoff. With 60% quick release nitrogen from urea plus sulfur, 16-0-6 provides almost instant green up, even on cool soils. 30% slow release nitrogen from UMAXX®, aerobic compost and methylene urea carry the color without excessive growth for up to 10 weeks.

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## Recommended Use:

Sustâne 16-0-6 is designed for use on premium turf grass applications where state or local laws restrict the use of phosphorus. Sustâne 16-0-6 is an excellent product for home lawns, golf course fairways and tee boxes, athletic fields and all high visibility turf.

## Features of Suståne 16-0-6:

- Homogeneous granulated professional turfgrass fertilizer.
- Developed for spring and autumn applications on long cut turfgrass, sports fields, home lawns and golf course fairways.
- Contains UMAXX® stabilized nitrogen combined with urea and methylene urea and organic slow release nitrogen from aerobic compost.
- Provides excellent color with reduced losses from leaching for up to 12 weeks on cool season grasses and 8 weeks on warm season grasses.
- Phosphorus free formulation is compliant with all state fertilizer regulations.
- Excellent coverage when organic is needed and efficiency is the name of the game.
- 6.4% Slow Release and Stabilized Nitrogen and 9.6% Quick Release Nitrogen provide a blended release ratio – 60% quick release followed by 40% slow release.
- 1 - 50 lb. bag covers 8,000 ft2 or 275 lb. per acre.

## Benefits of Suståne 16-0-6

- Contains all nutrients necessary for plant growth.
- Strengthens plants tolerance against hot dry conditions
- Promotes greater root development
- Improves buffering against changes in soil pH
- Increases the soil's ability to suppress plant pathogens
- Increases soil porosity and stability for greater root development and water holding capacity
- *All combined in each uniform homogeneous granule*

## Always Safe for Plants, People and the Environment

- Manufactured by Suståne in the USA at an EPA permitted facility.
- Pathogen and weed free, no blood or bone products. Allowed for export to over 60 countries world wide.
- Aerobic composting eliminates animal and rodent attraction to application site.
- Contains naturally occurring beneficial bacteria and fungi that are necessary to begin nutrient life cycle in poor soil.

- Suståne is fully composted eliminating the need for sterilization, permitting a healthy environment for beneficial microbial populations.

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## Guaranteed Analysis

| | |
|---|---|
| Total Nitrogen (N) | 16% |
| 0.2% Ammoniacal Nitrogen | |
| 13.4% Urea Nitrogen | |
| 1.4% Water Insoluble Nitrogen** | |
| Available Phosphate ($P^2O5$) | 0% |
| Soluble Potash ($K^2O$) | 6% |
| Calcium (Ca) | 1.00% |
| Magnesium | 0.50% |
| Sulfur | 2.00% |

## Total Plant Nutrition

| | |
|---|---|
| Manganese | 0.05% |
| Zinc | 0.05% |
| Humic Acid | 7% |

| | |
|---|---|
| Organic Matter | 50% |
| pH | 6.8 |
| Carbon:Nitrogen (C:N) | 4:1 |
| Bulk Density lb./cu. ft | 39 |
| Salt Index (scale 1-100) | 4 |
| % of Total N as Slow Release | 40% |

**Derived from aerobically composted turkey litter, aerobically composted green waste, stabilized urea, urea, methylene urea, ammonium sulfate and sulfate of potash.**
***3.3% urea nitrogen stabilized with dicyandiamide and N-(n-butyl) thiophosphoric triamide.**
****3.1% slowly available nitrogen from aerobically composted turkey litter.**

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## Availble Particle Sizes:

- Medium Grade, 200 SGN (2.8 mm - 1.4 mm)
- Fine Grade, 100 SGN (1.4 mm - 0.6 mm)

## Coverage:

- 50 lb. covers 7,500 $f^2$ @ 1 lb. N per 1000 $ft^2$ (44 lb. N per acre)
- 22.67 kg covers 697 $m^2$ @ 0.5 kg N per 100 $m^2$ (50 kg N per hectare)

## Rates:

- Apply 7 lb. per 1000 $ft^2$
- Apply 33 g per 1 $m^2$

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# Suståne Integrated Soil Management Program:

The following chart shows the recommended amounts of Suståne 16-0-6 for a typical integrated program.

| Use & Application: | Greens & Tees | | Fairways, Athletic Fields, Parks and Lawncare | |
|---|---|---|---|---|
| | **Rate (1b./1000ft²)** | **Application Frequency** | **Rate (lb./1000 ft²)** | **Application Frequency** |
| Early Feeding | 3-6 | 1-2 | 3-6 | 1-2 |
| Turf Establishment | N/A | N/A | N/A | N/A |
| Summer Stress/Disease Prevention | 3-6 | Monthly | 3-6 | Monthly |
| Core Aerification | N/A | N/A | N/A | N/A |
| Overseeding | N/A | N/A | N/A | N/A |
| Dormant Feeding | 6.25 | Prior to Dormancy | 6-25 | Prior to Dormancy |
| Snow Mold | 6-9 | 1 Late Season<br>1 Early Spring | 6-9 | 1 Late Season<br>1 Early Spring |

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## Landscape Maintenance:

Professional landscapers have increasingly turned to Suståne 16-0-6 for use on high maintenance turf and landscaped environments. While synthetic fertilizers supply plant growth nutrients, they do not supply the organic matter required to maintain quality growth. Using fully composted natural fertilizers increases the levels of beneficial microbial activity, which in turn convert nutrients into plant available forms.

### Warm Season Turf

- Athletic Fields, Parks and Lawncare
- Apply 4-7 times per season
- Spring and Fall - 3 lb. per 1000 $ft^2$
- Summer - 4.7 lb. per 1000 $ft^2$

## Cool Season Turf

- Athletic Fields, Parks and Lawncare
- Apply 2-3 times per season
- 6.25 lbs. per 1000 $ft^2$

## Soil Preparation For Flower & Shrub Beds

- Light, Sandy Soil: 8 lb. per 100 $ft^2$
- Medium, Clay Loam Soil: 6.25 lb. per 100 $ft^2$
- Heavy, Silty, Clay Loam: 5 lb. per 100 $ft^2$

# NUTRALENE® fertilizer
# 40-0-0 Standard

## Guaranteed Analysis

Total Nitrogen (N)*……..…….....40%
4% Urea nitrogen
17% Other/Water Soluble Nitrogen*
19% Water Insoluble Nitrogen**

## Derived from methylene ureas

*17% slowly available Nitrogen from methylenediurea and dimethlylenetriurea
**Water Insoluble Nitrogen determined with AOAC method 945.01 using 0.5 g of crushed sample to pass US Sieve N° 20 retained to N° 40

Information about the components of this lot of fertilizer may be obtained by writing to Koch Agronomic Services, LLC, PO Box 2900, Wichita, KS 67201**.** Use in accordance with recommendations of a qualified individual or institution, such as, but not limited to, a certified crop advisor, agronomist, university crop extension publication, or apply according to recommendation in your approved nutrient management plan, or write to Koch Agronomic Services, LLC, PO Box 2900, Wichita, KS 67201.

Information regarding the contents and levels of metals in this product is available at the following website:
http://www.aapfco.org/metals.htm

**NUTRALENE® fertilizer 40-0-0**

**Precautionary Statements:**
Observe good industrial hygiene practices. Wash hands after handling.

**Supplier:**

Koch Agronomic Services, LLC
PO Box 2900.
Wichita, KS 67201
866- 863-5550

kochmsds@kochind.com

FOR CHEMICAL EMERGENCY:
Call CHEMTREC day or night
USA/Canada- 1.800.424.9300

F1912

**Net Weight: 2205 lbs**
**PC: 531070**



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Priority Approach for Preventative Methods of IPM & Organic Based Pest Control:*
* Source Petrovic

**Diseases**

***Typhula blight (Gray Snow Mold)***

(1) EcoGuard ® Biofungicide, Bacillus licheniformis Strain 3086

(2) Endorse ®, Polyoxin D Zinc Salt

Microdochium Patch (Pink Snow Mold)

(1) EcoGuard ® Biofungicide, Bacillus licheniformis Strain 3086

(2) Endorse ®, Polyoxin D Zinc Salt

(3) Spot-Less®, Pseudomonas aureofaciens Strain Tx-1

***Dollar Spot***

(1) EcoGuard ® Biofungicide, Bacillus licheniformis Strain 3086

(2) Spot-Less®, Pseudomonas aureofaciens Strain Tx-1

(3) Endorse ®, Polyoxin D Zinc Salt

(4) Turfshield ® Granules, Trichoderma harzianum

***Brown Patch***

(1) Endorse ®, Polyoxin D Zinc Salt

(2) Turfshield ®, Trichoderma harzianum

Note: Ground sprayer application of Spot-Less® is preferred over chemigation.

***Insects***

White Grubs

(1) Hb2 ® Parasitic Nematode – Heterohabditis bacteriophora

(2) Azatin XL®, azadirachtin biopesticide

(3) Botanigard® 22WP, Beauveria bassiana

(4) Botanigard® ES®, Beauveria bassiana

(5) Naturalis L®, Beauveria bassiana

(6) Milky Spore®, Paenibacilluls popilliae

Black Ataenius (larvae)

(1) Hb2 ® Parasitic Nematode – Heterohabditis Bacteriophora

(2) Azatin XL®, azadirachtin biopesticide

(3) Botanigard 22WP®, Beauveria bassiana

(4) Botanigard ES®, Beauveria bassiana

(5) Naturalis L®, Beauveria bassiana

(6) Milk Spore®, Paenibacilluls popilliae

***Black Cutworms***

(1) Conserve®, Spinosad fermentation product

(2) Dipel Pro DF Biological Insecticide Dry Flowable®, Bacillus thuringiensis

(3) Javelin WG, Bacillus thuringiensis

# RHAPSODY®

**AN AQUEOUS SUSPENSION BIOFUNGICIDE**
**FOR USE ON LANDSCAPE PLANTS, TURF, LAWNS, SOD, GOLF COURSES**
**(GREENS, TEES, FAIRWAYS AND ROUGHS)**

**ACTIVE INGREDIENT**
QST 713 strain of *Bacillus subtilis* …….… 1.34%
**INERT INGREDIENTS**…….……98.66%
Total…….....100.00%
Contains a minimum of 1 x $10^9$ CFU/g

EPA Reg. No. 69592-19
EPA Est. No. 69592-MEX-1
U.S. Patent Nos. 6,060,051, 6,103,228, 6,291,426 and 6,417,163 on QST 713 strain of *Bacillus subtilis*

Can be Used for Organic Production

OMRI Listed

US014-B-005 AQ1351-005

**KEEP OUT OF REACH OF CHILDREN**

# CAUTION

## FIRST AID:

**IF INHALED**: Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. Call a poison control center or doctor for further treatment advice. Have the product label with you when calling a doctor or poison control center.

## PRECAUTIONARY STATEMENTS – Agricultural Use

**HAZARDS TO HUMANS & DOMESTIC ANIMALS**
**CAUTION**

Harmful if inhaled. Avoid breathing spray mist. Remove contaminated clothing and wash before reuse.

## PERSONAL PROTECTIVE EQUIPMENT (PPE)

Applicators and other handlers must wear:

- Long-sleeved shirt and long pants
- Waterproof gloves
- Shoes plus socks
- NIOSH approved respirator with any N, R, P or HE filter

Follow manufacturer's instructions for cleaning and maintaining PPE. If no such instructions are available, use detergent and hot water for washables. Keep and wash PPE separately from other laundry.

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d) (4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

## USER SAFETY RECOMMENDATIONS

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

## ENVIRONMENTAL HAZARDS – Agricultural Use

Do not apply directly to water or to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwater or rinsate. Do not apply when weather conditions favor drift or runoff from treated areas.

## DIRECTIONS FOR USE – Agricultural Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. For any requirements specific to your state or tribe, consult the state or tribal agency responsible for pesticide regulation.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application.

For emergencies such as leaks or spills, call 24-hour toll-free CHEMTREC hotline at 1.800.424.9300.

## AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard 40 CFR Part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries and greenhouses and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), and restricted entry intervals. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 4 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil or water is: coveralls, waterproof gloves, shoes plus socks.

Exception: if the product is soil injected or soil incorporated, the Worker Protection Standard, under certain circumstances, allows workers to enter the treated area if there will be no contact with anything that has been treated.

## STORAGE AND DISPOSAL – Agricultural Use

Do not contaminate water, food, or feed by storage and disposal.

**STORAGE**: Store in a dry area inaccessible to children. Store in original containers only. Keep container closed when not in use.

**PESTICIDE DISPOSAL**: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. Do not contaminate water when disposing of equipment rinsate.

**CONTAINER DISPOSAL**:

*For 2.5-gallon plastic containers –*

Nonrefillable container. Do not reuse or refill this container.

Triple rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or mix tank and drain for 10 seconds after the flow begins to drip. Fill the container ¼ full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Offer for recycling, if available.

*For 30-gallon plastic containers-*

Nonrefillable container. Do not reuse or refill this container. Triple rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or mix tank. Fill the container ¼ full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Empty rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Repeat this procedure two more times. Offer for recycling, if available.

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*For 110-gallon or larger returnable mini-bulk containers –*

Return empty container for reuse. Refillable container. Refill this container with pesticide only. Do not reuse this container for any other purpose. Cleaning the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller. To clean the container before final disposal, empty the remaining contents from this container into application equipment or mix tank. Fill the container about 10 percent full with water. Agitate vigorously or recirculate water with the pump for 2 minutes. Pour or pump rinsate into application equipment or rinsate collection system. Repeat this rinsing procedure two more times.

## GENERAL USE INFORMATION – Agricultural Use

Rhapsody® is an effective broad spectrum, preventative biofungicide for the control of many important foliar and soil-borne diseases. Rhapsody is an ideal resistance management tool given its unique, multiple modes of action. It may be applied as a foliar spray or soil drench alone, in alternating spray programs or in tank mixes with other registered crop protection products. For maximum effectiveness, apply Rhapsody prior to or in the early stages of disease development. When conditions are conducive to heavy disease pressure, use Rhapsody in a rotational program with other registered fungicides. Rhapsody may be applied with spray equipment

commonly used for making ground or aerial applications and sprinkler/irrigation systems commonly used for chemigation. Rhapsody can be used for organic production.

**INTEGRATED PEST MANAGEMENT (IPM)**

For disease resistance management, integrate Rhapsody into an overall disease and pest management strategy whenever fungicide use is necessary. Follow practices known to reduce disease development. Consult local agricultural authorities for specific IPM strategies developed for your crop(s) and location.

Be sure use of this product conforms to resistance management strategies, which may include rotating and/or tank-mixing with other products with different modes of action.

**USE RATE DETERMINATION** – Agricultural Use

Carefully read and follow all label directions, use rates and restrictions. Apply Rhapsody prior to or in the early stages of disease development. Use maximum label rates and shortened spray intervals for conditions conducive to rapid disease development. For proper application, determine the area to be treated, the recommended label use rate and select appropriate spray volume to give good canopy penetration and coverage of plant parts to be protected. Prepare only the amount of spray solution required to treat the measured acreage. Accurate spray equipment calibration is essential prior to use.

**PREHARVEST INTERVAL** – Agricultural Use

Rhapsody can be applied up to and including the day of harvest.

**APPLICATION INSTRUCTIONS** – Agricultural Use

**GENERAL**: Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment-and-weather–related factors determine the potential for spray drift. The applicator and the grower/treatment coordinator are responsible for considering all of these factors when making decisions. Where states have more stringent regulations, they should be observed. Note: This section is advisory in nature and does not supersede the mandatory label requirements.

**GROUND**: Be sure to maintain agitation during mixing and application to assure uniform product suspension. Thorough coverage of all foliage is essential for effective disease control. Rhapsody can be applied in commonly used ground equipment, hose-end, pressurized, and hand-held sprayers. To achieve good coverage use proper spray pressure, gallonage per acre, nozzles, nozzle spacing and ground speed. Consult spray nozzle and accessory catalogues for specific information on proper equipment calibration.

**AERIAL**: This product can be applied by aerial application. Refer to the Aerial Drift Reduction Advisory Information section of this label for general directions and precautions. Use the application rate indicated for the appropriate crop in sufficient water to achieve thorough coverage, or a minimum of 3 gallons of water per acre.

**CHEMIGATION**: This product can be applied through sprinkler or drip type irrigation systems, including a center pivot, lateral move, end tow, side wheel roll, traveler, solid set, and hand move. Refer to the Chemigation Directions for Use section of this label for general directions and precautions. Use the application rate indicated for the appropriate crop as specified in the Use Recommendations section of this label.

**MIXING INSTRUCTIONS** – Agricultural Use

**MIXING**: Rhapsody must be diluted with water for spray applications. Partially fill the spray tank with clean water and begin agitation. Add the specified amount of Rhapsody to the tank. Finish filling the tank to the desired volume to obtain the proper spray concentration. It is critical that the spray solution be agitated during mixing and application to assure a uniform suspension. Do not allow the spray mixture to stand overnight or for prolonged periods. Maintain a spray solution pH between 4.5 and 8.5.

Rhapsody may be tank-mixed with other registered fungicides to enhance plant disease control. Do not exceed recommended dosage rates. Rhapsody cannot be mixed with any product with prohibition against such mixing. Use of the resulting tank mix must be in accordance with the more restrictive label limitations and precautions.

**COMPATIBILITY**: Do not combine Rhapsody in the spray tank with pesticides, surfactants or fertilizers if there has been no previous experience or use of the combination to show it is physically compatible, effective and non-injurious under your use conditions.

Rhapsody is compatible with many commonly used pesticides, fertilizers, adjuvants and surfactants but has <u>not</u> been fully evaluated with all of these. To ensure compatibility of tank-mix combinations they should be evaluated prior to use, as follows: Using a suitable container add proportional amounts of product to water. Add wettable powders first, followed by water dispersible granules, then by liquid flowables and lastly, emulsifiable concentrates. Mix thoroughly and let stand for at least five minutes. If the combination stays mixed or can be remixed, it is physically compatible. Test the combination on a small portion of the crop to be treated to ensure that a phytotoxic response will not occur as a result of application.

**ADDITIVES**: Rhapsody is compatible with a wide range of additives. Since the product is primarily a protectant, thorough coverage of all above-ground plant parts is required for effective product performance. To improve plant surface coverage, it is recommended to add a non-phytotoxic adjuvant to spray tank.

## CHEMIGATION DIRECTIONS FOR USE

**General Requirements**:

1) Apply this product only through sprinkler or drip type irrigation systems including center pivot, lateral move, end tow, side wheel roll, traveler, solid set or hand move systems. Do not apply this product through any other type of irrigation system.
2) Crop injury or lack of effectiveness can result from non-uniform distribution of treated water.
3) Ensure that the irrigation system used is properly calibrated and if you have questions, call the State Extension Service specialists, the equipment manufacturer or other experts.
4) Do not connect an irrigation system (including greenhouse systems) used for pesticide application to a public water system unless the pesticide label-prescribed safety devices for public water systems are in place.
5) A person knowledgeable of the chemigation system and responsible for its operation, or under the supervision of the responsible person, shall shut the system down and make any necessary adjustments should the need arise.

**Equipment Requirements**:

1) Public water supply means a system for the provision to the public of piped water for human consumption if such system has at least 15 service connections or regularly serves an average of 25 individuals daily at least 60 days throughout the year.

2) Chemigation systems connected to the public water systems must contain a functional, reduced-pressure zone (RPZ), backflow preventer or the functional equivalent in the water supply upstream from the point of pesticide introduction. As an option to the RPZ, the water from the public water system should be discharged into a reservoir tank prior to pesticide introduction. There shall be a complete physical break (air gap) between the outlet end of the fill pipe and the top of the overflow rim of the reservoir tank of at least twice the inside diameter of the fill pipe.
3) The system must contain a functional check valve, vacuum relief valve, and low pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from back flow.
4) The pesticide injection pipeline must contain a functional, automatic, quick closing check valve to prevent the flow of fluid back towards the injection pump.
5) The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.
6) The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.
7) The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops, or in cases where there is no water pump, when the water pressure decreases to the point where pesticide distribution is adversely affected.
8) Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump), effectively designed and constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock.
9) Do not apply when wind speed favors drift beyond the area intended for treatment.

**Application Instructions**:

1) Remove scale, pesticide residues, and other foreign matter from the chemical supply tank and entire injector system. Flush with clean water. Failure to provide a clean tank, void of scale or residues may cause product to lose effectiveness or strength.
2) Do not combine Rhapsody with pesticides, surfactants or fertilizers for application through chemigation equipment unless prior experience has shown the combination physically compatible, effective and non-injurious under conditions of use. Rhapsody has <u>not</u> been fully evaluated for compatibility with all adjuvants or surfactants. It is advisable to conduct a spray compatibility test if mixture with adjuvants or surfactants is planned.

**Center-pivot, Lateral Move, End Tow, and Traveler Irrigation Equipment** (Use only with electric or oil hydraulic drive systems which provide a uniform water distribution):

- Determine size of area to be treated.
- Determine the time required to apply no more than 1/4 inch of water (6,750 gallons water per acre) over the area to be treated when the system and injection equipment are operated at normal pressures recommended by the equipment manufacturer. Run system at 80 to 95% of manufacturer's rated capacity.
- Using only water, determine the injection pump output when operated at normal line pressure.
- Determine the amount of Rhapsody fungicide required to treat area.
- Add required amount of Rhapsody fungicide and sufficient water to meet the injection time requirements of the solution tank.
- Maintain constant solution tank agitation during the injection period.
- Stop injection equipment after treatment is completed. Continue to operate the system until Rhapsody fungicide solution has cleared the sprinkler head.

**Solid-set, Side (wheel) Roll, and Hand Move Irrigation Equipment**:

- Determine acreage covered by sprinkler.
- Fill injector solution tank with water and adjust flow rate to use contents over a 10- to 30-minute interval.
- Determine the amount of Rhapsody fungicide required to treat area.
- Add the required amount of Rhapsody fungicide into the same quantity of water used to calibrate the injection equipment.
- Maintain constant solution tank agitation during the injection period.
- Operate system at normal pressures recommended by the manufacturer of the injection equipment and used for the time interval established during calibration.
- Inject Rhapsody fungicide at the end of the irrigation cycle or as a separate application to maximize foliar fungicide retention.

- Stop injection equipment after treatment is completed. Continue to operate the system until Rhapsody fungicide solution has cleared the last sprinkler head.

## AERIAL DRIFT REDUCTION ADVISORY INFORMATION

**General:** Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment-and-weather-related factors determine the potential for spray drift. The applicator and the grower are responsible for considering all these factors when making decisions. Where states have more stringent regulations, they should be observed. Note: This section is advisory in nature and does not supersede the mandatory label requirements.

**INFORMATION ON DROPLET SIZE:** The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (see Wind, Temperature and Humidity, and Temperature Inversions).

**CONTROLLING DROPLET SIZE:** Volume - Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows produce larger droplets. Pressure -Do not exceed the nozzle manufacturer's recommended pressures. For many nozzle types lower pressure produces larger droplets. When high flow rates are needed, use higher flow rate nozzles instead of increasing pressure. # of Nozzles - Use the minimum number of nozzles that provide uniform coverage. Nozzle Orientation - Orienting nozzles so that the spray is released parallel to the airstream produces larger droplets than other orientations and is the recommended practice. Significant deflection from horizontal will reduce droplet size and increase drift potential. Nozzle Type - Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce the largest droplets and the lowest drift.

**BOOM WIDTH**: For aerial applications, the boom width must not exceed 75% of the wingspan or 90% of the rotary blade. Use upwind swath displacement and apply only when wind speed is 3 -- 10 mph as measured by an anemometer. Use medium or coarser spray according to ASAE 572 definition for standard nozzles or VMD for spinning atomizer nozzles. If application includes a no-spray zone, do not release spray at a height greater than 10 feet above the ground or the crop canopy.

**APPLICATION HEIGHT:** Do not make application at a height greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces exposure of droplets to evaporation and wind.

**SWATH ADJUSTMENT**: When applications are made with a crosswind, the swath will be displaced downward. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the aircraft upwind. Swath adjustment distance should increase, with increasing drift potential (higher wind, smaller drops, etc.).

**WIND:** Drift potential is lowest between wind speeds of 2 - 10 mph. However, many factors, including droplet size and equipment type determine drift potential at any given speed. Application should be avoided below 2 mph due to variable wind direction and high inversion potential. NOTE: Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect spray drift.

**TEMPERATURE AND HUMIDITY**: When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

**TEMPERATURE INVERSIONS**: Do not apply during a temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small, suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.

**SENSITIVE AREAS**: The pesticide should only be applied when the potential for drift to adjacent sensitive areas (e.g. residential areas, bodies of water, known habitat for threatened or endangered species, non-target crops) is minimal (e.g. when wind is blowing away from the sensitive areas). Do not allow spray to drift from the application site and contact people, structures people occupy at any time and the associated property, parks and recreation areas, non-target crops, aquatic and wetland areas, woodlands, pastures, rangelands, or animals.

## FOR USE ON LANDSCAPE PLANTS, TREES, TURF, LAWNS, SOD, GOLF COURSES (GREENS, TEES, FAIRWAYS AND ROUGHS), SEEDLINGS, CONIFERS -Agricultural, Commercial, Residential Use and Reforestation

Rhapsody is a protectant fungicide for use outdoors for control of certain foliar diseases in the field, interiorscape, residential and commercial landscapes, golf courses (greens, tees, fairways and roughs), forests, and forestry seedling production sites.

Rhapsody can be applied to landscape plants and trees, forestry seedlings, turf, lawns, sod, golf courses (greens, tees, fairways and roughs) and conifer production for reforestation purposes (greenhouses, shade houses, nurseries, indoors, outdoors, containers or field).

**Foliar Application Use on, Landscape Plants, Trees, Seedlings, Conifers:**

**APPLICATION INSTRUCTIONS**: Apply Rhapsody at rates ranging from 2 to 8 quarts of product in 100 gallons of water per acre. Make applications on a 3 to 10 day schedule. Begin applications when conditions favor disease development prior to the onset of disease.

Under normal conditions apply Rhapsody at a rate of 4 quarts of product per 100 gallons of spray solution per acre on a 7-day schedule. When conditions favor severe disease development shorten the spray interval or use a higher rate. Thorough coverage is essential for effective disease control. When more diluted or concentrated spray solutions are needed for the type of equipment being used, follow the "Use Determination" section of this label. See application rate tables for more detailed application instructions.

**PLANTS EVALUATED FOR PHYTOTOXICITY**

Rhapsody has been tested for phytotoxicity on the ornamental species listed below. Since it is impossible to test all of the species and cultivars listed on this label under all conditions it is recommended that a small-scale preliminary trial be conducted to check for sensitivity before using this product on a large number of plants, using the product in accordance with all label use directions.

**TABLE 1**

**Annual and Perennial Flowering Plants**:

| | | | | | | |
|---|---|---|---|---|---|---|
| Alyssum | Asters | Azalea | Begonia | Calla lily | Chrysanthemum | Cyclamen |
| Dianthus | Dwarf Bee-Balm | Easter lily | Garden phlox | Geraniums | Gerbera | Golden Star |
| Hydrangea | Impatiens | Kalanchoe | Linaria | Lisianthus | Lobelia | Marigolds |
| Orchids | Pansies | Petunia | Poinsettia | Portulaca | Ranunculus | Roses |
| *Salvia* spp. | Snapdragons | Stock | *Verbena* spp. | Vinca | Violas | Zinnias |

**Tropical foliage**:

| | | | | | | |
|---|---|---|---|---|---|---|
| Aglaonema | Dieffenbachia | *Dracaena* spp. | English Ivy | Hibiscus | Leatherleaf Fern | Spathiphyllum |

**Trees and Shrubs:**

| | | | | | | |
|---|---|---|---|---|---|---|
| Azalea | Boxwood | Crape myrtle | Dogwood | Gumpo azalea | India (Indian) Hawthorn | Japanese maple |
| L*igustrum japonicum* | | Lilac | Loropetalum | Photinia | Rhododendron | *Rosaceae* spp. |
| Soft Touch Holly | Spirea | | | | | |

**FOR USE AS SOIL DRENCH on Landscape Plants, Trees, Seedlings, Conifers: Agricultural, Commercial, Residential Use, Outdoors**

Rhapsody is a broad spectrum biofungicide for the prevention, suppression and control of soil borne diseases on a wide range of landscape plants and trees, and in conifer production. Rhapsody enhances germination and plant growth by suppressing diseases caused by Rhizoctonia, Pythium, Fusarium and Phytophthora.

**APPLICATION INSTRUCTIONS**: Mix 128 fl oz to 256 fl oz of Rhapsody with 100 gallons of water. Use higher application rates under conditions of heavy disease pressure. Apply finished mixture at a rate to thoroughly soak the growing media through the root zone (1 pint / sq. ft. for each 3 inches of soil depth) as a drench or directed spray using hand held, mechanical or motorized spray equipment, or as a chemigation drench or directed spray using applicable sprinkler irrigation systems. Begin applications during or after seeding, sticking of cuttings or after transplanting to propagation beds, containers, pots or trays. Optimal performance is obtained with preventative treatments repeated every 21 – 28 days throughout the growing cycle. Rhapsody can be mixed with chemical fungicides registered for soil applications.
See application rate tables for more detailed application instructions.

**FOR USE ON TURF, LAWNS, SOD, GOLF COURSES**
**(GREENS, TEES, FAIRWAYS AND ROUGHS), ORNAMENTAL TURF- Agricultural, Commercial, Residential Use**

Rhapsody is a broad spectrum biofungicide for use in the prevention, suppression and aiding in control of turf and lawn diseases: brown patch, dollar spot, powdery mildew, rust and anthracnose.

**Turf, Lawns, Sod, Greens, Ornamental Turf Use:**

**APPLICATION INSTRUCTIONS:** Apply at the rate of 2.0 to 10.0 fl oz of Rhapsody per 1000 sq. ft. of surface area. Apply in sufficient water to provide thorough coverage, depending on the application equipment. Two gallons of water per 1000 sq. ft of surface is commonly used.

See application rate tables for more detailed application instructions.

## Application Rates for Use as a Foliar Spray on Landscape Plants and Trees

Rhapsody has a 0-Day PreHarvest Interval for all crops contained on this label.

Under moderate to severe disease pressure, for improved performance, increase rates and reduce spray intervals or use Rhapsody in a tank mix or rotational program with other registered fungicides.

| Crops | Disease | Rate* qts/100 gallons spray mix | Application Instructions |
|---|---|---|---|
| **Landscape plants and Trees**<br><br>**Outdoors Fields**<br><br>**Annuals**<br>**Perennials**<br>**Bedding plants**<br>**Potted flowers**<br>**Foliage plants**<br><br>**Deciduous trees**<br><br>**Deciduous shrubs**<br><br>**Tropical foliage**<br><br>**Container grown plants**<br><br>**Conifer production for reforestation purposes** | **Anthracnose**<br>*Colletotrichum* spp.<br>**Bacteria**<br>*Erwinia* spp.<br>*Pseudomonas* spp.<br>*Xanthomonas* spp.<br>**Black spot of rose**<br>*Diplocarpon rosea*<br>**Botrytis**<br>*Botrytis cinerea*<br>**Downy Mildew**<br>*Peronospora* spp.<br><br>**Leaf spots**<br>*Alternaria* spp.<br>*Cercospora* spp.<br>*Entomosporium* spp.<br>*Helminthsporium* spp.<br>*Myrothecium* spp.<br>*Septoria* spp.<br><br>**Powdery mildew**<br>*Erysiphe* spp.<br>*Oidium* spp.<br>*Podosphaera* spp.<br>*Sphaerotheca* spp.<br>***Phytophthora* spp.**<br><br>**Rust**<br>*Puccinia* spp.<br>**Scab**<br>*Venturia* spp. | 2 - 8 | Outdoors, Field: Apply Rhapsody at rates ranging from 2-8 quarts of product in 100 gallons of water per acre. Make applications on a 3- to 10-day schedule. Begin applications when conditions favor disease development prior to the onset of disease.<br><br>Under normal conditions apply Rhapsody at a rate of 4 quarts of product per 100 gallons of spray solution per acre on a 7-day schedule. When conditions favor severe disease development shorten the spray interval or use a higher rate. Thorough coverage is essential for effective disease control. When more diluted or concentrated spray solutions are needed for the type of equipment being used, follow the "Use Determination" section of this label. |

## Application Rates for Soil Drench Uses in the Field

Rhapsody has a 0-Day PreHarvest Interval for all crops contained on this label.

Under moderate to severe disease pressure, for improved performance, increase rates and reduce spray intervals or use Rhapsody in a tank mix or rotational program with other registered fungicides.

| Crops | Disease | Rate* qts/100 gallons spray mix | Application Instructions |
|---|---|---|---|
| **Ornamentals**<br>**Trees**<br>**Landscape plants**<br><br>**Shrubs**<br>**Annuals**<br>**Perennials**<br><br>**Flowering plants**<br>**Tropical plants**<br>**Bedding plants**<br><br>**Container plants**<br>**Potted plants**<br>**Foliage plants**<br><br>**Deciduous trees**<br>**Deciduous shrubs**<br><br>**Forestry Seedlings**<br>**Conifer production for reforestation purposes** | ***Rhizoctonia* spp.**<br><br>***Pythium* spp.**<br><br>***Fusarium* spp.**<br><br>***Phytophthora* spp.** | 4 - 8 | Soil Drench Field Uses:<br><br>Mix 128 fl oz to 256 fl oz of Rhapsody with 100 gallons of water. Use higher application rates under conditions of heavy disease pressure.<br><br>Apply finished mixture at a rate to thoroughly soak the growing media through the root zone (1 pint / sq. ft. for each 3 inches of soil depth) as a drench or directed spray using hand held, mechanical or motorized spray equipment, or as a chemigation drench or directed spray using applicable sprinkler irrigation systems. Begin applications during or after seeding, sticking of cuttings or after transplanting to propagation beds, containers, pots or trays. Optimal performance is obtained with preventative treatments repeated every 21 – 28 days throughout the growing cycle. Rhapsody can be mixed with chemical fungicides registered for soil applications. |

* Rate presented in quarts/100 gallons of spray mix unless otherwise noted.

## Application Rates for Turf, Lawns, Sod, Golf Courses (Greens, Tees, Fairways and Roughs), Ornamental Turf

Rhapsody has a 0-Day PreHarvest Interval for all crops contained on this label.
Under moderate to severe disease pressure, for improved performance, increase rates and reduce spray intervals or use Rhapsody in a tank mix or rotational program with other registered fungicides.

| Crops | Disease | Rate* fl oz/1000 sq. ft of surface area | Application Instructions |
|---|---|---|---|
| **Turf,**<br>**Sod,**<br>**Lawns,**<br>**Golf Course,**<br>**(Fairways, Roughs Greens, Tees)**<br><br>**Seed production grasses, turf, etc.**<br><br>**Bluegrass**<br>**Bentgrass**<br>**Bermuda grass (Common & Hybrid)**<br><br>**Dichondra**<br><br>**Fescue**<br>**Orchard grass**<br><br>**Poa Annua**<br>**St. Augustine**<br>**Ryegrass**<br>**Zoysia**<br><br>**Mixtures and other grasses or ornamental turf** | **Brown patch**<br>*Rhizoctonia solani*<br><br>**Dollar Spot**<br>*Lanzia* spp.<br>*Moellerodiscus* spp. (formerly *Sclerotinia homeocarpa*)<br><br>**Powdery Mildew**<br>*Erysiphe graminis*<br><br>**Rust**<br>*Puccinia* spp.<br><br>**Anthracnose**<br>*Colletotrichum graminicola*<br><br>**Grey Leaf Spot****<br>*Pyricularia grisea* | 2.0 - 10 fl oz | Apply at the rate of 2.0 to 10.0 fl oz of Rhapsody per 1000 sq. ft. of surface area. Apply in sufficient water to provide thorough coverage, depending on the application equipment. Two gallons of water per 1000 sq. ft of surface is commonly used.<br><br>Begin applications when conditions are conducive to disease development. Continue applications on 7 to 10 day intervals or as needed. Under moderate to severe disease pressure, for improved performance, increase rates and reduce spray intervals or use Rhapsody in a tank mix or rotational program with other registered fungicides.<br><br>Aids in control of brown patch, dollar spot, powdery mildew, rust and anthracnose. |

*Rate presented in fl oz /1000 sq. ft of surface area unless otherwise noted.
** **NOT FOR USE IN CALIFORNIA**

### CONDITIONS FOR SALE AND WARRANTY

AgraQuest warrants to those persons lawfully purchasing this product that at the time of the first sale of this product by Seller that this product conformed to its description and was reasonably fit for the purposes stated on the label when used in accordance with Seller's directions. Buyers and users of this product assume the risk of any use contrary to such directions. EXCEPT AS PROVIDED ELSEWHERE IN WRITING CONTAINING AN EXPRESS REFERENCE TO THIS WARRANTY AND LIMITATION OF DAMAGES, SELLER MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OR GUARANTY, INCLUDING ANY OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS OR OF MERCHANTABILITY AND NO AGENT OF SELLER IS AUTHORIZED TO DO SO. Except to the extent prohibited by applicable law, AgraQuest offers this product with the following conditions: 1) buyers and users of this product assume the risk of any storage, handling or use contrary to AgraQuest's label and directions and 2) AgraQuest's liability shall in no case exceed the purchase price of the applicable AgraQuest product.

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Made in Mexico

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www.agraquest.com

[This label replaces US014-04 (AQ1351-004)]

***Hills at Southampton Fertilizer Record***

SAMPLE FORM

| Date | Time | Hole & Section (circle) | Material & Brand | N-P-K | Rate | Area | Source: Irrigation | Source: Supplemental | Notes |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 2 3 4 5 6 7 8 910 11<br>12 13 14 15 16 17 18 19<br>PG Tee Fwy Green | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

**Weather** Temp: Cloud: Rainfall:

Humidity: Sun: ET:

**Preparer:** _____

**Table 19. Summary List of Pesticide Recommendations**

| Pesticide | Are Special Golf Course Restrictions Recommended? | Are Special Home Lawn Restrictions Recommended? |
|---|---|---|
| Herbicides | | |
| 2,4-D acid or salt | No | No |
| Benefin (with trifluralin below) | -- | No |
| Bispyribac-sodium | Yes (lined greens only) | No |
| Carfentrazone-ethyl | No | No |
| Dicamba | No | No |
| Ethofumesate | No | No |
| Fenoxaprop | No | No |
| Fluazifop-p-butyl | No | No |
| Glyphosate | No | No |
| Halosulfuron-methyl | No | No |
| MCPP | Yes (no GC use) | Yes (no lawn use) |
| Mesotrione | No | No |
| Pendimethalin | -- | Yes (no lawn use) |
| Prodiamine | No | No |
| Quinclorac | Yes (lined greens only) | No |
| Sethoxydim | No | No |
| Topramezone | -- | No |
| Trifluralin (with benefin above) | -- | No |
| Fungicides | | |
| Acibenzolar S-methyl | No (pending lab method) | ***Fungicides not generally recommended for lawn care*** |
| Azoxystrobin | No | |
| Boscalid | No | |
| Chlorothalonil | Yes (G&T use only) | |
| Etridiazole | Yes (no GC use) | |
| Fluazinam | No (pending lab method) | |
| Flutolanil | Yes (lined G &T) | |
| Fosetyl-Al | FEIQ=209 | |
| Iprodione | Yes (lined greens only) | |
| Mefenoxam | No | |
| Metconazole | No | |
| Myclobutanil | Yes (G&T use only) | |
| Penthiopyrad | No (pending lab method) | |
| Polyoxin D | No | |
| Propamocarb | Yes (G&T use only) | |
| Propiconazole | Yes (G&T use only) | |
| Pyraclostrobin | No | |
| Thiram | Yes (no GC use) | |
| Triadimefon | Yes (lined greens only) | |
| Trifloxystrobin | No | |

| Insecticides | | |
|---|---|---|
| Bifenthrin* | * | * |
| Carbaryl | Yes (no GC use) | Yes (no lawn use) |
| Chlorpyrifos | Yes (G &T) | Yes (no use) |
| Deltamethrin* | * | * |
| Imidacloprid | Yes (timing restriction) | Yes (timing restriction) |
| Indoxacarb | -- | No |
| Lambda-cyhalothrin* | * | * |
| Parasitic Nematodes | No | No |
| Spinosad | No | No |
| Growth Regulators | | |
| Ethephon | No | No |
| Paclobutrazol | No | No |
| Trinexapac-ethyl | No | No |

*A spray shroud should be placed over the tractor boom, if it is used. Otherwise, granular and hand-directed applications do not need additional restrictions beyond the legally enforceable product labeling.

# 30-0-0, 90% MSN

## Methylene Stabilized Nitrogen

## Guaranteed Analysis

**Total Nitrogen (N) ..... 30.00%**
**12.00% Urea Nitrogen***
**18.00% Slowly Available Water Soluble Nitrogen****

**Derived from Triazone-Methylene Urea Complex**

***9.0% Stabilized Nitrogen from N-butyl-thiophosphoric triamide (NBPT)**

****Slowly Available Nitrogen from Triazone and Methylene Urea**

**Green-T® 30-0-0, 90% MSN** contains a Methylene Stabilized Nitrogen that releases nitrogen over an extended period of time within the growing season. It is a combination of triazone-methylene urea complex and stabilized nitrogen. The stabilized nitrogen minimizes volitilization of the quick release nitrogen and prevents nitrate movement within the soil by keeping the nitrogen in the ammonium form.

- **Weight per gallon: 10.3 lbs. (4.67 kg)**
- **Each gallon contains:**
  **3.09 lb Nitrogen**
- **pH: 8.0 - 9.0**

**Directions for Use:**

**Greens, Tees and Fine Turf:** Apply 4.0 - 8.0 oz. of **Green-T® 30-0-0, 90% SRN** with 1.5 - 2 gallons of water per 1,000 sq. ft. (1.4 - 2.8 **Green-T® 30-0-0, 90% SRN** gallons of with 66 - 88 gallons of water per Acre) every 7 to 14 days throughout the growing season. This application shall provide 0.10 - 0.20 lb. of actual Nitrogen per 1,000 sq. ft. Application may be made to either wet or dry foliage.

**Fairways, Roughs, Sports Turf and Lawns:** Apply 2.0 - 4.1 gallons of **Green-T® 30-0-0, 90% MSN** with 44 - 88 gallons of water per Acre (6.0 - 12.0 oz of **Green-T® 30-0-0, 90% MSN** with 1 - 2 gallons of water per 1,000 sq. ft.) every 14 to 28 days throughout the growing season. This application shall provide 0.14 - 0.28 lb. of actual Nitrogen per 1,000 sq. ft. For a deeper green turf, tank mix with **Green-T® 12 Iron**.

**Sod Production:** Apply 2 gallons of **Green-T® 30-0-0, 90% MSN** with 3 gallons of **Blu-Gro® 10-10-10**. Apply monthly throughout the growing season.

**Application Rates for Green-T® 30-0-0, 90% MSN**

| Fluid Oz/ 1,000 sq. ft. | Gallons/ One Acre | ML/ 100 $M^2$ | L/HA Litre/ Hectare | Nitrogen/ 1,000 sq. ft. |
|---|---|---|---|---|
| 4.0 | 1.4 | 127 | 13 | 0.10 |
| 6.0 | 2.0 | 191 | 20 | 0.14 |
| 8.0 | 2.7 | 255 | 25 | 0.20 |
| 9.0 | 3.1 | 286 | 30 | 0.22 |
| 12.0 | 4.1 | 382 | 40 | 0.29 |

**Available Container Sizes:**

| | | |
|---|---|---|
| 2 x 2.5 gal | (2 x 9.46 L) | Case |
| 30 gal | (113.56 L) | Drum |
| 55 gal | (208.20 L) | Drum |
| 275 gal | (1040.99 L) | Tote |

**Store above 32° F.** Do not allow to freeze.

300090

PLANT FOOD COMPANY, INC.
*The Liquid Fertilizer Experts*

38 Hightstown-Cranbury Station Road ■ Cranbury, NJ 08512 ■ 800.562.1291 ■ pfc@plantfoodco.com ■ www.plantfoodco.com

SUSTÅNE®
Naturally...

***Known Worldwide***
***For Being Simply the Best...***
***Natural Fertilizers & Soil Builders***

***Recommended Use:***
*Landscapers' Choice all purpose slow release fertilizer for landscaped areas, overseeding and turf establishment. Fastest starter available. Golf course, home and sports turf grow in.*

***Description:***
*Suståne® 4-6-4 Landscapers' Choice is a natural organic starter and maintenance fertilizer. Suståne® 4-6-4 works by replenishing the soil with a rich supply of humus (stabilized organic matter) and the essential nutrients required for sound and long term fertility programs. Suståne® 4-6-4 provides a combination of slow release nutrients and organic substances. Derived from biologically stable compost plus natural potash and feathermeal.*

# 4•6•4 SUSTÅNE

## LANDSCAPERS' CHOICE ALL NATURAL FERTILIZER

OMRI™ Listed
Organic Materials Review Institute

## *Benefits of Suståne® 4•6•4 Natural Organic*

- Adds approximately 10% humates by volume
- Increases the nutrient and water holding capacity of the soil
- Strengthens plants tolerance against hot dry conditions
- Greater root development
- Improves buffering against changes in soil pH
- Increases the soil's ability to suppress plant pathogens
- Increased soil porosity and stability for greater root development and water holding capacity

## *Turf Establishment*

Turf establishment accelerates with 4-6-4 All Natural Organic Fertilizer from Sustane. A complete package containing Slow Release Nitrogen, chelated micronutrients, organic phosphorous and humic substances. Sustane 4-6-4 has been demonstrated time and again to surpass synthetic turf starter fertilizers and other sources of humates and plant biostimulants.

## *Landscapers' Choice*

Professional landscapers have increasingly turned to Suståne 4-6-4 for use on high maintenance turf and landscaped environments. While synthetic fertilizers supply plant growth nutrients, they do not supply the organic matter required to maintain quality growth. Using fully composted natural fertilizers increases the levels of beneficial microbial activity, which in turn convert nutrients into plant available forms.

QUALITY GROWTH THROUGH HEALTHY SOIL™

# Sustâne® 4 • 6 • 4

## ALL NATURAL

**Product Specifications**

## *Application Rates*

### Warm Season Turf

***Athletic Fields, Parks and Lawncare***

Apply 4-7 times per season.

**Spring and Fall** - 25 lb. per 1000 $ft^2$

**Summer** - 19 lb. per 1000 $ft^2$

### Cool Season Turf

***Athletic Fields, Parks and Lawncare***

Apply 2-3 times per season at a rate not exceeding 25 lbs. per 1000 $ft^2$

### Soil Preparation For Flower & Shrub Beds

- Light, High Sandy Soil: 6 lb. per 100 square feet of bed
- Medium, Clay Loam Soil: 4 lb. per 100 square feet of bed
- Heavy, Silty, Clay Loam: 2 lb. per 100 square feet of bed

***Sustâne® All Natural Fertilizers are allowed for use in production of certified organic crops.***

## *Turf Coverage*

50 lb. covers 2000 $ft^2$ @ 1 lb. N per 1000 $ft^2$ (44 lb. N per acre)

22.67 kg covers 186 m @ 0.5 kg N per 100 $m^2$ (50 kg N per ha)

25 lb. per 1000 $ft^2$
12.5 g per 1 $m^2$

## *Available particle sizes:*

Medium Grade, 200 SGN (2.8 mm - 1.4 mm)

Fine Grade, 100 SGN (1.4 mm - 0.6 mm)

## *Sustâne® Integrated Soil Management Program***

***For Turf Establishment, Seeding, New Lawn Construction Laying Sod and Sprigging***

**Preplant -** Broadcast and Incorporate into top 4 in. (5 cm) of soil
50 lb. per 1,000 $ft^2$ or 2,200 lb. per acre
25 kg per 100 $m^2$ or 1,250 kg per ha

**Postplant - 45-60 days**
Broadcast and water in 25 lb. per 1,000 $ft^2$ or 1,100 lb. per acre
12.5 kg per 100 $m^2$ or 1,250 kg per ha

**Overseeding -** Apply 25 lb. per 1,000 $ft^2$ at time of overseeding

**Hydroseeding -** Add 15 lb. per 1,000 $ft^2$ in tank with binder

### Fertilizer Maintenance for Large Trees

Once trees have become well established, apply Sustâne into holes punched into the ground within tree crown drip line. Once the tree has developed a 4-6 inch diameter, increase application rate to 1.5 lb. of Sustâne per inch of tree trunk diameter.

**NOTE: Adjust fertilizer program for local conditions and requirements.

### Guaranteed Analysis

| | |
|---|---|
| Total Nitrogen (N) | 4% |
| 0.4% Ammoniacal Nitrogen | |
| 0.4% Water Soluble Organic Nitrogen | |
| 3.2% Water Insoluble Organic Nitrogen* | |
| Available Phosphate ($P_2O_5$) | 6% |
| Soluble Potash ($K_2O$) | 4% |
| Calcium (Ca) | 4% |

Derived from aerobically composted turkey litter, feather meal, and sulfate of potash.

*3.2% slowly available nitrogen from aerobically composted turkey litter and feather meal

### Total Plant Nutrition

| | | | |
|---|---|---|---|
| Magnesium | 1.00% | Copper | 0.05% |
| Sulfur | 3.00% | Molybdenum | 0.05% |
| Iron | 0.50% | Boron | 0.05% |
| Manganese | 0.05% | Humic Acid | 7% |
| Zinc | 0.05% | Organic Matter | 50% |
| pH | 6.8 | Carbon:Nitrogen(C:N) | 4:1 |
| Bulk Density | 36 lb./$ft^3$ | Salt Index (scale 1-100) | 4 |
| C.E.C. Cation Exchange Capacity | | | 104 meq/100 g |
| % of Total N as Slow Release | | | 80% |

(507) 263- 3003
(800) 352-9245
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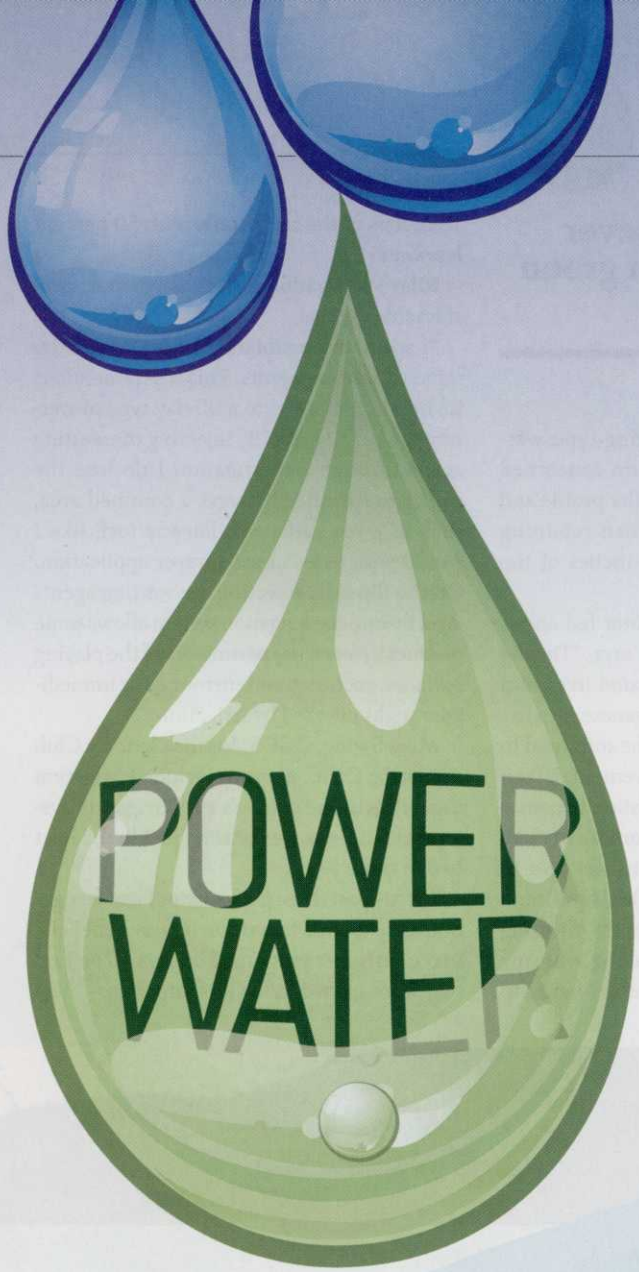
SUSTÂNE Naturally...

QUALITY GROWTH THROUGH HEALTHY SOIL™

# Appendix 18
# Fertigation




**There are a number of reasons fertigation may just make sense for your course.**

by John Torsiello

Implementing fertigation practices with the use of an irrigation system is becoming quite prevalent among turf professionals.

There are several reasons , the most significant being that the procedure allows superintendents to get bio-stimulants and nutrients to a wide area of the course without time-consuming and labor-intensive methods of traditional dispersal, such as machine or hand application.

"Using irrigation systems to fertigate certainly has become more popular, especially with some of the new guys who feel it is almost like having another assistant superintendent who can make applications where and when most needed," says Gary Bauman, a partner in the Shelter Island, N.Y., golf industry supply and consulting firm, Island Bio Greens. "You can make applications, albeit sometimes not very precise applications, at your discretion to areas of the course where a machine sprayer would have difficulty getting to, such as bunker banks and green surrounds."

Fertigation is the combination of mixing fertilizer and irrigation water and then distributing it through an irrigation system. Typically, small amounts of fertilizer are injected into the irrigation water supply and then distributed.

Brian Vinchesi, owner of Irrigation Inc. in Pepperell, Mass., says using irrigation systems to fertigate just makes sense.

"Having fertigation capabilities allows the superintendent to better time their applications. They do not have to water in a broadcast fertilizer or put down more than necessary to last longer as they have to avoid play. With fertigation, the turf can be spoon fed nutrients. Many superintendents also apply, or only apply, wetting agents through their fertigation systems."

Rich Silverman of Rain Rich, located in, quite appropriately, Greenlawn, N.Y., chimes in, "(Fertigation) is great for golf courses because turf is always being cut short and the soil compacted from golfers and equipment, so it always needs to be watered. By mixing in small amounts of fertilizer and other turf and soil-enhancing products the turf can better resist problems that plague it."

Fertigation results in very little waste of fertilizer and studies have shown small amounts of fertilizer distributed slowly and uniformly on a consistent basis produces healthier plants that are more resistant to disease, Silverman says.

Compatibility of today's irrigation systems with fertigation procedures are really unlimited, Vinchesi says. "Depending on the amount of money spent the systems can be very versatile, and the more sophisticated systems interact directly with pump stations and central control systems," he says. "Pretty much anything that is labeled for injection can be applied through an irrigation system. Injection of more than just fertilizer is commonplace. With the proper amount of storage tanks and mixing tanks, odd mixtures and teas can be applied."

Depending on the fertigation system manufacturer, units can be as basic as a quick coupler system with little or no control, or as sophisticated as any computer-driven control system, giving the user a very precise tool to apply fertilizers calculated in parts per million, says Erik Christiansen, president of EC Design Group , an irrigation consulting firm headquartered in West Des Moines, Iowa.

Brad Sparta, superintendent at Ballyowen Golf Club at the Crystal Springs Golf Resort in Sussex, N.J., is a big advocate of fertilization by irrigation.

"At Ballyowen, our fertigation is on constantly," he says. "We have our micrometers set very low, so whenever we are watering we are fertigating. It is constantly feeding your turf and you never get that `flush' of growth or that bright neon green flash."

**"It is constantly feeding your turf and you never get that 'flush' of growth or that bright neon green flash." – Brad Sparta, Ballyowen Golf Club**

When Ridgewood Country Club in Ridgewood, N.J., site of this year's PGA Tour Fed Ed Cup playoff series The Barclay's tournament, installed a new irrigation system in 2005 the club added a fertigation system "because it would have been foolish not to when the opportunity presented itself," says Todd Raisch, CGCS.

"Initially, I refused to entertain the idea of putting nitrogen through the system," he says. "I was concerned about rates, stuck heads, calibration, leaks, etc. We started out with wetting agents that first year and added phosphate the next year. In the last couple of years we have added nitrogen. At first, it was in the rough only and we were using larger quantities of nitrogen every three to four weeks just to supplement our granular program. As we became more comfortable with the system we eventually added the fairways.

He normally sprayed .35 lb/N/M every month on his fairways, Raisch says, and somewhere between that third and fourth week things would go a bit off color. "An extra tenth supplied through the system was just the right amount to carry us through to the next spray," he says. "The second half of this past season I went with ultra low rates across the board, .01 lb/N/M, every time we watered. We used ammonium sulfate and have been thrilled with the results. The consistency in color and growth improved almost immediately everywhere on the course."

The results, Raisch says, speak for themselves. "We held the Barclays and using the fertigation system in the outer roughs has done wonders to help it recover from foot traffic."

Dustin Riley, CGCS, Oconomowoc Golf Club in Oconomowoc, Wis., injects penetrating-type wetting agents into his course's irrigation system starting mid-May through August. He prefers penetrating-type wetting agents because he is more concerned with having the ability to wet the profile and simulate a soaking rainfall than retaining water within the upper four inches of the root zone.

"My irrigation is ground water fed and is very high in manganese," he says. "During stretches of low rainfall, repeated irrigation cycles continually dump manganese into the soil. As concentrations build the soils tend to seal up and restrict water movement. When the soils reach this state, irrigation becomes less effective and the turf becomes stressed. In the past, I was only able to wet two to three inches of the profile with a 30-minute irrigation cycle (about 0.25"). By injecting a penetrating wetting agent along with my normal irrigation cycle I am able to wet 12 to 18 inches of the soil profile with 50 percent less water."

Riley's fertigation processes result in considerable savings.

"I spend approximately $3,000 a year on injected wetting agents. This is a tremendous savings if compared to a 90-day type of wetting agent," he says. "By injecting the wetting agent through the irrigation I do lose the ability to specifically target a confined area, such as a tee surface or fairway turf, like I would with a dedicated sprayer application. On the flip side, injecting the wetting agents directly into the irrigation system allows some product to reach the perimeters of the playing surfaces, such as green surrounds or immediate roughs covered by irrigation."

Mike Swing, CGCS, Visalia Country Club in Visalia, Calif., plans to include fertigation capability in the course's new irrigation system scheduled to be installed within the next two to three years.

"At my past three golf courses I had fertigation installed and found it to be very beneficial in our fertilizer program," he says. "The first two were grow-ins. In this situation – new

Fertigation distributes small amounts of fertilizer and other turf and soil-enhancing products enabling it to better resist problems.

irrigation, good spacing and excellent coverage – it really helped address our poor soil conditions (high calcium bi-carbonate) and push our Bermuda grass fairways to quicker maturity. Because we were in a grow-in situation time was of the essence to meet a grand opening that was in step with the housing market. This is where fertigation really pays off in faster maturity and early mowing to develop that playability density. In conjunction with traditional granular fertilizers we were able to inject sulfuric acid to offset our high ph water and calcium bi-carbonate soils. We also used wetting agents to help the germination and soil percolation issues."

For a new course grow-in, Swing believes fertigation is an essential tool in addressing many issues that face a golf course superintendent and the high expectations of the owner and soon-to-come golfers.

Moving past grow-in, he says, fertigation can spoon feed a course to avoid growth surges commonly associated with granular fertilizer.

"Of course, you can use granular fertilizer in small rates and repeat several times," he says. "But then that's where fertigation excels. You can be fertilizing at night when you and your crew are sleeping, a huge labor savings, and have controlled growth. In many parts of the country, golf courses are over seeded. Again, fertigation is a great tool to get your rye grass up and going for that all important first cut."

When it comes to purchasing equipment for fertigation, Swing advises superintendents to do their homework.

"Choose only high quality injectors," he says. "Liquid fertilizers are very corrosive and you really don't want to have issues. Control packages that produce variable injections to match your pump station output are also critical. Double wall tanks may not be necessary in your state but you'll sleep better with a double wall tank. That also goes for high quality fittings. Also, spend time traveling to a golf course that is known to have a good system and management program."

Superintendents should first understand that fertigation systems are tools and as such can perform some tasks very well and others not as well, Christiansen says. "The superintendent should analyze the maintenance program to determine the potential uses for injection technology in their concept of course management," he says. "Some of the best uses of nutrient injection are color and growth management, particularly with materials that require frequent application at low rates; micro-nutrients for example. Water quality adjustments also fit well with injection."

The true benefit of fertigation is better sustained growth rates, addressing soil conditions in a very deliberate and consistent manner and the labor saved in applications that now can be scheduled for other course improvements, Swing says. "Fertigation will only perform to the level of your irrigation system," he says. "Poor coverage and station control will not live up to your expectations or monies spent."

Injecting wetting agents through his irrigation system has improved irrigation efficiency and playing conditions, Riley says, adding he highly recommend this option for wetting agent application.

While proven effective, using irrigation systems for fertigation may not be for everyone. Mark Mansur, superintendent at Wintonbury Hills Golf Course in Bloomfield, Conn., has considered using his irrigation system for fertigation, but he found it to be cost prohibitive for his small budget. A more targeted approach with a sprayer or spreader is in line for Wintonbury for more controlled nutrient management. "I'm sure it is a valuable tool for some golf courses," he says. "It probably depends on the layout and other topographical issues."

Many superintendents do not have fertigation and those that do utilize it in varying amounts, Vinchesi says. Some use it judiciously, while others use it for simpler applications, such as wetting agents or have abandoned them over time. Many times, non-use is due to a superintendent change. "Fertigation systems require a level of knowledge and maintenance that is different than just using a sprayer," he says. "For one, it is not at the maintenance facility it is at the pump station, which makes it less convenient. It also requires liquid products or dissolving other products."

To fertigate through an irrigation system, superintendents need a versatile, quality system, which is not cheap, Vinchesi says. "Inexpensive systems many times require that you apply large amounts of water to get down the desired application because the fertigation pump is too small," he says. "As a result, the golf course is over-watered to apply the fertilizer. There are drift concerns also. A golf course that is completely surrounded by residential homes may not be good for fertigation application. Some products are hazardous and require special handling, especially with acid inject systems."

For superintendents new to the concept of fertigation fear can be an overriding factor, Christiansen says.

"If they would start by trying a product that has low cost, low risk and high reward they would develop a trust," he says. "Magnesium sulphate is one such product. It used to be applied as often as iron for its greening ability but has gone out of favor. Many of the best injection products are more 'old school,' while the industry is pushing constantly to newer, more cutting edge technologies. What gets lost is the fact that the modern computer driven fertilizer injector is a very modern and sophisticated product."

While it may not be a panacea for best practices turf management, irrigation-based fertigation nonetheless can be a valuable tool in any superintendent's arsenal. **GCI**

*John Torsiello is a freelance writer based in Torrington, Conn.*

# COURSE CONDITIONING GUIDELINES

The purpose of the **PGA TOUR Conditioning Guidelines** is to assist the golf course Superintendent and the tournament organization in achieving the goal of providing a golf course that fairly tests the Players' skill and produces fair and consistent playing conditions in all areas.

**These guidelines are not directly applicable to all courses due to differences in grass types, course design, and timing of the tournament relative to seasonal weather and turf growth**. Therefore, a PGA TOUR Agronomist will visit the golf course in advance of the tournament. In doing so, he will work with the Superintendent, club officials, and host organization to help interpret these guidelines and make them applicable to this event. The Agronomist, in consultation with the PGA TOUR Rules Officials, will outline the specifications for tournament conditioning during these visits including greenspeed, fairway widths, cutting heights, and bunker preparations. He will also outline any necessary tree trimming, tee leveling, mowing contour changes, specific irrigation practices, and review the general agronomic programming leading up to the tournament. Any TOUR requests for tee leveling and changes in mowing contours should be completed well in advance of the tournament as determined by the Agronomist and Golf Course Superintendent. Any additional TOUR or course generated and PGA TOUR approved modifications to the golf course should also be completed as far in advance of the tournament as possible and as determined by the Agronomist and Superintendent. A PGA TOUR Rules Official will arrive on site during Advance Week to make final judgments on greenspeed, mowing heights, bunkers, and other course conditioning issues. The key to the success of this phase of the preparations is to have all the initial course conditioning requirements completed before his arrival.

All golfers enjoy and benefit from playing under great playing conditions. It is therefore recommended that the golf course be maintained as close as reasonably possible to tournament standards during the months and weeks leading up to the event. Some modifications to this may be necessary due to seasonal changes in turf conditioning requirements. The goal should be to peak the course during the week of the event, matching the requested specifications as near as possible without causing damage to the turfgrass. The PGA TOUR Agronomist is at your disposal to help accomplish this task. You are encouraged to take advantage of this resource any time you have a question on course conditioning, or would like additional information on any problem related to Agronomy. It is also important that you communicate directly with your PGA TOUR Agronomist if any situations arise that may potentially affect the playability of the golf course for the tournament. This includes construction or renovation projects that may be carried out in the twelve month period leading up to the event. Please remember that we are here to help you have a most successful tournament; one that satisfies financial goals, spectator enjoyment, and Player expectations.

## GREENS

In general most Superintendents will be asked to provide **consistent** greenspeeds in the range of 9½ to 11 feet as measured by a USGA Stimpmeter by the end of Advance Week. This allows the PGA TOUR Rules Official to make a final determination on a tournament speed which can be adjusted up or down as required. Arbitrary and excessive greenspeeds can eliminate prime hole locations for the tournament, and this must be avoided. The Stimpmeter will be used frequently prior to and during the tournament to check the overall pace and consistency of all greens. **It is essential that the prescribed greenspeed be maintained as consistently as possible during Tournament Week.** Situations where the greenspeed dramatically increases or decreases in speed as the tournament progresses must be avoided.

Firm, but not overly hard greens are the goal for tournament play. This may require hand watering prior to and during the event. Key staff members should be trained to recognize areas of the greens that dry out and require supplemental irrigation. The use of two SPECTRUM TECHNOLOGIES FIELD SCOUT TDR 300 Soil Moisture Meters can assist the staff in determining how much water to apply. If conditions are extremely dry, it will probably be necessary to do some overhead watering with the automatic system during Tournament Week. This will help maintain a consistent baseline of moisture in the rootzone. The PGA TOUR Agronomist will work with the Superintendent to determine the best combination of both hand and automatic watering. The SPECTRUM TECHNOLOGIES FIELD SCOUT TDR 300 Soil Moisture Meters (PGA TOUR HOST COURSE PACKAGE ITEM

#S89PGAH) are available from SPECTRUM TECHNOLOGIES, INC. phone: 800-248-8873 or 815-436-4440, fax: 815-436-4460 web: www.specmeters.com.

**Over watering of greens should be avoided at all costs** as this will increase spike marks and footprints, lessen the skill required to hold a shot, and possibly cause greenside bunker sand to become overly wet. The use of a hose-end canister containing a wetting agent has proven valuable in maintaining uniform moisture levels when hand watering is required. Also, a general application of wetting agent, either through spraying or irrigation injection methods, will promote more even infiltration and reduce dew or frost formation.

Great care should be taken to keep green approaches firm during periods of irrigation. This may require shutting off the fairway approach heads so as to not add to that which comes off the green. It can be helpful to include green approaches in the regular topdressing schedule to improve surface drying. Under no circumstances should an approach be watered to the point where it is made softer than the green surface.

Frequent light topdressing may be applied right up to the start of Advance Week. This will promote improved ball roll and reduced spike marks if done as part of a regular topdressing program.

Supplemental rolling may or may not be recommended leading up to and through the tournament. It is always good to have one or two units available, however, should rolling be necessary, especially to smooth the surface after a heavy rain or Pro-Am event. If triplex mowers are used for cutting, rolling will more likely be needed. The PGA TOUR Agronomist will discuss this potential with the Superintendent during the Pre-Tournament visit, as will the PGA TOUR Advance Rules Official when he arrives on site.

Multi-directional greens mowing in the weeks leading up to the tournament is designed to reduce grain. Grain orientation tends to be mostly in an east to west direction or on downhill slopes. Therefore, it is recommended that verticutting and turf grooming take place in a true north/south direction or across the general slope of the green. This should result in more of the grass blades being cut. Drag or hand brushing should be done against the prevailing grain, which can be found by hand brushing in a circle in a typical area of the green. Once the direction of grain on each green has been determined and marked, all brushing should be done in the opposite direction. Backtrack or reverse mowing on the same path to provide a double cut should also be done, with the first cut made against the prevailing grain direction. In preparation for the tournament and during the event, at least four mowing directions should be used - a true north/south and a true east/west, northeast/southwest and northwest/southeast.

The following other items will help produce quality tournament surfaces:

- ❑ Use vertical mowing and grooming equipment regularly to reduce surface grain throughout the year.
- ❑ Complete all core aeration procedures to reduce thatch and compaction at least eight weeks before the tournament. Be sure to apply enough topdressing as often as necessary to completely fill holes to the top.
- ❑ Program fertilizer applications so that clipping removal rates are moderate. Usually a rate of between ¼ and ½ basket per green is optimal one week before the tournament. The use of foliar fertilizer at light rates is recommended, starting eight weeks out, for better growth control.
- ❑ Review the previous year's hole locations or the likely selections by the Tournament Rules Officials and avoid these areas for regular play at least two weeks before the tournament.
- ❑ Ensure that all greenside sprinkler heads, drainage catch basins, valve boxes and snap-valve couplings are leveled to existing grade to prevent being marked as "ground under repair".
- ❑ Make sure that at least eight single unit or four triplex greens mowers are on hand, properly serviced, and set up to mow between .150 and .100 inch. Mowing heights on both cool and warm season grasses will vary according to the pace desired for the tournament. Walk mowers are preferred over triplex mowers for producing tournament putting surfaces.
- ❑ Have two experienced cup changers and necessary equipment on hand for the tournament. This includes a watering jug, soft brush, large towel, 3 inch PVC pipe section for hand rolling, knitting tool, depth setting tool, cup removal tool, extra greensmix, a pair of small scissors, "Hole-in-White" paint and applicator, a small foam brush, and a smooth bottomed bucket to carry them in. Smooth rubber soled shoes and sharp cup cutter blades are required.

- Generally collar or fringe width is set to 30 inches unless otherwise dictated by the golf course design. Height should be between ¼ and ½ inch, as specified by the Agronomy Checklist. Expanded collar areas will be recognized or outlined by the Agronomist in concert with the PGA TOUR Rules Officials to fit golf course design intent.
- Repair all scalped or low plugs regularly as needed one month prior to and through Advance Week, and use extreme care in cup cutting Advance Week.

## TEEING GROUNDS

Firm, level, and closely mown tee surfaces are required for tournament play. The mowing height should be between ¼ and ½ inch depending on grass type and time of year. A major problem with many championship tees is thatch accumulation, mainly due to lack of use. Where thatch is a problem, vigorous vertical mowing, hollow tine aeration, topdressing, and close monitoring of fertilizer applications should occur throughout the year to eliminate sponginess. If necessary, one heavy topdressing, 2 to 3 weeks prior to Advance Week will help firm a soft tee surface.

Tournament teeing areas on par 3 and short par 4 holes where iron shots are played during the tournament should be closed for regular play well in advance of the event, and extra efforts should be made to fill and seed divots on a regular basis. During practice rounds, these tees may need to be protected with plastic mesh or some other suitable screening material so that undisturbed areas are available for use during the tournament.

Mowing patterns that extend past the flat portions of the tee decks, or point towards the center of the landing area should be corrected.

## FAIRWAYS

Most well-designed golf courses have fairways that have various widths to accommodate different skill levels and to enable a player to approach certain pin positions on the putting surface. With this in mind, the main requirement is that fairway widths in the professional's landing areas should be in the range of 25-30 yards wide. There are exceptions to this, of course. Bunkers, trees, and water hazards can make it difficult to meet this standard. During the Initial or Pre-Tournament visit by the PGA TOUR Agronomist, any direction for changes in fairway contouring and widths will be given at that time. Narrowing fairways to a point where fairway bunkers end up set too far into the rough, or to where a prime fairway approach area is lost, will usually be avoided.

**As with the greens, over watering of the fairways during the tournament must not occur.** Providing a firm, uniform fairway surface over 18 holes can be accomplished if the Superintendent selectively irrigates only those fairway areas needing water for turf survival. Superintendents and irrigation technicians should practice programming their irrigation systems to achieve these conditions well before Advance Week. **During Tournament Week, all irrigation to the golf course must be discussed with the PGA TOUR Rules Officials on a daily basis.**

Mowing heights in the range of **7/16 – 1/2** inch, are usually specified depending on conditions. The trend towards lightweight mowing has generally produced improved playing surfaces but can increase the potential for increased thatch development. Soft, puffy fairways should be avoided for the health of the turf and for playability considerations. When thatch is a problem, vertical mowing, aeration, and sometimes topdressing should occur throughout the year, and be finished in time for complete healing of the turfgrass before the tournament begins.

Lightweight mowing units do allow more frequent cross mowing of fairways throughout the growing season and we encourage this practice. This reduces grain and allows surface depressions to be mowed more cleanly. Varying the mowing pattern left to right, right to left, cross mowing, and straight mowing before and during the tournament is recommended. **Repetitive tee to green mowing to "burn in" a striping pattern may negatively affect playability and is not encouraged.** Daily mowing should begin Advance Week, including the weekend before the tournament.

Fairway settlement, including sunken irrigation or drain lines, should be repaired as part of the regular maintenance program. Many Superintendents maintain the white lines put down to designate "Ground Under Repair" well after the tournament until the areas can be properly addressed. **It is very discouraging for the PGA TOUR Rules Officials to have to mark the same areas year after year on a tournament golf course, and this trend should be avoided by making the necessary repairs beforehand.**

## ROUGH

Rough mowing heights are usually in the range of 2 to 4 inches depending on the type of tournament, difficulty of the course, turf species (bermuda is shorter), and overall density. Every effort must be made to provide a consistent rough quality throughout the entire golf course and particularly through the playing corridor. This may require selective fertilization, supplemental irrigation, and interseeding to improve turf density. Since there is a tendency for rough near the fairway to become denser because of the overlapping of fairway irrigation and fertilizer, it is important that shots hit deeper into the rough are not penalized less than those that just miss the fairway. In most cases the normal intermediate cut at 1 to 1½ inches will compensate for the potential inequity. PGA TOUR Players prefer **not** to have a narrow strip of primary rough between fairway or green bunkers and the short cut turf. Thus, unless directed otherwise, please extend the intermediate rough to the bunker edge in those cases. This, along with rough mowing heights and cart traffic controls to reduce wear, will be discussed more specifically during the Agronomy visits.

As the rough height is increased for tournament play, it may be to the facility's benefit to continue with the normal rough height around the teeing grounds through the beginning of the fairways. Doing this will help higher handicap golfers and likely speed up Pro-Am rounds.

## BUNKERS

In an effort to maintain tournament ready bunker conditions, the following specifications should be adhered to:

- **All major inputs of new sand should be in place far enough in advance of the tournament to ensure compaction and firmness**.
- Ensure through frequent probing that there is a uniform settled depth of 4 to 5 inches throughout the bunker floor. If steep faces are part of the design, these areas should have no more than 2 inches of sand to prevent buried lies. If this is not possible, the sand must be firm enough to prevent balls from plugging into the slope. When sand is redistributed to maintain consistent depths, or after heavy rains, make sure that all areas are properly settled. Tamping, rolling, and/or hand watering to firm these areas may be necessary as long as it does not require excessive effort and time to the detriment of other preparations.
- When mechanical bunker rakes are used on a regular basis this can result in a tendency for the sand to "fluff" or become overly soft. When this occurs, cultivator bars and protruding spikes should be removed from the machines or at least shortened prior to the tournament. When requested, hand raking of bunkers should begin two weeks before the tournament. Extreme ridges, troughs or waves should be avoided during Tournament Week. The use of hand brooms or brush attachments may also be requested to help firm the surface of a soft sand where significant potential exists for buried lies.
- In some instances, mechanical cultivation may be necessary to loosen overly compacted sand in bunker bottoms to achieve the requested performance standards for the competition. This is usually done in the evening by "spin" raking with cultivation attachments, followed by a light, hand or mechanical raking in the morning to provide the proper "finish" to the surface.
- Small bunkers should always be hand raked, and extra efforts made to maintain consistent sand depths. Large bunkers may be raked mechanically if necessary with fan rakes or other suitable smoothing devices attached to the rake bar. All mechanical rake exit points should be checked for excessive sand depth and proper edge contouring.
- On course and maintenance staff rakes must be approved by PGA TOUR Agronomy. This will be discussed in more detail during the Agronomy visits.
- Edging of bunkers should be completed one month before the tournament. Thereafter, the grass runners should be hand trimmed as needed.
- Greenside grass bunker slopes may be requested to be mowed so as to prevent hanging lies, and in other instances, due to design considerations, the bunker slopes may be mowed at primary rough height. The Agronomist will discuss this with the Superintendent during one of his visits prior to the tournament.

- ❑ Remove all stones, roots, and debris regularly throughout the year. Final stone removal must be completed prior to Advance Week and then monitored daily thereafter.
- ❑ Before purchasing new sand for replacement or capping, it is best to send several samples from local sand suppliers to a USGA approved physical soil testing laboratory for a Bunker Sand Suitability Analysis. These labs can predict the playing quality of the sand and recommend the best choice for tournament play. While ideal sand may not be available in all areas of the country, every effort should be made to find the best possible material for your region. Color should be a secondary consideration to performance, not only for the PGA TOUR Players, but also for the general membership. The PGA TOUR Agronomist needs to be involved in this process and will assist the club in making the best choice to meet the guidelines.
- ❑ For a sand to drain quickly over a given period of time (a minimum of 20 inches per hour), and to minimize damage to the surface of a putting green or to the mowers, it should consist of the following characteristics for the sizes of sand particles.
  - A minimum of 65% of the sand should be between 1 mm and .25 mm. Of the total sand, no more than 25% should be .25 mm or smaller. Also, no more than 5% of the total sand should be .15 mm and smaller.
  - The combination of silt and clay should not exceed 3% of the total sample being considered.

  A penetrometer reading, or the degree a given sand will resist buried lies, can be obtained from a USGA accredited lab along with the particle size distribution and water infiltration rate. Since the penetrometer test has a wide degree of variability from lab to lab, it is critical that you check the performance of any given sand prior to mass installation. It is also preferable that the sand particles have some degree of angularity so that the fine and very fine particle content can be kept to a minimum.

  We realize that not all regions of the country have affordable and available sand that meets an ideal performance criteria. It is vitally important, however, to work with an accredited testing laboratory and the assigned PGA TOUR Agronomist to help select the best sand possible for the situation.

## PLAY RESTRICTIONS

The PGA TOUR recommends that all play be restricted to no more than 150 rounds per day during Advance Week, Sunday through Thursday, with the course closing on Friday, Saturday, and Sunday leading up to Tournament Week. This will allow the greens, tees, and landing areas time for recovery from divots, ball marks, and wear, as well as provide non-disruptive work time for tournament preparation. If Sunday is used for tournament purposes, the course closing should begin on Thursday. Also restricting cart traffic to paths prior to Advance Week and/or diverting cart traffic with appropriate mobile barriers as early as possible would be very helpful.

## COURSE MARKING

Professional level competitions require that the golf course be thoroughly and properly marked. This will be done by the PGA TOUR Rules Official during Advance Week. In preparation for marking, please see that the following requests are addressed:

- Supply stakes for marking the hazards. Plastic, color composite stakes with a spike attached, that are 2"x 2" and 2' long are recommended. If the type of stake on hand has been previously approved by a PGA TOUR Rules Official, it can be used instead. A supply of 50 yellow and 200 red will be a good number to start with, however be prepared to quickly supply additional stakes if requested.
- Supply stakes for marking the out-of-bounds. These should be white stakes that are 2"x 2" and 3-4' long or pre-approved by the Rules Official. There should be at least 120 stakes on hand, but be prepared to quickly provide additional out-of-bounds stakes if needed.
- A 2 pound mallet, 10 cases of red paint, 3 cases of yellow paint, 3 cases of white paint, 1 case of natural or forest green (not florescent), and 4 matching paint guns will be needed. The Agronomist will designate which brand is requested for this event.

- Mow a swath completely around all hazards and lateral hazards. This swath needs to be about 20 inches wide and about 1 inch high. Unless otherwise indicated by the Advance Rules Official, mow this swath about 2 feet away from the edge of the water unless the bank is too steep to permit this. In that case mow the swath as close as the slope permits. All grass clippings and debris should be cleared from the swath to ensure that a clean paint line can be applied.
- It will be necessary to mow between each existing out-of-bounds stake in a fashion that will permit the stretching of a string from the inside edge of any out-of-bounds stake to the next. All grass around the out-of-bounds stakes must be trimmed down to ground level.
- **Please do not mark (paint) the water hazards or drop circles during the 2 months that immediately precede the tournament.**

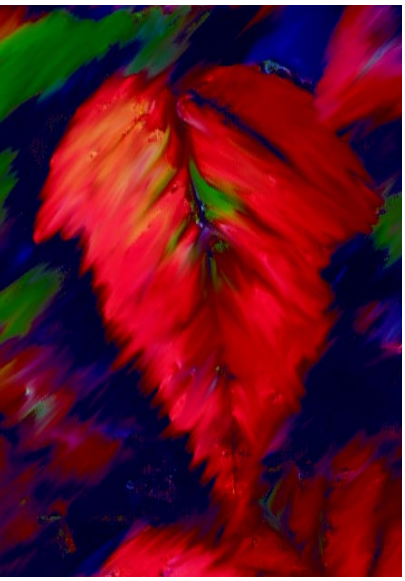
The preparation and assembly of all supplies along with all trimming should be completed by the end of the day on Monday of Advance Week.

## GENERAL

Factors to be remembered in the tournament preparations include:

- ❑ If this is a return event, review the previous year's tournament reports and pay special attention to any recommendations or requests made by the Rules Officials and as directed by the Agronomist.
- ❑ Have adequate mowing equipment and personnel on hand to completely prepare the course for daily play, keeping in mind that weather can reduce the time for this to be successfully accomplished before play begins. See the checklist for specific recommendations.
- ❑ Someone other than the Superintendent should be designated as the coordinator and/or facilitator between maintenance operations and tournament setup personnel. The logistics of tournament production are too demanding and complex to be handled by the Superintendent alone.
- ❑ A 5 to 6 foot wide walkway mowed at either fairway or intermediate rough height is to be provided from teeing grounds to fairways.
- ❑ Fairway divots need to be filled before and during the tournament using approximately a 50-50 mixture of sand and loam soil, sometimes combined with compost or some other suitable organic amendment; **not 100% sand.**
- ❑ Have at least 8 roller base squeegees on hand and a minimum of 4 mechanical pumps in good working condition available in case of rain.
- ❑ Obtain a "Hole-in-White" applicator and enough paint to paint cups. **This is now done for all 18 holes on a daily basis.**
- ❑ Make certain that all vehicles connected with the tournament (concessions, TV, etc.) have received approval from the course Superintendent in coordination with the PGA TOUR Advance Rules Official on routes to be taken to their destinations. This is **especially** important if wet conditions are present.
- ❑ During tournament play only electric carts may be used by the maintenance staff for transportation on the course.
- ❑ Refer to the **PGA TOUR Agronomy Tournament Preparation Checklist** frequently during the preparation process. Be sure to contact the PGA TOUR Agronomy Office for assistance in any matter related to the tournament as soon as possible once a problem has been identified.

# Appendix 19
# Record Keeping for Turf Management



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Brian Powell,
Pinehurst, NC

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*or visit*
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## DESIGNED SPECIFICALLY FOR GROUNDS CARE PROFESSIONALS

***GCS™ is the Ultimate Grounds Care System.***

GCS became the best selling grounds care system by providing turf professionals with a comprehensive and easy-to-use software package. The system covers all aspects of turf maintenance and can be operated with absolutely no computer experience. GCS makes management tasks simple, quick, and efficient.

## USER-FRIENDLY

***The Structure of GCS™ is Extremely Intuitive.***

All functions are accessible by a simple "point and click" of the mouse. The system integrates several management sections including: Chemical/Fertilizer, Personnel, Financial, Weather/Irrigation, Inventory, Equipment Maintenance, Work Orders, Calendar, Grounds Layout, Vegetation, and References. Help buttons appear on every major screen. Simply click on the button and context-sensitive help will appear for that particular screen.

## ADVANCED OPTIONS

***Access & Update GCS™ in the Field While Working.***

GCS interfaces with the Palm VII™ connected organizer to allow real-time access to your GCS system, the Internet, e-mail and much more. Using cellular phone technology, the Palm VII™ connected organizer is always in touch with your office based systems.

Now you and your staff can access and update important information in the field while working. Maintain equipment records, access and assign work orders, monitor irrigation, and send e-mail all from the palm of your hand.

## SAVE TIME AND INCREASE PRODUCTIVITY

***GCS™ Is Designed to Increase the Productivity of Supervisors.***

From day-to-day activities such as work scheduling and inventory control to detailed budget analysis and labor tracking, GCS helps supervisors efficiently organize and interpret grounds care activities. GCS also helps save time. Related sections automatically share data to minimize data entry.

## Chemical/Fertilizer

- Automatically calculates instant, accurate tank mixtures.
- Generate application work order details automatically from this section.
- Information logs automatically for audit trail and reporting.

## Personnel

- Comprehensive employee information at your fingertips.
- Easy to track employee performance.

## Financial

- Financial transactions post automatically from other sections.
- Intuitive graphs used to compare budgeted and actual expenditures.

## Weather/Irrigation

- Track weather and irrigation data for any range of dates.
- Degree days calculate automatically and are graphically displayed.
- Interfaces with most weather stations.

## Reference

- Full color reference for pH chart and particle size chart.
- Every conversion reference imaginable.
- Math section for area and volume calculations.

## GCS™ Main Screen

Your custom logo appears in the center of the main GCS screen. Across the top of the screen, various buttons display each section on a convenient toolbar. To access a specific section, simply click on the desired button.

## Inventory

- Always know current inventory on hand.
- Professionally formatted purchase orders faxed or e-mailed directly from your PC.
- Choose from many different reporting options.

## Calendar

- Schedule important events for you and your staff.
- Review your schedule by day, month or year.
- Scheduled work orders post automatically to the calendar.

## Equipment Maintenance

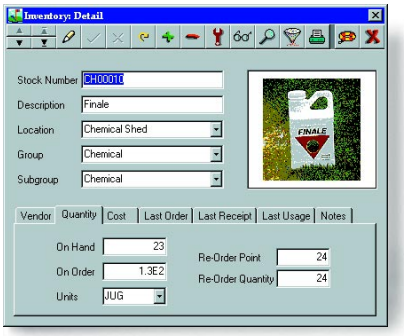
- Audible and visual alerts (on screen and via reports) when equipment requires service.
- Generate service work orders directly from the equipment section quickly and easily.
- Preventative maintenance schedules pre-loaded for your convenience.

## Grounds

- Set up ground dimensions in square footage/acreage (metric alsoavailable).
- Incorporate scanned images of your entire course and/or individual areas.
- Comprehensive vegetation database.

## Work Orders

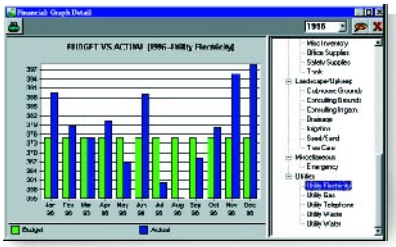
- Simply point and click with your mouse to assign an employee(s) to a particular task(s).
- Easy to determine cost and time spent for employee activities.
- Materials used for a work order are automatically subtracted from inventory.




## INVENTORY

***Know Current Inventory, Required Inventory, and All Types of Other Inventory Information.***

The Inventory section provides comprehensive information for your entire inventory, such as on-hand quantity, last usage, average cost, etc. This section also includes Purchase Orders, Order Receiving, Inventory Transactions, Inventory Validation, a Vendors Database, and more. Extensive reporting options indicate required inventory, inventory transaction histories, open purchase orders, etc. For inventory flagged as "Equipment," a detailed reference screen displays replacement parts, labor history, parts history and more!



## FINANCIAL

***Easy to Compare Budgeted Versus Actual Expenditures.***

Very little data entry! Financial transactions post automatically from other sections. To scrutinize budgeted versus actual expenditures, simply highlight the desired expense category, then choose from a variety of graphing options to visualize budget variances for that category. In addition, by simply selecting any given month with your mouse, the underlying detailed transactions/expenditures from that month will appear for your review.

## PERSONNEL

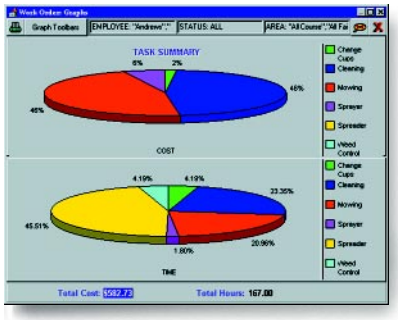
***Comprehensive Employee Information at Your Fingertips.***

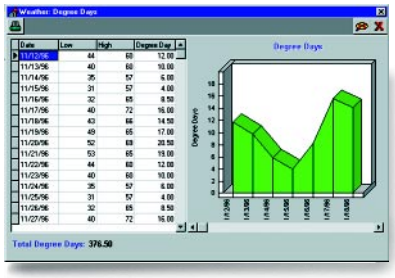
At a glance, view all types of employee information including a color photograph of each employee. With GCS, it's easy to track employee performance. The Personnel section includes an employee main listing, a performance review database, an accident report database, a pay-rates database, a calendar, and much more. GCS also includes a detailed labor tracking section.

## LABOR TRACKING

***Graph Labor Times and Costs for Different Tasks and Areas.***

It's simple to analyze individual, group, or total employee performance. Pie graphs indicate how much time and money is being spent for employees by task or area. Use your mouse to drill down to additional expense details, including work order labor cost, inventory cost, fuel cost, etc.

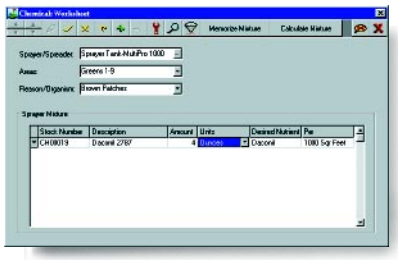





## WEATHER/IRRIGATION

***Tracking Weather and Irrigation Data is a Snap With GCS™.***

Precipitation, humidity, high and low temperatures and various other weather conditions can be recorded daily. GCS is designed to interface directly with most weather stations. Check irrigation history and treated areas by date with easy-access graphs. Degree days calculate automatically and are graphed for quick viewing.

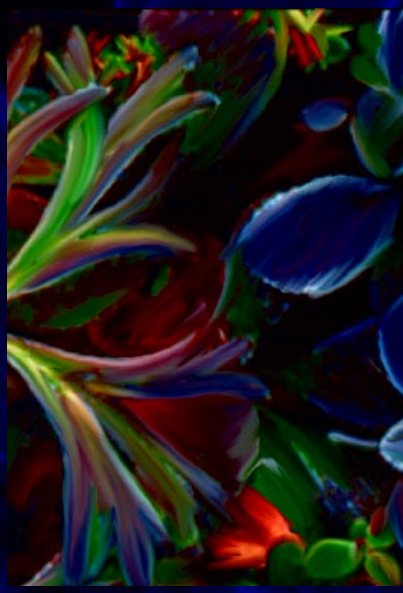



## CHEMICAL/FERTILIZER

***No More Manual Calculations.***

The Chemical and Fertilizer section allows the user to set up detailed information on sprayers, spreaders, chemicals, and fertilizers. To calculate a mixture, simply choose a sprayer or spreader, the areas you intend to treat, and the chemicals or fertilizers to be used, and GCS calculates instant, accurate tank mixtures.

GCS automatically logs all applications for future reference and reporting. Track information on date/time of application, equipment and personnel utilized, safety precautions, reason for the application, areas treated, weather conditions, and more. GCS provides proven methods for ensuring accurate applications and monitoring their results.

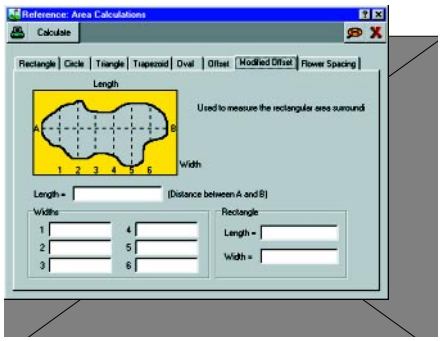


*You just fill in the blanks on the screen…then select the areas to spray and GCS™ does the rest in a few seconds!*

Landon C. Miller, Ph.D.
Clemson University

*The more I use GCS™…The more I see how much time and money it will save me.*

Matthew Bunch
Monroe, NC



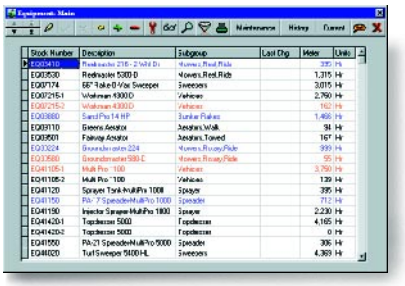

## REFERENCE

***GCS™ Includes Lots of Quick References for Your Convenience.***

Full color reference for pH and particle size charts. Reference every imaginable conversion. Calculate complex math equations quickly and easily. Area calculations include: Rectangle, Circle, Triangle, Trapezoid, Oval, and Offset. Volume calculations include: Curve, Cylinder, Cone, and Top-dressing.

## CALENDAR

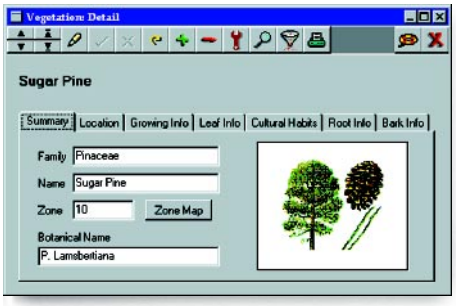
Schedule events for your employees or keep track of important equipment and supplies. View your schedule by day, month, or year. Work orders automatically post to the Calendar section for your convenience.




## EQUIPMENT MAINTENANCE

***Keeping Track of Required Maintenance on Equipment is as Easy as Clicking the Mouse.***

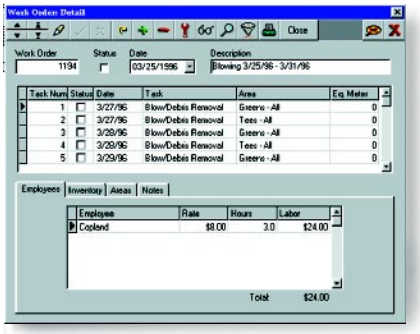
Simply click on "Required Maintenance" to view current maintenance requirements for any item in inventory. Items in need of service are outlined in red on the computer screen. Simply click on "Generate Work Order" to automatically create the order to service an item. All service requirements and equipment information automatically transfer to the Work Order section to reduce data entry. Analyze year-to-date and cumulative labor, parts, fuel, and other costs for any item to help with replace or repair decisions.




## GROUNDS

***Maintain Ground Dimensions, Course Drawings and Pictures, and a Comprehensive Vegetation Database.***

The Grounds section includes a database for maintaining all ground dimensions in square footage/acreage (metric settings also available). Include scanned images of your entire course or individual areas in the Pictures database. The vegetation library includes all types of information including growing characteristics, cultural habits, etc.




## WORK ORDERS

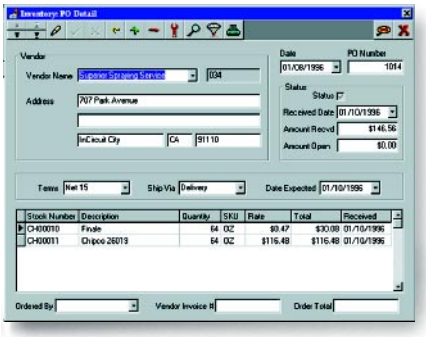
***Schedule Work Orders for Employees in Seconds!***

The Work Orders section is comprehensive, flexible, and easy to use. This section incorporates intuitive graphs that indicate employee cost and time spent for various tasks or areas. Choose “Add” to begin a new work order, then use the drop down menus to select a task, area, employee, etc. Choose the filter option to review work orders for an employee(s) on any given day, range of days, or all days. The “security” option even allows employees to fill in their own labor times while the rest of the application remains password protected. Materials used on work orders are automatically subtracted from inventory. Labor costs automatically post to the Financial section for proper budgeting. All transactions are cross–referenced and updated automatically.

## PURCHASE ORDERS

***Order Supplies and Equipment On-Line using Secure E-Commerce.***

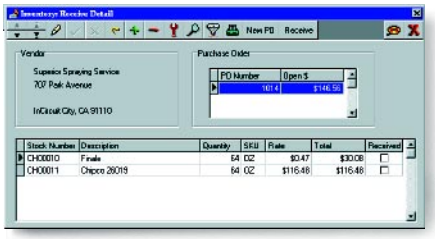
Create electronic or printed purchase orders quickly and easily with GCS. Automatic reminders indicate items that need to be reordered. With a few simple key strokes you can send an electronic or printed order to your preferred vendor. Once items are received, GCS automatically updates your on-hand inventory and financial ledgers.




## RECEIVING SCREEN

***Receiving Ordered Inventory Is Fast and Simple.***

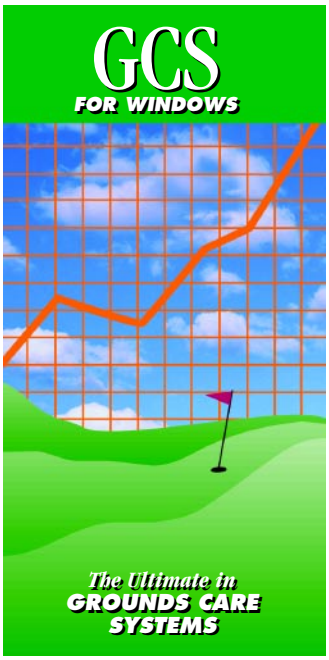
It’s easy to take delivery of ordered goods. Simply highlight the vendor you are receiving from and choose the appropriate PO. Enter the requested information such as receiving date, quantity, and amount. GCS will automatically update the on-hand amount in inventory and the associated cost in the financial ledgers.




## OTHER FEATURES

***GCS™ Includes Many Additional Custom Features.***

- QuickLoad Feature to Automatically Download Equipment Information (PM shedules and Replacement Parts), Chemical and Fertilizer Information, Parts Lookup, and Vegetation Library
- Integrated MSDS and Label Information for all Chemicals and Fertilizers
- Automate GCS Data Entry with Palm VII™ Connected Organizers for Equipment Maintenance, Work Order Scheduling, Spray Applications, Inventory Management, and much more.
- Create Unlimited Custom Reports with the Built-in Report Writer
- File Export/Import Utilities to Transfer Data with Other Business Software *(Excel, Lotus, Quattro, Quicken, etc.)*




## OUR COMMITMENT

*In addition to designing and delivering top-rated custom applications, InCircuit™ is committed to providing best-of-breed customer support.*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Austin, Texas 78746

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Web: www.incircuit.com


***Want to know more about GCS™? Call***

# 800-963-1925

***for a demo of the ultimate grounds care system.***

## UP AND RUNNING

If you need any assistance or have questions concerning the best way to set up your system, InCircuit is only a phone call away. We will walk you through the installation step-by-step and make any necessary recommendations. However, the installation of your custom system is just the beginning of your relationship with InCircuit. At InCircuit, we measure our success based on follow-up business. We are committed to providing exceptional post-sale support. InCircuit will be by your side after the installation to ensure your continued success.

***System Requirements***

To Install and Use GCS™, You Need:

| | Recommended | Minimum |
|---|---|---|
| Computer | Pentium III | Pentium I |
| RAM | 64 MB | 32 MB |
| Monitor | Super VGA | VGA |
| *Microsoft® Windows®* | 2000 | '95 or better |
| Free Hard Disk Space | 100 MB | 50 MB |
| Floppy Disk Drive | 3.5 inch | 3.5 inch |
| CD–ROM Drive | Yes | Yes |
| Mouse or Pointing Device | Required | Required |
| Browser | I.E. 5.5 or Better | Not Required |

## WORLD-CLASS TECHNICAL SUPPORT

InCircuit developed the best-selling grounds care system by listening to the requests of our users. We value a close working relationship with all our customers and want to provide you with the most comprehensive and easy-to-use software system possible. After all, the objective of a custom system is to increase your productivity. If you need any assistance to help get the most out of your system, give us a call. InCircuit is available 24 hours a day, every day of the year!

## COMPREHENSIVE SUPPORT PLANS

For customers who want a complete support plan at a fixed annual rate, InCircuit offers you several packaged support options. These options include unlimited technical support, special upgrade offers, and other custom consulting features. Ask your InCircuit customer representative for additional details.



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*GCS for Windows is a registered trademark of InCircuit Development Corporation.*

***Hills at Southampton Fertilizer Record***

SAMPLE FORM

| Date | Time | Hole & Section (circle) | Material & Brand | N-P-K | Rate | Area | Source: Irrigation | Source: Supplemental | Notes |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 2 3 4 5 6 7 8 910 11<br>12 13 14 15 16 17 18 19<br>PG Tee Fwy Green | | | | | | | |
| | | | | | | | | | |
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| | | | | | | | | | |

**Weather** Temp: Cloud: Rainfall:

Humidity: Sun: ET:

**Preparer:** _____

# Appendix 20
# ETS Response to February 1, 2016 Comments to the DEIS

**ENVIRONMENTAL & TURF SERVICES, INC.**
11510 Georgia Avenue, Suite 227
Wheaton, MD 20902
301-933-4700 ets@ets-md.com

March 30, 2016

**Responses to Dr. Marty Petrovic's Completeness Review Comments on the December 2015 Preliminary DEIS**

Stuart Cohen & N. LaJan Barnes

Dr. Marty Petrovic reviewed Appendix H of the DEIS for the Town ("Integrated Turf Health Management Plan [ITHMP], 12/9/15). It was produced by Jeff Seeman, CGCS, of EQGC, but pages 29-44 of the ITHMP were taken from selected parts of our report, "Comprehensive Risk Assessment for Pesticides and Nutrient Nitrogen for the Proposed Golf Course at The Hills of Southampton" (12/2/15). Dr. Petrovic's February 1, 2016 review of pesticide and fertilizer issues was part of the more comprehensive February 3 completeness review of the preliminary DEIS by AKRF. The latter document did not comment on our work.

Our responses follow Dr. Petrovic's comments that are within our expertise and/or our area of responsibility. For the sake of completeness, we list each of Dr. Petrovic's subtopic headings even if we do not respond. ("N/R" means we have no response.)

***"I. Review of Section 1-5***
*<u>Sections 1.4.2</u> Soils and Recognized Environmental Conditions (page I-25, 4)*
*The soil at the former farm land was tested for pesticides. If the site had been used for corn production the soil should also be tested for atrazine since it is very persistent and a common groundwater contaminate on farms (testing also needed in groundwater, Section 2.2.1 and Table 2-3)."*

We concur. The top foot of soil should be sampled and analyzed.

*"<u>Section 1.4.5</u> Benefits of the Proposed Project: General Water-Resource Related Benefits"*

N/R

*"<u>Section 1.6.2</u> Clearing & Grading and Drainage System"*

N/R

*"<u>Section 1.6.5</u> Landscaping, Lighting and Amenities*

*Irrigation Strategy: Irrigation will come from two onsite wells that currently contain concentrations of nitrogen as high as 29 mg/L. The irrigation ponds will be tested and the fertilizer applied to the golf course and other lawn areas will be adjusted based on the amount of nitrogen applied in the irrigation water. For this fertilizer strategy to be effective, the pond will need to be tested. There is no information on how often the pond will be tested for this purpose,*

*just that quarterly testing will be done. The variation in nitrogen concentration of the irrigation pond needs to be determined. A pond sampling frequency protocol needs to be provided to evaluate the effectiveness of this type of fertilization."*

We concur that such testing is necessary, but it need not be highly accurate nor very precise. Therefore we recommend that the future golf course superintendent acquire colorimetric test kits, and measure the water for nitrate and phosphate. These test kits, e.g., www.chemetrics.com, can detect less than 1 ppm nitrate and phosphate, and, assuming the superintendent reads the results, the precision is probably ±1 ppm. Each test kit can be used to process typically 20 samples. They address various concentration ranges; the test kit should be purchased for the appropriate concentration range. The sampling should be done biweekly in the peak season, monthly in the shoulder season, and once or twice during the off-season.

*"Section 1.5.8 (I believe it should be 1.6.8) Site Ownership & Operations and Maintenance Site Management: for Residential and Common Areas-The golf course superintendent should be responsible for all fertilizer and pesticide applications to comply will* [sic] *all the standards and methods used on the golf course to further insure that lawns/landscapes in the section of the project be managed to protect groundwater quality."*

We concur, but that should be decided by the Discovery Land Company.

*"Section 1.7.3 Excess Soil Removal and Impacts"*

N/R

*"Section 1.7.4 Erosion Control Measures*
*If sod is to be used in any areas of this project it must be from a Suffolk County source. If not then the sod must be tested for pesticides and the list of pesticides found on the sod be added to the list of pesticides the will be tested in the GMP. Sod that originates from outside of Suffolk County has been shown to contain pesticides that have been detected in groundwater monitoring wells at the Sebonack Golf Club."*

We concur in principle, but we have found that sod producers are often reluctant to disclose the list of pesticides applied to purchased sod. We suggest that the sod producer be asked to certify whether pesticides permitted for use in Suffolk County were the only pesticides applied to the sod prior to shipment. If not, then those pesticides should be added to the analyte list.

*"Section 1.7.5 Maintenance Area Facilities and Operation"*

N/R

*"Section 2.1.1 Soils"*

N/R

*"Section 2.2.2*
*Hydrology: Pumping 35million gal/yr for irrigation could have at least a temporary impact on groundwater flow during the months of irrigation and minimal groundwater recharge."*

It is our understanding that this figure refers to the whole project site. We cannot comment on the aquifer drawdown issue, but we feel it should be noted that an upper 90th percentile water use rate for the golf course should be well under 30 million gallons.

> *"Groundwater Quality: There is no mention of the potential impacts of the pesticides and fertilizers use on the lawns on the non-golf part of the project."*

It is true that there is no explicit statement regarding lawn care chemical impacts to ground water. However, section IX of our December draft, "Lawn Care on the East End", described the potential use of fertilizer N and pesticides at The Hills. (Apparently, this was overlooked in the Town's review.) The potential risks of most of the pesticides had been evaluated in sections V, VI, and VII.

However, in response to this comment, we amended section IX of our draft report, which is now section VIII of our March 28 report and includes a new subsection (D) that explicitly addresses the risk issue

> *"The statement that "The Hills at Southampton golf course will utilize management practice controls to **severely** restrict the use of agricultural chemicals associated with turf maintenance" needs clarification. The ITHMP (Tables 9, 10 & 11 of Appendix H) has defined a list of 29 pesticide active ingredients that could be applied from 1 to 6 times a year. Such an extensive list coupled with a no restrictions on application frequency or total amount applied per year is not **severely** restricted. In contrast, a golf course like The Bridge only used 4 fungicides and 4 herbicides in 2014. A much more specific and detailed pest management/pesticide use protocol needs to be presented to be able to evaluate the impact. A more detailed review will follow in the review of Appendix H."*

We concur, but please note that we have added more restrictions since the first draft that was produced prior to the completeness review.

> *"The greens liners do collect drainage water from the greens but may not collect all of the water or be 100% effective of biological uptake/retention of drainage water, nutrients or pesticides."*

N/R

> *"GMP should be amended to test for all pesticide applied to the project site in the previous 12 months, except for biological pesticides."*

We constructed Table 1 below to demonstrate which pesticides could be readily analyzed with off-the-shelf technology, and which pesticides do not yet have a feasible water analytical method. It is possible that methods could be adapted to analyze these latter pesticides in the future, but the project team should plan to not use pesticides that cannot be analyzed. Table 1 is also Table 17 in our March report.

**Table 1. Pesticides and Analytical Methods**

| Pesticide | Methods | Method Reporting Limit (µg/L) | COMMENTS |
|---|---|---|---|
| Herbicides | | | |
| Benefin | S150 | 0.1 | |
| Bensulide | L300/L302 | 0.5 | |
| Bispyribac-sodium | L302 | 0.5 | |

| Pesticide | Methods | Method Reporting Limit (µg/L) | COMMENTS |
|---|---|---|---|
| Carfentrazone-ethyl | L302 | 0.5 | |
| Dimethylamine salt of 2,4-D | 515.3 | 0.1 | |
| Dicamba | 515.3 | 0.1 | |
| Ethofumesate | S150 | 0.1 | |
| Fenoxaprop | S150 | 0.1 | |
| Fluazifop-P-butyl | S150 | 0.1 | |
| Glyphosate | 547 | 6.0 | |
| Halosulfuron-methyl | L300/L302 | 0.5 | |
| MCPP | 515.3 | 0.5 | Will not be used at The Hills |
| Mesotrione | L305 | 1.0 | |
| Pendimethalin | S150 | 0.1 | |
| Potassium Salts of Fatty Acids* | -- | -- | Not applicable |
| Prodiamine | L302 | 0.5 | |
| Quinclorac | L302 | 0.5 | |
| Sethoxydim | RD-100[†] | 0.1 | Special Eaton lab method – LC/MS |
| Trifluralin | S150 | 0.1 | |
| Fungicides | | | |
| Aluminum tris O-ethyl (Fosetyl-Al) | L303 | 1.0 | |
| Azoxystrobin | L300/L302 | 0.5 | |
| Bacillus subtilis | -- | -- | Not applicable |
| Boscalid | L302 | 0.5 | |
| Chlorothalonil | S150 | 0.1 | |
| Acibenzolar | * | * | No Eaton Lab method |
| Etridiazole | S150 | 0.1 | |
| Fluazinam | * | * | No Eaton Lab method |
| Flutolanil | S150 | 0.1 | |
| Iprodione | S150 | 0.5 | |
| Mefenoxam (Metalaxyl) | L302 | 0.5 | |
| Metconazole | S150 | 0.5 | |
| Mineral oil + pigment | -- | -- | Not applicable |
| Myclobutanil | S150 | 0.1 | |
| Penthiopyrad | * | * | No Eaton Lab method |
| Polyoxin D | -- | -- | Not applicable |
| Propamocarb | L301 | 0.5 | |
| Propiconazole | S150 | 0.1 | |
| Pyraclostrobin | L302 | 0.5 | |
| Thiram | L301 | 10.0 | |
| Triadimefon | L300 | 0.5 | |
| Triadimenol[§] | L300 | 0.5 | |
| Trifloxystrobin | L302 | 0.5 | |
| Insecticides | | | |
| Bifenthrin | S150 | 2.0 | |
| Carbaryl | L300/L302 | 0.5 | |
| Chlorpyrifos | S150 | 0.1 | |
| Deltamethrin | S150 | 0.1 | |
| Imidacloprid | L300/L302 | 0.5 | |
| Lambda-cyhalothrin | S150 | 0.1 | |
| Parasitic Nematodes | -- | -- | Not applicable |

| Pesticide | Methods | Method Reporting Limit (µg/L) | COMMENTS |
|---|---|---|---|
| Spinosad | -- | -- | Not applicable |
| Growth Regulators | | | |
| Ethephon | L303 | 1.0 | |
| Paclobutrazol | L300/L302 | 0.5 | |
| Trinexapac-ethyl | S150 | 1.0 | |

†This method was developed from the standard and run using the LC/MS (liquid chromatography/mass spectrometry) technique.
*Eurofins Eaton Analytical Laboratory does not currently analyze for these three pesticides. However, they can obtain the standards for each, if available, and develop a method or run it under their special RD-100 method, which is a method they use for pesticides not in one of their current analytical methods.
§ triadimenol – metabolite of triadimefon

> *"X. CONCLUSIONS AND RECOMMENDATIONS:*
> *Pesticides: based on the risk assessment 7 pesticides (bensulide, carbaryl, chloropyrifos, flutolanil, chlorothalonil, etridiazole and iprodione) will only be applied to greens and occasionally to tees based on their higher level of risk. The assumption is the application to greens will not affect groundwater quality because the greens drainage will be captured by the liners and treated by the rain gardens. The effectiveness of these particular rain gardens to filter these specific pesticides (and nutrients) has not been provided to justify the use of these high risk pesticides to greens. Because of the higher risk these 7 pesticides should not be applied to tees unless there is some pest emergency and no other control option is available. Furthermore, any pesticide that has been detected in the groundwater monitoring wells at The Bridge and Sebonack golf courses should not be used at The Hills since they have shown the ability to leach into groundwater from the similar soils and management that The Hills is proposing.*
>
> *As a guiding principal, The Hills should consider not using pesticides that have been classified now or in the future as possible, probable or likely carcinogenic to humans to protect works, golfers, residents, visitors to The Hills and the general public. The list of current pesticides includes: bifenthrin, carbaryl, tridiamefon, propaconazole, iprodione, prodiamine, chlorothalonil and etridiazole. That being said, if there are situations where no other control methods are available or have not work, there should be a consideration given to allow for their use under emergency set of the conditions. Furthermore, USEPA and NYSDEC in registering these pesticides take into consideration many factors including long term chronic effects and can be used in accordance with the label directions without causing oncogenic effects in humans. Environmental & Turf Services did considered all of these factors and included them in their report."*

The following table addresses Dr. Petrovic's concerns. Basically, we explain that several of the pesticides that yielded positive results in the rodent cancer bioassays have elevated thresholds for causing any type of cancer effects (they are not governed by linear low-dose extrapolation); i.e., if one protects for the most sensitive non-cancer endpoint, one will be very protective for potential cancer effects.

**Table 2. Recommendations for Restricting Pesticide Use Based on Dr. Petrovic's Review**
**(Table 18 of our revised 03/28/16 report, "Recommendations for Restricting Pesticide Use Based on a Higher Level Toxicologic Analysis)**

| Pesticides Flagged for Oncogenic Characteristics | Comments on Toxicology | Detected in Sebonack's or The Bridge's Ground Water? [PRZMGW results: mean conc. ppb in brackets] | Field EIQ > 25? Yes or No | Field EIQ >50? Yes or No | Recommendation |
|---|---|---|---|---|---|
| Triadimefon + metabolite triadimenol | The most sensitive No Observed Adverse Effects Level (NOAEL) in the mouse carcinogenicity study was 13.5 mg/kg-day, and the NOAEL in the subchronic neurotoxicity study in rats was 3.4 mg/kg-day (Griffin et al., 2006). Therefore basing the drinking water HAL on the latter effect is more protective of the cancer effect. (Group C) | Triadimefon [3.2E-6] not detected, but the triadimenol metabolite [7.9E-3] was detected. | Yes (62) | Yes | Use on turf at the project should not be prohibited, but use on home lawns should be minimized. |
| Propiconazole | "Propiconazole is not genotoxic and this fact, together with special mechanistic studies, indicate that propiconazole is a threshold carcinogen . . . At doses below the RfD, liver toxicity is not expected; therefore tumors are also not expected" (US EPA 2014). Therefore basing the drinking water HAL on the 0.1 mg/kg-d RfD will be protective for the cancer effect. (Group C) | Propiconazole detected [1.99E-6] | Yes (34.8) | No | Use on tees and greens should not be prohibited. Not recommended for the lawn care program. The FEIQ score is "low". |
| Iprodione | "Likely" human carcinogen (Taylor, 2012). Linear low dose extrapolation yields a *de minimus* HAL of 0.8 ppb, vs. an HAL of 350 ppb (US EPA, 2013) based on a hormonal effect (Taylor, 2012). | Iprodione detected [3.72E-3] | Yes (66.0) | Yes | Based on Dr. Petrovic's concerns, this pesticide is not recommended for use in the lawncare program, and is not recommended for use on the golf course except for lined greens. |
| Prodiamine | "The EPA Peer Review Committee classified prodiamine as a Group C carcinogen based on a weight of evidence consideration. They concluded that a Reference Dose (RfD) approach was indicated as being appropriate for quantification of human risk. Their recommendation was based on the absence of genotoxicity, the nature of the response (benign thyroid follicular cell tumors) and the lack of a clear neoplastic response at sites other than the thyroid" (Lindsay, 1992). Therefore an HAL based on the chronic reference dose is more protective of the cancer effect. | Not detected [0.0] | No (11.5) | No | Use on turf at the project should not be prohibited. The FEIQ score is "very low", and cancer is not a risk to people exposed to levels much higher than might occur in the environment. |

| Pesticides Flagged for Oncogenic Characteristics | Comments on Toxicology | Detected in Sebonack's or The Bridge's Ground Water? [PRZMGW results: mean conc. ppb in brackets] | Field EIQ > 25? Yes or No | Field EIQ >50? Yes or No | Recommendation |
|---|---|---|---|---|---|
| Chlorothalonil | "EPA has determined that the mechanism of carcinogenicity is non-linear (i.e., not a non-threshold effect) and that the point of departure used in calculating the cPAD is protective of the cancer effects" (Federal Register, 2008). This conclusion appears to form the basis for the fact that the US EPA has issued tolerances for chlorothalonil use (residues) on more than 40 crops (40 CFR §180.275). Also, the FEIQ score is very high, mostly due to chlorothalonil's toxicity to aquatic organisms (Tables 10 and 13 of our report), but no aquatic organisms will be exposed. | Chlorothalonil detected [0.0] | Yes (308.7) | Yes | Use on the home lawns should be prohibited, based on Dr. Petrovic's concerns. Use on tees and greens should not be prohibited. |
| Etridiazole | It is a category B2 carcinogen ("probable"), with linear low dose extrapolation (US EPA 2000). Its carcinogenic potency factor is also relatively high, yielding a low HAL. "Moderate" FEIQ. | No [1.81E-12] | Yes (95.3) | Yes | Prohibit use on all turf, based on Dr. Petrovic's concerns. |
| | "Low" FEIQ. Group C ("possible" carcinogen), but the cRfD protects for cancer, which followed a nonlinear response (US EPA, 1997) | Pendimethalin† not modeled w/PRZM GW | Yes (265.5) | Yes | No lawn use. |
| | Not a carcinogen (Group E), and "low" FEIQ score, but detections very long after use, albeit at low levels, warrant caution. | Myclobutanil [1.76E-6] | Yes (31.7) | No | Recommend use on tees and greens only. |
| | Flutolanil is in carcinogenicity category Group E, "no evidence of carcinogenic potential," and its HAL is very high (low toxicity), but its FEIQ score is very high. | Flutolanil* [1.39E-4] | Yes (399.6) | Yes | Allow use on golf course, prohibit use in lawn care. |
| | "Low" FEIQ score (close to "very low"). | Paclobutrazol [4.58E-2] | Yes (26.4) | No | Allow use on all turf. |
| | "Low" FEIQ score. High HAL (low toxicity). | Ethofumesate* [9.9E-6] | Yes (38.7) | No | Allow use on all turf. |
| | "Very low" FEIQ score. Not carcinogenic (Group E). | Imidacloprid [2.285E-3] | No (11) | No | Allow use on all turf, but do not apply within two weeks of blossoming of adjacent flowers. |
| | "Very low" FEIQ score, but high PRZSM-GW result. | Quinclorac* [53.5] | No (16) | No | Allow use on tees and greens only. |

*It was not used on the golf courses; it may have originated from purchased sod after application by a sod farm.
† listed for lawn care not golf course use.

**References for Table 2 above**

Federal Register. December 3, 2008. Chlorothalonil; Pesticide Tolerances. 73(233), pp.73580-73586.

Griffin, R., J. Facey, S. Recore, Y. Barnes, and S. Ary. February 9, 2006. Triadimefon. Preliminary Human health Risk Assessment (revised memorandum). Health Effects Division, Office of Pesticide Programs, US EPA, Washington, DC. 102 pp.

Taylor, L. March 27, 2012. Iprodione. Revision of Endpoint Selection for New Dietary Assessment. Memorandum. Health Effects Division, Office of Pesticide Programs, US EPA, Washington DC.

US EPA. June 1997. Reregistration Eligibility Decision. Pendimethalin. EPA 797-R-97-007.

US EPA. September 2000. Reregistration Eligibility Decision (RED). Etridiazole (Terrazole®). EPA 783-R-00-019.

US EPA. April 2, 2014. Propiconazole; Pesticide Tolerances (Final Rule). Federal Register, 791(63), pp. 18461-18467.

US EPA. 2013. Human Health Benchmarks for Pesticides. Site visited 3/22/16. https://iaspub.epa.gov/apex/pesticides/F?p=HHBP:home

> *"Section 4.7 Impact on Public Health*
> *The reference to restricted use on the above list pesticides (and others that are possible, probable or likely carcinogenic to humans) needs to be modified as described above."*

See section IX of our March 28 report.

> *"Section 5.6.1 Using the Same Natural Organic Turf Management Techniques for Both the Golf Course and Residential Landscape Areas:*
> *Due to the much more limited pest complexes that lawns have (little or no diseases, but similar weeds and fewer insects) compared to golf courses, natural organic practices are much more feasible and should be studied further, pest by pest. There also needs to be a much more complete analysis of why the organic practices used at the Vineyard Golf Club golf course in Edgartown, MA (which has been operating an organic golf course with similar conditions to The Hill project site for the past 12 years) would not work at The Hills golf course. Both the golf course and residential landscapes need a much more detailed management plan that is now contained in Appendix H."*

Our lawn care management plan was overlooked during the Town review, probably because it was not excerpted and placed into the ITHMP. We have expanded it – it is now section VIII of our March 28 report – and added a risk evaluation component. We defer to Jeff Seeman of EQGC regarding the Vineyard Golf Club issue.

> *"**II Appendix F: SONIR MODEL (Simulation of Nitrogen in Recharge), Nelson, Pope & Voorhis, LLC, December 18, 2015**"*

N/R

*"**III. Appendix H: Integrated Turf Health Management Plan (ITHMP) for the Hills Golf Course East Quogue, Southampton, New York, Jeffrey L. Seeman, December 9, 2015***

*1. Fertilizer program"*

N/R

*"2. Grass selection and clipping management"*

N/R

*"3. Pest Control"*

N/R

*"4. Risk Assessment*
*The risk assessment should be further analyzed to only contain the pesticides that will be used. The reason is, with the fewer list of pesticides, the number of applications of some of the materials (especially fungicides) will likely increase. Using pesticide records from other close by golf courses can help determine the most prevalent pests, when they occur, and how often pesticides might be needed. The Field EIQ can be redone with this information and is needed to give a more realistic risk assessment. All pesticides that will be used should have the reanalyzed Field EIQ < 25.*

*Table 11 contains a fungicide acibenzolar which appears to not have been run through the risk assessment protocol and thus should be removed. None of the pesticide that are possible, probable or likely carcinogenic to humans (bifenthrin, carbaryl, tridiamefon, propaconazole, iprodione, prodiamine, chlorothalonil and etridiazole) should be used on this proposed site (golf and non-golf areas) or only used under emergency conditions where no other control methods are available or have not work."*

Acibenzolar was modeled; see Tables 12 & 13 in our report. It is listed with chlorothalonil because they are both active ingredients in the product Daconil Action. Acibenzolar results are identified in all tables.

*"Specific Comments on the ITHMP not described in any of the sections above*

*Table 5, page 33-34: Trimec Classic (2,4-D, dicamba and mecoprop) is often applied in fall (not just in the spring) for better control of many broadleaf weeds; change one of the spring applications to a 10/1 date."*

We remodeled the Trimec pesticides using a spring and fall application, as well as adjusting three soil input parameters FC, WP, and OC as requested (see below).

*"Page 37: There are extensive weather data sets for eastern Long Island, why use Atlantic City? Unless it can be shown that the rainfall patterns and intensity are very similar, Southampton and other factors important in a water balance (like temperature, wind, relative humidity) are similar a more appropriate data set should be used. All other weather data used in other sections are from eastern Long Island sources."*

We selected a weather file from the U.S. EPA database in the northeast that has a similar annual average rainfall and temperature to The Hills site. The weather file selected is Atlantic City, New Jersey, and the EPA provides it in the specialized format required to run the PRZM-GW model (http://www2.epa.gov/exposure-assessment-models/meteorological-data). The Atlantic City weather data for the PRZM-GW modeling was used because it is a coastal environment similar to Long Island. However, in response to comments received from Dr. A.M. Petrovic during the completeness review, we quantitatively compared the precipitation and temperatures for Atlantic City and Long Island, as follows.

We compared the Atlantic City (NJ-3 coastal) and Long Island (NY-4 coastal) precipitation and temperature for the 30 modeled years (1961-1990) using the regional data tables from the NRCC (National Regional Climate Center; Cornell University) to show the similarities (Figures 1 and 2 below). The data show that the 30-yr average precipitation for the NY-4 coastal (44.69") is slightly higher than the NJ-3 coastal (42.79") for the same years; NY-4 is only 4.4% higher. The RPD (relative percent difference) is only 7% for the 30 year period, which indicates consistency between the amounts. In addition, we compared the temperatures for those stations for the same time period. The average temperature for the NY-4 coastal is 51.46ºF compared with NJ-3 coastal of 52.10ºF, a 3% RPD, also a very minor difference (http://www.nrcc.cornell.edu/regional/tables/tables.html). Therefore, the Atlantic City weather file that was selected and provided by the US EPA in the correct format for the PRZM-GW modeling is comparable to Long Island weather. In addition, the US EPA does not offer datasets for Long Island or coastal NY for modeling. In any case, the differences in weather between NJ-3 coastal and NY-4 coastal are insignificant, i.e., RPDs are very low for precipitation and temperatures.

Figure 1. Annual Average Precipitation NJ-3 vs. NY-4

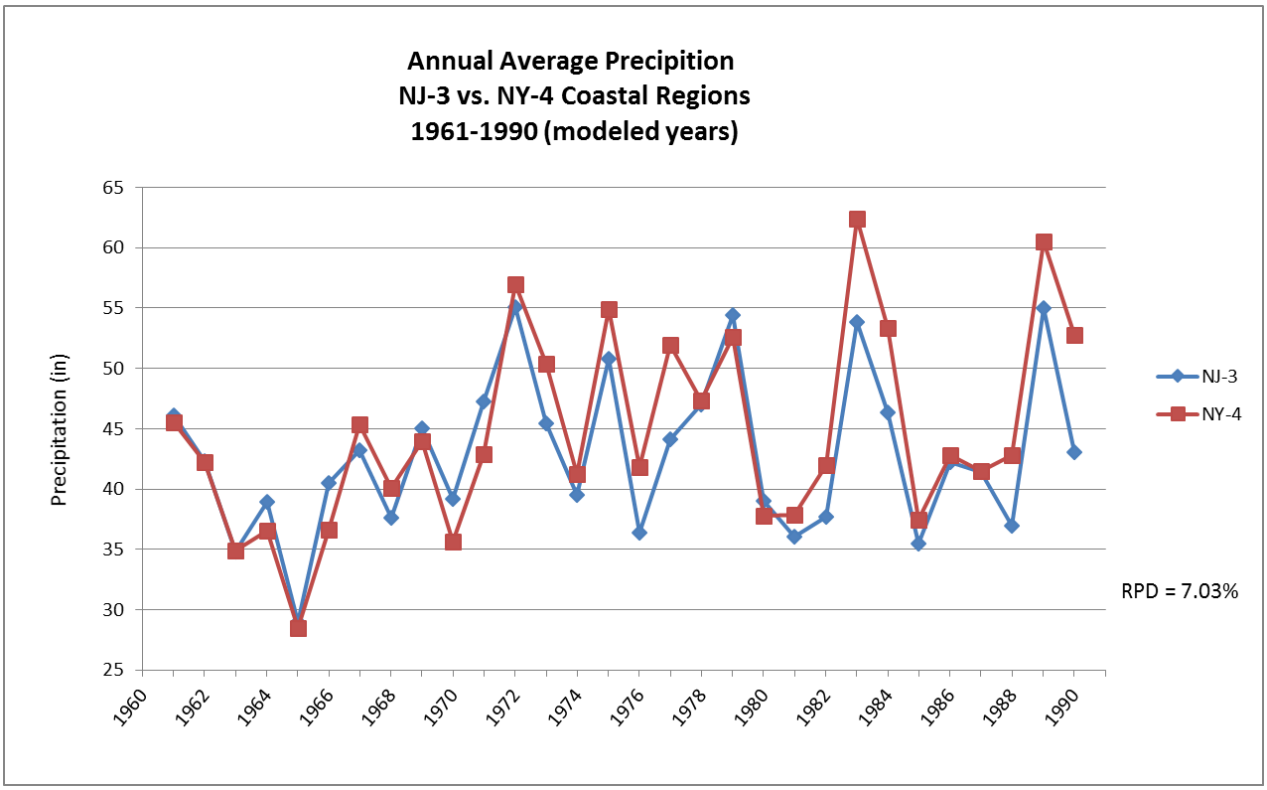
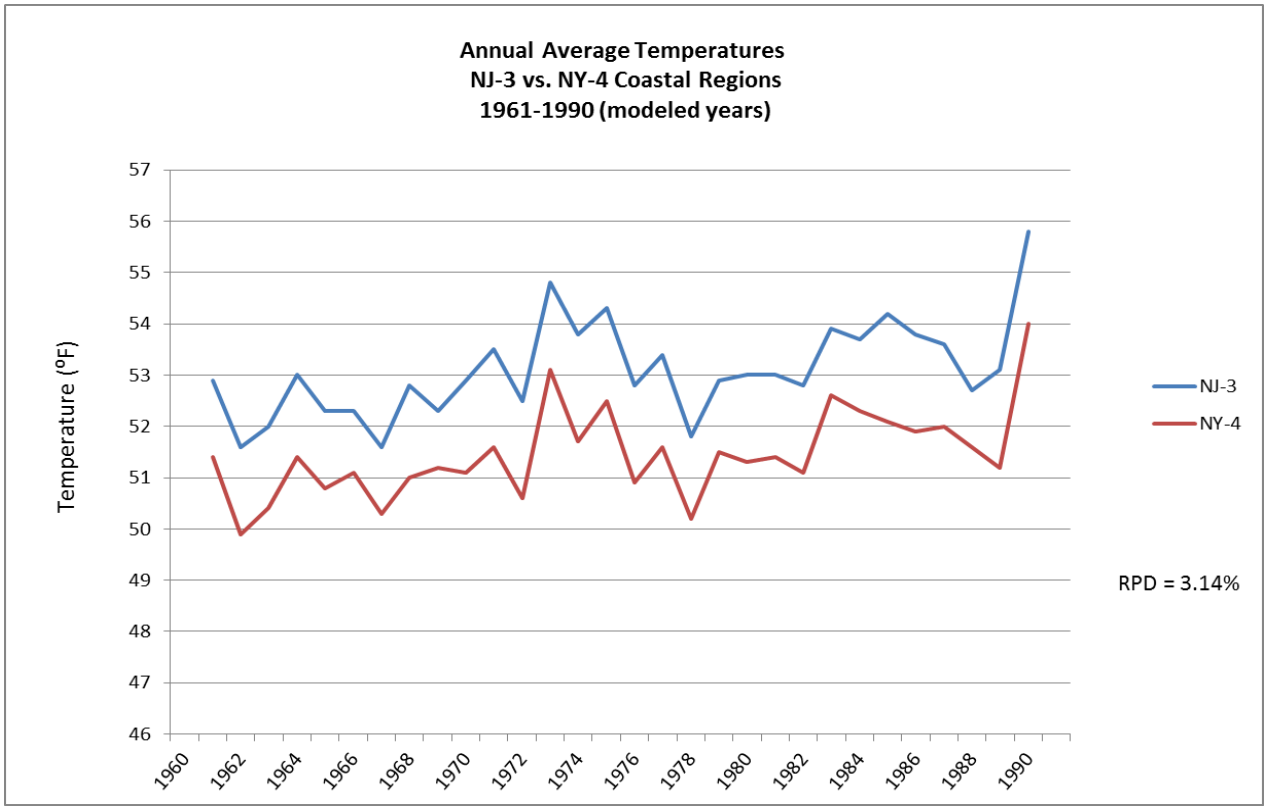


Figure 2. Annual Average Temperature NJ-3 vs. NY-4




> *"Page 37, Table 7: the 0-4" data for Max and Min water capacity is based on samples taken on site (found in the appendix of this section). However, one of the 3 samples had very high max and min result that elevated the numbers used in the risk assessment. Having 26% max and 24% min are not realistic for a sand soil like the ones on this site and should not be used. The risk assessment should be redone using more a legalistic* [sic] *value. To be on the conservation side of risk determination, the organic carbon (OC) values for soils below 24" should be zero not 0.46 unless there is data to confirm OC at those levels at those depths. Organic carbon is important in reducing the leaching of many pesticides."*

We assume that "*legalistic value"* mentioned above should be "realistic value." The model input parameters for the soil were based on the analytical results of the soil samples collected on-site as mentioned in our report.

However, we adjusted the field capacity (FC), wilting point (WP), and organic carbon (OC) for three pesticides: 2,4-D, dicamba, and MCPP (see results below). The average of the three samples collected to determine FC and WP at the 0-4 inch depth used in modeling pesticides was 16% at 1/3 bar [(7+14+27)/3=16%] and 12.67% at -15 bar [(5+8+25)/3=12.67%], respectively (see Soil Results, Table 3 in our March report). Although the results for the one sample appear to be relatively high, it is within the range of values for PRZM-GW modeling for sand and sandy loam soils. The FC range of values for sand is 0.018 to 0.164, and for WP the range for sandy loam is 0.031 to 0.159 (Suarez, 2005). The average values that we used are within these ranges. In addition, the Northeast Regional Certified Crop Advisor

(NRCCA) Study Resources from Cornell University state that the "moisture content remaining at FC is about 15 to 25% for sandy soils" (http://nrcca.cals.cornell.edu/soil/CA2/CA0212.1-3.php). The 16% we used for FC is on the low end of that range. The NRCCA study also shows that the range for WP in sandy soils is 5 to 10%. We were only slightly outside the high end for WP. However, the RPD for the 27% FC and 25% WP sample is only ~8% compared with the other samples with lower FC and WP values (i.e., RPDs = 33 and 55% for the two lower values, respectively). Therefore, the average values used for the original modeling for FC and WP at the 0-4" depth are well within the appropriate ranges for water holding capacities for The Hills soils.

Nonetheless, we remodeled three pesticides (noted above) using the PRZM-GW model, omitting the higher FC and WP values, and averaged two samples instead of three, which lowered the FC and WP values: FC = 10.5 [(7+14)/=10.5%] instead of 16.0 and 6.5 [(5+8)/=6.5%] instead of 12.67 for WP (see Table 3 below; 7b in our revised report). In addition, we used 0.0 OC% (i.e., no organic matter) for the input parameter at depths >24" as requested. Table 3 below shows the input parameters that were changed (bold).

Reference: Suarez, L.A. September 2005. PRZM-3, A Model for Predicting Pesticide and Nitrogen Fate in the Crop Root and Unsaturated Soil Zones: Users Manual for Release 3.12.2. EPA/600/R-05/111. U.S. Environmental Protection Agency, Office of Research and Development, Washington DC.

**Table 3. Revised PRZM-GW Soil Input Parameter for Remodeling (Taken from Table 7b of our revised report)**

| Sampled Depths (in) | Modeled Depths (m) | Bulk Density (g/mL)*† | Max Water Capacity** (FC; 1/3 bar) | Min Water Capacity‡‡ (WP; -15 Bar) | OC %§ |
|---|---|---|---|---|---|
| 0-4 | 0-0.1 | 1.208 | **10.5** | **6.5** | 1.41 |
| 4-8 | 0.1-0.2 | 1.236 | 6.33 | 3.33 | 0.41 |
| 8-12 | 0.2-0.4 | 1.236 | 6.33 | 3.00 | 0.6 |
| 12-24 | 0.4-0.6 | 1.236 | 5.67 | 2.67 | 0.46 |
| No Sample | 0.6-0.8 | 1.236 | 5.67 | 2.67 | **0.0** |
| No Sample | 0.8-1.0 | 1.236 | 5.67 | 2.67 | **0.0** |
| No Sample | 1-11 | 1.236 | 5.67 | 2.67 | **0.0** |
| No Sample | 11 to (11+1) | 1.236 | 5.67 | 2.67 | **0.0** |

The three pesticides remodeled were 2,4-D, dicamba, and MCPP. Table 4 below shows our original results. We changed the values of three input parameters (FC, WP, and OC) at specific depths, as noted above. In addition, the application timing was changed to reflect a spring and fall application as recommended. The results for the remodeling (Table 5 below) show only a slight increase in the risk ratio (RR) to humans for 2,4-D: the original modeling result for the human RR = 2.10E-4 (Table 4) compared with the remodeling RR = 2.12E-4 (Table 5), basically no change for 2,4-D. However, there was an increase in the RRs (less conservative) for dicamba and MCPP (see the tables below to compare the results). Note that a very old standard for these two chemicals was used to determine the risk ratio (i.e., old/"former" NYDEC standard of 0.44 ppb).

**Table 4. Risk Quotient Calculations – original results (Taken from Table 11a in our revised report)**

| CHEMICAL | Peak Conc. (ppb) | Did the Result Exceed One of the Acute Values in Table 10? | Entire Simulation Mean Concentration (ppb) | Did the Result Exceed One of the Chronic Values in Tables 10 or 9? | Risk Quotient | | |
|---|---|---|---|---|---|---|---|
| | | | | | Human | Aquatic | |
| | | | | | | Acute | Chronic |
| 2,4-D | 0.031 | No | 0.0105 | No | 2.10E-4 | 2.37E-03 | 7.39E-07 |
| dicamba | 1.31 | No | 0.583 | 0.44 (old/"former" NYDEC std) | 1.33 | 2.15E-02 | 5.30E-02 |
| MCPP | 7.09 | No | 3.16 | 0.44 (old/"former" NYDEC std) | 7.18 | 5.06E-01 | 6.22E-05 |

**Table 5. Risk Quotient Calculations – remodeled results (Taken from our revised report: Table 11b.)**

| CHEMICAL | Peak Conc. (ppb) | Did the Result Exceed One of the Acute Values in Table 10? | Entire Simulation Mean Concentration (ppb) | Did the Result Exceed One of the Chronic Values in Tables 10 or 9? | Risk Quotient | | |
|---|---|---|---|---|---|---|---|
| | | | | | Human | Aquatic | |
| | | | | | | Acute | Chronic |
| 2,4-D | 0.454 | **No** | 0.106 | No | 2.12E-4 | 3.47E-02 | 7.46E-06 |
| dicamba | 11.5 | No (dicamba acid chronic invertebrate = 11 ppb) | 7.76 | 0.44 (old/"former" NYDEC std) | 17.6 | 1.89E-01 | 7.05E-01 |
| MCPP | 14.1 | No (MCPP-P DMAS nonvascular plants acute = 14 ppb) | 6.3 | 0.44 (old/"former" NYDEC std) | 14.3 | 1.01E+00 | 1.24E-04 |

***"IV. Appendix I: Groundwater Monitoring Protocols (GMP), Nelson, Pope & Voorhis, LLC, October 16, 2014"***

N/R; however, see Table 1 above and its explanatory text.

# Appendix 21
# Typical Fairway Soil Standards

Profilegolf™

# *Profile Field & Fairway™*

## *"Pre-Blending" with Native Soil Root Zones or "Fairway Capping"*

Listed below are the suggested guidelines for blending Profile Field & Fairway™ into a native soil prior to apply the finished product as a capping material.

*In order to maximize the end result or finished playing surface:*

- The excavated or imported topsoil shall be stockpiled in a fashion, which promotes the natural shedding of rainfall, minimizing the potential for supersaturating the stockpiled topsoil.

- The stockpiled topsoil shall be free of sticks, stone and any other foreign materials prior to blending. The stockpiled soil and blended topsoil mix shall be screened and must pass through a 1½-inch opening. Excessive pulverizing or impact shattering should be avoided to prevent soil structure loss.

- Contractor shall incorporate Profile Field & Fairway into the stockpiled topsoil at a rate of 10-20% (by volume) or an inclusion rate of 95-190 pounds (respectively) per blended yard of finished fairway capping material. The finished capping material shall be homogeneous in appearance, lacking any pockets or heavy concentrations of Profile Field & Fairway.

- The actual blending/incorporating shall be accomplished via a double-hopper blending/screening unit. The opening or gate on each feed hopper shall be adjustable to control the calibration and flow of materials.

- The stockpiled capping material shall be inspected and approved prior to placing it on the playing surface area.

- Apply the fairway capping material at the pre-determined depth. Typically this is between 4 -12 inches. Be sure the application depth is carefully followed. An over-application of just 1-inch in depth will result in the need for an additional 135 cubic yards of fairway capping blend per acre.

- Once the fairway capping material is placed and graded, seed and/or sod areas as desired.

Profile Project Managers specially trained in root zone development, erosion control and turf establishment are available to assist you with your new construction or renovation project. Call Profile Products at **1-800-207-6457** to request a free project consultation.

Profilegolf™

# Profile Field & Fairway™

## "On-Site Tilling Method" with Native Soil Root Zones

Listed below are the suggested guidelines for tilling/incorporating Profile Field & Fairway™ into native soil applications.

*In order to maximize the end result or finished playing surface:*

- The sod and thatch (organic) layer of the area should be stripped and properly discarded. Extra care shall be exercised to minimize the loss of the existing topsoil layer.
- Evenly apply a layer of Profile Field & Fairway to the stripped area to the depth matching the tilling depth and percentage of Profile Field & Fairway desired.

**Application Chart**

(Depth in Inches of Profile Field & Fairway)

| | 10% | 15% | 20% |
|---|---|---|---|
| 4" tilling depth | .4" | .6" | .8" |
| 5" tilling depth | .5" | .75" | 1.0" |
| 6" tilling depth | .6" | .9" | 1.2" |

| Application Depth | Pounds/1,000 sq. ft Profile Field & Fairway | Tons/Acre Profile Field & Fairway |
|---|---|---|
| .4" | 1162 | 25 |
| .5" | 1455 | 32 |
| .6" | 1748 | 38 |
| .75" | 2183 | 48 |
| .8" | 2334 | 51 |
| .9" | 2627 | 57 |
| 1.0" | 2911 | 64 |
| 1.2" | 3496 | 76 |

- Incorporate the Profile Field & Fairway into the desired depth via the use of a reverse-tilling machine (i.e. Rotadiron, or Blec-a-Vator). Care must be taken so as not to exceed the desired depth. This will dilute the incorporation volume.
- The tilling operation shall be performed twice with the second run at a 45-degree angle to the first run.
- With the soil amended and prepared, seed or sod as desired.

Profile Project Managers specially trained in root zone development, erosion control and turf establishment are available to assist you with your new construction or renovation project. Call Profile Products at **1-800-207-6457** to request a free project consultation.

# Appendix 22
# Turf Sprayer with Boom Shrouds

# OPTIMUM

SPRAYING DEVICES, INC.

## Series

# VM160D/DS, VM225D/DS, & VM300D/DS

SDI manufactured to pin mount exclusively on the Cushman® Turf-Truckster® by Jacobsen®.

***Model Shown:*** VM225D/DS equipped with the OTB15/10-3 triple nozzle Greens & Tees Boom and the Raven SCS440 Spray Controller fitted with SDI's Motorized Boom Valves.

Form: 1903.108.sb

Spraying Devices, Inc., P.O. Box 3107, Visalia, CA 93278-3107 • Tel: (559) SDI-5555 • Fax: (559) SDI-5591
www.sprayingdevices.com • e-mail: sales@sprayingdevices.com

| ***Standard Specs:*** | ***Optimum VM160D/DS*** | ***Optimum VM225D/DS*** | ***Optimum VM300D/DS**** |
|---|---|---|---|
| *Fiberglass Tank:* | 160 Gallons | 225 Gallons | 300 Gallons |
| *Dimensions (tank only):* | 56"L x 52"W x 25"H | 56"L x 64"W x 26"H | 59"L x 64"W x 30"H |
| *Dry Weight:* | 265 lbs. | 300 lbs. | 335 lbs. |
| *Agitation:* | V-6 Hydro-Mix Jet | V-6 Hydro-Mix Jet | V-6 Hydro-Mix Jet |
| *Spray Pump:* | (3) Diaphragms w/ Damper | (3) Diaphragms w/ Damper | (3) Diaphragms w/ Damper |
| *Pump Regulator:* | Micrometer Adj. 0-200 PSI | Micrometer Adj. 0-200 PSI | Micrometer Adj. 0-200 PSI |
| *Pump Power:* | Auxiliary Hydraulics | Auxiliary Hydraulics | Auxiliary Hydraulics |
| *Standard Color:* | Jacobsen® Orange | Jacobsen® Orange | Jacobsen® Orange |
| *Cushman® Mounting:* | 2-Pin System | 2-Pin System | 2-Pin System** |

****Please note: 300 gallon model can only be used on diesel truckster and must be modified with rear axle truss and 6 ply tires.**

**Special Features:**

•Pin Mounts exclusively to the Cushman® Turf-Truckster® in less than 5 minutes. Uses two utility box hinge pins for quick easy attachment.

•Custom molded low profile fiberglass tank has color-matched orange gel coat with UV protection. **SDI designed tank bottom features a large capacity suction sump for *Optimum* safety & performance** (excellent for low solution levels and hilly terrain conditions).

•300 gallon model features tank anti-surge baffles.

•16" screw-in filler opening is offset to operator's side of the tank for easy loading of spray solution. Integrated pillow type gasket assures leak free operation.

**•Exclusive top mount rear access houses diaphragm pump and system controls for easy maintenance and adjustments.**

•30 GPM hydraulic drive piston-diaphragm spray pump with built-in pulsation damper. Easily handles all spray chemicals including abrasive wettable powders, corrosive iron formulas and dyes. **This design even allows the pump to be run without spray solution (dry) with no damage to the pump's diaphragms or mechanical components.**

•Maximum system pressure of 200 PSI allows the use of a hand gun for trees and shrubs or the use of a "Walking Spray Boom" at the end of 200' of 1/2" spray hose.

•SDI's "V-6 Hydro-Mix" six venturi-jet agitation with ceramic metering orifice discs provides high performance hydraulic agitation throughout the solution tank.

•Daily vehicle maintenance is enhanced by the sprayer's design and mounting.

•SDI designed oil cooler provides *Optimum* hydraulic oil temperature during spraying, keeping pump RPM/GPM/PSI constant for accurate spray rate.

•Select from a wide variety of custom accessories to complete your sprayer package - motorized, or computerized boom controls - Economy, Optimum, or Shielded Spray Booms - hose reel, and spray guns - walking spray booms - as well as other user friendly options to personalize the system to your needs.

Spraying Devices, Inc., P.O. Box 3107, Visalia, CA 93278-3107 • Tel: (559) SDI-5555 • Fax: (559) SDI-5591
www.sprayingdevices.com • e-mail: marketing@sprayingdevices.com

# WARNING - WARNING

SPRAYING DEVICES INC.

Photo "A" Below illustrates the suggested storage position for the Windbreaker Boom.

Photo "B" Below illustrates the ***only position*** for transporting the Windbreaker Boom.

Transporting the Windbreaker boom in any position other than shown below in Photo "B", will void any SDI warranty. *(The Wing Arms on the Windbreaker Boom are not designed for transporting when in the Storage Position).*

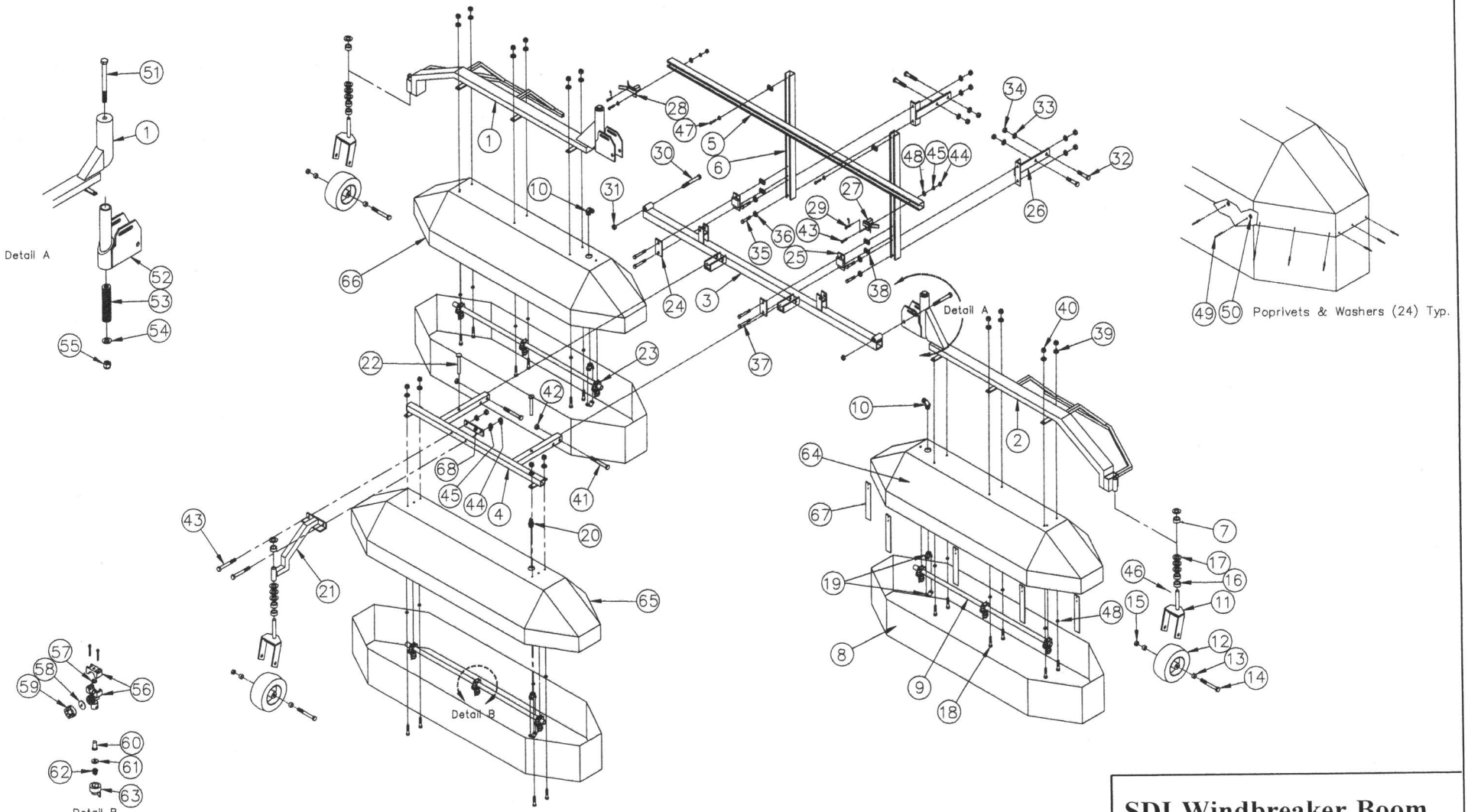
Photo "A" - Suggested **Storage Position Only**

Photo "B" - **Transport Position - Only**

**SDI Windbreaker Spray Boom No. WB2-SB15/20**

*Spraying Devices, Inc., P. O. Box 3107, Visalia, CA. 93278 (559) SDI-5555 Fax: (559) SDI-5591*

SPRAYING DEVICES INC.




**SDI Windbreaker Boom**
**Model WB2-SB15/20**

*Spraying Devices, Inc., P. O. Box 3107, Visalia, CA. 93278 Tel:559-SDI-5555, Fax: 559-SDI-5591*

# SDI "Windbreaker 2000" Shielded Spray Boom

| Item Number | Part Number | Description | Qty |
|---|---|---|---|
| | **WB2-SB15/20** | **Windbreaker Boom** | |
| 1 | 11-573 | Left Wing Section | 1 |
| 2 | 11-572 | Right Wing Section | 1 |
| 3 | 11-570 | Main Center Section | 1 |
| 4 | 11-571 | Center Section | 1 |
| 5 | 11-213-80 | 80" Cross Member | 1 |
| 6 | 11-212-40 | Boom Upright Channel 40" Long | 2 |
| 7 | 11-723 | Spacer Ring 1/2" | 3 |
| 8 | 64-035 | 10" Wide Vinyl Black, 14' | 3 |
| 0 | 51-467 | Boom Pipe 43"/20" Spacing SST | 3 |
| 10 | 53-092 | Elbow 1/2 FPT x 3/4" HB 90° | 2 |
| 11 | 11-579 | Wheel Yoke Assembly | 3 |
| 12 | 80-026 | Wheel | 3 |
| 13 | 11-726 | Spacer Axle | 6 |
| 14 | 35-121 | Hex Bolt 5/8 x 5-1/2" NC | 3 |
| 15 | 41-115 | Lock Nut 5/8" NC | 3 |
| 16 | 11-724 | Spacer Ring 3/4" | 7 |
| 17 | 42-108SS | Flatwasher 3/4" | 6 |
| 18 | 31-504 | Hex Bolt 5/16 x 1-1/4" SST | 16 |
| 19 | 52-418 | Pipe Saddle 1/2" MPT Poly | 3 |
| 20 | 52-110 | Adapter 1/2 FPT x 3/4" HB | 1 |
| 21 | 11-574 | Center Wheel Bracket | 1 |
| 22 | 69-050 | Ball Snap Clevis Pin 1/2" | 2 |
| 23 | 64-397 | Spray Tip Assembly | 9 |
| 24 | 11-311 | Center Section Bracket | 2 |
| 25 | 11-278 | Center Section Clamp | 2 |
| 26 | 11-577 | Bracket Mount | 2 |
| 27 | 11-575R | Right Bracket Boom Rest | 1 |
| 28 | 11-575L | Left Bracket Boom Rest | 1 |
| 29 | 80-105 | Locking Pin | 2 |
| 30 | 35-110 | Hex Bolt 5/8 NC x 4" Plated | 2 |
| 31 | 41-115 | Lock Nut 5/8" NC | 2 |
| 32 | 34-105 | Hex Bolt 1/2 x 1-1/2" Plated | 4 |
| 33 | 43-104 | Lockwasher 1/2" Plated | 8 |
| 34 | 41-104 | Hex Nut 1/2" Plated | 8 |
| 35 | 34-104 | Hex Bolt 1/2 x 1-1/4" Plated | 4 |
| 36 | 42-104 | Flatwasher 1/2" Plated | 8 |
| 37 | 34-114 | Hex Bolt 1/2 x 3-3/4" | 4 |
| 38 | 41-110 | Channel Nut 1/2" | 6 |
| 39 | 43-502 | Lockwasher 5/16" SST | 16 |
| 40 | 41-502 | Hex Nut 5/16" SST | 16 |
| 41 | 34-111 | Hex Bolt 1/2 x 3" | 2 |
| 42 | 41-114 | Lock Nut 1/2" | 2 |
| 43 | 32-509 | Hex Bolt 3/8 x 2-1/2" SST | 4 |

# SDI "Windbreaker 2000" Shielded Spray Boom

| Item Number | Part Number | Description | Qty |
|---|---|---|---|
| 44 | 41-503 | Hex Nut 3/8" SST | 4 |
| 45 | 43-503 | Lockwasher 3/8" SST | 4 |
| 46 | 48-104 | Cotter Pin 3/32 x 1-1/4" | 3 |
| 47 | 32-102SS | Hex Bolt 3/8 x 3/4" SST | 2 |
| 48 | 42-503 | Flatwasher 3/8" SST | 10 |
| 49 | 45-104 | Pop Rivet 1/8" Medium | 69 |
| 50 | 42-099 | Flatwasher 1/8" | 84 |
| 51 | 35-217 | Bolt 5/8 x 7" | 2 |
| 52 | 11-566 | Boom Pivot Assembly | 2 |
| 53 | 45-183 | Spring | 2 |
| 54 | 42-105 | Flatwasher 5/8" | 2 |
| 55 | 41-115 | Lock Nut 5/8" | 2 |
| 56 | 64-411 | Split Eyelet Check Valve | 9 |
| 57 | 64-416 | Washer | 9 |
| 58 | 64-414 | Diaphragm | 9 |
| 59 | 64-415 | Check Valve | 9 |
| 60 | 64-403 | Strainer Screen | 9 |
| 61 | 64-404 | Washer | 9 |
| 62 | 64-643 | Spray Tip TP8003VP Polymer | 9 |
| 63 | 64-406 | Black Cap | 9 |
| 74 | *15-703R | Right Shield | 1 |
| 75 | *15-702C | Center Shield | 1 |
| 66 | *15-701L | Left Shield | 1 |
| 67 | 64-038 | Skirt Stiffeners (5 per shield) | 15 |
| 68 | 11-574/1 | Support Bracket for 11-574 | 1 |
| | | *The following part is not illustrated:* | |
| | 11-569 | Forward Storage Arm - for use only without actuators - for storage only. Each piece is 15" long. | |

***NOTE: 15-703R, 15-702C and 15-701L are sold with the vinyl skirt, stiffeners and hardware and are assembled complete prior to shipping.**