Wisconsin Golf Industry

Best Management Practices

Wisconsin Golf Course Superintendents Association

Wisconsin Chapter GCSAA

GCSAA

Introduction

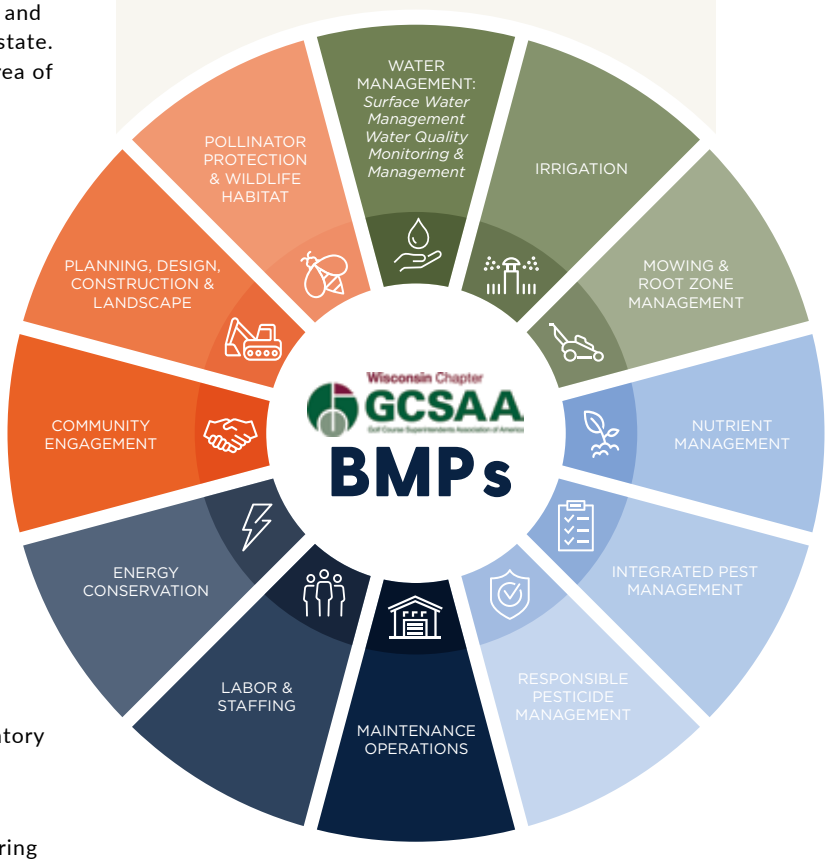
Wisconsin, located in the heart of the Midwest, is known for its agriculture, education, sense of community, sports and vast outdoors. Golf plays a special role within the State, as the industry generates $2.4 billion in total economic output, produces 38,431 jobs, and contributes $772 million in wage income. (Economic Impact by State. 2008. WE ARE GOLF.) Wisconsin is home to approximately 500 golf facilities ranging from municipal to top-ranked courses, including Whistling Straits, Erin Hills, Milwaukee Country Club, Sand Valley, and Blackwolf Run. The state draws major championships including the Ryder Cup, US Open, PGA Championship, and many other professional events. The Wisconsin Golf Course Superintendents Association (WGCSA) and Northern Great Lakes (NGL) chapter of the GCSA are comprised of dedicated agronomists, golf maintenance professionals, industry partners, and educators who are responsible for the maintenance and sustainability of these golf courses throughout the state. The NGL represents members in the Northwoods area of Wisconsin, Minnesota, and Michigan.

The WGCSA, founded in 1930, and the NGL are dedicated to a quality golfing experience and committed to preserving natural resources through using science-based practices. We also share strong midwestern values and a commitment to our families and communities. is critical for sustainable operations and environmental stewardship. We developed this guide of best management practices (BMPs) to serve as operating standards for superintendents to strive toward and an educational resource for all stakeholders. This guide was developed in collaboration with Radius Sports Group, a sustainability consulting firm, and has been reviewed by leaders in golf course management, construction, regulatory, and academic fields.

The document details 12 sections ranging from community engagement to irrigation to integrated pest management and water quality protection, to name a few. Each section contains BMPs and regulatory considerations, as well as local resources for additional information.

On behalf of the Wisconsin Golf Industry BMP steering committee, our WGCSA and NGL members, and allied partners, we hope that this BMP guide conveys the dedication and care that each Wisconsin superintendent has for the environment, our communities, and the game of golf.

Sustainability is integrated throughout our BMPs in order to help guide golf courses in balancing performance and economic impact with environmental stewardship and community. Our golf courses have adopted recommendations and BMPs encouraged by the Wisconsin Department of Natural Resources and the Wisconsin Department of Agriculture Office of Sustainability and Clean Energy for greening businesses statewide. Cities, regions, and communities have varying levels of sustainability planning; courses are encouraged to collaborate within their communities for continuous environmental improvement to make a positive impact today and in the future.



THROUGH CARING FOR THOUSANDS OF ACRES OF GREENSPACE, WE CONTINUOUSLY SEEK WAYS TO CONTRIBUTE TO OUR COMMUNITIES. THIS RANGES FROM DEVELOPING POLLINATOR AND WILDLIFE HABITATS TO WATER CONSERVATION AND WATER QUALITY INITIATIVES FOR THE BENEFIT OF OUR LOCAL ECOSYSTEMS.

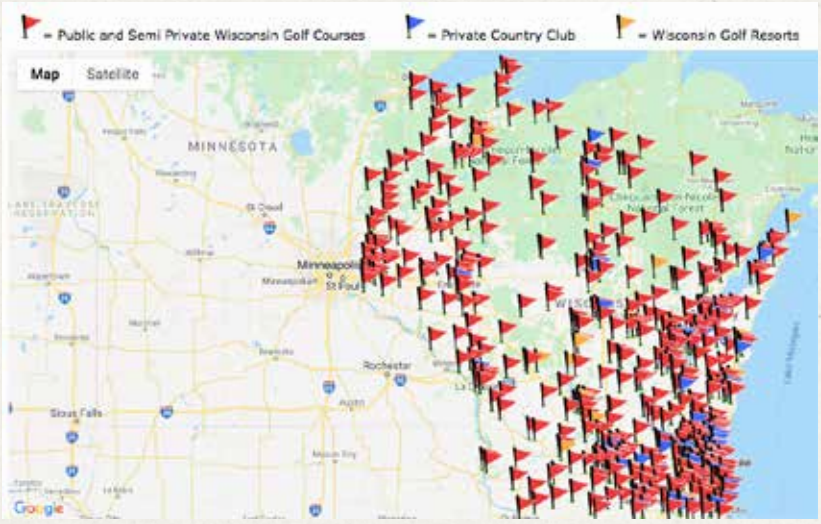
Overview: Wisconsin's Climate, Soils, and Ecology

Wisconsin is an ecologically diverse area with golf courses situated amongst rolling hills, across the plains, adjacent to rivers, next to farmlands, in urban settings, and on the coastlines. Two Great Lakes border the state to the North and East, blending beaches, bluffs, and plains in a way that is rarely found in the otherwise homogenous landscape of the Midwest. The Kettle Moraine State Forest, the Niagra Escarpment, and bluffs situated along the Mississippi and Lake Superior provide wildlife habitats, recreational areas, and breathtaking natural beauty. Wisconsin's diverse geography makes golfing a unique experience, no matter where the golf course is located in the state.

Wisconsin Golf Course Locations

The state encompasses two Köppen Climate zones; most of the state is considered to be Warm Summer Humid Continental, but the Southern and Eastern edges are Hot Summer Humid Continental, as the mean temperature of its warmest month is higher than 71.6°F (22°C). Wisconsin experiences four distinct seasons and constant precipitation throughout the year. The most popular time of the year to enjoy golfing in the state is from late spring to early fall, when the weather is warmest.

Wisconsin's most common biomes, or regions that consist of certain plant and animal species that thrive under the same environmental conditions, include coniferous forests, deciduous forests, and temperate grasslands. Wisconsin is different from the rest of the Midwest due to its relatively uneven topography, splitting the state into five distinct regions.

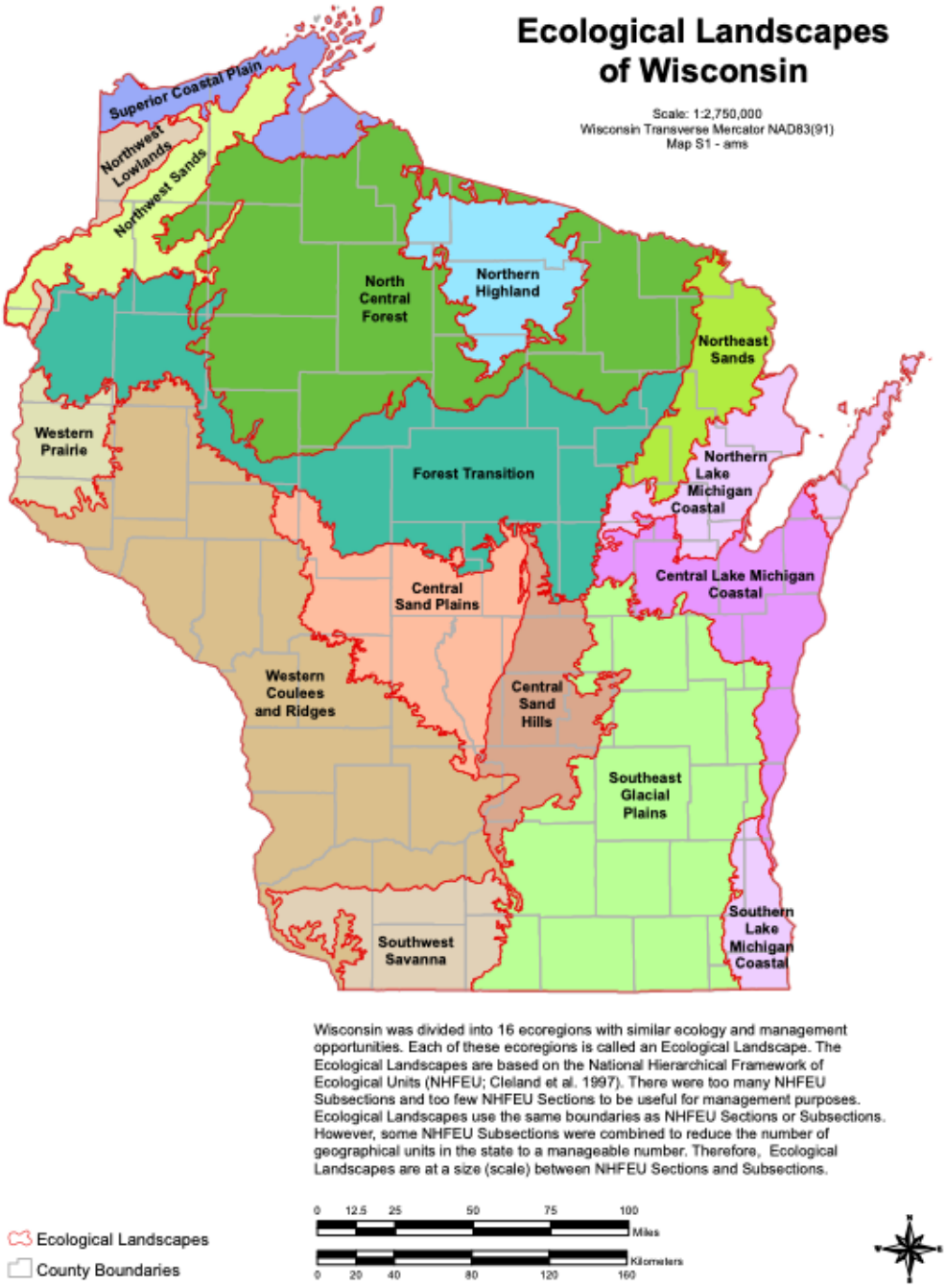


Source: https://www.golfwisconsin.com/maps/golfmap.cfm

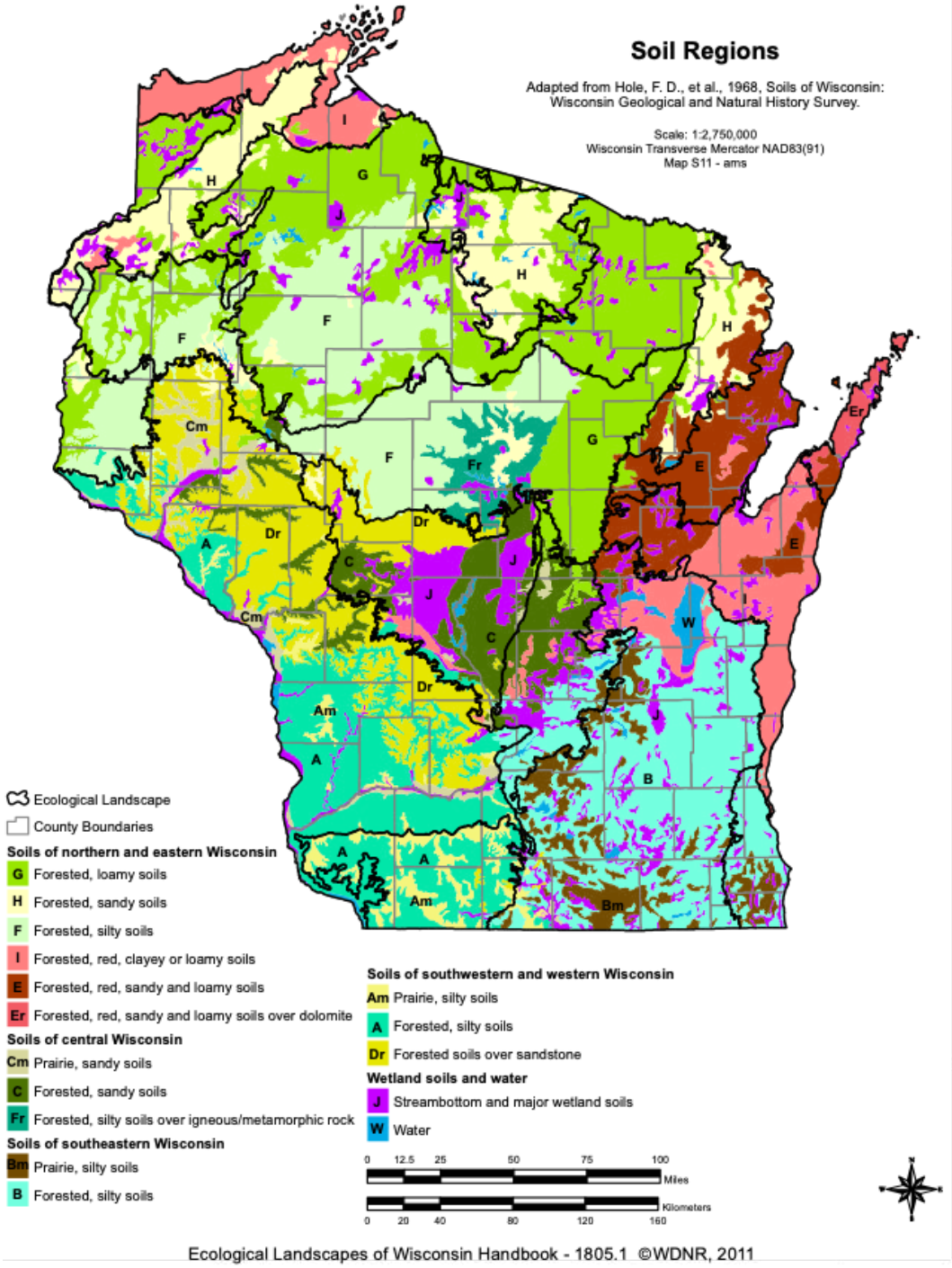
Ecological Landscapes of Wisconsin

The southwestern two-thirds of the state compromise the Western Uplands, characterized by rugged terrain, deep river trenches, and sharp elevation changes. The Eastern Ridges and Lowlands span from Green Bay to Wisconsin's southern border on the eastern edge of the state. The lowland located between two elevated ridges is relatively flat and fertile. Most of Wisconsin's population lives in this region, and a majority of its golf courses are located here due to the ideal environment. The Central Plain is flat and sandy and separates northern and southern Wisconsin. Almost the entirety of northern Wisconsin makes up the Northern Highland, which was once part of a mountain range that has now been smoothed through erosion and glaciation into a flat plain at a high altitude. Finally, the northern tip of Wisconsin comprises the Lake Superior Lowland, known for its gently sloping plain that has dropped due to faulting in the region.

In the northern part of Wisconsin, forested loamy soils dominate, with some pockets of silty or sandy soil. However, sandy and loamy red soils lie over dolomite in the Northern tip of the state. On Wisconsin's eastern edge, soil is red clay and loam, but in its southeast region, soils are primarily silty. Most soils in western and central Wisconsin are also silty, but central Wisconsin consists of more prairies than the forested western region. When choosing where to place a golf course, understanding Wisconsin's unique topography and soils are essential for its success.



Wisconsin Soil Regions



Ecological Landscapes of Wisconsin Handbook - 1805.1 ©WDNR, 2011

Acknowledgments

National Best Management Practices Planning Guide & Template developed by the GCSAA and USGA in partnership with the PGA TOUR. Funded through the EIFG.

Golf Course Superintendents Association of America

GCSAA is the professional association for the men and women who manage and maintain the game's most valuable resource — the golf course. Today, GCSAA and its members are recognized by the golf industry as one of the key contributors in elevating the game and business to its current state.

Since 1926, GCSAA has been the top professional association for the men and women who manage golf courses in the United States and worldwide. From its headquarters in Lawrence, Kansas, the association provides education, information and representation to more than 18,000 members in more than 78 countries. GCSAA's mission is to serve its members, advance their profession and enhance the enjoyment, growth and vitality of the game of golf.

Environmental Institute for Golf

The Environmental Institute for Golf (EIFG) fosters sustainability by providing funding for research grants, education programs, scholarships and awareness of golf's environmental efforts. Founded in 1955 as the GCSAA Scholarship & Research Fund for the Golf Course Superintendents Association of America, the EIFG serves as the association's philanthropic organization. The EIFG relies on the support of many individuals and organizations to fund programs to advance stewardship on golf courses in the areas of research, scholarships, education, and advocacy. The results from these activities, conducted by GCSAA, are used to position golf courses as properly managed landscapes that contribute to the greater good of their communities. Supporters of the EIFG know they are fostering programs and initiatives that will benefit the game and its environment for years to come.

United States Golf Association

The United States Golf Association (USGA) provides governance for the game of golf, conducts the U.S. Open, U.S. Women's Open and U.S. Senior Open as well as 10 national amateur championships, two state team championships and international matches, and celebrates the history of the game of golf. The USGA establishes equipment standards, administers the Rules of Golf and Rules of Amateur Status, maintains the USGA Handicap System and Course Rating System, and is one of the world's foremost authorities on research, development and support of sustainable golf course management practices.

Special Acknowledgments

The GCSAA and EIFG wish to thank the University of Florida, Institute of Food and Agricultural Sciences, faculty, Dr. J. Bryan Unruh, Dr. Travis Shaddox, Dr. Jason Kruse, and Mr. Don Rainey, who worked on this project, providing their knowledge and expertise to help the golf course industry; the USGA for their grant to fund this important project; the volunteers who served on the task group to review BMPs and provide technical assistance; and the Florida Department of Environmental Protection for permission to copy its publication, "Best Management Practices for the Enhancement of Environmental Quality on Florida Golf Courses".

The WGCSA and NGL would like to extend their gratitude to Radius Sports Group for its expertise in developing the BMP guide and to everyone who contributed time, knowledge, and resources. Thank you to superintendents and contributors across the state who provided photo contributions.

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Community Engagement

Section 1

Philanthropy and charitable giving are at the core of the golf industry. The We Are Golf coalition estimates $3.9 billion in total annual charitable impact from golf nationwide. The WGCSA has a rich history of service and volunteerism in Wisconsin for more than 90 years. Golf clubs and courses provide exceptional venues for fundraising events and charity golf tournaments.

Effective community engagement creates rich relationships with neighbors and local stakeholders, identifies concerns, optimizes resources, increases participation, improves decision-making, resolves conflicts, and creates trust. Developing rapport with neighboring community members, customers, legislators, regulators, and civic leaders helps all stakeholders better understand the actions golf courses are taking to protect human and environmental health.

Wisconsin golf course maintenance departments provide full-time and seasonal work for a diverse workforce. Superintendents frequently hire students from local schools and universities for golf maintenance positions and internships. Engaging with the community includes working with local schools to host First Green STEM programs and golf course education days.

Wisconsin superintendents are actively involved in meetings with local legislators and regulatory bodies. Together with the GCSAA and partner affiliates, the WGCSA meets annually with state legislators on environmental, economic, and health-related legislation including participation in National Golf Day on behalf of the golf industry in Washington D.C.

SUPERINTENDENTS AND THEIR TEAMS HOST FIELD TRIPS WITH LOCAL SCHOOLS TO EXPLORE GOLF COURSES FROM A SCIENCE, MATH, BIOLOGY, AND LEARNING PERSPECTIVE.

Best Management Practices

- Conduct stakeholder mapping to understand who to best engage in outreach efforts
- Identify what is important to each stakeholder
- Establish engagement targets, goals, and desired outcomes
- Identify community values and principles
- Understand the importance of building trust
- Plan engagement efforts, strategies, and methods of communication

More information on community engagement: https://extension.psu.edu/understanding-community-engagement

Community Safety and Coronavirus

Pandemics and other crises may involve circumstances where golf course play must be modified to keep the public safe while allowing recreational opportunities. BMPs have been developed to limit touch points and reduce risks in order to provide safe playing conditions.

It is important to adhere to local, state, and federal guidelines from the Center for Disease Control and Prevention (CDC):

https://www.dhs.wisconsin.gov/covid-19/index.htm

https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/cases-in-us.html

Best Management Practices

- Removal of ball washers, bunker rakes, and most trash cans
- Use pool noodles or PVC or EZ Lift devices to limit golf ball settling in cup
- Single rider golf carts
- Sanitation programs to kill virus
- Manual clocking in of staff
- Staggering start times to limit exposure
- Maintain minimum of six feet of social distancing
- Wash hands frequently with soap for a minimum of 20 seconds
- Wear masks as required

Additional resources related to golf club operations:
http://www.wgcsa.com/WGCSA-COVID-19-UPDATES
https://wsga.org/news/covid-19-updates/

Planning, Design & Construction

Section 2

New golf course development or renovations of existing facilities require consideration of environmental, economic, and site suitability factors. Evaluation includes review of onsite and neighboring ecological features, water resources, stormwater management, habitats, topography, historic and cultural use of the land, and a variety of other considerations. All factors must be carefully considered to ensure a viable and sustainable project.

This document is not intended as a blanket standardization, there are differences between every golf course location and project, resulting in variance in the design process and vision; the approaches outlined may not be applicable to all situations. Utilization of BMP guidelines help provide a framework for sound decision-making throughout each phase of a project.

Regulatory Considerations

Federal, state and local permitting may be required prior to initiating construction. It is important to seek the advice of experts familiar with permitting during planning in order to determine what regulations may be impacted and whether survey or mapping of jurisdictional areas is required. The permits necessary for construction will vary based on location and scope. Early engagement among developers, designers, engineers, local community groups, and permitting agencies is essential to designing and constructing a golf facility that minimizes environmental impact and meets the approval process.

For new course projects, determine whether the property is zoned for a golf course development. A new course development will be subject to environmental regulation permits for the locality, such as a general environmental review, water withdrawal and wetland impacts, etc. For renovation projects, an early site meeting with an environmental consultant can help identify the extent of permitting required.

Permits from local, state, and federal agencies typically include general and project-specific conditions that must be followed. Contractors should be provided copies of the approved permit plans and conditions prior to bidding the work. Compliance is generally monitored by the golf course superintendent or consultants who assist with permitting.

Stormwater Management

Stormwater management planning is necessary to ensure sediment controls are in place during construction and ensure that runoff from the course doesn't impact adjacent properties and waters.

For information about a construction site stormwater permit, reference the below links for submitting an application of Notice of Intent (NOI) to the Wisconsin Department of Natural Resources (DNR):

https://dnr.wisconsin.gov/topic/Stormwater/construction/overview.html
https://dnr.wisconsin.gov/topic/Stormwater/construction/forms.html

Wetlands

Boundaries and buffer zones of wetlands, ephemeral ponds, coastal zones, water bodies, streams, and rivers should be identified and mapped in accordance with local, Wisconsin, and federal regulations prior to beginning planning. Wisconsin DNR rules protect water bodies from loss and degradation through regulating draining, dredging, clearing, and filling within, or in proximity to, wetlands. Regulations include an authorization process implemented in coordination with the federal government through the Army Corps of Engineers. Wetland Confirmation, Wetland Identification, and Wetland Exemption Service Requests are available online in the DNR's Water ePermitting system.

https://dnr.wisconsin.gov/topic/Wetlands/identification.html

https://dnr.wisconsin.gov/topic/Wetlands/permits

The DNR has established a wetland screening process requiring customers applying for stormwater, waterway, and wetland permits to submit specific screening information to assist with making a preliminary determination of potential for wetlands on a given property. Only a wetland professional can verify wetlands are present on a property.

https://dnr.wisconsin.gov/topic/Stormwater/construction

Floodplains

Activities associated with construction or renovation within a floodplain zone will likely require a permit. Regulations have been enacted to reduce the potential for downstream or coastal flooding. Regulators will seek to ensure there is no net loss in floodplain area on the site during design and construction. For Wisconsin regulatory information and floodplain mapping, reference:

https://dnr.wi.gov/topic/Floodplains/documents/Floodplain_Development_Basics.pdf

https://dnr.wisconsin.gov/topic/FloodPlains/mapping.html

Erosion & Sediment Control

It is important to eliminate sediment in runoff prior to it leaving a construction project site and entering a waterway or wetland area. Wisconsin regulations establish criteria for erosion and sediment control; the erosion control plan for a construction site, in accordance with s. NR 216.46, Wis. Adm. Code, addresses the discharge of sediment and other pollutants that are carried in runoff from the construction site:

https://docs.legis.wisconsin.gov/code/admin_code/nr/200/216/III/46

It is also important to follow city regulations for erosion and sediment control, as applicable.

Water Management

Wisconsin regulates the amount of water a course can use for irrigation and the source of that water. Pursuant to chs. NR 820 & 856, Wis. Adm. Code, a completed Water Withdrawal report form is required to report monthly volumes of the withdrawal on an annual basis. Reports must be submitted by March 1 for the previous year's withdrawals.

Additional water management items to consider:

- Dewatering Wells: Temporary wells used during construction; depending on design, these wells may need approval from the DNR's Water Use and Wastewater programs
- High-Capacity Wells: If new wells are to be installed and the sum of the pump capacities on the property equal or exceed 100,000 gallons per day, the wells need to be reviewed and approved by the DNR prior to construction
- Amount of Water required: If the sum of pump capacity's equal or exceed 100,000 gallons per day the property will need to be registered with the DNR
- Reporting: If the property has a combined pump capacity of 100,000 gallons per day, a monthly water use must be reported to the DNR on an annual basis

Noting these items could save a project time ensuring awareness of possible permits and/or approvals that may be required related to water use.

https://dnr.wisconsin.gov/topic/WaterUse/registration.html

http://docs.legis.wisconsin.gov/statutes/statutes/281.pdf

https://dnr.wi.gov/topic/WaterUse/documents/ConservationFactsheet.pdf

https://dnr.wisconsin.gov/topic/WaterUse

Rare and Endangered Species and Habitats

It is important to determine if there are any state-listed species or habitats of special concern in potential proximity to the project site.

http://bit.ly/3aBY4dc

To request a site review from the DNR:

https://dnr.wisconsin.gov/topic/erreview/review.html

Listing of rare and endangered species for the State of Wisconsin:

https://dnr.wisconsin.gov/topic/EndangeredResources/ETList

https://dnr.wi.gov/files/PDF/pubs/er/ER001.pdf

Registered Archaeological/ Historical Sites

The State Archaeologist and the Burial Sites Preservation Office maintains a list of consultants qualified to conduct archaeological studies to identify and evaluate sites under various federal and state historic preservation laws.

https://www.wisconsinhistory.org/Records/Article/CS4050

GREENSPACE PROVIDED BY GOLF COURSES HELPS REDUCE THE URBAN HEAT ISLAND EFFECT, SUPPORTS ECOSYSTEM FUNCTION, AND PROVIDES WILDLIFE HABITATS.

Planning

Proper planning is essential from an environmental, economic, and social perspective. Sound planning provides opportunities to optimize and integrate environmentally favorable characteristics into the property. It also minimizes expenses resulting from unforeseen construction requirements.

Best Management Practices

- Comply with Federal, Wisconsin, and municipal laws and regulations
- Assemble qualified team of internal and external stakeholders; retain a qualified director of agronomy and/or a golf course superintendent, golf course architect, and project manager at beginning of design and construction process to integrate sustainable maintenance practices
- Establish objectives and conduct a site analysis and feasibility study
- Incorporate an understanding of topography, access to water, management of water, energy, labor, and material sources into plan
- Identify rare, protected, endangered, threatened plant/animal species; plan, design, construct to preserve
- Archaeological awareness of the site and surrounding area should be considered
- Preserve, maintain, and enhance adjacent wetlands, ensure proper permitting is obtained
- Every new development and existing golf course should adopt a long-range plan, often referred to as a Master Plan, which allows phased projects to tie together seamlessly over time with one vision in mind

Building the Planning, Design, and Construction Team

A qualified stakeholder team includes the following:

- Golf course architect
- Golf course superintendent/ agronomist
- Clubhouse architect
- Landscape architect
- Irrigation designer/engineer & pump station designer
- Ecologist
- Entomologist
- Biologist
- Geologist
- Soil scientist
- Environmental engineer
- Energy analyst
- Economic consultant
- Civil engineer
- Archaeologist
- Turfgrass consultant
- Golf course builder
- Legal team
- GM/Director of Golf (club representatives)

Careful planning requires the involvement of a qualified team of internal and external stakeholders. This includes an experienced golf course superintendent who is integral to the planning process. For course renovations, the superintendent can work directly with the golf course architect in determining the most suitable design and can inform the design team of issues that may impact maintenance or enjoyment of the facility. The superintendent's knowledge of BMPs and the direct participation in planning and construction greatly affect the success of the project.

The Milwaukee area is heavily dominated by urban development, which has resulted in clearing of forests, conversion of prairie and savannas, reduced wetlands, and increased infrastructure. The percentage of impermeable surfaces (which include concrete, asphalt, and structures) is 16.5 percent, the highest in the state, as recorded by the Wisconsin Department of Natural Resources. Not much natural landscape remains in this area. Greenspace provided by golf courses helps reduce the urban heat island effect, supports ecosystem function, and provides wildlife habitats.

Wisconsin Rare and Endangered Species

Threatened

- Canada Lynx *(Lynx canadensis)*
- Northern long-eared bat *(Myotis septentrionalis)*
- Rufa Red knot *(Calidris canutus rufa)*
- Eastern massasauga rattlesnake *(Sistrurus catenatus)*
- Dwarf lake iris *(Iris lacustris)*
- Prairie bush-clover *(Lespedeza leptostachya)*

Endangered

- Gray Wolf *(Canis Lupus)*
- Kirtland's warbler *(Setophaga kirtlandii/Dendroica kirtlandii)*
- Higgins eye pearlymussel *(Lampsilis higginsii)*
- Rusty patched bumble bee *(Bombus affinis)*
- Karner blue butterfly *(Lycaeides Melissa samuelis)*

Endangered and Critical Habitat

- Piping plover *(Charadrius melodus)*
- Hine's emerald dragonfly *(Somatochlora hineana)*
- Poweshiek skipperling *(Oarisma Poweshiek)*

Additional information:
https://www.fws.gov/midwest/endangered/lists/wisc-spp.html
https://www.fws.gov/midwest/endangered/lists/pdf/WisconsinStateList.pdf
https://dnr.wi.gov/topic/endangeredresources/Animals.asp?mode=list&Grp=7

Access to Resources

It is important to establish and document an understanding of existing conditions. This identifies property boundaries, topography, vegetation limits, utilities, irrigation and drainage asbuilts, roads, wetlands, floodplain limits, and other jurisdictional areas. A good base map is a critical tool in planning a project to avoid negative environmental impacts and to determine the feasibility of achieving project goals. The development of a constraints plan, along with identification of a suitable water source (for new courses) may determine that a site is unsuitable for the intended golf project before expensive planning and permitting has begun.

The team should determine objectives for construction prior to getting started. Objectives should be well-defined, measurable, and time-bound. Complete a site analysis and feasibility study to identify needs, resources, obstacles, strengths and weaknesses of potential site(s), possible environmental and cultural impacts, potential opposition to development, timeframes, cost estimates, availability of materials and water sources, energy demands and accessibility, regulations or restrictions, and expected return on investment. Consider whether needs are feasible given existing resources. Select an appropriate site that can achieve the needs and objectives of stakeholders.

Sensitivity to Plant and Animal Species

Be sure to identify rare, protected, endangered, or threatened plant or animal species on the site. Reference the US Fish and Wildlife Service to identify species federally protected under the Endangered Species Act, in addition to Wisconsin rare and endangered species, and develop a long-term protection plan that preserves, promotes, or expands critical habitat.

Assess and identify wildlife habitat requirements (food, water, cover, space). Implement operations and areas that preserve wildlife habitat and migration corridors. Design and locate cart paths to minimize environmental impacts. Design crossings to accommodate wildlife movement.

Construct and place birdhouses, bat houses, nesting sites, and beehives in out-of-play areas. Plant butterfly gardens around out-of-play areas, including the clubhouse and other buildings. Retain riparian buffers along waterways to protect water quality and provide food, nesting sites, and cover for wildlife. Remove nuisance and exotic/invasive plants that have been identified as pests and replace with native species adapted to the site, based on site needs and preference. Minimize stream or river crossings to protect water quality and preserve stream banks.

Reference Pollinator Protection, Wildlife Habitat, Landscape for additional BMPs.

Archaeological, Cultural, and Historical Sites

Wisconsin is home to 11 federally recognized Native American tribes, in addition to other non-federally recognized tribes. Good stewardship includes respecting the traditions, history, and culture of Native Americans within the state of Wisconsin.

When a golf course is located near or being constructed in close proximity to an archaeological or historical site, a cultural advisory team is recommended, comprised of a qualified archaeological consultant, lineal descendants, and a stakeholder representative This team can help determine how to preserve existing archeological finds and historic sites. They can also determine optimal ways to incorporate unique features throughout the property which will highlight its cultural significance.

The Wisconsin State Archaeologist and the Burial Sites Preservation Office maintains a list of consultants qualified to conduct archaeological studies. Obtain information through conducting or preparing archeological assessments, site preservation plans, archaeological inventory surveys, cultural impact assessments, and gathering historical research. Archaeological awareness should be a priority of owners and stakeholders of the golf course and/or development.

Blackhawk Indian Mounds, National Register of Historic Places at Blackhawk Country Club.

American Indians in Wisconsin

Wisconsin is home to 11 federally recognized Native American tribes. As of 2008, the distribution of American Indian populations in Wisconsin included over 60 percent in the counties of Milwaukee, Brown, Menominee, Shawano, Sawyer, Outagamie, Vilas, Dane, Ashland, and Bayfield. About 45 percent of Wisconsin's American Indian population resided in metropolitan areas; 13.7 percent, or 7,313 people, resided in Milwaukee County.

- Bad River Band of Lake Superior Chippewa
- Ho-Chunk Nation
- Lac Courte Oreilles Band of Lake Superior Chippewa
- Lac du Flambeau Band of Lake Superior Chippewa
- Menominee Tribe of Wisconsin
- Oneida Nation
- Forest County Potawatomi
- Red Cliff Band of Lake Superior Chippewa
- St. Croix Chippewa
- Sokaogon Chippewa (Mole Lake)
- Stockbridge-Munsee

Source: https://www.dhs.wisconsin.gov/minority-health/population/amind-pop.htm

Design

Proper design will meet the needs of stakeholders, protect the location's environmental resources, and be economically sustainable. Retain a qualified Director of Agronomy, golf course superintendent, golf course architect, environmental engineer, and project manager at the beginning of the design and construction process to integrate sustainable maintenance practices in the development, maintenance, and operation of the course.

Routing should identify areas that provide opportunities for restoration and retain as much natural vegetation as possible. Where appropriate, consider enhancing existing vegetation through supplemental planting of native vegetation/materials in select clusters along holes, out-of-play areas, and along water sources supporting fish and other water-dependent species. Nuisance, invasive, and exotic plants should be removed, and if appropriate, replaced with native species that are adapted to the site.

Best Management Practices

- Work with a qualified golf course architect, such as a member of the American Society of Golf Course Architects, with significant environmental advocacy experience
- Design to minimize the need to alter or remove existing native landscapes; retain as much natural vegetation as possible; minimize infrastructure while achieving desired objectives
- Water conservation should be an integral part of the design, efficiently capturing runoff, incorporating low maintenance areas and native or drought tolerant vegetation
- Design to maximize play and minimize negative environmental impact
- Design irrigation systems to minimize water use, drift or overspray
- Plant turfgrass from Wisconsin-certified seed and select a species that meets needs of stakeholders, the regional environment, and the site
- Consider implementing increased plant diversity into the site to improve habitats

- Have engineering, the golf course architect, construction team, and golf course superintendent focus a significant amount of time on properly sizing drainage on and around the golf course property
- When planning golf cart paths or other areas with potentially high vehicle traffic, try to predict the effect the trail's layout could have on vegetation (e.g., running over vegetation due to sharp turns) or the layout of the irrigation system

Selecting Turfgrass

Select a turf species that meets the needs of stakeholders while adhering to the principle of "right plant, right place." Create turfgrass research plots and/or a research green to test for the desired species and cultivars for density, color, and tolerances. Refer to national trials (NTEP) for additional cultivar evaluations. Consider whether the maintenance team will be able to keep the turf stands pure and uncontaminated for the long-term when selecting one species and cultivar versus multiple, one species is usually a cost-effective selection. The putting surface, apron, tee, fairway, and rough height-of-cut are also determining factors for plant selection. Plant turfgrass from certified seed and check for the most updated restrictions of turfgrass propagation and cultivation.

Turfgrass Tolerances and Establishment Rates

Table 4-1: Turfgrass Tolerances.

Species	Establishment Rate	Leaf Texture	Density	Cold	Heat	Drought	Shade	Acid	Submersion	Salinity	Wear
Kentucky bluegrass	2-3	3	2-3	4	2-3	3	1	2-3	2	1	2-3
Roughstalk bluegrass	4	2-3	2-3	4	1	1	3-4	2-3	3-4	1	>1
Supina bluegrass	3	2-3	3	3	2-3	1	4	3	?	1	4
Canada bluegrass	2-3	3	1	4	4	2	4	2	2	1	
Annual bluegrass	3	2-3	3	1	1	1	2	2-3	3-4	1	3
Creeping bentgrass	3	2-3	3	4	3	1	2-3	3	4	3-4	2-3
Colonial bentgrass	3	2-3	3	3	2	3	2-3	3	2	1	1-2
Velvet bentgrass	3-4	1	3	3	1	1	2-3	3	3	1	3
Redtop	3-4	3	1-2	3	1	3	2-3	3	3-4	3	1
Creeping red fescue	3-4	1	3	3	2	4	4	4	1	1	1-2
Chewings fescue	3-4	1	3	3	2	4	4	4	1	1	1-2
Sheep fescue	3-4	1	3	3	2	4	4	4	1	1	1-2
Hard fescue	3-4	1	3	3	2	4	4	4	1	1	1
Tall fescue	3-4	3-4	1-2	2	3	4	2-3	4	3	3	3-4
Perennial ryegrass	4	2-3	2-3	2-3	2-3	2-3	1	2-3	2	2	3
Annual ryegrass	4	3-4	2	>1	2	2	1	2-3	2	2	3-4
Zoysiagrass	1	3-4	3	4	3	2-3	4	2	3	4	
Buffalograss	4										

Establishment Rate: 1 = Very Slow 2 = Slow 3 = Medium 4 = Fast
Leaf Texture: 1 = Very Fine 2 = Fine 3 = Medium 4 = Coarse
Density Potential: 1 = Low 2 = Medium 3 = High
Tolerances: >1 = Very Poor 1 = Poor 2 = Fair 3 = Good 4 = Excellent

Source: http://cag.uconn.edu/documents/Turfgrass-IPM-manual-s.pdf

Natural Landscape & Garden Areas

Most golf courses will include out-of-play areas that can provide enhanced course aesthetics, wildlife habitat, external sound/noise abatement, and natural cooling. An environmental landscape design approach addresses environmentally safe and energy-saving practices; and is economically important. The fundamental principle for the environmentally-sound management of landscapes is RIGHT PLANT, RIGHT PLACE.

Reference Pollinator Protection, Wildlife Habitat, Landscape for additional Landscape BMPs.

Determining Factors in Selecting Best Turfgrass Species

- Playability
- Wear tolerance
- Climate
- Water usage
- Water quality
- Adaptation
- Drought tolerance
- Salinity tolerance
- Pest & disease susceptibility
- Fertility requirements
- Color
- Shade tolerance
- Seedhead production
- Cost to plant (seed vs. sod) & patented rights
- Cost to maintain

Additional references:
https://wisconsinturfgrassassociation.org/wp-content/uploads/2015/07/2015-Field-Day-Guide.pdf
http://american-lawns.com/states/wi.html
https://archive.lib.msu.edu/tic/holen/article/2000may5.pdf

Greens

When designing greens, select a location with adequate sunlight, air flow and sufficient drainage to meet plant-specific needs. Work with the golf course architect to determine green sizes, slopes and layout. Green size is primarily determined by the topography, length and strategic layout of the golf hole. Ensure size and slopes are appropriate for the typical shot being played into the green while allowing for plenty of hole locations to provide for variety in daily setup and the ability to spread wear. Green slopes should be determined by the intended height of cut (HOC) which will influence green speed. Modern HOCs and green speeds generally require pinning areas to be sloped between 1.5 to 3 percent. Steeper slopes are acceptable in transition areas, ridges or rolls, but should be limited to a maximum 10 to 12 percent. Greens should be large enough to accommodate traffic and play, while remaining sustainable using existing maintenance resources. Mapping of final green surfaces is recommended for use in determining and recording day-to-day hole locations.

Consult with a golf course architect and soil scientist to select the appropriate method and materials for green construction to suit the site and character of the course, which may include USGA-recommended profiles or other proven means. USGA-recommended construction is the most common and research-proven method used today, requiring a sand-based rootzone material as designated by specific performance guidelines. Sand, pea gravel and amendments (e.g. peat moss or porous inorganics) should be sent to a certified soil testing facility for physical analysis to determine proper bridging, air space, and water retention and removal capacities. Native soil analysis will determine whether to incorporate a perimeter liner to prevent lateral infiltration. It is a good idea to install tracer wire along the perimeter to track and maintain the green shapes over the long-term. Sand used for construction and future topdressing should be from the same source.

Greens should be irrigated separately from surrounding turf where budgets allow. If the water quality from the main water source is poor, arrange for a water treatment process to correct poor water quality and consider designing greens to receive water separately from the main water source, leaving the potable water reserve for other uses.

Additional USGA resources:
https://archive.lib.msu.edu/tic/usgamisc/monos/2018recommendationsmethodputtinggreen.pdf
https://www.usga.org/content/usga/home-page/articles/2018/02/decades-of-research-fuel-new-specs-for-putting-greens.html
https://www.usga.org/course-care/digitalcollections/creating-usga-putting-green.html

Sand Selection for Greens

Sand selection is critical to successful green performance. Sand particle size in particular will greatly influence greens performance including water retention, drainage, and firmness. The following guidance is per USGA recommendations for putting green construction.

Finer sands retain a greater amount of water, while sands that are exceptionally uniform may fail to form a firm surface due to inadequate particle packing. The USGA recommends sands have a coefficient of uniformity (Cu) within the ranges shown in table 1. The lower the Cu, the more uniform the sand particle size, which presents a greater risk for unstable, soft greens. Sands with high Cu values will potentially provide firmer surfaces. Sand particle shape also influences stability - a rounded sand may require a higher Cu to provide a firm surface while a more angular sand with a lower Cu may pack sufficiently. The sand used to build USGA greens should be selected so that the particle size distribution of the final root zone mixture is as described in Table 1. The sand should be naturally occurring, not a manufactured sand produced by crushing rock.

Recommended Particle Size Distribution for a Putting Green Rootzone Mixture

PARTICLE	DIAMETER	SIEVE	% BY WEIGHT
Coarse gravel	> 4 mm	No. 5	0%
Fine gravel	2.0 – 3.4 mm	No. 10	≤ 3% gravel
Very coarse sand	1 – 2 mm	No. 18	≤ 10% combined in this range
Coarse sand	0.5 – 1.0 mm	No. 35	≥ 60% of the particles in this range
Medium sand	0.25 – 0.5 mm	No. 60	
Fine sand	0.15 – 0.25 mm	No. 100	≤ 20%
Very fine sand	0.05 – 0.15 mm	No. 270	≤ 5%
Silt	0.002 – 0.05 mm		≤ 5%
Clay	< 0.002 mm		≤ 3%
Total fines	Very fine sand + silt + clay		≤ 10% combined
Coefficient of Uniformity (D60/D10)		1.8 - 3.5	Rootzone mixtures with peat
		2.0 - 3.5	Rootzone mixtures with inorganic amendments
		2.0 - 3.5	Pure sand rootzone mixtures

Source: https://archive.lib.msu.edu/tic/usgamisc/monos/2018recommendations-methodputtinggreen.pdf

Greens Mix Blending

Mix all greens mix components offsite. The blending equipment should be designed for producing consistent greens mix; bucket blending is not acceptable. Avoid excessive handling of peat and the blended root zone mix. The peat and sand should be moist during the blending process to ensure uniform mixing and to minimize segregation.

Physical Properties of the Rootzone Mix

The root zone mix should have physical properties tested per ASTM F1815. These performance parameters include saturated hydraulic conductivity (infiltration rate), total porosity, density, and capillary and aeration porosity. The root zone mix should have physical properties meeting those listed in Table 2.

Table 2: Physical Properties of the Root Zone Mix

Physical Property	Recommended Range
Total Porosity	35% – 55%
Air-filled Porosity	15% - 30%
Capillary (Water-filled) Porosity	15% - 25%
Saturated Hydraulic Conductivity (Ksat)	Minimum of 8 inches/hour (200 mm/hr.)

Source: https://archive.lib.msu.edu/tic/usgamisc/monos/2018recommendations-methodputtinggreen.pdf

Bunkers

Understand the planned size and number of bunkers/square feet of bunkers as it relates to strategic value of the golf course and resources available for daily maintenance. Limiting overall bunker square footage and/or incorporating native sand and scrub areas (if appropriate to the site) can save labor and maintenance resources. Consider bunker placement in relation to intended strategy of each hole, and where possible incorporate bunkers into existing landforms (e.g. ridges and slopes) that allow for a natural appearance. Review or adjust drainage patterns around bunker perimeters to prevent erosion and contamination caused by surface water flow and consider golfer circulation patterns at greens to allow adequate entry points and prevent concentration of turf wear. When determining bunker style, assess future labor, maintenance and playability impacts, allow for ample ingress/egress points for golfers and equipment, minimize potential wear areas and assess various methods of construction.

Bunker construction methods will vary depending on budget, availability of materials, and long-term maintenance expectations. Where maintenance budgets are limited, build bunkers with slopes and shapes that minimize erosion, contamination, and hand labor. If possible, incorporate sub-surface liners (e.g. fabric, aggregate) and use more angular sands, whether natural or manufactured, to further prevent erosion and extend the useful life of the sand. Bunkers can be designed to minimize water entry which helps reduce the need for bunker liners, thus reducing construction costs upfront and over the long-term.

Final determination of sand color, bunker sizes, methods of construction and locations should be coordinated with the golf course architect to meet the course needs, design goals, and sustainability objectives.

Additional bunker sand selection considerations include uniformity coefficient, infiltration rate, penetrometer value, angle of repose, crusting and set-up potential, and acid reaction.

Additional information: https://www.usga.org/content/usga/home-page/course-care/green-section-record/58/11/a-guide-to-selecting-the-right-bunker-sand-for-your-course-.html

Tees & Approaches

Minimizing the size of tee complexes can reduce maintenance costs, but can result in excessive wear that may lead to poor turf quality and long-term financial and resource impacts. It is important to select the size of teeing areas to accommodate daily and annual usage, plus allow for ample in-season recovery. Tee placement should utilize naturally elevated flat or gently sloped areas where possible to avoid the need for excessive resources (e.g. fill) during construction. Determine number and location of tees with the golf course architect to setup proper angles, relate to fairway landing areas, and satisfy the ability levels of the various users. Consider using a sand-based upper profile in construction to facilitate drainage and minimize potential compaction.

Reference for additional information: https://www.usga.org/content/dam/usga/pdf/imported/course-care/020301.pdf

Fairways & Rough

Fairway widths and perimeter layouts should be considered with the golf course architect to facilitate strategy on a per hole basis. Fairway width should generally be wider in the shorter landing areas to accommodate the recreational player, and narrower in select areas to challenge the expert player. When determining overall fairway size, consider the long-term costs of maintenance inputs and look to reduce excessive widths in areas of low golfer impact.

USE ENVIRONMENTALLY SOUND CONSTRUCTION TECHNIQUES AND SOIL STABILIZATION TECHNIQUES TO MINIMIZE EROSION AND MAXIMIZE SEDIMENT CONTAINMENT.

Construction

Development of thoughtful planning and specifications can minimize costly changes during construction and assist with overcoming unforeseen challenges. A well-qualified contractor will have significant experience with golf course renovation or new construction and will be familiar with environmentally responsible construction methods.

Guide contractors to ensure efficient delivery, optimal safety, and environmental preservation; conduct a pre-construction conference with relevant stakeholders. Prior to starting, meet with the project team and contractor to review construction protocols, including defining lines of communication, scope of work, methods for reducing environmental impacts, and reviewing permit requirements. Maintain a construction progress report and communicate the report to the proper permitting agencies.

The golf course architect, engineer, irrigation designer and other key consultants should remain involved throughout the construction phase to observe the work being completed and ensure plans and specifications are being followed and permit requirements are met.

Stage construction to maximize site drainage, environmental conservation, and resource management. Build temporary construction compounds in a way that minimizes environmental impacts. For large renovation or new course projects, limit the amount of disturbed area at a given time; this may require completing and stabilizing a portion of the site prior to starting a new area. On smaller projects, consider narrowing the construction window to prevent environmental impacts.

Establishment of ground water testing protocols as well as coastal water sites before, during, and after construction will assist in assuring any potential impacts to the environment are actively observed and managed. Testing sites on properties where elevations vary should include testing sites above and throughout the gradient of the property to ensure impacts outside and on the site can be mitigated and properly recorded. Testing protocols should be determined in advance, including testing intervals for each site based on sensitivities toward surrounding features, ground water flows, proximity to drinking wells, coastal impacts, and other related factors.

Best Management Practices

- Use only qualified contractors (with the guidance of a golf course architect) who are experienced in the special requirements of golf course construction; such as a member of the Golf Course Builders Association of America, or one with significant local golf course construction experience. Reference https://www.gcbaa.org/Resources/Find-a-Member/Individual-Directory/pagesize/10?p=CertifiedBuilder&Name=A
- Collaborate with golf course architect, engineer, and irrigation designer to develop construction plans that clearly communicate scope of work and ensure all parties, including contractor, understand the scope
- Complete construction with care to minimize environmental impact and financial ramifications; incorporate all conditions per the permitting process
- Minimize environmental risk during grow-in and establish Special Management Areas where needed
- Ensure state requirements are followed for erosion and sediment control
- Incorporate proper drainage for containment of runoff, adequate buffer zones, and filtration techniques
- Incorporate a stormwater “treatment train” approach; a stormwater pollution prevention plan (SWPPP) may be required for construction activities
- Schedule construction to maximize efficient turfgrass establishment
- Provide monitoring of the work; maintain a construction progress report and communicate the report to the proper permitting agencies
- Build temporary construction components and siltation barriers in a way that minimizes environmental impacts. Review all components before and after any rain event and make repairs where damage has occurred.
- Design and construct maintenance facilities to provide optimal ventilation, containment of site runoff, pesticide mixing area containment, energy efficiency, and proper storage of pesticides, fertilizers, equipment, oils, solvents, and fuel
- Understand, and when practicable, pursue certifications and recognized frameworks to support environmental stewardship programs, community engagement, health and wellness
- Promote a healthy habitat for plant and wildlife

Grow-In

The soil preparation and turfgrass establishment phase is a critical time in the development process. The process must be carefully planned to minimize environmental risk. When using seed, schedule construction to take advantage of preferred grassing windows (i.e. August/September) to maximize turfgrass establishment prior to winter dormancy and utilize erosion control covers that will stay intact until adequate germination. A normal establishment period for cool season grasses can range from three to six months, but consideration should be given to the specific grow-in requirements of various seed types. Special Management Areas may require a different approach and should be calculated. Wait to remove erosion control measures (silt fence, straw wattles, etc.) until adequate germination of turf.

Most projects use a combination of seed and newly imported sod. The selection of the most appropriate grass, identifying drought and disease resistant cultivars, and determining starter fertilizer is critical. Consult with a regional USGA agronomist or a turfgrass consultant regarding best varieties of grass based on soil conditions, watering capabilities, and anticipated maintenance.

A "Grow-in" Fertility Program should create calculated rates of pre-plant and establishment nutrient guidelines. Soil test reports should identify amendments and nutrient requirements prior to planting. Potential long-term issues such as weed encroachment, disease, and drought susceptibility can be reduced with proper seedbed fertility.

During the establishment period, mow as soon as the sod has knitted-down and/or seedlings have reached a height of one-third greater than intended height-of-cut. Continue with frequent mowing at roughly twice the final height of cut. This will hasten establishment. Create a timeline when areas are planted to give consistent time for establishment.

Heights of cut will be determined by the timeline as turf becomes established and will be managed depending on area. Light verticutting and topdressing will improve playing surface and assist when reducing height-of-cut in each area. Reducing the height-of-cut often reduces weed establishment. Consider spot application of herbicides versus wide-spread applications.

Key Factors for Grow-In

- Prepare area properly and clear of pests (weeds, pathogens, etc.)
- Properly prepare with a suitable depth of growing medium for the turf; soil in seeded areas should be loose enough to allow for good penetration of seed; compacted areas should be loosened prior to planting
- Erosion and sediment control devices must be in place and properly maintained
- Spreading mulch may be necessary to slow runoff over finely graded and smoothed ground surface
- Utilize hydro mulching and/or erosion blankets on bunkers, slopes, special management areas
- Top-dress sod to fill gaps between sod pieces, hastening establishment and providing a smoother surface
- Use appropriate seeding methods for course conditions
- If using sod, delay nutrient applications until sod has sufficiently rooted
- On newly seeded areas, irrigation should be applied lightly and frequently to keep the soil damp, but without runoff; irrigation will become less frequent and heavier as grass grows and thickens

Erosion and Sediment Control

Sediment occurs when heavy rain or irrigation flows over exposed soil causing particles to be picked up and deposited offsite. Sediment can also be dispersed when exposed soil is dry, and particles are carried by the wind. Water quality can be degraded if sediment and eroded soils reach surface waters. Turbid water can harm aquatic plants and impair aquatic habitats. In addition, soil contaminants such as pesticides and excess nutrients may be picked up and transported with eroding soil. This is of special concern for golf courses adjacent to ponds, lakes, streams, and rivers. It is important to ensure that erosion barriers are in place through soil preparation and remain throughout grow in.

Develop a working knowledge of erosion and sediment control management, ensure proper steps are taken and state requirements are followed regarding structures, materials, and design features. Wisconsin has erosion and sediment control regulations in place that require proper runoff control measures. Landowners must submit a Notice of Intent (NOI) to obtain construction site stormwater permit coverage from the DNR. Submit the NOI at least 14 working days before land-disturbing construction activities begin. Coverage occurs automatically 14 working days after the DNR receives a complete application, unless the applicant receives notification that the "clock has stopped" and additional information or review is needed.

More information on Wisconsin's erosion and sediment control permitting process: https://dnr.wisconsin.gov/topic/Stormwater/construction/forms.html

Reference Surface Water Management and Water Quality Monitoring and Management for additional BMPs.

Strategies to control sediment, minimize topsoil loss, protect water resources, and reduce disruption to wildlife and plant species:

- Hydro-seeding, hydro-mulching, and sodding offer soil stabilization and assist in water retention
- Establishment of vegetative buffer strips
- Construction of swales that empty into detention basins
- Use of riprap to slow runoff and settle out sediment
- Installation of erosion control barriers
- Consider limiting the area of disturbance at one time
- Check and repair erosion control barriers after every rain event

Wetlands

Wetlands provide critical habitats for plants, fish and wildlife, clean water, flood protections, recreation, and scenic beauty. Wetlands vary based on three factors: soil type, hydrology (timing, frequency and level of flooding or soil saturation each year), and vegetation. Wisconsin's vegetation is divided into the northern forest floristic province, roughly the northeastern half of the state, and the prairie-forest floristic province, the southwestern half. The vegetation tension zone, a transitional band that corresponds to a number of climatic factors and has a mixture of species from both provinces, lies between these two areas.

Wetlands in Wisconsin are protected under state law and most are under the federal Clean Water Act. At the federal level, the U.S. Army Corps of Engineers (USACOE), EPA, U.S Fish and Wildlife Service (FWS), National Oceanic and Atmospheric Administration (NOAA), and maritime agencies may all be involved. Wetlands may also be protected by local regulations or ordinances.

Landowners and developers are required to avoid wetlands whenever possible; if wetlands can't be avoided, they must apply for permits and receive approval to proceed with proposed wetland impacts.

Information on identifying and locating wetlands in Wisconsin may be found at:
https://dnr.wisconsin.gov/topic/Wetlands/locating.html
https://dnr.wi.gov/topic/wetlands/documents/WWI_Classification.pdf
https://dnr.wisconsin.gov/topic/Wetlands/inventory.html
https://www.wisconsinwetlands.org/wp-content/uploads/2016/10/GuidetoWisconsinWetland-Types.pdf

Prior to commencement of planning, boundaries and buffer zones of any wetlands, ephemeral ponds, coastal zones, water bodies, streams, and rivers should be identified, flagged and mapped as activities taking place within these boundaries (and buffer zones) may require permits. Wisconsin has rules which protect such water bodies from loss and degradation. This protection is achieved through the regulation of draining, dredging, clearing and filling within or in proximity to the wetlands.

Constructed or disturbed wetlands may require a permit to be an integral part of the stormwater management system. A professional consultant should be utilized to assist with permitting and the design of the project to reduce impacts. Always ensure proper permitting has been obtained, properly delineate, and establish buffer zones and erosion control before working in, and around, wetlands.

Why Wetlands Matter in Wisconsin

Maintaining the overall health of lakes, rivers, prairies, and forests.

- Wetlands reduce flooding peaks by as much as 60 percent and the U.S. Environmental Protection Agency estimates that an acre of wetlands can store one to 1.5 million gallons of floodwaters
- Polluted runoff from cities, farms, and construction sites is filtered by wetlands before entering lakes and rivers; clean lakes and rivers are the backbone of Wisconsin's tourism industry, which generated $12 billion in 2009 and supported more than 286,000 jobs
- The filtering capability of wetlands cuts the cost of treating drinking water; some wetlands can remove a quantity of pollutants from the watershed equivalent to that removed from a $5 million treatment plant
- Nearly 40 percent of Wisconsin's 370 species of birds live in or use wetlands and many important game birds, mammals, fish, amphibians and reptiles are associated with wetlands, among them waterfowl, white-tailed deer, ring-necked pheasants, northern pike and walleye; in Wisconsin, birdwatchers and wildlife watchers spend $271 million annually waiting for a glimpse of their favorites
- One–third of the plants and animals on Wisconsin's state endangered and threatened list depend on wetlands

Source: https://dnr.wisconsin.gov/topic/Wetlands/protect.html

WHEN INCORPORATED INTO A GOLF COURSE DESIGN, WETLANDS SHOULD BE MAINTAINED AS PRESERVES AND SEPARATED FROM HIGHLY MANAGED TURF AREAS WITH NATIVE VEGETATION OR STRUCTURAL BUFFERS.

Drainage

Adequate drainage is necessary for growing healthy turfgrass. A comprehensive plan for drainage addresses containment of runoff, adequate buffer zones, and filtration techniques in the design and construction process to achieve acceptable water quality. Drainage systems should be properly installed, repaired, and maintained to achieve optimal performance that positively impacts play and supports water quality.

Good drainage is achieved through both surface and subsurface drainage systems. Very flat areas may require subsurface drainage and steep areas may warrant installation of berms and interceptor swales, along with sub-surface piping and drain inlets, to slow surface runoff and reduce soil erosion. It is highly recommended that drainage installations be documented in their "as-built" form following installation so that sub-surface pipes are easier to find in the future for maintenance or tie-in purposes.

Key Factors for Drainage

- Pay close attention to engineering details such as subsoil preparation, the placement of gravel, slopes, backfilling, and placement of drainage gravel
- Surface water runoff from tees, greens, intensively managed fairways, and internal golf course drains should not drain directly into an open body of water
- These should discharge through pretreatment zones (i.e. grass swales or retention basins) and/or vegetative buffers to help remove nutrients and sediments
- Drainage system should be routinely inspected and maintained to ensure proper function
- Post development flow rates should be equal to or less than predevelopment conditions

Surface Water: Stormwater, Ponds, Lakes

Controlling stormwater on a golf course prevents flooding of facilities and play areas, plus controls amount and rate of water leaving the course. Stormwater control also involves storing irrigation water, controlling erosion and sediment, enhancing wildlife habitat, and addressing aesthetic and playability concerns.

Stormwater on a course may not originate from the course, but from adjoining lands, including residential or commercial developments. An environmental benefit that golf courses provide includes filtering stormwater naturally to remove waterborne pollutants through planned "treatment trains" (i.e., vegetated swales, depressed landscape islands, and constructed wetlands). Through a treatment train, water is conveyed from one treatment to another by conveyances that themselves contribute to the treatment.

Methods of stormwater management include infiltration chambers that allow water to better enter the ground and recharge aquifers, retention basins that slow the flow of water off the property during heavy rain events while also trapping sediments, installation of swales with check dams to slow runoff, installation of erosion control barriers and use of mulch on seeded areas to assist with germination without soil erosion.

Eliminate or minimize directly connected impervious area (DCIA). Maximize the use of pervious pavements, such as brick or concrete pavers separated by sand and planted with grass. Special high-permeability concrete is also available for cart paths or parking lots.

Reference Surface Water Management and Water Quality Monitoring and Management for additional BMPs.

Reference Maintenance Operations and Energy Conservation for additional BMPs and detail regarding maintenance facility design, construction, and operations.

Reference Pollinator Protection, Wildlife Habitat, Landscape for additional detail regarding wildlife and landscape considerations.

Reference Irrigation BMPs for additional information regarding irrigation systems.

Reference Surface Water Management and Water Quality Monitoring and Management for additional information about surface water management and protecting water quality.

Section 3

Pollinator Protection, Wildlife Habitats & Landscape

Golf courses help promote a unique connection with nature and wildlife. This accessibility to nature is a critical community benefit, especially in cities with sprawling urban developments and increasing infrastructure with few trees, grassland, or wetland areas.

Regulatory Considerations

- Pollinator protection language is a label requirement found on pesticide labels and must be followed by law
- Pesticide applicators must be aware of honeybee toxicity groups and be able to understand precautionary statements
- Recordkeeping, as required by Wisconsin law, should be maintained to refer to and follow the best course of action with future applications if necessary
- Applicators of pesticides should be mindful of applications and the effects on the target or any others that may be compromised
- Reference Wisconsin Endangered and Threatened Species Laws: https://dnr.wisconsin.gov/topic/endangeredresources/laws

WISCONSIN COURSES PROVIDE MORE THAN 50,000 TOTAL ACRES OF GREENSPACE AND BLUESPACE INCLUDING STREAMS, LAKES, AND PONDS TO HELP ENRICH SURROUNDING COMMUNITIES WITH VALUABLE ECOSYSTEM SERVICES, INCLUDING POLLINATOR AND WILDLIFE HABITATS.

Pollinator Protection

Healthy pollinator populations are critical to our wellbeing. Most flowering plants need pollination to reproduce and grow fruit. Protecting bees and pollinators is important to the sustainability of agriculture in the United States. In Wisconsin, pollinator-dependent crops account for more than $55 million in annual production. While some plants are pollinated by wind, many require assistance from insects and other animals. Populations have declined in the last several decades due to factors such as pathogens, parasites, habitat loss, and insecticide exposure. In the absence of pollinators many plants species would fail to survive.

Wisconsin Pollinators include:

- Bumble bees (more efficient than honeybees, which also work well)
- Non-native honeybee (Apis mellifera)
- Blue orchard bee (Osmia lignaria)
- Hummingbirds
- Monarch butterflies
- Flies, wasps, moths, beetles, ants

These guidelines provide ways to encourage pollinator habitats and help take precautionary steps to reduce potential impact, if any, on pollinator populations caused by pesticide usage.

Additional resources: https://dnr.wisconsin.gov/topic/endangeredresources/pollinators.html

APPLES, CHERRIES, CRANBERRIES, CUCUMBERS, AND GREEN BEANS ARE EXAMPLES OF KEY WISCONSIN CROPS THAT RELY ON HONEYBEES AND NATIVE BEES FOR POLLINATION.

Best Management Practices

- Follow label instructions when applying pesticides
- Avoid application when plants are in bloom
- Consider lures, baits, and pheromones as an alternative to pesticides for pest management
- Mow flowering plants before pesticide applications to remove blooms
- Consider manual removal of weeds or spot treat with herbicide before insecticide
- Use the latest spray technologies such as drift-reduction nozzles to prevent off target application
- Apply during times of little or no wind in order for more accurate placement of pesticide
- Avoid applications during low temperatures and when dew is forecasted
- Mow natural areas 1x per year late in season when plants are going dormant in order to control growth of woody ornamentals and other undesirable plants to minimize effects on pollinators
- If possible, wait until May or June for insecticide applications to avoid exposing pollinating insects during blooming periods
- Apply pesticides at times when pollinators are least active during early morning or late evening
- Plant flowers with varying characteristics like color, shapes, sizes, flowering times, and growth habits that attract pollinators
- Join a local beekeeper association to become connected with local education events and mentoring opportunities
- Consider setting up hives within a natural area of the golf course that can be maintained by an interested staff member or person within the community
- Obtain a list of beekeepers within a 3-mile radius of the golf course; contact these beekeepers about pending applications in order to allow them to take precautions they feel necessary to protect the hives
- Attend workshops and online seminars to learn more about pollinators and steps to protect them
- Use social media and local news outlets to educate golfers and the general public on steps taken to minimize effects on pollinators
- Invite local schools, garden clubs, master gardeners, etc. to visit the facility to demonstrate the steps taken to protect pollinators

Professionals who apply pesticides must diligently follow label precautions when using insecticides including irrigating, mowing weeds before applications, and choosing the proper insecticide class and formulation. Proper insecticide stewardship can control pests, reduce harm to beneficial insects, and ensure that insecticide tools remain viable for use in turf. By diversifying golf courses and other turf areas, we take a proactive role in protecting pollinators by providing food plants and habitat, while educating the public about the importance of these insects to our environment.

Additional pollinator and wildlife BMP information regarding pesticide use in Wisconsin:
https://datcp.wi.gov/Documents/HTCLandscape.pdf

Encouraging Pollinator Habitats

Protecting native bees, bumblebees, honeybees, butterflies, hummingbirds, and other pollinators is important for sustainable agriculture, including pollination of important Wisconsin fruits and vegetables like cherries, cranberries, apples, cucumbers, and green beans. Below is a listing of key pollinator plants which encourage habitats.

Wisconsin Pollinator Plants

- Pussy willow
- Serviceberry
- Lupine
- Lanceleaf coreopsis
- Milkweed
- Purple coneflower
- Virginia mountain mint
- Wild bergamot
- Blue vervain
- Blazing star
- Sweet joe-pye weed
- Aster

Additional information on pollinator protection: https://www.xerces.org/

Selecting Plants for Pollinators & General BMPs

Pollinator Protection Resources

https://datcp.wi.gov/Pages/Programs_Services/PPPResources.aspx

http://www.dem.ri.gov/programs/agriculture/documents/pwg_docs_pollinator_plan_wi.pdf

https://datcp.wi.gov/Documents/PPPGardens1pg.pdf

https://www.pollinator.org/guides

https://pollinators.wisc.edu/pollinator-resources/

https://bit.ly/3rg0IAB

https://www.ncipmc.org/action/bmpturf.pdf

Pollinator Habitat Protection and Enhancement

Pollinators face numerous challenges related to loss and degradation of natural habitat as suburban areas encroach into more rural settings. Minimizing these reductions can be mitigated by golf courses through providing or enhancing pollinator habitats in non-play areas and being mindful when applying pesticides near non-play areas. Pollinators require a diverse variety of flowering species to complete their lifecycle. It's important to understand colors, shapes, odors, native plant species, and the variety of plants that encourage pollinators. Aesthetic gardens, window boxes and container gardens, should contain plants of different heights that provide attractive color and nectar.

Include resources for pollinators to use as nesting sites. Construct domiciles for bees out of pieces of hollow bamboo or purchase pre-made "bee houses" to station in out-of-play areas. To help out butterflies and moths, include larval food resources such as milkweed for monarchs or parsley for black swallowtails.

Resources for plant varieties that attract pollinators specific to Wisconsin the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) Wisconsin Pollinator Protection Plan, an educational resource meant to provide voluntary guidance and scientifically sound information. The Pollinator Partnership also provides resources and ecoregional planting guides to promote the health of pollinators, critical to food and ecosystems, through conservation, education, and research.

Reference Integrated Pest Management for additional pollinator protection BMPs.

Wildlife Habitat

The Wisconsin Society of Ornithology reports nearly 400 species of birds in the state of Wisconsin. According to the U.S. Fish & Wildlife Service, Wisconsin is home to endangered or threatened communities of bird species including the Kirtland's warbler, piping plover, and red knot. Mammals which are threatened or endangered include the Canada lynx, gray wolf, and northern long-eared bat. Its flora and fauna face conservation challenges magnified by habitat destruction. Golf courses often provide critical habitats for these mammals and avian species.

Additional information: https://www.fws.gov/midwest/endangered/lists/pdf/WisconsinStateList.pdf

Best Management Practices

- Develop relations with the DNR or local fish and wildlife service organizations
- Understand whether your property is an existing or potential habitat for endangered species
- Develop a management plan and objectives
- Retain existing vegetation when possible and plant native vegetation
- Use native drought tolerant plants where feasible
- Educate staff, members/guests, and community through communications and inviting them to tour the golf course
- Use social media and local news outlets to educate golfers and the general public on steps taken to promote wildlife habitats
- Invite local schools, garden clubs, master gardeners, etc. to visit the facility to demonstrate the steps taken to promote habitats
- Participate in bird counts or bird-watching tours for guests

The primary wildlife on golf courses will probably be small mammals and birds. It's not uncommon in Wisconsin to see deer, coyotes, wild turkeys, pheasants, foxes, eagles, or hawks enjoying the golf course surroundings. Ponds, lakes, and streams are also home to many species of fish, frogs, and turtles; in addition to providing wintering habitat for large numbers of waterfowl. Forested buffers along golf course streams and wetland areas can provide sanctuaries for birds and other wildlife, while protecting water quality. When riparian buffers connect isolated blocks of habitat, they also serve as important travel corridors for species that may not cross large open areas. Natural vegetation should be retained and enhanced through supplemental planting of native trees, shrubs, and grasses in non-play areas. Avoid exotic species, particularly invasive plants, or plants that are not well adapted to the local environment. Natural cover around a course also serves as a buffer to reduce urban traffic noise.

Reference for additional Wisconsin wildlife habitat information: https://dnr.wisconsin.gov/topic/WildlifeHabitat

Reference Surface Water Management and Water Quality Monitoring and Management for additional information about protecting water quality for wildlife and aquatic habitats.

Examples of Wisconsin Native Wildlife

- Badger
- Black Bear
- Eastern Chipmunk
- Least Chipmunk
- Coyote
- White-tailed Deer
- Gray Fox
- Red Fox
- Pocket Gopher
- Snowshoe Hare
- Deer Mouse
- Muskrat
- Opossum
- River Otter
- Porcupine

Landscape

Landscape (non-play) areas are an essential part of the overall course design, providing enhanced course aesthetics, wildlife habitat, external sound/noise abatement, and natural cooling and freeze protection. The ideal plant from an environmental standpoint is the one nature and evolution placed there. It has adapted specifically to the soil, microclimate, rainfall and light patterns, insects and other pests, and endemic nutrient levels over thousands of years.

Best Management Practices

- Base plant selection as close to the natural ecosystem as practical, while meeting the needs of the golf course; it has adapted to the soil, microclimate, rainfall, light patterns, insects and other pests, and endemic nutrient levels over many years
- Select trees, plants, and grass species to attract birds seeking wild fruits, herbs, seeds, and insects
- Know the ultimate sizes and growth rates of trees, shrubs, and ground covers
- Use plants that are adapted for the site based on the United States Department of Agriculture (USDA) cold-hardiness map: https://plants.usda.gov/hardiness.html
- Select stress-tolerant species or cultivars to manage periodic dry/wet conditions and for a particular area
- Aesthetic gardens, window boxes, and container gardens should include a variety of plants of different heights that provide nectar for hummingbirds, butterflies, and other pollinators
- When integrating turf areas into the landscape around buildings/the clubhouse, entries, and other areas, design for ease of maintenance and optimizing turf growth in areas with adequate sun
- Garden plants, shrubbery, ground covers, or native plants may provide a pleasing a view and useful food, cover, or other environmental benefits to wildlife; they may also reduce maintenance
- Trees and shrubs along streams provide temperature moderation
- The plant palette and irrigation system should be appropriate for site conditions; in some cases, soil improvement can enhance water use efficiency
- Plants should be grouped together based on irrigation demand
- Percentage of landscaped area in irrigated high-water-use hydrozones should be minimized
- Add proper soil amendments in garden areas to improve the soil's physical and chemical properties, increase water-holding capacity, and reduce leaching

THE GOAL OF LANDSCAPE BMPS IS TO MAINTAIN AS CLOSE TO A NATURAL ECOSYSTEM AS PRACTICAL, WHILE MEETING THE NEEDS OF THE COURSE.

One of the first steps in golf course landscape planning is to assess the site's general environment and ecology. An environmental landscape design addresses environmentally safe and energy-saving practices. Map environmentally sensitive areas such as wetlands, ephemeral ponds, or flood zone areas, and identify federal and state endangered or threatened species. It is important to preserve natural surroundings and wildlife habitats.

Well-designed forested buffers should contain a mixture of fast and slow growing native trees, shrubs, and grasses to provide a diverse habitat. By leaving dead trees and supporting "no-mow" and native grass areas, the amount of labor and resources needed to maintain a course are reduced. These practices also:

- Provide ability to trap and remove upland sources of sediment, nutrients, and chemicals
- Protect fish and wildlife by supplying food, cover, and shade
- Maintain a healthy riparian ecosystem
- Make sure snags are a safe distance from playing surfaces

Wisconsin Native Plants

- Wild geranium *(Geranium maculatum)*
- Columbine *(Aquilegia canadensis)*
- Solomon's seal *(Polygonatum biflorum)*
- Common milkweed *(Asclepias syriaca)*
- Maidenhair fern *(Adiantum pedatum)*
- Culver's root *(Veronicastrum virginicum)*
- Bee-balm *(Monarda fistulosa)*
- Heart-leaved aster *(Aster cordifolius)*
- New England Aster *(Aster novae-angliae)*
- Little bluestem *(Schizacyrium scoparium)*
- Stiff goldenrod *(Solidago rigida)*

Wisconsin native plant resources, landscaping recommendations, native plant sources, planting for monarchs and birds:

https://dnr.wisconsin.gov/topic/endangeredresources/nativeplants.html

https://dnr.wi.gov/files/pdf/pubs/nh/nh0936.pdf

http://www.plantnative.org/rpl-mimnwi.htm

https://ipaw.org/

Species Selection and Size Considerations

Landscape areas should be fundamentally designed to facilitate rapid plant establishment to conserve water and lower nutritional input requirements once mature. Plants within areas that are not in play or are not critical to the design of the course may be removed and replanted with native plant material that requires little to no maintenance after establishment. Natural vegetation should be retained and enhanced through the supplemental planting of native trees, shrubs, and herbaceous vegetation to provide wildlife habitat in non-play areas (50 to 70 percent of the out-of-play areas should remain natural cover).

Choose the most stress tolerant species or cultivar for the area. Know ultimate sizes and growth rate of trees, shrubs, and ground covers. This reduces the need for pruning and debris removal, plus lowers maintenance costs. Non-play areas require a mix of sun and shade, optimal soil conditions, and adequate canopy air movement to sustain growth and function. Use native drought tolerant plants where feasible around buildings or other appropriate places.

In most instances, established, drought-tolerant landscape plants have a root system substantial enough to keep them alive with little or no supplemental irrigation. Consider use of water-holding polymers, water-sorbing polymers, or water storing crystals as means of water retention and reducing water loss to evaporation. The use of rocks, sand, gravel, volcanic cinder or lava, and decorative pebbles have functional aesthetic purpose and conserve water.

Planting Methods

Soil testing should be done prior to planting to ensure that the selected plants will be planted in soil that is naturally compatible to the desired plants (i.e. proper pH, nutrient levels, wet versus dry tolerant, shaded versus full sun, etc.). Organic amendments are decomposed by soil microorganisms and add to soil tilth. The use of organic mulches in gardens and aesthetic areas increases the moisture-holding capacity of plantings and prevents weed growth when applied in enough depth. Keep mulch 2 to 3 inches away from plants, to prevent fungal growth from excess dampness. Excess mulch or compacted mulch may be detrimental, causing water to shed away from the root zone and encouraging overwatering.

Education

Train the crew on identifying endangered species and educate members and guests through newsletters, meetings, and signage. Section off habitat areas so that nesting wildlife is left undisturbed. Plan and implement a public awareness program to increase landowner and land manager knowledge of wildlife needs.

External Certification Programs & Standards

Environmental management programs, health and wellness platforms, and environmentally-friendly building design can help courses protect the environment and promote community relations. These programs can help enhance natural areas and wildlife habitats that golf courses provide and improve efficiencies. Obtaining certifications and adhering to standards can enhance community, member/guest, employee, and civic relations.

Certifications and internationally-recognized frameworks that golf courses and clubs can pursue range from environmentally-focused programs to certifications related to health and wellness. Establish a communications plan to educate members/guests and the community

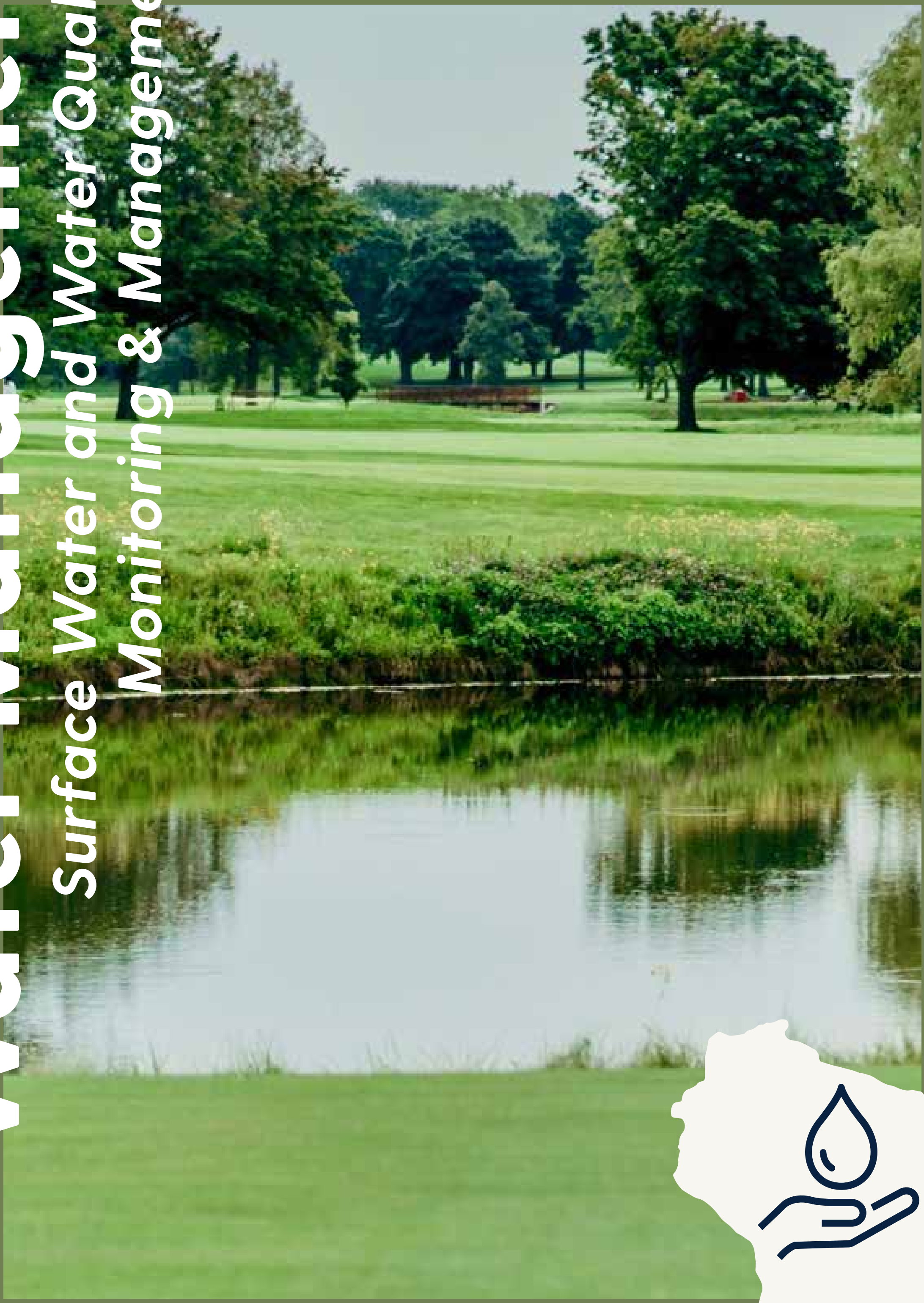
Reference GCSAA Environmental Institute of Golf for more information: https://www.eifg.org/

External Certifications and Frameworks

- Audubon International Cooperative Sanctuary, Signature, and Sustainable Communities Programs https://www.audubonintenational.org/
- US Green Building Council Leadership in Energy and Environmental Design (LEED) https://new.usgbc.org/leed
- Global Reporting Initiative GRI Standards https://www.globalreporting.org/standards/
- Blue Zones Project https://www.bluezonesproject.com/
- B Corp Certification https://bcorporation.net/certification
- Sustainable Development Goals https://sustainabledevelopment.un.org/sdgs

Water Management

Surface Water and Water Quality Monitoring & Management



Section 4

Wisconsin has 15,000 lakes, more than 12,600 rivers and streams, five million acres of wetlands, and 1,000 miles of Great Lakes shoreline. Wisconsin's waters extend over 330 watersheds and 32 basins, including the Great Lakes Basin and the Mississippi River Basin. Golf courses can minimize impacts to waterbodies from golf course operations and prevent nonpoint sources of pollution through effective utilization of BMPs.

Generally, a quantity of stormwater enters the golf course area, supplemented by what falls on the golf course property, and then the stormwater leaves the golf course. Golf courses are realistically capable of having only a small impact on major stormwater flow. That impact should be to add only small increments of water over a given period of time. This function is known as "detention."

When golf courses are designed and built, their drainage capability is guided by an average rainfall event of a given frequency. For example, typically, a golf course drainage system is designed to detain a two- or five-year rain event. In other words, when that rain event happens, the golf course will have the ability to be reasonably drained in a matter of hours, as excess water not absorbed by the soil flows through the drainage system, is temporarily held, and eventually leaves the property. In some instances, the designs of golf courses and other recreational facilities are required to handle a 20-, 50- or 100-year rain event, which means the golf course must detain more water for perhaps a longer period of time.

Golf courses employ a variety of practices to protect surface water and groundwater quality. In Wisconsin, these include nutrient management plans, integrated pest management plans, stormwater pollution prevention plans, aquatic plant management plans, water quality monitoring plans (including water sampling), and other protocols incorporating BMPs designed to protect and conserve water.

Reference the Planning, Design, and Construction; Irrigation; Nutrient Management: Mowing and Rootzone Management; Integrated Pest Management; Responsible Pesticide Management; and Maintenance Operations Sections for additional BMPs.

SURFACE WATER AND STORMWATER MANAGEMENT BMPS ARE INTENDED TO PROLONG THE DETENTION PROCESS AS LONG AS PRACTICAL, HARVEST AS MUCH OF THE STORMWATER IN SURFACE OR UNDERGROUND STORAGE AS REASONABLE, AND TO IMPROVE THE QUALITY OF WATER LEAVING THE PROPERTY WHEN POSSIBLE.

Regulatory Considerations

In Wisconsin, the DNR is responsible for ensuring that the state's surface water, groundwater, wastewater, and drinking water resources meet state water quality standards and federal requirements. The DNR monitors and assesses the quality of the state's rivers, streams, lakes, reservoirs, groundwater, and sources of drinking water. This information is used to comply with federal reporting requirements and to make decisions regarding water quality management. Permitting, preservation activities, and compliance are enforced by the DNR; pursuant to Wis. Stat. s.283.83, the department establishes a continuing water pollution control planning process (CPP) resulting in plans for waters of the state, including:

- Adequate effluent limitations and schedules of compliance
- The incorporation of all elements of any applicable areawide waste management plans, basin plans and statewide land use plans
- Total maximum daily load (TMDLs) for pollutants
- Procedures for revision
- Procedures for intergovernmental cooperation
- Implementation procedures (including schedules of compliance) for revised or new water quality standards
- Controls over the disposition of all residual waste from any water treatment processing
- An inventory and ranking, in order of priority, of needs for construction of waste treatment works required to meet applicable requirements

The DNR is responsible for establishing Wisconsin's surface water quality standards, including designated uses, water quality criteria, antidegradation, water quality variances, reporting, permit limits, TMDLs, and water quality management plans. The state also classifies waterbodies using categories that indicate special ecological value, known as Areas of Special Natural Resources Interest (ASNRI). Every three years, the DNR reviews Wisconsin's water quality standards or related guidance to determine which standards need development or revision, as required by the CWA.

All standards are protective and signal a situation where there is possibility that water quality may be inadequate to meet its designated uses. Four general categories for water use are defined in the Wisconsin Surface Water Quality Standards:

- Aquatic Life
- Recreation
- Public Health & Welfare
- Wildlife

Some pollutants or conditions that may violate the Aquatic life standard include low levels of dissolved oxygen (DO), or toxic substances such as metals or pesticides. Wisconsin Administrative Code NR 102 contains criteria for phosphorus, DO, pH, bacteria, and temperature.

The DNR is responsible for developing a water quality strategic plan, which is used as a state blueprint for improving water quality and supports monitoring responsibilities under the federal Clean Water Act (CWA). The DNR must identify and prepare an assessment of lakes, rivers, streams, and estuaries failing to meet or not expected to meet water quality standards and not supporting designated uses (swimming, drinking, aquatic life, etc.); this assessment known as the 303(d) list of impaired or threatened waters must be sent to the Environmental Protection Agency (EPA) every two years as part of Sections 305(b) and 303(d) of the CWA. The State must then establish a Total Maximum Daily Load (TMDL) for waterbodies identified on the 303(d) List. TMDLs are scientifically derived targets that set the greatest amount of a particular substance that can be added to a waterway on a daily basis and still keep it healthy.

The DNR also administers Wisconsin's Nonpoint Source Program to reduce water quality impacts from nonpoint sources (NPS) of pollution. NPS pollution is caused by rainfall or snowmelt moving over and through the ground. Runoff picks up natural and human-made pollutants, depositing them into rivers, lakes, wetlands, and groundwater. Golf courses are required to follow NPS

state regulations for fertilizers and pesticide use under Wis. Adm. Code NR 151 and NR 216. Under state law, the DNR coordinates NPS program implementation with the DATCP.

Through Chapter ATCP 50, Wis. Adm. Code, DATCP establishes technical standards and elements for program implementation. The DATCP regulates soil and conservation practices and standards in Wisconsin, at a county level. This includes approval of Land and Water Resource Management (LWRM) Plans by county, pursuant to Wis. Stat. s.92.

LWRM plans define a mix of approaches (e.g., regulatory, nonregulatory, financial, and technical assistance) for implementing state performance standards. The steps involved mirror the EPA's NPS Program (Section 319) requirements for watershed-based plans. The non-agricultural performance standards are primarily implemented through Chapter NR 216, Wis. Adm. Code, the state's Storm Water Discharge Permit rule.

Lastly, the DNR is the lead agency for administering the Section 401 certification program in Wisconsin. The DNR conducts Section 401 certification reviews of projects requiring a Section 404 permit from the U.S. Army Corps of Engineers for the discharge of dredged or fill material into waters of the U.S., including wetlands. Pursuant to Wis. Stat. s.281.

The following resources and references will help inform golf course water management planning; owners and golf course superintendents should further investigate local surface water and groundwater regulatory requirements that may apply for the golf facility and its location.

Golf courses are responsible for reporting monthly water use and reporting annually to the DNR. Water Withdrawal Report Form: https://dnr.wi.gov/files/pdf/forms/3300/3300-275.pdf

Water Withdrawal Report Instructions: https://dnr.wi.gov/topic/WaterUse/documents/WWReportGuidance.pdf

Wis. Stat. s.283.83 DNR Continuous Planning Process: https://docs.legis.wisconsin.gov/statutes/statutes/283/v/83

NR 102. Wisconsin Water Quality Standards for Surface Waters: https://docs.legis.wisconsin.gov/code/admin_code/nr/100/102 https://dnr.wisconsin.gov/topic/SurfaceWater/Standards.html

NR 103. Wisconsin Water Quality Standards for Wetlands https://docs.legis.wisconsin.gov/code/admin_code/nr/100/103

NR 104. Wisconsin Water Uses and Designated Standards https://www.epa.gov/sites/production/files/2014-12/documents/wiwqs-nr104.pdf

Wisconsin Nonpoint Source Program Management: Overview https://dnr.wisconsin.gov/topic/Nonpoint/aboutNPSprogram.html

NR 151 Runoff Management https://docs.legis.wisconsin.gov/code/admin_code/nr/100/151
Wis. Stat. s.35.93, ATCP 50 Soil and Water Resource Management Program http://docs.legis.wisconsin.gov/code/admin_code/atcp/020/50.pdf
NR 216 Stormwater Discharge Permits https://docs.legis.wisconsin.gov/code/admin_code/nr/200/216/_1
Wis. Stat. s.35.93, ATCP 29.01 Pesticide Use and Control https://docs.legis.wisconsin.gov/code/admin_code/atcp/020/29.pdf

Information on TMDLs: https://dnr.wisconsin.gov/topic/TMDLs https://dnr.wi.gov/water/tmdlmap.aspx https://dnr.wisconsin.gov/topic/TMDLs/TMDLReports.html

Full Overview of DNR Water Permit Applications (includes Aquatic Plant Management, Stormwater Management During Construction, Well Construction, Dredging, Wetland Disturbance, etc.): https://dnr.wisconsin.gov/permits/water

Water Sample Collection Requirements for Well Construction & Pump Installation https://dnr.wi.gov/files/PDF/pubs/DG/DG0088.pdf

Wis. Stat. s.281 Section 401 Certification Reviews: https://docs.legis.wisconsin.gov/statutes/statutes/281 https://www.epa.gov/wqs-tech/water-quality-standards-regulations-wisconsin

Wis. Stat. s.92 LWRM Plans: https://docs.legis.wisconsin.gov/1989/statutes/statutes/92.pdf

Best Management Practices

- Adhere to all federal, state, and local water management and water quality regulations
- Consult federal, state, and local water management agencies, and/or consult an approved management plan before performing construction activities, irrigation installation, integrated pest management, fertilization, or aquatic plant management
- Golf course management may be affected by TMDL, mitigation, and watershed basin management action plans; determine applicability through the DNR
- Wetlands are protected areas; consult with the DNR and federal agencies before altering natural aquatic areas
- Studies of water supplies are needed for irrigation systems, including studies of waterbodies or flows on, near, and under the property to properly design a course's stormwater system and water features to protect water resources
- The disposal of sediments from surface water ponds (stormwater detention) may be subject to regulation
- Golf courses must complete and submit monthly water use reporting to the DNR annually
- Golf courses must comply with state-required pesticide reporting and maintain a nutrient management plan consistent with NR 151
- Seek professional assistance from an environmental specialist to design an appropriate water sample collection strategy (i.e., sample water quality four to six times per year including field and lab analyses); use reputable equipment and qualified technicians to determine sites to be analyzed

WATER IS A CRITICAL NATURAL RESOURCE WHICH REQUIRES THOUGHTFUL MANAGEMENT FOR CONSERVATION AND WATER QUALITY.

Site Analysis

A watershed is commonly defined as a topographically delineated area that collects and drains water from rain and snowfall to a common outlet such as a stream, lake, or river. It is important to identify the watershed where the golf course is located.

Wisconsin watersheds may be searched by geography at: https://dnr.wisconsin.gov/topic/Watersheds/basins

Once the watershed is identified, check with the DNR to see if there is a Watershed Plan, or Water Quality Management (WQM) Plan, established for it.

Additional information on WQM Plans: https://dnr.wisconsin.gov/topic/SurfaceWater/wqmplan

WQM Plans are targeted watershed assessment-based water quality planning strategies which outline goals, land use, measures, monitoring levels, management options, requirements and recommendations. They describe sources of pollution for a watershed area and define actions to reduce pollution or restore quality. They are developed in collaboration with regional and local stakeholders, such as County Land and Water Conservation Departments. WQM Plans are created under the state's Water Resources Planning and Monitoring Programs as part of Areawide Water Quality Management Plan requirements under Section 208 of the CWA. These areas may also have TMDLs for waterbodies in place.

Wisconsin law requires each county to have a land and water resource management (LWRM) plan that has been approved by the DATCP. The Land and Water Conservation Departments for each of Wisconsin's 72 counties are required to develop LWRM plans which incorporate soil and water conservation standards, work plans, programs and regulations, monitoring, evaluation, stakeholders involved, and education strategies.

If a WQM, LWRM plan, or TMDLs are in place for the site - determine overall goals, understand concerns, and observe regulations to determine actions and tailor BMPs for the facility. The site's physical attributes and location, watershed and groundwater assessments, presence of invasive or weedy species, aesthetics, and other environmental considerations, should all be identified. Trace the property's local stream to its closest outlet point and then follow it to its final destination - the major river or other waterbody into which it drains. Evaluate the site's impact and take steps to reduce pollution. Water drainage and flows, water quality protection, and aquatic plant management strategies should be designed which address all intended uses of stormwater, waterbodies, and groundwater to optimize

Additional Watershed Information
The Natural Resources Conservation Service (NRCS) provides Rapid Watershed Assessments (RWA) which incorporate combined LWRM and DNR watershed report data by area: https://www.nrcs.usda.gov/wps/portal/nrcs/main/wi/technical/dma/rwa/

Questions on Wisconsin Watersheds or WQM Plans?

Contact a DNR or DATCP water quality specialist:

DNR Water Quality Program
Lisa Helmuth (Kosmond)
Phone: (608) 266-7768
Email: Lisa.Helmuth@wisconsin.gov

DNR Watershed General Questions
Email: DNRWMSPublicInquiry@Wisconsin.gov

DATCP - LWRM Plans
Lisa Trumble
Phone: (608) 224-4617
Email: lisa.trumble@wisconsin.gov

Water Management Strategy Planning: Key Questions

When planning effective water management strategies for the specific site, answer and address the following questions:

- ✓ How does water naturally enter your property: rain, wetland, river, etc.?
- ✓ What is the lowest point or points where water settles?
- ✓ Where does water leave the property, and where does it go?
- ✓ Could it pick up any contaminants because of your land use practices?
- ✓ Does water quality improve, decline, or stay the same as it moves over your property?

Best Management Practices

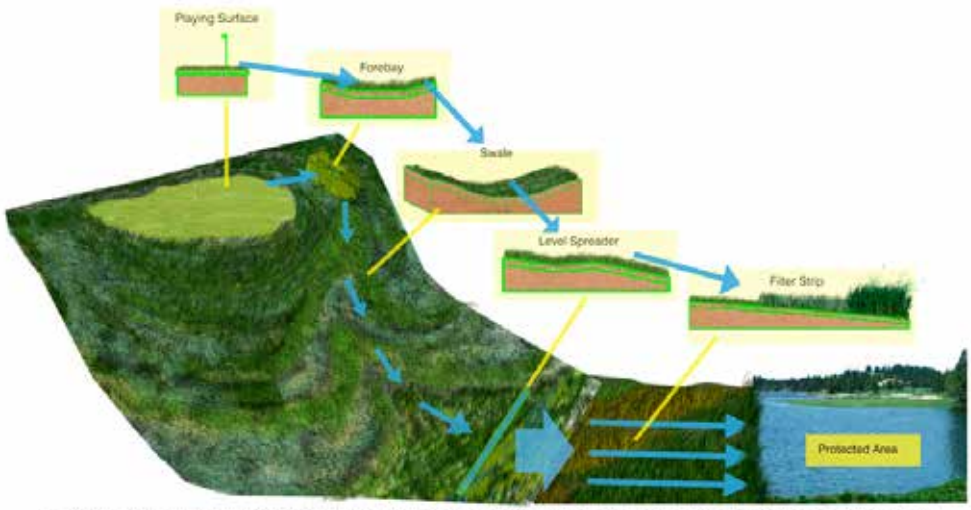
- Identify and explore the watershed within which the facility is located; determine if there is an existing WQM, LWRM plan, or TMDLs in place, determine overall goals and qualify concerns, identify water quality actions for the facility
- Develop a water quality monitoring plan to monitor surface water, groundwater, and pond sediments
- Outline goals and priorities to guide the development of the BMP necessary to support the lake/aquatic management plan
- Identify possible downstream watershed areas that could receive surface water runoff from the property
- Indicate surface water and flow patterns, stormwater flow, as well as existing and potential
- holding capacity
- Indicate impervious surfaces, such as buildings, parking lots, or pathways; location of all facilities, structures, treatments and measures used for soil erosion and sedimentation control and long-term stormwater management
- Indicate major drainages and catch basins that connect to local surface water bodies
- Accommodate/enhance natural lake processes in the construction of lakes and ponds; include herbaceous and woody vegetation and emergent and submergent shoreline plants to facilitate natural versus conventional erosion control techniques (e.g., riprap) and reduce operational costs where applicable
- Determine groundwater locations in relation to the surface of the course, particularly in any areas that have a seasonally high-water table (<24”) or shallow bedrock (<4’); mapping areas of relatively high-water table is also important in identifying areas prone to groundwater flooding
- Identify and understand depth to bedrock, depth to water tables, and soil types
- Establish source control practices
- Locate and protect wellheads
- Irrigation should not directly strike or runoff to waterbodies and no-fertilization buffers should be maintained along edges
- Use part-circle sprinklers along perimeters of natural water features to minimize their contact with reclaimed/fertigation overspray

Stormwater Management, Ponds, and Lakes

When the golf course is properly designed, rain and runoff captured in water hazards and stormwater ponds may provide most or all of the supplemental water necessary for irrigation under normal conditions, though backup sources may be needed during drought conditions. Stormwater capture is desirable where the lowest quality of water is needed to conserve potable water, maintain hydrologic balance, and improve water treatment.

Stormwater is the conveying force behind NPS pollution. Not all stormwater on a golf course originates there; it may flow from adjoining lands, including residential or commercial developments. Pollutants commonly found in stormwater include the microscopic wear products of brake linings and tires; oil; shingle particles washed off roofs; soap, dirt, and worn paint particles from car washing; leaves and grass clippings; pet and wildlife wastes; lawn, commercial, and agricultural fertilizers; and pesticides. The golf course serves as an important community resource for filtration. Stormwater control involves more than preventing flooding of facilities and play areas, it also includes:

- Controlling amount and rate of water leaving the course
- Storing irrigation water
- Controlling erosion and sediment
- Enhancing wildlife habitat
- Removing waterborne pollutants
- Addressing aesthetic and playability concerns



A comprehensive systems approach uses a treatment train and the natural drainage systems to protect water quality at a high priority area.

Stormwater Treatment Train

Source: BMPs for NY State Golf Courses

Example: Steps for Maintaining A Stormwater Treatment Train

Step 1: Establish Special Management Zones defined as areas that have distinct management practices that coincide with their position in the watershed and are based on the analysis of resources and habitat protection requirements.

Step 2: Use a Natural Systems Engineering Approach to stormwater management that maximizes the use of natural systems to treat water. Vegetative swales, stormwater ponds, marshes and wetlands can serve as habitat for many creatures, including wetland birds and other waterfowl.

Step 3: Maximize Use of Pervious Pavements such as brick or concrete pavers separated by sand and planted with grass. Special high-permeability concrete is available for cart paths or parking lots.

Step 4: Establish BMP "Trains" for maximum environmental protection. The most effective way to protect surface water and groundwater is by using a comprehensive systems approach that includes integration of preventative practices and structural controls. Preventative measures include nonstructural practices that minimize or prevent the generation of runoff and contamination of runoff by pollutants; for example, using organic fertilizers. Structural controls are capital improvements designed to remove, filter, detain, or reroute potential contaminants carried in surface water.

STORMWATER MANAGEMENT ON A GOLF COURSE INCLUDES STORING IRRIGATION WATER, CONTROLLING EROSION AND SEDIMENT, ENHANCING WILDLIFE HABITAT, REMOVING WATERBORNE POLLUTANTS, CONTROLLING THE AMOUNT AND RATE OF WATER LEAVING THE COURSE, AND ADDRESSING AESTHETIC AND PLAYABILITY CONCERNS.

Develop a stormwater pollution prevention plan (SWPPP), especially prior to initiating construction activities. Source control practices should prevent pollution by limiting or reducing potential pollutants at their source, which involves keeping a clean, orderly construction site. The SWPPP should also include establishing water quality buffers and special management zones. If possible, construct ponds in a series, or "train", to treat stormwater/site runoff. The first pond will catch the "first flush", the second will provide additional filtering, and the third will filter and serve as a primary withdrawal pond for irrigation; infiltrating the first inch of stormwater helps to prevent water quality impacts.

A common treatment train includes turf swales on side slopes designed to filter and slow down the movement of stormwater, the second car in the train includes a swale or main channel that directs stormwater to the final car in the train, often a constructed wetland. Vegetated swales slow and infiltrate water and trap pollutants in the soil, where they can be destroyed naturally by soil organisms. Depressed landscape islands in parking lots can catch, filter, and infiltrate water, instead of letting it run off. When hard rains occur, an elevated stormwater drain inlet allows the island to hold the treatment volume and settle out sediments, while allowing the overflow to drain away.

Additional measures include maximizing use of pervious pavements, such as brick or concrete pavers, separated by sand and planted with grass. Special high-permeability concrete is available for cart paths or parking lots. Also, disconnect runoff from gutters and roof drains from impervious areas, so that water flows onto permeable areas, allowing it to infiltrate near the point of generation.

Most golf courses plan lakes and water hazards to be a part of the stormwater control and treatment system. However, natural waters of the state cannot be considered treatment systems and must be protected.

Best Management Practices

- The course site plan should maintain the natural wetland and watercourse systems and buffers, plus locate necessary stormwater management structures to upland areas; this helps maintain the natural drainage patterns and allows for recharge of runoff
- A series or train of stormwater diversions, swales, and basins can be designed to collect stormwater runoff for use in supplementing irrigation
- Avoid the direct discharge of stormwater runoff from parking lots, service areas, buildings and roadways directly into wetlands and watercourses; design stormwater treatment trains to direct stormwater across vegetated filter strips (such as turfgrass), through a swale into a wet detention pond, and then out through another swale to a constructed wetland system
- Develop a SWPPP which includes a "natural systems engineering" or "soft engineering" approach that maximizes the use of natural systems to treat water; including special management zones, swales and slight berms, along with buffers to slow and infiltrate water and trap pollutants in the soil where they can be naturally destroyed by soil organisms
- A swale and berm system will allow for resident time (ponding) for water to infiltrate through the root zone to reduce lateral water movement to the surface water body
- Ideally buffers should be planted with native species to provide water quality benefits, pleasing aesthetics, and habitat/food sources for wildlife
- Eliminate or minimize directly connected impervious areas
- Use depressed landscape islands in parking lots to catch, filter, and infiltrate water, instead of letting it run off; when hard rains occur, an elevated stormwater drain inlet allows the island to hold the treatment volume and settle out sediments, while allowing the overflow to drain away
- Ensure that no discharges from pipes go directly to water; disconnect runoff from gutters and roof drains from impervious areas, so that it flows onto permeable areas that allow the water to infiltrate near the point of generation
- Discharge or divert surface runoff onto wide, relatively flat vegetated areas to promote infiltration and ground water recharge
- Reduce the frequency of mowing at the lake edge and collect or direct clippings to upland areas where runoff and wind will not carry them back to the lake
- Consider using pervious pavers for walkways, such as brick or concrete pavers separated by sand and planted with grass; and minimize use of curbing on parking areas; where reduction is difficult, large parking areas can incorporate landscaped areas to help maintain natural recharge; special high-permeability concrete is available for cart paths or parking lots; pervious overflow parking should be used to accommodate seasonal parking
- Constructed wetlands (artificial wetland to treat greywater or stormwater runoff) should have an impervious bottom to prevent groundwater contamination
- Reverse-grade around the perimeter to control surface water runoff into ponds and reduce nutrient loads
- Dredge or remove sediment to protect beneficial organisms that contribute to the food web and overall lake health
- The placement of bunkers and the shaping of contours surrounding a green should allow proper drainage and provide for the treatment and absorption of runoff from the green
- Monitor pond water level for water loss (seepage) to underground systems; if seepage is occurring, it may be necessary to line or seal the pond or install pumps to relocate water
- Install water-intake systems that use horizontal wells placed in the subsoil below the storage basin; use a post pump to filter particulate matter

Additional information on constructed or artificial wetlands in Wisconsin: https://dnr.wi.gov/topic/wetlands/documents/3500-2018-02FinalNonfederalWetland.pdf

Reference the Planning, Design, and Construction section for additional stormwater BMPs.

Buffer Zones

A riparian buffer, for the purposes of this document, is a riparian zone that is managed in a vegetated condition in order to achieve water quality protection or improvement. Buffers around the shore of a waterbody or other sensitive areas filter and purify runoff as it passes across the buffer. Ideally, plant buffers with native species in order to provide a triple play of water quality benefits, including filtering of runoff, provide pleasing aesthetics, and supplying habitat/food sources for wildlife. Continue these plantings into the water to provide emergent vegetation for aquatic life, even if the pond is not used for stormwater treatment. Effective buffer areas filter and trap sediment from stormwater runoff to reduce pollutants.

Reference for additional information on filter strips and buffer areas: https://prod.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_020349.pdf

Golf Course Buffer Zones Diagram

Source: Oklahoma Golf Industry BMP Guide, 2020

Best Management Practices

- Buffer areas should be maintained along all water edges above the high-water mark; widths should be a minimum of 5 feet but as wide as possible without impacting course difficulty, course design, or pace of play; these areas are critical in filtering overland runoff and reducing pollutants; they should be left in a natural state
- Institute buffers and special management zones up gradient of riparian buffers to protect waterbodies
- All or most of the out-of-play waterbodies should have shoreline buffers planted with native or well-adapted noninvasive vegetation to provide food and shelter for wildlife
- Mow buffers in the direction that allows the mower discharge chute to direct clippings away from riparian areas
- Construct random small dips and ridges of a few inches to a foot within buffer strips to promote diversity within the plant community and provide a healthier and more productive littoral zone
- Irrigation should not directly strike or run off to waterbodies
- Apply fertilizer and pesticides based on the effective swath; keep application on target and away from buffers or channel swales; as a general practice, keep all chemical applications at least 20 feet away from the water's edge when using rotary spreaders
- Use a deflector shield to prevent fertilizer and pesticide spills from contacting surface waters
- Where a desired buffer width cannot be met due to course layout, prevent runoff from entering the water body at that location by diverting it to adjacent areas where adequately wide buffers can be developed and maintained; methods of diversion can include shallow swales, low berms, and grading of fairway slopes away from stream banks
- Reference the DNR Technical Standard 1100 for additional guidelines on management of buffer zones: https://dnr.wi.gov/topic/stormwater/documents/dnr1100-TurfNutrientManagement.pdf

Aquatic Plant Management

The extensive damage caused to aquatic ecosystems by invasive and nuisance aquatic plant species in the United States has been well documented. An aquatic plant management strategy should address the intended uses of the waterbody to maintain water quality. Proper documentation includes the site's physical attributes and location, the presence of invasive or weedy species, aesthetics, watershed and groundwater assessments, and other environmental considerations.

Superintendents can employ a variety of practices to assist in maintaining aquatic ecosystems or restoring them to health, including biological, mechanical, cultural, and chemical methods. Collecting and reviewing these practices for a specific site is one of the first steps in formulating an integrated control strategy.

Properly designed ponds with a narrow fringe of vegetation along the edge are more resistant to problems than those with highly maintained turf. Superintendents should encourage clumps of native emergent vegetation at the shoreline, plus use ecosystem, watershed, and cost-benefit perspectives to determine long-term management strategies.

Plant life growing on littoral shelves may help to protect receiving waters from the pollutants present in surface water runoff, and a littoral shelf is often required in permitted surface water-retention ponds. In ponds with littoral plantings, problem plants should be selectively controlled without damaging littoral shelves. It's frequent practice to remove filamentous algae by hand and/or frequently apply algaecide to small areas of algae (spot treatment).

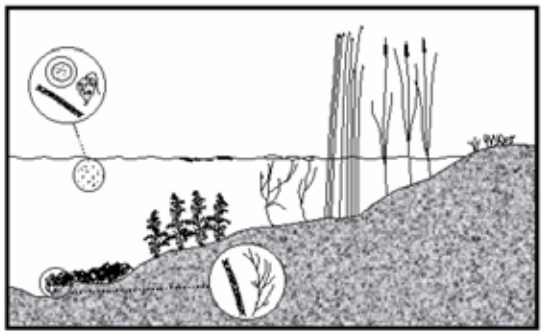
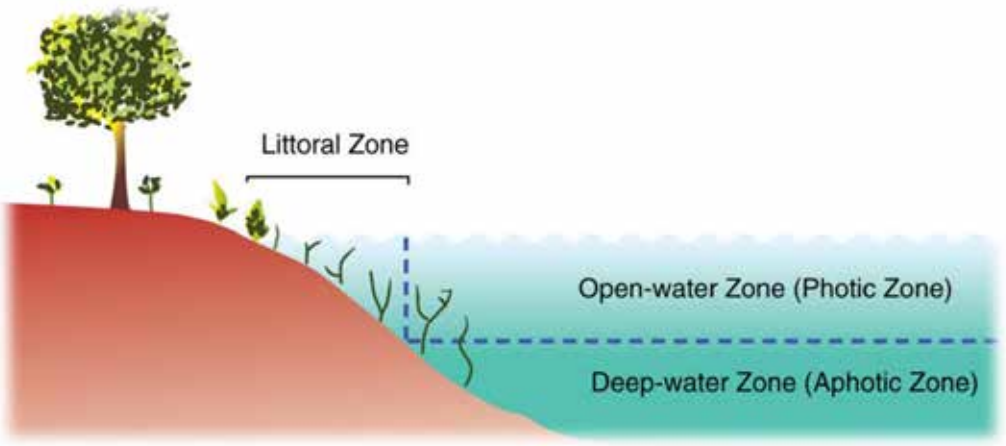


Figure 1. Main groups of aquatic plants found in both still and moving waters:
(a) emergent plants
(b) floating leaved plants
(c) submersed plants
(d) filamentous algae
(e) microscopic algae.
(Adapted from Seagrave 1988).

Regularly assess results of invasive weed control programs (including quantitative documentation of results from control strategies) and re-evaluate management options as part of a professional plant management strategy.

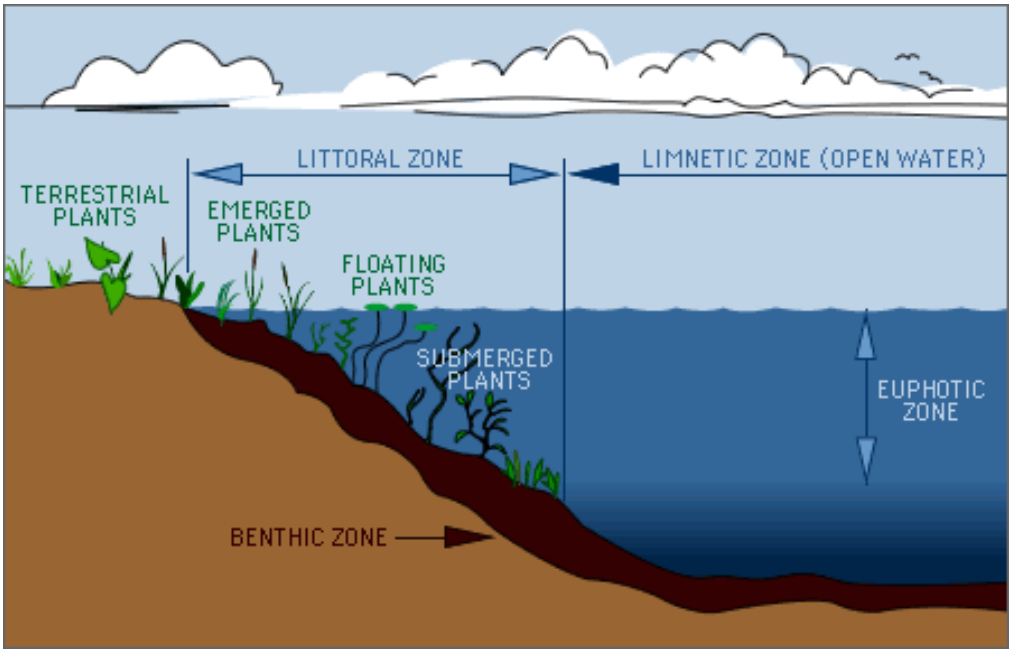
Phytoplankton give water its green appearance and provide the base for the food chain in ponds. Tiny animals called zooplankton use phytoplankton as a food source. Large aquatic plants (aquatic macrophytes) can grow rooted to the bottom and supported by the water (submersed plants), rooted to the bottom or shoreline and extended above the water surface (immersed plants), rooted to the bottom with their leaves floating on the water surface (floating-leaved plants), or free-floating on the water surface (floating plants). Different types of aquatic macrophytes have different functions in ponds.

Ponds may be constructed on golf courses strictly as water hazards or for landscape purposes, but they often have the primary purpose of drainage and stormwater management and function as a source of irrigation water. The use of aquatic plants to improve the appearance of a pond (aquascaping) can be included as part of the overall landscape design.



Littoral Zone Diagram

Source: Florida Lakes and Ponds Guidebook | https://bit.ly/37Jh6MS



Lake Zones Diagram

Source: https://www.waterontheweb.org/under/lakeecology/10_biological_lakezones.html

Aquatic Invasive Species in Wisconsin

- Eurasian Water-milfoil *(Myriophyllum spicatum)*
- Purple Loosestrife *(Lythrum salicaria)*
- Curly-leaf Pondweed *(Potamogeton crispus)*
- Brazilian elodea *(Egeria densa)*
- European Frogbit *(Hydrocharis morsus-ranae)*
- Hydrilla *(Hydrilla verticillata)*
- Phragmites *(Common Reed or Phragmites australis)*
- Water Chestnut *(Trapa natans)*

Source: https://www.seagrant.wisc.edu/our-work/focus-areas/ais/invasive-species/invasive-species-fact-sheets/plants/

Additional Resources:

https://dnr.wisconsin.gov/topic/invasives/classification.html

https://dnr.wi.gov/lakes/invasives/AISByWaterbody.aspx

Best Management Practices

- Adhere to federal, state, and local regulations for aquatic plant management, secure proper permits for nuisance control activity
- Outline goals and priorities to guide the development of the BMP necessary to support aquatic plant management
- Design pond basin dimensions to limit pond littoral zone (area where light penetrates to bottom) and therefore area supporting aquatic plant growth; except in instances of extreme water clarity, basins slopes of 3:1 are routinely effective
- Maintain a narrow band of open water at the pond edge to control the expansion of plants into more desirable littoral plantings
- Proper design with a narrow fringe of vegetation along the pond's edge are more resistant to problems than those with highly maintained turf
- In ponds with littoral plantings, problem plants should be selectively controlled without damaging littoral shelves
- Encourage clumps of native emergent vegetation at the shoreline; establish special management zones around edges
- A comprehensive lake management plan should include strategies to control the growth of nuisance vegetation that can negatively affect a pond's water quality and treatment capacity
- Only licensed individuals or contractors certified in aquatics and mosquito (5.0) by DATCP should be allowed to select and apply aquatic pesticides; utilize physical or other controls first under a proper IPM program; pesticides should be used as a last resort
- Frequently remove filamentous algae (typically long, stringy, slimy, and thread-like in appearance) by hand and/or frequently apply algaecide to small areas of algae (spot treatment)
- If possible, avoid the use of copper or aquatic herbicides; apply copper products to tie-up phosphorus and use shading compounds to reduce light penetration as per label instructions to reduce the risk of impairing water quality and causing negative biological impacts
- To reduce the risk of oxygen depletion, use an algaecide containing hydrogen peroxide instead of one with copper or endothall
- Where possible, allow plants such as arrowhead or pickerelweed to inhabit littoral zones to improve water quality
- Beneficial aquatic plants can help filter nutrients and chemicals, stabilize shorelines, and provide important fish and wildlife habitat; consult with a professional aquatic management consultant for proper planning, permitting, and implementation
- Triploid grass carp (with a DNR permit) are sometimes used as a biological control for aquatic plants

Additional information for aquatic plant management and Wisconsin permit requirements: https://dnr.wi.gov/lakes/plants/

Wetland Protection

Wetlands provide critical habitat for Wisconsin plants, fish and wildlife, clean water, protection from floods, recreation, and natural beauty. Wetlands are the transitional zones between uplands and deep water -- the areas are dependent on the presence of water for all or part of the time, at or above the surface, or within the root zone. Wetland soils include soil characteristics that differ from surrounding uplands and vegetation containing plants that have adapted to the presence of water; wetlands generally lack plants that are intolerant of wet conditions.

Wetlands are recognized for their role as nurseries for many species and as filters for removal of pollutants, helping to purify surface waters. The biological activity of plants, fish, animals, insects, and especially bacteria and fungi in a healthy, diverse wetland is the recycling factory of our ecosystem.

When incorporated into a golf course design, wetlands should be maintained as preserves and separated from managed turf areas with native vegetation or structural buffers. Constructed or disturbed wetlands may be permitted to be an integral part of the stormwater management system. Manmade buffers should be designed to improve habitat diversity and include a mixture of fast and slow-growing native trees, shrubs, or grasses to provide a diverse habitat for wildlife.

All wetlands in Wisconsin are protected under state law and most under the federal CWA, and in some places, by local regulations or ordinances. Activities such as filling for commercial development require a permit review process, administered by the USACE, to ensure no discharge of dredged or fill material significantly degrades the protected wetland area or to determine if a practicable alternative exists that is less damaging to the aquatic environment. Certification reviews of USACE Section 404 permit applications are conducted by the DNR.

Wisconsin wetlands information and regulations:
https://dnr.wisconsin.gov/topic/Wetlands
https://dnr.wisconsin.gov/topic/Wetlands/identification.html
https://dnr.wisconsin.gov/topic/Wetlands/permits

Wisconsin Section 401 Certification Reviews:
https://www.aswm.org/~aswm/pdf_lib/401_cert/wisconsin_case_study.pdf
https://www.epa.gov/sites/production/files/2014-12/documents/wiwqs-wetlands.pdf

Best Management Practices

- Adhere to federal, state, and local regulations for wetlands
- Establish, maintain, or restore wetlands where water enters lakes to slow water flow and trap sediments
- Maintain appropriate silt fencing and BMPs on projects upstream to prevent erosion and sedimentation
- Natural waters cannot be considered treatment systems and must be protected (natural waters do not include treatment wetlands)
- Establish a low- to no-maintenance level within a 75-foot buffer along natural wetlands
- Establish and maintain a 100-foot riparian buffer around wetlands, springs, and spring runs
- Do not fertilize riparian buffer areas above the high-water mark; leave them in a natural state

Wisconsin TMDL Information by Location

Wisconsin has nearly 28,000 lakes, rivers, and streams. The DNR has identified impaired waterbodies and determined TMDLs. These scientifically derived targets set the greatest amount of a particular substance that can be added to a waterway on a daily basis and still keep it healthy.

DNR Contacts for TMDLs:

Kari L Fleming, Environmental Toxicologist
Phone: 608-267-7663
Email: Kari.Fleming@wisconsin.gov

Andrew Craig, Water Resources Mgmt Specialist (nonpoint)
Phone: 608-267-7695
Email: Andrew.Craig@wisconsin.gov

TMDLs indicated by location:

https://dnr.wi.gov/water/tmdlmap.aspx

Reference additional information:

https://dnr.wisconsin.gov/topic/TMDLs

https://dnr.wisconsin.gov/topic/SurfaceWater/ConditionLists.html

Water Quality Monitoring, Management, and Sampling

Water quality monitoring is used to determine whether outside events are impacting the water quality entering the golf course, and whether the golf course is having a positive, neutral, or negative effect on water quality. Monitoring also provides a body of evidence on the golf course's environmental impact. It is important to include monitoring of surface water, groundwater, and pond sediments in a water quality monitoring plan.

A water quality monitoring plan should be implemented in three phases: background, construction, and long-term management. The same sites should be monitored at all stages, including preconstruction phase, although the monitoring plan can be modified based on site-specific conditions. Sampling of all watershed ingress and egress points is important to know what is flowing into the property to identify potential impacts and baseline of water quality data.

Golf course operation and watershed-specific parameters of concern (including applicable WQM plan, LWRM plan, or TMDLs) are used to determine sampling parameters. Typically, samples should be analyzed for nutrients, pH and alkalinity, sediments, suspended solids, dissolved oxygen (DO), heavy metals, bacteria, any pesticides expected to be used on the golf course; in addition to any other chemicals identified in TMDLs. The purpose of quality assurance/quality control (QA/QC) is to ensure that chemical, physical, biological, microbiological, and toxicological data are appropriate and reliable. Data should be collected and analyzed using scientifically sound procedures. It is strongly recommended that a certified laboratory be utilized, and all QA/QC procedures followed. Consideration must be given to procedures that are simple, cost effective, and technically sound, and that minimize sampling related biases and ensure data integrity.

A single water quality sample is rarely meaningful in isolation, but regular monitoring is useful for establishing trends. Post-construction surface-water quality sampling should begin with the installation and maintenance of golf course turf and landscaping. Samples should be collected a minimum of three times per year. Should there be no discharge on the scheduled sample date, samples should be taken during the next discharge event.

Post-construction surface-water quality sampling should continue through the first three years of operation and every third year thereafter, provided that all required water quality monitoring has been completed and the development continues to implement all current management plans. It may also be wise to sample if a significant change has been made in course operation or design that could affect nearby water quality.

Seasonally the total dissolved salt concentrations (specific conductance) may become an issue if runoff from streets and highways contains deicing salts. This can potentially become a turf management issue if this saline water is captured and used for irrigation. Golf courses should also sample for macroinvertebrates as determined useful by water quality specialists.

EVERY GOLF COURSE SHOULD HAVE A PLAN TO MONITOR THE STATE OF THE ENVIRONMENT AND THE EFFECTS THE GOLF COURSE MAY BE HAVING ON THE ENVIRONMENT.

Best Management Practices

MONITORING

- Keep apprised on DNR Water Quality Standards and Rules updates
- Generally accepted DO thresholds below which fish are stressed (3-4 ppm) or die (2 ppm) can be used as guides to implement mitigation strategies (e.g., artificial aeration); reduce stress on fish by keeping DO levels of property ponds above 4 ppm, measured in early morning hours (between dawn and 8 am); critical DO levels often happen at night when algae aren't photosynthesizing, a morning measurement is more indicative of whether or not there are problems
- Secondary environmental effects on surface water and groundwater from the chemical control of vegetation should be monitored and recorded
- Manage impacts from waterfowl on waterbodies; monitor for bacteria, in addition to nutrients
- Superintendents should monitor designated waters in their area for the persistence of highly toxic herbicides and algaecides in the environment
- Record observations of fish, wildlife, and general pond conditions
- Use a meter at each source of water withdrawal for irrigation; metering of the sources should be at the discharge side of the source pumps prior to any off-take piping; choose a meter that provides both a numeric cumulative volume reading and an instantaneous flow reading; this will enable the user to gauge consumption and obtain a quick estimation of the flow rate

MANAGEMENT

- Adhere to all federal, state, and local water management and water quality regulations
- Accommodate natural lake processes in the construction of lakes and ponds; include herbaceous and woody vegetation and emergent and submergent shoreline plants
- Plants included in a riparian buffer zone restoration or an overall habitat enhancement plan should be native and non-invasive
- Select woody vegetation to provide shade, especially along the south side of wide sections of a watercourse or waterbody, to provide cool water temperatures and to maintain suitable dissolved oxygen (DO) levels
- Manipulate water levels to prevent low levels that result in warmer temperatures and lowered DO levels; aerate shallow lakes less than 6 feet in depth to maintain acceptable DO levels; aeration of deep lakes is also beneficial to mix stratified layers of water of differing temperatures
- Install desirable native plants to naturally buffer DO loss and fluctuation
- Maintain a buffer of at least 10 feet of healthy, unmowed vegetation along water edges to slow and filter overland flow to waterbodies
- Maintain a narrow band of open water at the pond edge to control the expansion of plants into more desirable littoral plantings
- Locate littoral shelves at the pond's inlets and outlets to reduce problems with the playability and maintainability of a water hazard
- Use dyes and aeration to maintain appropriate light and DO levels
- Where applicable, aerate at night to control oxygen depletion in any pond
- Mow lake and pond collars at 2 inches or higher to slow and filter overland flow to water bodies
- Avoid the use of trimmers along the edge of the water body
- Sod or reseed bare or thinning turf areas
- Mulch areas under tree canopies to cover bare soil
- Use integrated pest management (IPM) strategies to limit pesticide use when possible
- Through the IPM plan, apply appropriate herbicides to minimize damage to non-target littoral plantings; use appropriate aquatic herbicides to avoid turfgrass injury
- Apply algaecides to small areas to prevent fish mortality; do not treat the entire pond at once
- Select algaecides containing hydrogen peroxide instead of copper or endothall to treat high populations of phytoplankton; if possible, avoid the use of copper, at least for natural water systems - if copper products are used, apply per label instructions to reduce the risk of impairing water quality and causing negative biological impacts
- Spot-treat filamentous algae or frequently remove algae by hand to prevent lowering oxygen concentrations in water; consider working with a reputable pond manager to strategize best ways to address

- Use appropriate aquatic herbicides to minimize damage to non-target littoral plantings, prevent turfgrass injury, and to protect water quality and wildlife habitat
- Follow a site-specific Nutrient Management Plan and nutrient management BMPs
- Apply fertilizer and reclaimed irrigation/fertigation appropriately to avoid surface and groundwater contamination
- The introduction of aquatic triploid grass carp, biological controls, aeration, and chemical controls (herbicide/algaecide) must be approved and monitored according to permit and licensing protocols and compliance
- Dredge excess sediments from ponds in accordance with approved plan to reduce irrigation system failures; treat dredged materials as a toxic substance; avoid contact with turf and dispose according to approved plan
- Calibrate meters in accordance with the manufacturer's recommendations at least once per year, prior to the start of the irrigation season

SAMPLING

- Seek professional assistance from an environmental specialist to design an appropriate water sample collection strategy (i.e., sample water quality four to six times per year including field and lab analyses); use reputable equipment and qualified technicians to determine sites on property to be analyzed
- Define data values appropriately based on the associated BMP, WQM plan, LWRM plan, or TMDLs to protect water quality
- Conduct chemical and bacteriological testing through a Wisconsin accredited Water Quality Testing Lab; use reputable equipment and qualified technicians to determine sites to be analyzed
- Post-construction surface-water quality sampling should begin with the installation and maintenance of golf course turf and landscaping; samples should be collected a minimum of three times per year and continue through the first three years of operation and during the wet and dry seasons every third year thereafter
- Follow DNR water sample collection requirements for wells under NR 812
- Follow DNR water standards and sample collection requirements for effluent/reclaimed water use under NR 217 and NR 218

Additional information:

DNR Water Quality Standards Rules Updates:
https://dnr.wisconsin.gov/topic/SurfaceWater/RuleUpdates.html

DNR Water Sampling Requirements for Wells:
https://dnr.wi.gov/files/PDF/pubs/DG/DG0088.pdf

DNR Water Sampling Requirements for Effluent Water:
https://dnr.wisconsin.gov/topic/Wastewater/WastewaterRules.html

Wisconsin Accredited Water Quality Testing Labs

Safe Drinking Water Act laboratories certified by the DNR for chemical testing:
https://dnr.wisconsin.gov/topic/labCert/certified-lab-lists

Safe Drinking Water Act laboratories certified by the DATCP for bacteriological testing:
https://dnr.wi.gov/dwsviewer/BactiLab

Sediment

During construction and/or renovation, temporary barriers and traps (i.e., silt fencing) must be used to prevent sediments from being washed off-site into waterbodies. Wherever possible, keep a vegetative cover on the site until it is ready for construction, and then plant, sod, or otherwise cover it as soon as possible to prevent erosion.

Best Management Practices

- Have silt fences, sandbags, hay bales or other suitable soil entrapment barriers in place at all times during construction to prevent soil and other runoff contaminant movement from unexpected rainstorms; utilize erosion and sediment control BMPs such as wattles (logs), straw, or erosion matting as appropriate
- Coordinate construction/renovation activities and plan in phases to minimize the amount of disturbed area and possible risk of contamination via runoff
- When constructing drainage systems, pay close attention to engineering details such as subsoil preparation, the placement of gravel, slopes, and backfilling
- Internal golf course drains should not drain directly into an open waterbody; the drains should discharge through pretreatment zones and/or vegetative buffers to help remove nutrients and sediments
- Use shoreline grasses and/or other vegetation to prevent bank erosion
- Use dry detention basins/catchments to buffer flooding and excessive runoff that may contain sediment
- Maintain a vegetative cover on construction sites until it the site is ready for construction
- Allow for ample turf cover before removing sediment controls
- Control cart traffic to avoid highly erodible areas
- Follow soil erosion control and stormwater guidance from the DNR https://dnr.wisconsin.gov/topic/Stormwater/publications.html

Reference Planning, Design, and Construction section for additional BMPs.

Human Health Concerns

Be sure to address areas where standing water may provide habitat for nuisance organisms. The use of pesticides should be part of an overall IPM strategy that includes biological controls, cultural methods, pest monitoring, and other applicable practices.

Best Management Practices

- Use IPM principles to address insects that may pose a hazard to human health
- Drain areas of standing water during wet seasons to reduce insect populations
- Use Bacillus thuringiensis (Bt) products according to label directions to manage waterborne insect larvae

Reference the Planning, Design, and Construction; Irrigation; Nutrient Management: Mowing and Root Zone Management; Integrated Pest Management; Responsible Pesticide Management; and Maintenance Operations Sections for additional BMPs.

Floodplain Restoration

Land use decisions and engineering standards must be based on the latest research science available. Reestablishment of natural water systems helps mitigate flooding and control stormwater. Address high sediment and nutrient loads and vertical and lateral stream migration causing unstable banks, flooding, and reductions in groundwater recharge.

Best Management Practices

- Understand site characteristics and take necessary actions to control stormwater movement and prevent flooding
- Develop a flood mitigation or flood management plan
- Install stream buffers to restore natural water flows and flooding controls
- Stabilize and restore natural areas that will attract wildlife species through installation of buffers in play areas
- Install detention basins to store water and reduce flooding at peak flows

Irrigation

Section 5

Irrigation is essential to maintain healthy turfgrass and landscape areas. When rainfall is not enough to sustain healthy playable turf, especially during dry periods, an irrigation system is needed.

Proper irrigation helps provide for optimal course playability, aesthetics, marketability, energy efficiencies, and turf stress reduction. An irrigation management plan can also help extend equipment life, limit repairs, and minimize risks plus supports compliance with local and state regulations. New systems and technologies continue to drive greater efficiencies and controls, while minimizing labor requirements.

Aside from structural BMPs, irrigation practices may reduce administrative management strain, improve employee communications, and reinforce effective training procedures.

WELL PLANNED IRRIGATION SYSTEMS AND PROCESSES CAN SUPPORT LOCAL AND STATEWIDE WATER CONSERVATION MEASURES.

Embracing Irrigation BMPs

There are several environmental, performance, and employee benefits from adopting BMPs for irrigation:

- Conserve and protect the water supply
- Increase water efficiency
- Protect existing water quality
- Maintain optimal ball roll and playing conditions
- Save electricity, which helps reduce energy costs and facility's carbon footprint
- Increase pump and equipment life longevity
- Demonstrate responsible environmental stewardship
- Retain knowledgeable and effective employees

Reporting Water Use in Wisconsin

Registered withdrawers are required to measure or estimate the volume of water they withdraw every month and report that information annually to the DNR. Withdrawals may be reported by the property owner or by an authorized lessee, agent or operator of the source. Even if water is not withdrawn during the previous year, a withdrawal report is still required annually by March 1.

Reporting is required for:

- *All high capacity well properties*
- *Permitted (Chapter 30, Wis. Stats.) surface water withdrawals*
- *Properties with a Water Use Permit (in the Great Lakes Basin)*
- *Any properties that withdrew an average of 100,000 gallons per day or more in any 30-day period*

Water Withdrawal Report Form: https://dnr.wi.gov/files/pdf/forms/3300/3300-275.pdf

Water Withdrawal Report Form Instructions: https://dnr.wi.gov/topic/WaterUse/documents/WWReportGuidance.pdf

Additional Information: https://dnr.wisconsin.gov/topic/WaterUse/report.html

Regulatory Considerations

- Golf course owners are responsible for contacting federal, state, and local water use authorities at the pre-and post-construction phase to determine annual or specific water consumption, permitting guidelines, and other requirements allowed by regulators
- Before an owner begins construction, a water source must be obtained; in the event a new well is to be constructed, in accordance with Sections NR 812.09(4)(a) & (b), Wis. Adm. Code, prior department approval is necessary for the construction or operation of a high capacity well system, with capacity to withdraw more than 100,000 gallons per day, or a well that, together with all other wells on the same property, has a capacity of more than 100,000 gallons per day. Reference for additional information: https://dnr.wisconsin.gov/topic/Wells/HighCap
- Water withdrawals must be registered for a water supply system (e.g. well or surface water intake pipe) with the capacity to withdraw 100,000 gallons per day; water use withdrawal includes taking water from surface water or groundwater including springs, ponds, lakes, rivers, streams and the Great Lakes via many different methods for withdrawing water including wells, intake pipes, and ditches
- Water withdrawal registration form, plus additional information for permitting, conservation, and efficiency requirements for withdrawals from the Great Lakes Basin and the DNR Waterways Protection Program, including rivers and streams: https://dnr.wisconsin.gov/topic/WaterUse/registration.html
- Superintendents have a responsibility to adhere to water-quality and quantity standard rules regarding groundwater and surface water flows resulting from the removal of water for irrigation use
- Water samples are required in a variety of situations; this fact sheet outlines applicability for well construction and pump installation to comply with NR 812: https://dnr.wi.gov/files/PDF/pubs/DG/DG0088.pdf

There are several water-management approaches which may be utilized:

Conservation and Efficiency

Conservation and efficiency consider the strategic use of appropriate course and irrigation design, plant selection, computerized and data-integrated scheduling, and alternative water quality/supply options that maximize plant health benefits and reduce the potential for negative impacts on natural resources.

Resource Protection

Resource protection is an integrated approach that includes irrigation practices as part of the course design, pesticide and nutrient practices, and regulatory compliance measures and structural measures as they concern environmental stewardship and policy.

Irrigation BMPs are consistent with the BMP framework developed by GCSAA and incorporating the Wisconsin DNR's and EPA's water use guidance:

- EPA's Water Sense - what WI DNR typically references: https://www.epa.gov/watersense
- GCSAA BMPs: https://www.gcsaa.org/environment/best-management-practices
- GCSAA/USGA BMPs: https://www.gcsaa.org/docs/default-source/environment/bmp-planning-guide-print.pdf?sfvrsn=24cee83e_2

Understanding Distribution Uniformity vs. Efficiency

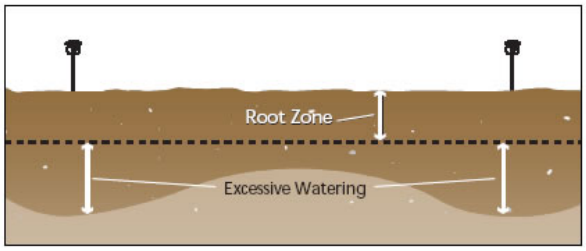


FIGURE 1: Depiction of irrigation resulting in poor DU and excessive watering

Poor DU combined with poor application efficiency wastes water applied beyond the root zone and perhaps wet playing conditions depending soil drainage

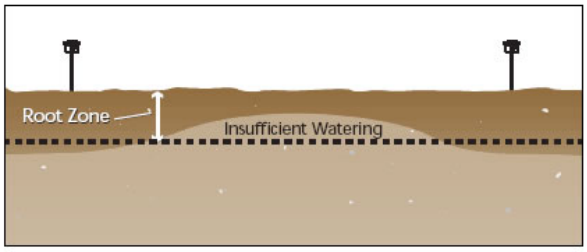


FIGURE 2: Depiction of irrigation resulting in poor DU and insufficient irrigation in parts of the field

Poor DU and good application efficiency does not waste water but in a turf application would leave noticeable dry spots in turf

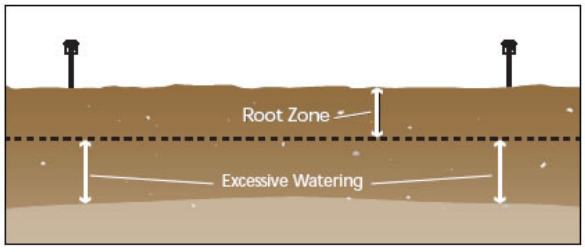


FIGURE 3: Depiction of irrigation resulting in good DU but poor irrigation efficiency

Good DU and poor application efficiency results in wasted water applied beyond the root zone and perhaps wet playing conditions depending soil drainage

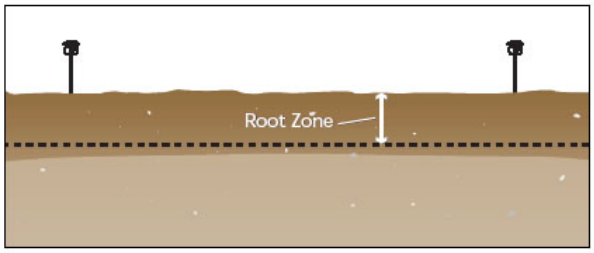


FIGURE 4: Depiction of irrigation sufficiently watering the entire field with good DU and irrigation efficiency

Good DU and good application efficiency does not waste water and optimizes playing conditions

Source: Connecticut Golf Industry BMP Guide, 2020

Best Management Practices

- Comply with all Federal and Wisconsin laws and regulations
- Design and/or maintain a system to meet site's peak water requirements under normal conditions and be flexible enough to adapt to various water demands and local restrictions
- Develop an annual water budget that includes irrigation scheduling for the golf course and maintain accurate records of actual annual water use as compared to the water budget and actual annual evapotranspiration data
- Maintain irrigation scheduling that considers periods of maximum ET and energy use.
- Demonstrate good stewardship practices by supplementing watering only for the establishment of new planting and new sod, hand watering of critical hot spots, and watering-in of chemicals and fertilizers (if permissible)
- Protect aquatic life and impairment of water systems by adhering to state and local water withdrawal allocations (gallons/day)
- Design an irrigation system that delivers water with high distribution uniformity (DU) and schedule the system for maximum application efficiency
- Identify optimal water source for accessibility, sustainability, water quality, and turf selection; ensure ability to meet seasonal and bulk water allocations for grow-in and routine maintenance
- Consult with an irrigation designer to evaluate site and water availability
- Pump station should consist of Variable Frequency Drive (VFD) motors, pressure sensors (both high and low), water meters, and leak detection
- Consider gravity feed to reduce energy consumption and costs
- Utilize a central computer to allow for time adjustments, use weather stations for a baseline, and control costs by using efficiency to run the shortest water cycle with best pressure and distribution
- Use the weather station to calculate evapotranspiration (ET) and determine amount of water that needs to be returned to the soil
- Conserve water using tools like soil moisture meters, infrared pictures to detect hot spots quicker, hoses, and live feeds of the system via a computer or smart phone
- Consider reduction of manicured turf and conversion to native areas to reduce water use
- Separate the landscape into separate program for clubhouse and common areas
- Monitor soil moisture and set an acceptable threshold, when below threshold, hand water the specific site
- Use mulches in shrubs and flower beds to reduce water evaporation losses
- Use drip irrigation in landscape areas to supply water only to plants that need it
- Perform daily, weekly, quarterly, and annual inspections of the irrigation system
- Choose correct type of irrigation for area requiring water; ranging from full or part circle sprinkler heads to rotor or pop up to drip irrigation
- Place meters at wells and pump stations; monitor daily

Irrigation Water Suitability

Water sources should be investigated, and golf course designers and managers should attempt to use alternative supply sources to conserve freshwater drinking supplies, promote plant health, and protect the environment. Sources include potable water, well water, surface water, and reclaimed water. Reclaimed/effluent water use is not commonly used for irrigation in Wisconsin, BMPs have been provided as a reference if applicable.

- Potable water: Water suitable for drinking
- Well water: Underground water held in the soil and in pervious rockSurface water: Water from streams, ditches, or diversions
- Reclaimed water: Water processed from converting wastewater to a form reused for other purposes such as irrigation

The routine use of potable water supply is not a preferred practice; municipal drinking water should be considered only when there is no alternative. Studies of water supplies are recommended for irrigation systems, as are studies of the waterbodies and flows on, near, and under the property. This information may be useful for the design of stormwater systems and water features of the golf course, in addition to the protection of water resources.

Budget for potential treatment options to address water quality and equipment maintenance as needed.

Additional information on irrigation water suitability:

http://gsr.lib.msu.edu/2000s/2000/000914.pdf
http://plantscience.psu.edu/research/centers/turf/extension/fact-sheets/water-quality
https://anrcatalog.ucanr.edu/pdf/8009.pdf
http://www.fao.org/3/t0234e/t0234e00.htm

Accounting for Nutrients in Effluent Water Supply When Making Fertilizer Calculations

Water reports from wastewater treatment plant's internal laboratories do not always report nitrate (NO3) and ammonium (NH4) as nitrogen (N). NO3-N means nitrogen in the form of nitrate (NO3) and NH4-N means nitrogen in the form of ammonium (NH4) in mg/l.

To convert nitrate (NO3) or ammonium (NH4) to nitrogen, 10 mg/l N = 45 mg/l NO3 = 13 mg/l NH4, each should be reported as 10 mg/l NO3-N or 10 mg/l NH4-N.

For further discussion visit Water Quality for Agriculture: Section 5.1 at: http://www.fao.org/3/t0234e/T0234E06.htm#ch5.1

To calculate the nitrogen contribution provided from a recycled water supply, multiply the mg/l (or ppm) of NO3-N and NH4-N combined by 2.72 to determine the pounds of actual nitrogen contained in an acre-foot (326,000 gallons) of water. One acre-foot (AF) is the equivalent of 12" of water applied over one acre.

Example:

10 mg/l of NO3-N and 20 mg/l NH4-N for a total of 30 mg/l total N are reported by laboratory analysis to be contained in a recycled water sample.

30 mg/l X 2.72 = 81.6 lbs. of N per AF

If 32,600,000 gallons per year are used to irrigate 50 irrigated acres of turf. 32,600,000 gal / 50 Acres = 652,000 gal/Acre

652,000 gallons per acre / 326,000 gallons per AF = 2 AF per Acre

2 AF per Acre X 81.6 lbs of N per AF = 163.2 lbs. of actual N per Acre or 3.74 lbs of N per 1000 sq ft.

Source: Huck, M. 2020. Accounting for Nutrients in Effluent Water Supply When Making Fertilizer Calculations. San Juan Capistrano, California.

Best Management Practices

- Irrigation pipeline systems directly connected to municipal water distribution mains must have an approved backflow device at the point of connection
- Meter the water supply and maintain accurate records to document irrigation water used monthly and annually; avoid relying on estimated flow data provided by the central irrigation control computers, instead install a totalizing flow meter for accurate record keeping
- Monitor the quantity of water withdrawn to avoid aquatic life impairment
- Routinely monitor shallow groundwater table of freshwater for contamination of heavy metals and nutrients
- Use salt-tolerant varieties of turf and plants to mitigate saline conditions resulting from an alternative water supply or source, if applicable
- Reclaimed, effluent, and other non-potable water supply mains must be protected by an approved backflow protection device as specified by state and/or local regulations
- Backup/emergency supplies of potable water used to replenish recycled water storage reservoirs must be protected by an approved backflow protection device such as a reduced pressure principle device or an air gap structure as specified by state and/or local regulations
- Amend sodic water systems appropriately (with gypsum or an appropriate ion) to minimize sodium buildup in soil
- Flush with freshwater or use amending materials regularly to move salts out of root zone and/or pump brackish water to keep salts moving out of the root zone, if applicable
- Monitor sodium and bicarbonate buildup in the soil using salinity sensors
- Account for the nutrients in effluent water (if applicable) when making fertilizer calculations
- Monitor reclaimed water tests regularly for dissolved salt content

- Regularly perform soil testing to monitor the accumulation of salts and sodium delivered in the recycled (reclaimed, effluent, or non–potable) water supplies
- Where practical, use reverse-osmosis (RO) filtration systems to reduce chlorides (salts) from saline groundwater; if using RO to improve water quality, be certain the reject concentrate (brine) is disposed of in a legal, proper, and environmentally responsible manner
- Potable supply lines to buildings (for domestic uses) at recycled (reclaimed, effluent, non-potable) water use sites typically must be protected with backflow prevention device(s) in place, that are operating correctly and tested regularly
- Post signage in accordance with local utility and state requirements when reclaimed water is in use

Water Conservation and Efficient Use Planning

Establishing water conservation strategies, alternative sources, and efficiencies can help reduce water consumption and costs. Document watering practices at the golf course to show savings in water use over annual, quarterly, or monthly usage and set goals for continuous improvement. Help align the maintenance team with water conservation goals by regularly and clearly communicating regarding actions which have been implemented, the purpose for those actions, and results. It can be effective to share goals and results with members and the public to support community conservation initiatives. BMP usage and communications are useful for educating the community and public around water use.

If practicable, converting turf in out-of-play areas to naturally adapted native plants, grasses, or ground covers can help reduce the amount of irrigation needed. The best and most effective method to reduce water use on any golf course is to reduce the irrigated acreage where possible.

Best Management Practices

- Selecting drought-tolerant varieties of turfgrasses can help maintain an attractive and high-quality playing surface, while minimizing water use
- Non-play areas may be planted with drought-resistant native or other well-adapted, noninvasive plants that provide an attractive and low-maintenance landscape
- Native plant species are important in providing wildlife with habitat and food sources; after establishment, site-appropriate plants normally require little to no irrigation
- The system should be operated to provide only the water that is needed by the plants, or to meet occasional special needs such as salt removal
- If properly designed, rain and runoff captured in water hazards and stormwater ponds may provide supplemental water under normal conditions, though backup sources may be needed during severe drought
- Always closely monitor soil moisture levels, particularly during a drought; whenever practicable, irrigate at times when the least amount of evaporative loss will occur
- Control invasive plants or plants that use excessive water
- Existing golf courses can try to convert turf in out-of-play areas to naturally adapted native plants, grasses, or ground covers when feasible to reduce water use and enhance aesthetics

General information on water conservation on golf courses:
United States Golf Association (USGA) Research on Turfgrass Water Use
http://www.usga.org/course-care/water-resource-center/research-on-turfgrass-water-use.html

"Water Conservation" Golf Course Superintendents Association of America (GCSAA)
http://www.gcsaa.org/course/communication/golfcoursefacts/water-conservation

Irrigation System Design

Courses should use well-designed irrigation systems with precision scheduling for maintained turf areas based on soil infiltration rates, soil water-holding capacity, plant water-use requirements, the depth of the root zone, and the desired level of turfgrass appearance and performance in order to maximize efficient watering. Irrigation is supplemental and is not a replacement of rainfall.

A well-designed irrigation system should operate at peak efficiency to reduce energy, labor, and natural resource use. An irrigation designer and water quality specialist should evaluate the site, water quality mitigation requirements, and water availability. An owner should make the designer aware of details such as plant materials, soils, elevation, expectations, and budget. The designer should produce drawings for the pump station, hydraulics, configure pipe sizing, and determine sprinkler locations based on pre-planning meetings. The water quality specialist will assist in determining any required source balancing delivery system, material requirements, and flushing requirements.

Irrigation managers should be trained to understand soil-water relationships and principles of crop coefficients and ET to prevent applying excess water that percolates beyond the root zone (except when purposely leaching salts). Budget properly for pipe sizing and pump capacity in order to have the shortest and most efficient water-time-window. Sprinkler selection, spacing, configuration (as triangular or rectangular arrangements) and nozzle selections should maximize DU.

Water conservation can also be achieved by separating the landscape into a separate program. Clubhouse and common areas, with correct species selection, can require one to two cycles of irrigation per week compared to four or five cycles for turf. Another option is to use drip irrigation in landscape areas to supply water only to the plants that need it. Utilize reclaimed water when possible. Separate irrigation zones within landscapes, combine plants with similar water requirements (verses watering to the highest water requiring species in a planting) to minimize water usage and pruning requirements

Best Management Practices

- Designer should be a qualified irrigation designer/ consultant
- Designer must approve any design changes before construction
- Design should account for optimal distribution efficiency and effective root-zone moisture coverage; target 80% or better DU
- Putting surface, slopes, and surrounds should be watered independently; turf and landscape areas should be zoned separately; specific use areas zoned separately: greens, tees, primary roughs, secondary roughs, fairways, native, trees, shrubs, etc.
- Incorporate individual sprinkler control instead of “block systems” into design, particularly with fine turf areas
- Secure a general irrigation schedule with recommendations and instructions on modifying the schedule for local climatic, soil, and growing conditions as part of the design package; it should include base ET rate for the location
- The application rate must not exceed the infiltration rate, ability of the soil to absorb and retain the water applied during any one application; conduct saturated hydraulic conductivity tests periodically; since golf rotors and many other sprinklers’ precipitation rates may exceed soil infiltration rates, avoiding surface runoff is often accomplished by operating sprinklers in short durations with a “soak in time” programmed to occur between each application cycle
- Ensure proper operating pressure is included with design – it must not be greater than the available source pressure or a booster pump will be necessary
- The design operating pressure must account for peak-use times, maximum flow rates, and supply line size and operating pressures at final buildout for the entire system
- The system should be flexible enough to meet peak water requirements and allow for operating modifications to meet seasonal irrigation changes or local restrictions; typically, a system should be designed with at least 15% additional capacity (i.e.; flow rate at the specified operating pressure) to accommodate “catching up” over 7 days if an irrigation event is missed due to a power failure, etc.
- Design should account for the need to leach out salt buildup from poor-quality water sources by providing access to freshwater

- Underground cables, pipes, and other obstacles must be identified, and their locations flagged prior to construction
- Only qualified specialists should install the irrigation system
- Construction must be consistent with the design
- Construction and materials must meet existing standards and criteria
- Permanent irrigation sprinklers and other distribution devices should be spaced according to manufacturer's recommendations
- Sprinklers in turf areas should be spaced for head-to-head coverage
- Sprinkler spacing distance should be based on average wind conditions during irrigation
- For variable wind directions, triangular spacing is more uniform than square spacing
- Distribution devices and pipe sizes should be designed for optimal uniform coverage
- The first and last distribution device should have no more than a 10% difference in flow rate; this usually corresponds to about a 20% difference in pressure
- Distribution equipment (such as sprinklers, rotors, and micro-irrigation devices) in each zone must have the same precipitation rate
- Water supply systems (for example, wells and pipelines) should be designed for varying control devices, rain shutoff devices, and backflow prevention
- Water conveyance systems should be designed with thrust blocks (or joint restraints) and air-release valves and/or vacuum release valves as necessary
- Sites with significant elevation change may require a design incorporating pressure reducing valve (PRV) station(s) and/or multiple points of connection (POCs), pump stations and/or mainline systems separately pressurized to minimize zones of excess and/or insufficient pressure due to elevation-related pressure loss and/or gain
- Flow velocity must be 5 feet per second or less
- Pipelines should be designed to provide the system with the appropriate pressure required for maximum irrigation uniformity
- Pressure-regulating or compensating equipment must be used where the system pressure exceeds the manufacturer's recommendations
- Equipment with check valves must be used in low areas to prevent low head drainage
- Isolation valves should be installed in a manner that allows critical areas to remain functional while making repairs to the system
- Manual quick-coupler valves should be installed near greens, tees, and bunkers so these can be hand-watered during severe droughts; consider adding manual quick-coupler valves to areas known to be drier than others
- Update multi-row sprinklers with single head control to conserve water and to enhance efficiency
- Ensure heads are set at level ground and not on slopes

Benefits & Placement of Part-Circle or Adjustable Heads

- Install along lakes, ponds, and wetlands margins
- Use to avoid overspray of impervious areas such as roadways and sidewalks
- Use to avoid overspray into natural water features and/or other environmentally sensitive areas particularly when using recycled/ reclaimed/effluent water
- Place along areas that will be considered non-irrigated, such as forest borders, native meadows, perennial rock gardens, etc.

NATIVE VEGETATION THAT DOES NOT REQUIRE SUPPLEMENTAL IRRIGATION SHOULD BE RETAINED AND ENHANCED FOR NON-PLAY AREAS TO CONSERVE WATER WHERE POSSIBLE.

Non-Play and Landscape Areas

Map environmentally sensitive areas such as sinkholes, wetlands, or flood-prone areas, and identify species classified as endangered or threatened by federal and Wisconsin designation, and state species of special concern. Identify and eliminate invasive species. The most efficient and effective watering method for non-turf landscape is drip or micro-irrigation.

With the help of a golf course architect, golf professional, golf course superintendent, and other key personnel, the amount of functional turfgrass can be evaluated and potentially transitioned into non-play areas requiring minimal, if any, irrigation.

Rain gardens may be installed near roofs and other impervious surfaces to catch and temporarily hold water, helping to provide supplemental irrigation needs for landscape areas.

Best Management Practices

- Designate 50% to 70% of non-play area to remain as natural cover according to "right-plant, right-place," a principle of plant selection that favors limited supplemental irrigation
- Incorporate natural vegetation in non-play areas
- Consider rain gardens for supplemental irrigation
- Use micro-irrigation and low-pressure emitters in non-play areas to supplement irrigation
- Routinely inspect non-play irrigation systems for problems related to emitter clogging, filter defects, and overall system functionality

Irrigation Pumping System

Pump stations are critical for water and energy conservation. The pump station needs to be properly maintained and sized to deliver the most efficient use of water and electricity. It should be equipped with control systems that protect distribution piping, provide for emergency shutdown necessitated by line breaks, and allow maximum system scheduling flexibility. Pump stations can also have injection systems for wetting agents, fertilizers, water conditioners, etc.

The pump station should consist of Variable Frequency Drive (VFD) motors, pressure sensors (both high and low), water meters, and leak detection. VFDs can help reduce energy usage to improve conservation and cost reductions.

- VFD motors: Regulate water pressure and deliver pump control based on pressure; help reduce energy costs by alternating pump starts and running at lower RPMs based on flow and pressure needed for the system
- Pressure Sensors: Provide adjustable sensor pressure to maintain optimal system pressure with current flow; can set high pressure and low-pressure levels for automatic shutdown
- Water Meters: Current flow monitored by control unit to optimize energy consumption
- Leak Detection: A combination of pressure and water output that can activate shutdown for low pressure

Best Management Practices

- The design operating pressure must not be greater than the available pump's capabilities or source pressure and must account for peak-use times, peak flow rates, and supply-line diameter and operating pressures at final buildout for the entire system
- Maintain air-relief and vacuum-breaker valves by using hydraulic-pressure-sustaining values
- Install VFD systems to lengthen the life of older pipes and fittings until the golf course can afford a new irrigation system
- An irrigation system should have high- and low-pressure sensors that shut down the system in case of breaks and malfunctions
- Pumps should be sized to provide adequate flow and pressure
- Pumps should be equipped with control systems to protect distribution piping
- Check filter operations frequently; an unusual increase in the amount of debris may indicate problems with the water source
- Even under routine conditions, keeping filters operating properly prolongs the life of an existing system and reduces pumping costs
- Keep records of filter service performed, as this could be an early sign of system corrosion, well problems, or declining irrigation water quality
- Document pump motor/equipment run-time hours and monitor pumping station power consumption
- Monthly bills should be monitored over time to detect a possible increase in power usage; compare the power used with the amount of water pumped; requiring more power to pump the same amount of water may indicate a problem with the pump motor(s), control valves, or distribution system; quarterly checks of amperage by qualified pump personnel may more accurately indicate increased power usage and thus potential problems
- Application/distribution uniformity should be checked annually; conduct a periodic professional irrigation audit at least once every five years; implement a PM program to replace worn components before they waste fertilizer, chemicals, and water
- Conduct pump efficiency tests every 1 to 5 years to monitor pump wear, ensure pumps are in good working order, operating efficiently, and not wasting energy

- Test frequency should depend on the water quality with 1 to 3-year intervals used if the water is contaminated with sand, silt, clay etc., and longer intervals of 3 to 5 years used with clean or potable water
- System checks and routine maintenance on pumps, valves, programs, fittings, and sprinklers should follow the manufacturer's recommendations
- Ensure that all lubrication, overhauls, and other preventive maintenance are completed according to the manufacturer's schedule

Gravity Feed

Some courses use gravity to supply pressure to the irrigation system. This type of system uses pressure reducing valves (PRV) to regulate pressure as it travels downhill. This design has the reservoir placed at a higher elevation than the highest point of area needing water. The system uses less energy to run, as electrical motors are not needed to supply pressure. There is maintenance required with quarterly upkeep to the PRVs, but compared to energy costs, it is much less.

Irrigation System Scheduling

Irrigation scheduling must take plant water requirements and soil intake capacity into account to prevent excess water use that could lead to leaching and runoff. Plant water needs are determined by ET rates, recent rainfall, recent temperature extremes, and soil moisture. Irrigation should not occur on a calendar-based schedule. An irrigation system should be operated based only on the moisture needs of the turfgrass or to water-in a fertilizer or chemical application, as directed by the label.

Electric/mechanical time clocks cannot automatically adjust for changing ET rates. Frequent adjustment is necessary with these to compensate for the needs of individual turfgrass areas.

An onsite weather station provides the best ET information. A weather station can record sun intensity, temperature, humidity, wind, and rain. It uses data collected to produce a daily ET reading. ET is the process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by the transpiration of plant cells.

If unavailable, follow several local weather stations, such as Weather Underground: www.weatherunderground.com. When using local weather station data, the ET may not be calibrated for turf and the weather station location may not be on turf, so the numbers may not be exactly what is desired. It is possible however to draw conclusions over time in relation to what the turf requirements are.

Best Management Practices

- The reliability of older clock-control station timing depends on calibration of the timing devices; this should be done periodically, at least seasonally
- An irrigation system should have rain sensors to shut off the system after 0.25 to 0.5 inch of rain is received; computerized systems allow a superintendent to access the control system and cancel the program if it is determined that the course has received adequate rainfall
- Install control devices to allow for maximum system scheduling flexibility
- Generally, granular fertilizer applications should receive 0.25 inch of irrigation to move particles off the leaves while minimizing runoff
- Irrigation quantities should not exceed the available water holding capacity of the soil based on texture and root zone depth
- Irrigation schedule should coincide with other cultural practices (for example, the application of nutrients, herbicides, or other chemicals)
- Irrigation should occur during hours of the least amount of evapotranspiration
- Base plant water needs should be determined by ET rates, recent rainfall, recent temperature extremes, and soil moisture; all driven by site surveying and scouting
- Use mowing, verticutting, aeration, nutrition, and other cultural practices to control water loss, maintain infiltration rates, encourage conservation, and increase efficiency
- Depending on physical soil characteristics and turf type, using solid-tine aeration equipment in place of verticutting is an option
- Slicing and spiking help relieve surface compaction and promote better water penetration and aeration
- Visually monitor for localized dry conditions or hot spots to identify poor irrigation efficiency or a failed system device
- Use predictive models to estimate soil moisture and the best time to irrigate
- Avoid use of a global setting; adjust watering times per head
- Base water times on actual site conditions for each head and zone
- Adjust irrigation run times based on current local meteorological data
- Install rain switches to shut down the irrigation system if enough rain falls in a zone
- Use computed daily ET rate to adjust run times to meet the turf's moisture needs
- ET rates should be adjusted by the appropriate crop coefficient (Kc); average Kc values are 0.80 for cool season turfgrasses; Kc values may require minor adjustment through the growing season; average Kc values can be used when creating annual water budgets and/or as a starting point when scheduling for ET replacement
- Manually adjust individual control stations' automated ET data with a Kc to reflect wet and dry microenvironments on the course
- Use soil moisture sensors, or if unavailable a soil sampling tube, to assist in scheduling or to create on-demand irrigation schedules
- Use multiple soil moisture sensors to reflect soil moisture levels; evaluate variations in soil types across the property using the USDA Web Soil Survey when selecting locations for multiple sensors placement: https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
- Install soil moisture sensors in the root zone for each irrigation zone as feasible to enhance scheduled timer-based run times
- Place soil moisture sensors in a representative location within the irrigation zone; installing a soil moisture sensor in the driest or wettest irrigation zone of the irrigation system may lead to over or under watering on a larger scale
- Wired soil moisture systems should be installed to prevent damage from aerification
- Periodically perform catch-can uniformity tests
- Reducing dry spots and soil compaction improves infiltration, reducing water use and runoff
- Install emergency shutdown devices to address line breaks
- Check to ensure system is operating properly after power outages

Sensor Technology

Irrigation management and control devices need to be installed correctly for proper irrigation management. Soil moisture sensors and other irrigation management tools should be installed at representative locations and depths; and maintained to provide the information necessary for making sound irrigation management decisions. Rain gauges track how much rain has fallen at a specific site on the golf course. More than one station may be necessary to get a complete measure of rainfall or evaporation loss on some courses. Utilization of soil moisture probes and inspections for visual symptoms such as wilting turf, computer models, and tensiometers may supplement these measurements. Computerized displays are available to help visualize the system.

Predictive models based on weather station data and soil types are also available. These are relatively accurate and applicable, especially as long-term predictors of annual turf water requirements. Weather data such as rainfall, air and soil temperature, relative humidity, and wind speed are incorporated into certain model formulas, and soil moisture content is estimated. Note that models rely on data collected and the number of assumptions made for effectiveness and accuracy.

Best Management Practices

- Irrigation controllers/timers should be reset as often as practically possible to account for plant growth requirements and local climatic conditions
- Properly calibrated flow meters, soil moisture sensors, rain shut-off devices, and/or other automated methods should be used to manage irrigation
- Computerized control systems should be installed on new course irrigation systems to help ensure efficient irrigation application; these allow for timing adjustments at every head when systems are designed to provide individual head control
- Rain shut-off devices and rain gauges should be placed in open areas to prevent erroneous readings
- Ensure that onsite weather stations are properly calibrated and maintained

Pond Location and Design

Lakes and ponds may be used as a source of irrigation water; it is important to consider this when designing and constructing ponds. Careful design may significantly reduce future operating expenses for lake and aquatic plant management.

Best Management Practices

- Consult with a qualified golf course architect with stormwater experience, working in conjunction with a stormwater engineer, to develop an effective stormwater management system that complies with the requirements of the DNR
- When constructing drainage systems, pay close attention to engineering details such as subsoil preparation, the placement of gravel, slopes, and backfilling
- Where practical, internal golf course drains should discharge through pretreatment zones and/or vegetative buffers to help remove nutrients and sediments; carbon filters can be added in cases where vegetative buffers are unavailable
- Studies of water supplies are needed for irrigation systems, and studies of waterbodies or flows on, near, and under the property are needed to properly design a course's stormwater systems and water features, and to protect water resources
- Peninsular projections and long, narrow fingers into ponds may prevent water mixing; ponds that are too shallow may reach high temperatures, leading to low oxygen levels and promoting algal growth and excess sedimentation
- In shallow or nutrient-impacted ponds, the use of aeration equipment may be required to maintain acceptable dissolved oxygen (DO) levels in the water

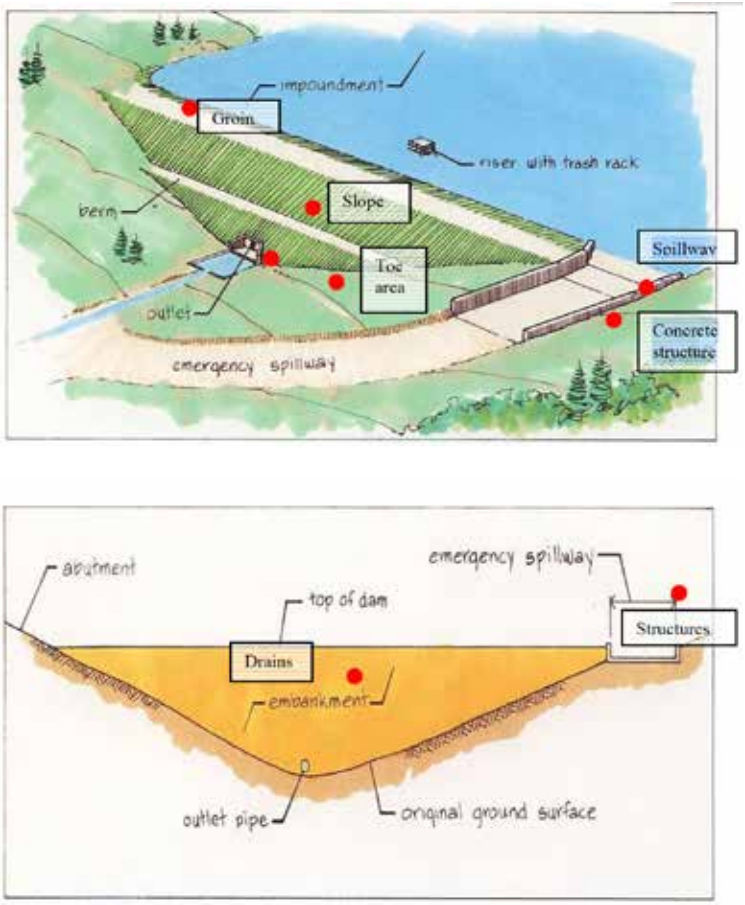
Pond Use and Maintenance

Each pond has regions or zones that significantly influence water quality and are crucial in maintaining the ecological balance of the system. It is important to understand their function and how good water quality can be maintained if these zones (riparian zone, littoral zone, limnetic zone, and benthic zone) are properly managed.

Evaporation losses are higher in some regions than others and vary from year to year and within the year. However, evaporative losses could approach six inches per month during the summer. Aquatic plants are more difficult to control in shallow water. Surface water sources can present problems with algal and bacteria growth. Algal cells and organic residues of algae can pass through irrigation system filters and form aggregates that may plug emitters. Use an expert in aquatic management to help develop and monitor pond management programs.

Best Management Practices

- Pond leaks should be controlled and managed properly; use leak controls in the form of dike compaction, natural-soil liners, soil additives, commercial liners, drain tile, or other approved methods
- Maintain a riparian buffer to filter the nutrients and sediment in runoff
- Reduce the frequency of mowing at the lake edge and collect or direct clippings to upland areas
- Prevent overthrowing fertilizer into ponds; practice good fertilizer management to reduce nutrient runoff into ponds, which causes algae blooms and ultimately reduces DO levels; use drop spreaders instead of rotary spreaders near these sensitive areas
- Establish a special management zone around pond edges
- Dispose of grass clippings where runoff will not carry them back to the lake
- Encourage clumps of native emergent vegetation at the shoreline
- Maintain water flow through lakes, if they are interconnected
- Establish wetlands where water enters lakes to slow water flow and trap sediments
- Maintain appropriate silt fencing and BMPs on projects upstream to reduce erosion and the resulting sedimentation
- Manipulate water levels to prevent low levels that result in warmer temperatures and lowered DO levels



FEMA Figure 6 | FEMA 534, Technical Manual for Dam Owners: Impacts of Plants on Earthen Dams, Figure 6, Page 5-19, September 2005.

- Aerate ponds and dredge or remove sediment before it becomes a problem
- A pond should hold surplus storage of at least 10 percent of full storage; in other words, the difference between primary spillway elevation and auxiliary spillway elevation provides 10 percent of pond volume when water level is equal to elevation of the primary spillway
- Provide an alternative source for ponds that may require supplemental recharge from another water source such as a well during high-demand periods
- Estimated losses from evaporation and seepage should be added to the recommended depth of the pond and if supplied by the irrigation supply, should be included in irrigation water budgets

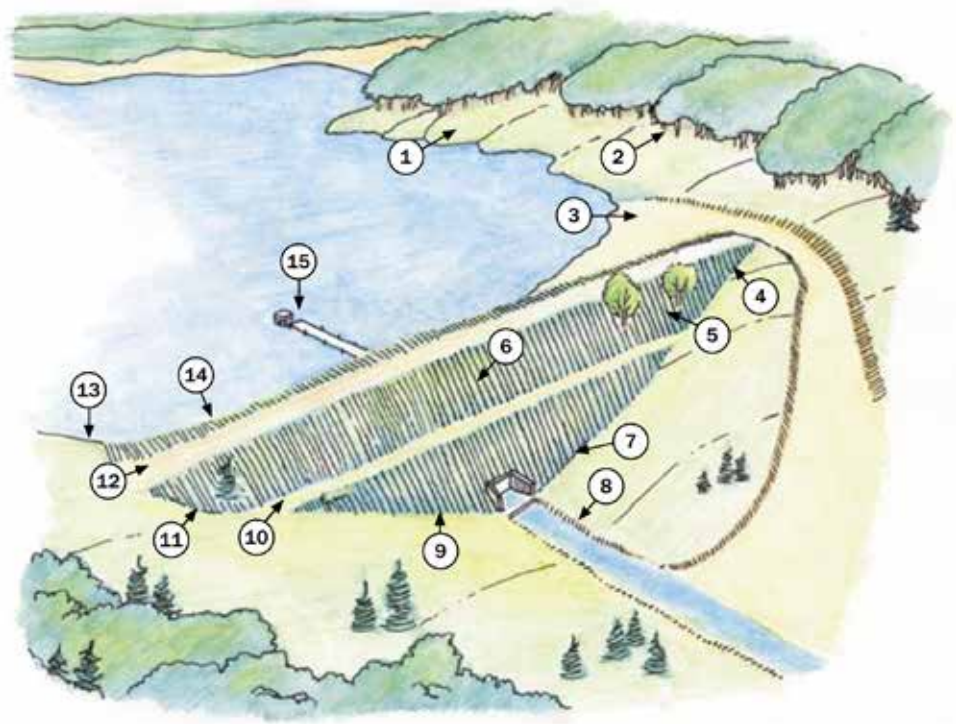


Figure 3-2. The Earthen Dam from Biological and Engineering Perspectives.

1. **Upland Areas.** Many species live in the upland areas, away from the water. Even the downstream slope, abutments, and groin areas of the dam can be considered upland in terms of habitat.
2. **Forest Fringe.** The zone between two environments (the edge) is the best place to observe those species living at and around the dam. The more habitat types at the dam, the greater number of species likely to inhabit the dam. Mountain beaver or armadillo prefer forested/wooded areas.
3. **Emergency Spillway.** Beaver often dam the spillway, causing the pond water levels to rise.
4. **Left Abutment contact.**
5. **Inappropriate Vegetation on Embankment.** Many dams contain vegetation other than mowed grass. Improper vegetation provides cover and food supply, which encourage animals to inhabit the dam.
6. **Downstream Slope.** This area is often the location where groundhogs, coyote, and fox excavate burrows. Canada geese will feed on the downstream slope, which could cause loss of protective vegetative cover and associated erosion. Species that prefer upland areas could be found in this area.
7. **Left Groin.**
8. **Discharge Conduit and Outlet Channel.** Beaver can dam the outlet structure. Aquatic species may inhabit this area depending on water flow and availability of vegetation.
9. **Toe of Embankment and right groin.**
10. **Erosion Pathways on the Embankment.** Livestock traverse the embankment creating erosion pathways.
11. **Right abutment contact.**
12. **Crest.** Livestock traverse the crest which creates ruts. The ceilings of beaver and muskrat burrows in the upstream slope are often just below the dam crest.
13. **Aquatic Fringe.** The zone where the bank meets the pond usually contains aquatic vegetation preferred by many animals such as nutria.
14. **Upstream Slope.** Beaver, muskrat, and nutria prefer the upstream slope for burrow excavation. Alligators, otters, and turtles usually live in the shallow waters near the upstream slope.
15. **Principal Spillway (with riser and trash rack).** Beavers can block principal spillways by constructing dams.

Spillway Systems Diagram

FEMA Figure 3-2 | FEMA 473, Technical Manual for Dam Owners: Impacts of Animals on Earthen Dams, Figure 3-2, Page 11, September 2005.

Golf Course Ponds

Maintenance Challenges

- *Low dissolved oxygen*
- *Sedimentation*
- *Changes in plant populations*
- *Nuisance vegetation*
- *Maintenance of littoral shelves*
- *Vegetation on the lakeshore*
- *Mammal intrusion such as beavers or muskrats*
- *Zebra mussels from golfers retrieving golf balls*

More About Spillway Systems

Spillway Systems are control structures over or through which flows are discharged, they include Primary Spillways through which normal flows and small stormwater flows are discharged and Auxiliary or Emergency Spillways through which stormwater flows (floods) are discharged.

Metering

Rainfall may vary from location to location on a course; the proper use of rain gauges, rain shut-off devices, flow meters, soil moisture sensors, and/or other irrigation management devices should be incorporated into the site's irrigation schedule. It is important to measure the amount of water that is delivered through the irrigation system via a water meter or a calibrated flow-measurement device. Knowing flow or volume will help determine how well the irrigation system and schedule are working.

Best Management Practices

- Calibrate equipment periodically to compensate for wear in pumps, nozzles, and metering systems
- Properly calibrated flow meters, soil moisture sensors, rain shut-off devices, and/or other automated methods should be used to manage irrigation
- Flow meters should have a run of pipe that is straight enough — both downstream and upstream — to prevent turbulence and bad readings - consult manufacturers recommendations for the minimum length of straight pipe required in front of the meter
- Flow meters can be used to determine how much water is applied over the irrigated area; that can then be converted to inches applied and compared to ET to confirm the average application of water applied as a percentage of ET

Irrigation System Quality

Irrigation system maintenance on a golf course involves four major efforts: calibration or auditing, preventive maintenance (PM), corrective maintenance, and record keeping. Good system management starts with good PM procedures and recordkeeping. Corrective maintenance is simply the act of fixing what is broken. It may be as simple as cleaning a clogged orifice, or as complex as a complete renovation of the irrigation system. Renovating a golf course irrigation system can improve efficiencies, conserve water, improve playability, and lower operating costs.

Best Management Practices

- Respond to day-to-day failures in a timely manner, maintain the integrity of the system as designed, and keep good records
- System checks and routine maintenance on pumps, valves, control systems, adjustment of programs, fittings, and sprinklers should follow manufacturer's recommendations
- Application/distribution efficiencies should be checked annually. Implement a PM program to replace worn components before they waste fertilizer, chemicals, and water
- Conduct a periodic professional irrigation audit at least once every five years
- Exercise manual isolation valves annually by closing and reopening to prevent the threads of operating stems from corroding and seizing
- Keep valve boxes edged regularly to quickly locate and shut a section of the system off if there is a leak
- Annually disassemble, clean and service air and vacuum release valves, PRVs, and any other specialized components included in the design
- Gather all the documentation collected as part of the PM program, along with corrective maintenance records for analysis
- Correctly identifying problems and costs helps to determine what renovations are appropriate
- Maintain written and photo records of pipe or other component failures and repairs; this can become valuable documentation when proposing system renovations and replacements

Sprinkler Maintenance

Maintaining a system is more than just fixing heads. It also includes documenting system and maintenance-related details so that potential problems can be addressed before exhaustive repairs are needed. Establishment of a document indicating what sprinkler configuration is needed for each head in the field as part of an as-built map is recommended to prevent employees from being sent to the field for repairs or audits without the proper information needed, which can cause improper changes to sprinkler heads, leading to inefficiencies. It also provides a basis for evaluating renovation or replacement options. Examples include:

- Pipe failures may be caused by material failure or problems with the pump station and/or control system programming resulting in pressure surges and spikes
- Wiring problems could be caused by corrosion, rodent damage, insulation nicks, or frequent lightning or power surges
- Control tubing problems could result from poor filtration or water supply chemical precipitants such as calcium carbonate

Best Management Practices

- The system should be inspected routinely for proper operation by checking computer logs and visually inspecting the pump station, remote controllers, and irrigation heads
- A visual inspection should be carried out for leaks, misaligned or inoperable heads, and chronic wet or dry spots, so that adjustments can be made or replaced
- Part-circle sprinklers should be checked periodically for proper adjustment; particularly important when irrigating with recycled water so that it does not spray outside of the designated use area
- Flush drip/micro-irrigation irrigation lines and filters regularly to minimize emitter clogging; to reduce sediment buildup, make flushing part of a regular maintenance schedule; if fertigating, prevent microbial growth by flushing all fertilizer from lateral lines before shutting down the irrigation system
- Clean and maintain filtration equipment
- Systems should be observed in operation at least monthly or more frequently if regularly occurring problems dictate otherwise; this can be done during maintenance programs such as fertilizer or chemical applications where irrigation is required, or the heads can be brought on-line for a few seconds and observed for proper operation; this process detects controller or communications failures, stuck or misaligned heads, and clogged or broken nozzles
- Monitor and record the amount of water being applied, including system usage and rainfall; by tracking this information, identify areas where minor adjustments can improve performance; this information is essential in identifying necessary renovations and to compute current operating costs for comparison to possible future costs after renovation
- Factor in rainfall and compare the total amount of water applied per irrigated acre to ET as a measure of application efficiency
- Keep sprinklers edged regularly to ensure proper distribution
- Document and periodically review the condition of infrastructure (such as pipes, wires, and fittings); if the system requires frequent repairs, it is necessary to determine why these failures are occurring; for diagnosis of PVC failure causes visit: https://edis.ifas.ufl.edu/ch171

Irrigation System Inspection Checklist

Daily

Visual field inspections for:

__ Leaks (in pipes or heads)
__ Stuck-on heads
__ Flow (actual vs. projected)
__ Meter readings
__ Computer logs
__ Rapid pressure loss at pump stations cycling motors
__ Visually inspect resevoir

Weekly

__ Inspect individual clocks
__ Run the system & watch sprinklers
__ Cleaning filters at the pump station to remove debris
__ Check rotation of heads
__ Make needed adjustments
__ Inspect for proper pressures at sprinklers (visual and measured)

Quarterly

__ Read electrical current drawn by pumps
__ Check voltage at breakers
__ Record run time hours
__ Inspect motors
__ Inspect PRV
__ Pressure adjustments to each zone or sprinkler

Annually

__ Inspect all sprinklers on the course
__ Replace worn parts
__ Record each head
__ Visually inspect reservoir
__ Sprinkler nozzle replacement program by zone or area
__ Clean satellite control boxes of debris, insect and/or rodent nests that may have accumulated over the previous season

Reference: Hawai'i Golf Maintenance BMP Handbook, 2019

System Maintenance

Routine maintenance helps ensure water quality is maintained and water is used responsibly. System checks include pumps, valves, programs, fittings, and sprinklers. An irrigation system should be calibrated regularly by conducting periodic irrigation audits to check actual water delivery and nozzle efficiency.

Best Management Practices

- Irrigation audits should be performed by trained technicians
- A visual inspection should first be conducted to identify necessary repairs or corrective actions; it is essential to make repairs before carrying out other levels of evaluation
- Pressure, flow, and precipitation rate should be evaluated to determine that the correct nozzles are being used and that the heads are performing according to the manufacturer's specifications
- Check pressure and flow rates at each head to determine average application rate in an area
- Conduct catch-can tests on representative areas of the golf course, basic schedule calculations should be executed to determine uniformity of coverage, precipitation rate, and to accurately determine irrigation run times
- Conduct internal irrigation audit annually to facilitate a high-quality maintenance and scheduling program for the irrigation system
- Inspect for interference with water distribution due to sprinklers below grade, or blockage by tree limbs and/or shrubs
- Inspect for broken and misaligned heads
- Check that the rain sensor is present and functioning
- Inspect the backflow device to determine that it is in place and in good repair
- Examine turf quality and plant health for indications of irrigation malfunction or needs for scheduling adjustments
- Be aware that early symptoms of root feeding insects may initially be misdiagnosed as droughty areas
- Schedule documentation: make adjustments and repairs on items diagnosed during the visual inspection before conducting pressure and flow procedures

PREVENTIVE MAINTENANCE

- In older systems, inspect irrigation pipe and look for fitting breaks caused by surges in the system. For diagnosis of PVC fitting and pipe failure visit: https://edis.ifas.ufl.edu/ch171
- Install thrust blocks to support conveyances
- The system should be inspected daily for proper operation by checking computer logs and visually inspecting the pump station, remote controllers, and irrigation heads; visually inspect for leaks, misaligned or inoperable heads, and chronic wet or dry spots so adjustments can be made
- Maintain air-relief and vacuum-breaker valves
- Annually service pressure regulation, pressure relief and/or pressure sustaining valves to assure proper operation
- Check filter operations frequently; keeping filters operating properly prolongs the life of an existing system and reduces pumping costs
- Application/distribution efficiencies should be checked annually
- Conduct a periodic professional irrigation audit at least once every five years
- Document equipment run-time hours: ensure that all lubrication, overhauls, and other preventive maintenance are completed according to the manufacturer's schedule
- Monitor power consumption of pump stations for problems with the pump motors, control valves, or distribution system
- Qualified pump personnel should perform quarterly checks of amperage to accurately identify increased power usage that indicates potential problems
- Increase frequency of routine inspection/calibration of soil moisture sensors that may be operating in high-salinity soils
- Winterize irrigation system to prevent damage

CORRECTIVE MAINTENANCE

- Replace or repair all broken or worn components before the next scheduled irrigation
- Replacement parts should have the same characteristics as the original components
- Record keeping is an essential practice; document all corrective actions

SYSTEM RENOVATION

- Appropriate golf course renovations can improve system efficiencies, conserve water, improve playability, and lower operating costs
- Correctly identify problems and their cost to determine which renovations are appropriate
- Determine the age of the system to establish a starting point for renovation
- Identify ways to improve system performance by maximizing efficient use of the current system
- Routinely document system performance to maximize the effectiveness of the renovation
- Evaluate cost of renovation and its return on investment and other benefits including financial, course playability, and turf management (fewer weeds, disease, wet and/or dry spots, etc.)

Irrigation Leak Detection

Irrigation systems are complex systems that should be closely monitored to ensure leaks are quickly detected and corrected. Golf courses without hydraulic pressure-sustaining valves are much more prone to irrigation pipe and fitting breaks because of surges in the system, creating downtime for older systems. If part of the course is moist during dry periods and/or lush vegetation, this could be an indication of a leaking system.

Best Management Practices

- Monitor water meters or other measuring devices for unusually high or low readings to detect leaks or other problems in the system; make needed repairs
- An irrigation system should have high- and low-pressure sensors that shut down the system in case of breaks and malfunctions
- The system should be monitored daily for breaks; log amount of water pumped each day
- Document and periodically review the condition of infrastructure (such as pipes, wires, and fittings) - if the system requires frequent repairs, determine why these failures are occurring; pipe failures may be caused not only by material failure, but also by problems with the pump station
- Ensure that pump control systems provide for emergency shutdowns caused by line breaks and allow maximum system scheduling flexibility
- Programming of central controllers with flow management software must be performed by qualified individuals who understand the relation between pipe size, flow rates, flow velocities and friction loss (of dynamic pressure) so as not to create water hammer or pressure losses by allowing zones to exceed maximum allowable values

Turf Drought Response

Use a soil moisture meter to determine moisture needs of greens and tees. Managers of golf greens cannot afford to wait until symptoms occur. Be prepared for extended drought or restrictions by developing a written drought management plan in consultation with public water suppliers, and applicable local and state agencies.

Best Management Practices

- Use soil moisture meters to determine moisture thresholds and plant needs
- Irrigating too shallowly encourages shallow rooting, increases soil compaction, and favors pest outbreaks
- For golf greens and tees, most roots are in the top several inches of soil, use a soil sampling tube or soil profiler to regularly monitor and determine rooting depths
- For fairways and roughs, use infrequent, deep irrigation to supply enough water for plants and to encourage deep rooting
- Proper cultural practices such as aeration, mowing height, irrigation frequency and amounts should be employed to promote healthy, deep root development
- Create a drought management plan for the facility that identifies steps to be taken to reduce irrigation/water use and protects critical areas, etc.
- Use appropriate turfgrass species adapted to the location of the golf course being managed

COLLABORATION BETWEEN GOLF COURSES, PUBLIC WATER SUPPLIERS, MUNICIPALITIES, AND THE DNR IS IMPORTANT FOR DROUGHT MANAGEMENT AND RESPONSE.

Winterization and Spring Startup

Winterization of the irrigation system is important to protect the system and reduce equipment failures resulting from freezing. Winterizing an irrigation system should occur before temperatures drop below 32° F. It is important to remove as much water from the lines as possible. Many irrigation systems have valves on the low ends that can be opened to drain the lines. This should be completed two to three days prior to connecting an air compressor. The compressed air blow out method is the most common method of draining systems. It clears water out of the pipes, sprinkler control valves, and sprinkler heads. Consult with the manufacturer of the irrigation system components for additional steps regarding winterization.

Best Management Practices

- Conduct a visual inspection of the irrigation system: inspect for mainline breaks, low pressure at the pump, and head-to-head spacing
- Flush and drain above-ground irrigation system components that could hold water
- Remove water from all conveyances and supply and distribution devices that may freeze with compressed air or open drain plugs at the lowest point on the system
- Clean filters, screens, and housing; remove drain plug and empty water out of the system
- Secure systems and close and lock covers/compartment doors to protect the system from potential acts of vandalism and from animals seeking refuge
- Remove drain plug and drain above-ground pump casings
- Record metering data before closing the system
- Secure or lock irrigation components and electrical boxes
- Perform pump and engine servicing/repair before winterizing
- Power up the pump station and pump motors at least a couple of weeks before starting to use the system
- Recharge the irrigation system in the spring and avoid recharging an empty system with high pressure, keep at a lower pressure (60 PSI or lower) when priming the lines
- Each sprinkler should be operated until excess air is flushed from the system; inspect for corrective maintenance issues during spring start up
- Ensure proper irrigation system drainage design

Additional information and winterization recommendations may be found at: https://www.usga.org/course-care/regional-updates/central-region/preparing-your-irrigation-system-for-winter.html

Wellhead Protection

Wellhead protection is the establishment of protection zones and safe land-use practices around water supply wells in order to protect aquifers from accidental contamination. It also includes protecting wellheads from physical impacts, keeping them secure, and sampling wells according to the monitoring schedule required by the regulating authority, which may be a local health department and/or the Wisconsin DNR, Bureau of Drinking Water and Groundwater. Licensed water-well contractors may be needed to drill new wells to meet state or local well-construction permit requirements.

When installing new wells, contact the local city regulating authority to determine permitting and construction requirements and the required isolation distances from potential sources of contamination. Locate new wells up-gradient as far as possible from likely pollutant sources, such as petroleum storage tanks, septic tanks, chemical mixing areas, or fertilizer storage facilities.

Best Management Practices

- Use backflow-prevention devices at the wellhead, on hoses, and back flow and air gaps to be used at pesticide mix/load station to prevent contamination of the water source
- Properly close/plug abandoned or flowing wells
- For wellheads located where runoff may contact and/or collect around any part of the wellhead, the area should be graded to include berms to divert surface flow away from the wellhead
- Site new wells so that surface water runoff does not contact or collect around any part of the wellhead, including the concrete pad or foundation; or construct a berm near the wellhead that is sufficient to prevent surface water runoff from contacting or collecting around the wellhead
- Surround new wells with bollards or a physical barrier to prevent impacts to the wellhead
- Inspect wellheads and well casing at least annually for leaks or cracks; make repairs as needed
- Conduct a well pump efficiency test every 1 to 5 years to monitor pump and electric motor wear; the frequency of testing should depend on the water quality with 1 or 3-year intervals for water contaminated with sand, silt, clay etc., and every 3 to 5 years for clean water

- Maintain records of new well construction and modifications to existing wells
- Obtain a copy of the well log for each well to determine local geology and depth; these factors have a bearing on vulnerability to contamination
- Sample wells for contaminants according to schedule and protocol required by the DNR
- Never apply a fertilizer or pesticide next to a wellhead
- Never mix and load pesticides next to a wellhead if not on a pesticide mix/load pad
- A good source of tips to protect groundwater is the Groundwater Foundation: www.groundwater.org and https://www.cdpr.ca.gov/docs/emon/grndwtr/wellhead_protection.pdf

Additional information on wellhead protection in Wisconsin: https://dnr.wisconsin.gov/topic/DrinkingWater/SourceWaterProtection.html https://dnr.wisconsin.gov/topic/DrinkingWater/wellheadProtection/faq.html

References for licensed well contractors in Wisconsin: https://dnr.wisconsin.gov/topic/Wells/contacts.html

References for DNR private water supply specialists: https://dnr.wisconsin.gov/topic/Wells/PrivateWaterSupply.html

Section 6

Mowing & Root Zone Management

Practices such as mowing, aerification, tree and shade management, and verticutting are keys to providing a high-quality playing surface. Turf variety, climate, budget, and golf course standards all inform what BMPs are needed and how they are carried out.

Mowing

When developing a management plan, mowing is one of the most important practices to consider. Turf growth, texture, density, color, wear tolerance, and root development are all affected by mowing practices.

Frequency and mowing height matter. Mowing too frequently increases shoot density and tillering, as well as decreases root and rhizome growth due to plant stress related to leaf tissue removal. Infrequent mowing results in alternating vegetative growth cycles followed by scalping, leading to further depletion of the plant's food reserves.

Based on the species/cultivar being managed and the intended use of the site, there are several factors that determine proper mowing height including frequency, shade, root growth, abiotic and biotic stress, mowing equipment, and time of the year. Improper mowing practices will result in weakened turfgrass with poor quality and density.

It is crucial that an optimal root-to-shoot ratio be maintained. Mowing too low will result in turfgrass plants that need a significant amount of time in order to provide the food required to produce shoot tissue for future photosynthesis. Mowing turf too low at one time can lead to an imbalance between the root system and the residual vegetative tissue. This will leave more roots present than the plant physiologically needs and cause the plant to shed unnecessary roots. It is best to remove no more than 30 to 40 percent of the leaf area in a single mowing as the root growth will be least affected.

Table 6-2. Mowing heights commonly utilized for golf course playing surfaces in New England.*

Species	Greens Regular Membership play	Greens Tournament conditions	Collars, Tees, and Approaches	Fairways	Rough (primary)
	inches				
Creeping bentgrass	0.1 - 0.14	0.09 - 0.125	0.25 - 0.4	0.35 - 0.5	-
Velvet bentgrass	0.1 - 0.14	0.09 - 0.125	0.25 - 0.4	-	-
Perennial ryegrass	-	-	0.4 - 0.5	0.4 - 0.5	1.5 - 3
Kentucky bluegrass **	-	-	0.5	0.5 - 0.65	1.5 - 3
Fine Fescue	-	-	0.4 - 0.5	0.4 - 0.5	-
Tall fescue (turf-type)	-	-	-	-	1.5 - 3

**Variables that often dictate mowing heights include playing surface, turfgrass species and/or cultivar, foot traffic (amount of play), budget, rolling, and whether the golf course is set up for tournament play or regular play.*
***When selecting Kentucky bluegrass varieties for tees and fairways, select cultivars that are tolerant of 0.5-inch mowing heights.*

Recommended golf course mowing heights, by area

Source: Best Management Practices for New England Golf Courses, February 2020

Mowing frequency required during active growth, conforming to 1/3 rule based on mowing heights

Mowing Height (Inches)	1/3 rule Height (inches)	Frequency
0.12	0.18	Every 1-1.15 days
0.25	0.37	Every 2 days
0.50	0.75	Every 2-3 days
1.0	1.5	Every 3-4 days
1.5	2.25	Every 4-5 days
2.0	3.0	Every 5-6 days
3.0	4.5	Every 6-7 days

PROPER MOWING PRACTICES AND ROOT ZONE MANAGEMENT ARE CORNERSTONES FOR HEALTHY TURF. THESE PRACTICES WORK HAND-IN-HAND WITH IPM, WATER AND IRRIGATION MANAGEMENT, PLUS GOLF COURSE PLAYABILITY.

Best Management Practices

- Maintain proper mowing heights and frequency within the ranges adapted for the species and cultivars being managed
- Increase mowing frequency during periods of rapid growth and decrease frequency during dry and stressful periods
- For turf that has grown too tall, avoid mowing down to the proper height all at one time. This kind of severe scalping reduces density and can result in significant reduction in root growth. Mow tall grass frequently, gradually decreasing the height until the proper height of cut is reached
- When turfgrass is shaded, its growth is affected by the plant filtering out photosynthetically active radiation; this will cause the turfgrass to grow upright in an effort to consume the light needed to meet the plant's photosynthetic needs; to aid and improve the health of shaded turfgrass, mowing height should be increased by a minimum of 30%
- Using plant growth regulators for grasses grown in shaded areas is a management tool that has been shown to improve overall turf health
- Periods of drought are environmental stressors that significantly impact turf health - during these periods, increasing mowing heights to the maximum that use will allow will help increase the plant's rooting depth and photosynthetic capacity
- It is important to use proper mowing equipment; reel mowers produce the best quality and are suited for maintaining a height of cut below 1.5 inches
- For maintaining turfgrass at a height of cut above one inch, rotary mowers deliver adequate cutting quality; rotary mowers are more versatile when compared to reel mowers on uneven terrain
- Maintain sharp blades and proper adjustment; dull blades will shred leaf tissue resulting in increased water loss and potential for diseases to develop
- Flail mowers are most commonly used for maintaining utility turf areas that are rarely mowed and have low aesthetic requirements
- Mowing patterns influence functional characteristics of a turf surface in addition to aesthetic
- When turfgrass shows signs of stress, alternate between mowing and rolling

- Turfgrass clippings contain significant amounts of potassium and phosphorus in addition to 2%-4% nitrogen on a dry-weight basis which is a source of nutrients; these clippings should be properly handled as these nutrients can also be a source of pollution
- Return grass clippings to the site during the mowing process except in the case where underlying turfgrass plants could be smothered by a large number of clippings and when clippings on golf greens have a negative impact on play and functional use such as affecting ball roll; in such cases, grass clippings should be removed
- Grass clippings should also be removed during seasons of weed seed production to reduce the spread of weeds
- Properly dispose of collected clippings in order to avoid unpleasant odors near play areas and prevent fire hazards; consider composting or dispersing clippings evenly on natural areas where they can organically decompose without accumulation; do not compost or dispose of clippings on impervious surfaces or near ponds and streams

Mowing Directions

It is important for growing grass to keep an upright growth habit, thus providing a smooth playing surface. This is achieved with varying mowing directions. Rotating directions prevents turfgrass from lying over which causes it to grow in the direction that it's being mowed. It also gives operators more visibility of lines.

Varying mowing directions prevents other issues such as "grain", marcelling, and rutting. "Grain" is the result of lateral growth habit, which effects the playing surface by influencing the ball to roll in the same direction the grass is growing and inconsistent ball roll speed. In addition, the mower will not cut effectively causing the accumulation of thatch which results in marcelling over time. Marcelling is the washboard or wavy appearance of turfgrass that adversely affects playing conditions. Rutting is another downside of a singular mowing direction as tires driving the same area repeatedly causes wear and soil compaction. As a solution, many golf courses provide a chart of daily mowing directions. One method is to use clock positions to determine the daily mowing pattern. For instance, Monday's direction is 12 to 6, Tuesday is 3 to 9, Wednesday is 8 to 2, and Thursday is 10 to 4.

Types of Mowers

Using appropriate equipment is essential when it comes to mowing turf. Rotary mowers and reel mowers are the best cutting units for the job.

Rotary mowers are best suited for grass that is maintained at a higher height-of-cut. This mower's blades are mounted horizontally to a vertical shaft that spins at high speeds. The sharp, speedy blade impacts the turf by cutting the leaf blade like a knife as opposed to a scissor cut. It is important to maintain a sharp blade. Disadvantages of the rotary mower include the inability to mow shorter than one inch and swinging blade-related danger.

Reel mowers are used for other areas that are maintained at a shorter height-of-cut such as golf course greens, tees, and fairways. This is a cylinder mower with eight to 16 evenly spaced blades with a sharp stationary bedknife mounted beneath the reel. Unlike the rotary mower, reel mowers create a scissor cut between the blade and bedknife as the cylinder spins. These mowers save fuel and allow for battery operated options as they require less power. It is important to properly adjust and maintain reel mowers in order to get the lowest mowing height and highest cut quality. Disadvantages of reel mowers are height-of-cut options, skill needed for proper adjustment which must be done in accordance with the manufacturer, and maintenance.

Height of Cut

Golf courses consist of various types of playing surface which require different mowing frequencies and height-of-cut. There are other factors that influence mowing practices such as time of year, temperatures, and the grass' growing speed. For example, early spring and late fall bring cooler temperatures and shorter days. This reduces the plant's opportunity for photosynthesis resulting in slower growing speeds and require less mowing. With warmer temperatures and longer days in the summer months, grass has the opportunity to photosynthesize causing rapid growth and increases the need for additional mowing. As a general guideline, it's important not to remove more than one-third of the top growth in a single mowing.

Using the appropriate equipment for differing surfaces helps create a more optimal golf course. For roughs, set a rotary mower between two and three inches for height-of-cut and mow once or twice weekly on average. Other areas of the course require reel mowers such areas as fairways, tees, and approaches. Depending on how quickly the turfgrass is growing, these areas will likely need mowing two or three times weekly.

Since golf course greens are the most important feature, they demand the highest priority with daily maintenance and mowing. Reel mowers are a must for course greens as they require lower mowing heights. The average mowing height for greens ranges from .07 to .125 inches, each golf course will determine the best mowing height for the respective course. The key is a height that can be maintained to provide smooth and constant green speed. Occasionally, a roller can substitute mowing. It's important that reel mower blades are sharpened and adjusted often for cut quality. These practices will ensure an ideal playing surface.

Rolling

Daily rolling of a putting green can increase putting speeds for improved ball roll, without lowering the height-of-cut. Any time height-of-cut is raised, turf is healthier; research has shown that rolling contributes to less weeds and occurrence of disease. Rolling also helps improve smoothness of the ball roll by pushing down imperfections.

Plant Growth Regulators (PGRs)

PGRs are used for a variety of reasons such as controlling seed heads, improving density, reducing growth, improving color, reducing irrigation and fertility needs, improving stress tolerance, and improving overall turf quality. Gibberellic acid (GA) inhibitors are most widely used for golf course maintenance. These are divided into six classes based on mode of action, Table 1 shows the most widely used PGRs.

Table 1: PGR chemical classes, modes of action, chemical names, and products

PGR Class	Mode of Action	Chemical and Trade names
A	Late gibberellic acid inhibitor	Trinexapac-ethyl (Primo Maxx) Prohexadione-Ca (Anuew)
B	Early gibberellic acid inhibitor	Flurprimidol (Cutless) Paclobutrazol (Trimmit 2SC)
C	Cell division inhibitor	Mefluidide (Embark)
D	Herbicide	Methiozolin (Poa Cure) Glyphosate (Roundup)
E	Phytohormone	Ethephon (Proxy)
F	Natural growth regulator	Seaweed extracts, humic acids

Source: Adapted from Connecticut Golf Industry Best Management Practices Guide, 2020

Cultivation

When it comes to golf course turf management, cultivation practices are essential. Putting greens, fairways, and tees experience deterioration as these areas experience higher traffic with routine use. Negative impacts of routine use include compacted soil and thatch accumulation. Soil issues caused by excessive use will typically be limited to the top three inches of the soil profile. Persistently managing these issues will enhance plant health by improving nutrient and water uptake, reducing root penetration, promoting atmospheric gas exchange, and removing thatch accumulation.

Aerification

Customary soil practices call for periodic tilling in order to correct problems related to soil compaction. Turfgrass does not allow for significant physical disruption from tilling without destroying the playing surface. A practice used to manage soil compaction with reduced physical disturbance is core aerification. This method helps manages soil compaction and improves drainage. In conjunction with core or solid tine aerification, applying light sand frequently will help control thatch, smooth playing surfaces, and potentially alter the soil's physical characteristics.

Verticutting

Thatch accumulation can commonly occur in areas with less traffic. Over accumulation of thatch and other organic matter may result in increased insect activity, disease, scalping, along with reduced water infiltration, root growth reduction and overall undesirable playing surface. Verticutting, otherwise known as vertical mowing, can help manage grain and remove accumulated thatch. Groomers are a miniature vertical mower attached to the front of the reels which cut through stolons in order to improve plant density and manage grain.

Best Management Practices

- Core aerification is the removal of small cores, typically 0.25 to 0.75 inch in diameter, from the soil profile. Core aerification programs should only remove 15% to 20% of the surface area on an annual basis; high traffic areas may need two to four or more core aerifications annually. For help determining the area's specific needs reference the International Sports Turf Research Center (ISTRC) http://www.istrc.com/
- Perform core aerification when turfgrass is actively growing to recover surface density more quickly
- To prevent the formation of compacted layers in the soil profile from cultivation, vary the depth of aerification with varying length tines during each event
- To temporarily reduce soil compaction when grass growth rate is slower, use solid tines; this helps soften hard turf surfaces with less disruption - since this method does not remove soil from the profile, it is only a temporary solution
- Solid tine aeration has also proven to be a replacement for core aeration on sand root zones and when organic matter levels are in check
- Deep-drill aerification brings soil to the surface and distributes it into the canopy by drilling deep holes in the soil profile with drill bits. Using sand or other root-zone materials to backfill holes allows the replacement of heavy soil in an effort to increase water infiltration in the soil profile
- Sand injection is another form of aeration using water-based injection to create aeration holes through the root zone and simultaneously fill holes with sand
- Slicing is best performed on moist soil and can reduce soil compaction and promote water infiltration with little surface damage; it is faster than core aerification but not as effective
- Spiking also reduces soil compaction by breaking up crusts on the surface and disrupting algae layers to allow better water infiltration
- Setting a verticutter to a depth that nicks the turf's surface can reduce the grain of putting greens; to stimulate new growth, set the verticutter to an increased depth of penetration to cut through stolons and rhizomes and remove thatch; depth for thatch removal should be set to reach the bottom of the thatch layer extending beneath it into the soil surface
- Vertical mowing should be initiated when thatch level reaches 0.25 to 0.5 inch in depth; for putting greens, shallow vertical mowing (shallow enough to avoid intermixing the native soil and the sand topdressing layer) should be initiated at least monthly to avoid thatch accumulation
- Topdressing playing surfaces with sand after heavy vertical mowing and core aerification help turf to recover; rates are determined by how well the turf canopy absorbs the material without risk of burying the plant; typical rates range from a depth of 0.125 to 0.25 inch

Additional information:
https://www.usga.org/articles/2012/10/course-care-thatch-control-key-to-firm-resilient-fairways-21474850692.html

Comparison of Methods Used to Selectively Cultivate Turf

Cultivation method	Soil penetration (inches)	Spacing between blades or tines (inches)	Relative level of soil loosening	Relative disturbance of the turf surface
Core aerification: conventional and deep-tine, hollow-tine	2 to 12	1 to 8	Minimal to high	Moderate to high
Deep-tine, solid-tine aerification	2 to 16	1 to 8	Minimal	Minimal to moderate
Water injection	4 to 20	3 to 6	Minimal to moderate	Minimal
Spiking	¼ to 12	1 to 2	Minimal	Minimal
Slicing	2 to 8	4 to 12	Minimal to moderate	Minimal

Source: https://extension.tennessee.edu/publications/Documents/W161-B.pdf

Objectives of Sand Topdressing

- *Dilute thatch accumulation*
- *Smooth the playing surface*
- *Maintain surface drainage*
- *Increase infiltration*
- *Increase soil macroporosity at the surface by increasing the sand content of the soil*
- *Increase surface firmness*

Topdressing

Managing turfgrass with topdressing encourages maximum root development, water, and air movement; and minimizes pest susceptibility. Topdressing achieves these benefits when desirable rootzone material, or sand mixture, is added to the surface. This helps the crown of the plant to remain as close to the soil surface as possible. Before application, thatch and other organic matter need to be removed through cultivation practices.

Particle size is important when it comes to topdressing because it must be compatible with the existing rootzone material to be effective. If texture of the materials used is finer than the original sand mix, this can have the undesired result of excessive moisture retention in the topdressing layer, due to lower rootzone infiltration rates. Modifying the top three inches of soil with topdressing creates better infiltration rates and reduces runoff. Sand should be tested by a Certified Lab before implementing a topdressing program or changing material.

Best Management Practices

- Throughout the growing season, apply light topdressing sand frequently (every seven to 14 days) or match the applications with the plant growth potential; this will help control thatch and smooth uneven playing surfaces on putting greens
- Weed-free topdressing material with a similar particle size to the underlying rootzone is recommended; using finer materials may cause layering and reduce water infiltration
- In the spring and fall, increase the amount of topdressing to putting greens in conjunction with aggressive cultivation practices; harvest cores and refill the holes with topdressing
- Lab test topdressing material with the Standard Test Method for Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sport Field Rootzone Mixes known as ASTM F1632
- Include 15 to 20 subsamples at 4-inch depth; if previously topdressed, use the current topdressing layer depth; to determine the suitability of the topdressing material, compare test results to USGA guidelines and the prospective topdressing material to determine compatibility
- To ensure the topdressing material meets USGA guidelines for hydraulic conductivity, lab test the material with the Standard Test Methods for Saturated Hydraulic Conductivity, Water Retention, Porosity, and Bulk Density of Putting Green and Sports Turf Rootzones or ASTM F1815
- Accredited labs for testing:
- International Sports Turf Research Center
- Turf & Soil Diagnostics

Bunkers

Bunkers are designed to create aesthetic appeal that some consider to be the course's personality and serve as a strategic hazard that provides an obstacle for golfers. Golf course architects plan bunkers specifically based on shot values, playability, and level of management desired.

A bunker is made up of a drainage component, a liner in some cases (optional), and top sand. The drainage system is installed within the bunker floor. Depending on the capacity of the drainage, or how quickly moisture clears the bunker floor, the sand layer may be softer or firmer. When a liner is installed on the base of the bunker it helps to remove water quickly, reduces sand from washing down steep banks, and aids in avoiding contaminated sand due to subsoil infiltration.

Sand selection influences playability, it is recommended to perform a sand analysis with an accredited lab. There are several important parameters to consider when selecting potential sand:

- Particle size analysis
- Particle shape (angularity and sphericity)
- Uniformity coefficient
- Angle of repose
- Acid reaction
- Color
- Climate

A penetrometer reading is a good predictor of the sand's tendency to result in fried egg or plugged lies. Infiltration rate is another parameter that determines favorable sand. A rate of at least 30 inches per hour is recommended. As it relates to depth, factors like moisture release curves and moisture column tests should be included to find optimum sand depth especially with the use of porous aggregate bunker liners. An average sand depth of 4 to 6 inches at the base of the bunker and 2 to 3 inches on the faces is recommended by the USGA, but can vary based on sand type and incorporation of a liner system. Acquiring several potential sands and constructing test bunkers or testing bunkers at other golf courses is recommended before sand selection when possible.

Long-term maintenance should always be considered in bunker design and construction. Bunkers need raking and there are many types of rakes and methods that can be used to create a desired playing surface. Larger bunkers will allow for motorized raking while smaller bunkers may need to be raked by hand. Firmer bunker surfaces are desired by most golfers and will develop with regular rainfall or irrigation and shallow or minimized raking. Softer bunker surfaces, which result in buried lies, result from dry weather and deep or continuous raking, and should be avoided.

Best Management Practices

- Golfer clientele and maintenance costs will inform bunker designs; constructing numerous bunkers and features such as intricate edges, revetted, and high flashed faces will increase costs and difficulty
- Extensive herringbone drainage and a quality bunker liner is recommended
- Avoid washouts by shaping bunker surrounds so that surface water doesn't drain into the bunker
- Irrigating bunker banks can keep the sand from becoming too dry, but can be costly to install
- Construct test bunkers or visit other golf courses to help with sand selection
- Lab test prospective sand with an accredited lab when selecting bunker sand
- Sand depth of 4 to 6 inches on the bunker floor and 2 to 3 inches on the banks is a typical recommendation, but varies depending on sand type and construction method
- Maintaining firmer bunker banks and bottoms will help prevent "fried egg" lies.
- To maintain a consistent surface, lightly rake and limit 2 or 3 times per week if possible, performing touch-ups in between to save labor
- Bunker banks should be mowed weekly and lightly edged on an as-needed basis.
- Maintain proper depths by probing the sand about every two weeks depending on whether the bunkers are highly contoured or flat, or in a location of high use
- Dirty and contaminated bunkers may sometimes be refreshed by removing the top one or two inches of sand and replaced with new sand
- Turn sand over when bunkers are too firm by using a motorized bunker rake with cultivating tines
- Studies indicate bunker sand should be replaced every five to seven years depending on condition; use of liners may extend this period

Resources for Sand Analysis:
Turf & Soil Diagnostics
613 E. 1st Street
Linwood, KS 66052
(855) 769-4231
lab@turfdiag.com
http://www.turfdiag.com/

Thomas Turf Services
11183 State Highway 30
College Station, TX 77845
Attn: Bob Yzaguirre
(979) 774-1600
http://thomasturf.com/

A. McNitt & SerenSoil Testing
1338 Deerfield Drive
State College, PA 16803
(610) 360-5985
andy@turfsoiltesting.com
tom@turfsoiltesting.com
http://www.turfsoiltesting.com

Shade and Tree Management

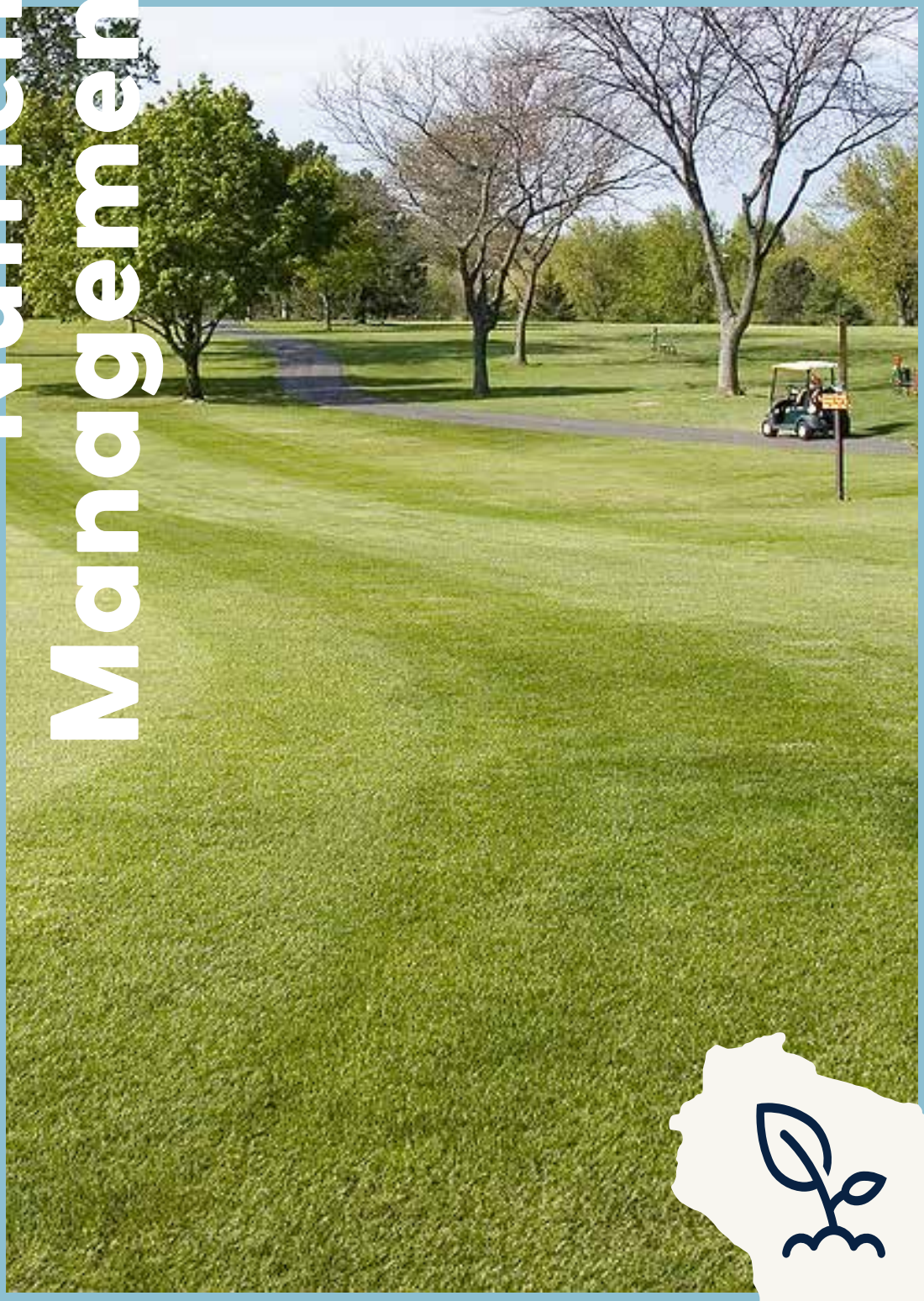
Most turfgrasses typically perform best in full sun. Heavily shaded areas have decreased air circulation and opportunity for photosynthesis which can lead to turf decline, disease, and pest issues. Annual shade audits are recommended to identify problems. Survey sun patterns throughout the year to determine which trees are blocking light from desired areas. Remove necessary branches to increase airflow and light. For severe issues, select trees may need to be removed.

Turfgrass plant health is the key consideration when planning tree planting and/or removal. Competing tree roots can cause turfgrass health and performance to suffer. Notate tree species, value, health, life expectancy, location, maintenance requirements, and safety concerns.

Best Management Practices

- Tree limbs and roots can be pruned in order to reduce competition for nutrients, sunlight, and water
- Trees located near low mowed areas like greens and tees can disrupt turf growth; thin the tree's canopy to promote growth or remove and/or relocate the tree if possible
- Survey sun angles throughout the year to understand how it affects plant health
- Annual shade audits should be performed to identify problems; apps like "Sun Seeker" can be used to pinpoint the shade-causing trees
- Tree surveys can be conducted with an arborist to identify tree species, value, health, life expectancy, location, maintenance requirements, and safety concerns

Nutrient Management



Section 7

Proper nutrient management is critical for maintaining healthy turf and an aesthetically pleasing surface for playability. The NMP indicates timing, amount, and form of nitrogen (N) and phosphorus (P), plus other nutrients that can be applied to an area based on soil properties, topography, land use, and proximity of fertilized areas to water bodies and groundwater resources. It provides education regarding site characteristics, environmentally sensitive areas, soil composition, fertilizer application rates, soil testing results and method, plus appropriate actions for spill response.

The appropriate application of essential nutrients allows turfgrass to recover from damage and player wear. Conditions such as drought, disease, and insect pests increase turfgrass stress – proper application of nutrients helps build turf resistance to these stressors. The goal of a proper nutrient management program should be to apply minimal nutrients to achieve an acceptable playing surface in the most efficient manner, helping the plant to recover from the stresses that it faces. Proper fertilization, in combination with other cultural practices, allows for sustainable turfgrass while reducing chemical inputs.

It is crucial to have an understanding of application rates and timing for effective use of applied nutrients at minimal environmental risk. Proper management helps prevent leaching or runoff in order to protect surface and groundwater resources. The State of Wisconsin has nutrient management regulations in place to protect water quality of these resources throughout the state.

A THOUGHTFUL AND COMPREHENSIVE NUTRIENT MANAGEMENT PLAN (NMP) IS IMPORTANT FOR MINIMIZING ENVIRONMENTAL RISKS AND MANAGING MAINTENANCE COSTS.

Regulatory Considerations

- Wisconsin DNR administrative rule NR-151 requires NMPs for fertilized areas greater than five acres. Reference: https://docs.legis.wisconsin.gov/code/admin_code/nr/100/151
- The turf portions of NR-151.10-15 and DNR Turf Nutrient Management Technical Standard (1100) provide current requirements and changes to the administrative rule. https://dnr.wi.gov/topic/stormwater/documents/dnr1100-turfnutrientmanagement.pdf
- Reference NR-151 Rule Changes at https://dnr.wisconsin.gov/topic/Nonpoint/nr151Strategy.html
- University of Wisconsin-Madison Turfgrass Science NMP checklist for compliance with DNR Technical Standard 1100 (NR-151.13(1)(b)3 and NR-151.14) https://turf.wisc.edu/2016/05/assistance-for-creating-a-nutrient-management-plan/
- NR-151 video overview from University of Wisconsin-Madison Turfgrass Science: https://www.youtube.com/watch?v=RxzaF81j2Bk
- University of Wisconsin-Madison Turfgrass Science DNR Turf Nutrient Management Technical Standard (1100) fact sheets: https://bit.ly/3mOBmkw
- Reference DATCP fertilizer certification and licensing regulations: https://datcp.wi.gov/Pages/Programs_Services/PesticidesFertilizersCertificationLicensing.aspx
- Be sure to follow any additional local regulations and ensure BMPs are tailored to local requirements as needed

Best Management Practices

- Comply with Federal requirements, Wisconsin NR-151, the DNR Turf Nutrient Management Technical Standard (1100), and any local regulations
- Identify who will develop and implement the NMP; the nutrient management planner should be qualified with certification of professional management, a bachelor's degree in turfgrass science or related field, or experience equivalent
- Conduct a site analysis
- Undergo soil tests, understand pH levels, conduct plant tissue sampling. Conduct a water analysis annually
- Establish a written NMP incorporating five key components (site characteristics, site map, fertilizer application rates/restrictions, soil testing results/methods, and spill-response plan)
- Comply with NR-151 requirements based on high-traffic areas, low traffic areas, and newly established turfgrass
- Consult with University of Wisconsin-Madison Turfgrass Science for N application rate guidelines as needed beyond NR-151 guidelines
- Identify and map surface water management areas and ground water management areas; follow DNR and University of Wisconsin-Madison Turfgrass Science nutrient management guidelines
- Choose the appropriate spreader for a given fertilizer material; calibrate and conduct preventative maintenance on application equipment according to manufacturer's recommendations; include dates of calibration and names of employees conducting calibration in the NMP
- Incorporate a general fertilizer application schedule by area into the NMP showing the amounts of N and P to be applied during each month of the growing season
- Incorporate an overview of routine procedures for establishment, overseeding, and re-establishment of turf areas into the NMP. (i.e., how divots are filled, or practice tees managed) Include timing and fertility practices for seeding
- Understand the components of fertilizers, labels, and functions of each element
- Apply nutrients when turfgrass is actively growing
- Apply slow-release N fertilizers at appropriate time of year to maximize product release characteristics
- Use light, frequent applications (spoon feeding) to provide consistent nutrition and minimize potential for leaching and runoff; alternatively many courses use light, frequent granular applications to meet their needs
- Avoid applying fertilizers to soils that are at, or near, field capacity or following rain events that leave the soils wet
- Do not apply fertilizer when the National Weather Service has issued a flood watch or if heavy rains are likely
- Use caution when loading, applying, and storing nutrients; adhere to proper fertilizer storage, loading, and clean-up procedures
- Communicate fertilizer spill-response plan regularly with employees and include in NMP
- Keep accurate records of fertilization (including date, location, fertilizer applied, rates, grade, N source, % slow-release N, form, applicator) and include within NMP

Nutrient Management Plan (NMP)

A nutrient management plan should be established in written format and shared with all parties associated with management of the site. The NMP should consist of the following:

FIVE KEY COMPONENTS

1. A narrative description of the site (acres, location, fertilized acres, soil type, grass species, size of waterbodies, etc.) land use, turfgrass species, soil types, and areas which are environmentally sensitive
2. Site map with topography, land uses, soil test locations, environmentally sensitive areas, and surface water bodies
3. Application rates and restrictions for recommended fertilizers by land use designation and environmentally sensitive areas
4. Results and method used for soil testing
5. Fertilizer spill-response plan

Source and additional NMP information: https://cdn.shopify.com/s/files/1/0145/8808/4272/files/A3876.pdf

University of Wisconsin-Madison Turfgrass Science resources for compliance with NR-151: assistance creating NMP, education, NMP template, and NMP checklist: https://turf.wisc.edu/2016/05/assistance-for-creating-a-nutrient-management-plan/

University of Wisconsin-Madison Turfgrass Science video guidance for developing NMP: https://www.youtube.com/watch?v=Rx-zaF81j2Bk

Site Analysis

The site analysis incorporates an understanding of land use, turfgrass species, soil types, and areas which are environmentally sensitive. The land use areas and environmentally sensitive areas should be mapped with topographical mapping, including indication of soil test locations and surface water bodies. The DNR recommends different fertility rates by land use designation. Three designated land use areas include: high-traffic areas, low traffic areas, and newly established turfgrass.

Three types of professional analysis are needed for the foundation of the NMP in order to ensure turfgrass health, performance, and recovery: soil, plant tissue, and water sampling.

Soil Sampling

The purpose of soil sampling is to provide a detailed report which includes measurable variables including pH, organic matter content, salinity, and nutrients available for plant use. It also offers a prediction of a plant's response to applied nutrients. Proper use of testing results includes analysis, interpretation, and recommendations.

NR-151 requires fertilizers are applied based on appropriate soil tests. The DNR technical standard defines appropriate as each area that is managed differently, has a unique soil type, or displays obviously different turfgrass growth.

Take 10 to 15 random soil core samples from each area. Each sample should be from the same depth, a six-inch depth (or four-inch for golf greens and tees). Break the cores and mix them together in a clean plastic bucket, removing debris. Determine a labeling system and place two cups of the mixed soil in a labeled bag for the soil testing lab.

Select a laboratory which uses a nutrient extraction method appropriate for the soils. The Bray-1 and Mehlich-3 soil tests have been properly calibrated for turfgrass grown on native soil and sand-based root zones in Wisconsin. Both tests have been shown to provide reliable results for phosphorus and potassium.

Soil analysis combined with proper plant tissue sampling can provide the best picture of what is missing and what needs to be done to remediate the soil.

Best Management Practices

- Accurate, consistent sampling is essential to providing useful information over any period of time
- Divide course into measurable components based on DNR technical standard definition: areas managed differently, with unique soil types, or that display obviously different turfgrass growth
- Take 10-15 samples from each area, break cores and blend together to get a uniform and representative mixture; place in a clean plastic bucket, removing debris; determine a labeling system, place two cups of the mixed soil in a labeled bag for the soil testing lab
- Each soil sample should be taken at an equal depth; 6” depth or 4” for golf greens and tees
- If the location has correlation data between a given nutrient applied to a soil and a response to that nutrient by turfgrass, then recommendations may provide expected results; if the location does not have correlation data, then soil test recommendations may be of little value
- Use Bray-1 or Mehlich-3 soil tests and remain consistent in using extraction method when comparing test results from different periods of time
- Soil test with a lab as approved by the University of Wisconsin
- Keep soil tests from previous years for observation of changes over time to help make appropriate decisions in the future

Soil Testing Labs in Wisconsin

It is not required to test turfgrass soil samples at DATCP certified labs, however these labs are approved by the University of Wisconsin for their analytical procedures and consistent results.

DATCP-certified soil testing laboratories

Dairyland Laboratories
709 W Meadow St
Stratford, WI 54484
Phone: (715) 687-9997
Email: info@dairylandlabs.com
https://www.dairylandlabs.com/agronomy-services/soil-sampling-services

A&L Great Lakes Laboratories
3505 Conestoga Dr.
Fort Wayne, IN 46808
Phone: (260) 483-4759
Email: lparker@algreatlakes.com
https://algreatlakes.com/

AgSource Laboratories
Soil & Forage Lab
106 N. Cecil Street
Bonduel, WI 54107
Phone: (715) 758-2178
Email: speterson@agsource.com
Email: bonduel@agsource.com
Email: aglab@agsource.com

Mowers Soil Testing Plus, Inc.
117 E. Main St.
Toulon, IL 61483
Phone: (309) 286-2761
swiedan@mowersplus.com

Rock River Laboratory
710 Commerce Drive
PO Box 169
Watertown, WI 53094
Phone: (920) 261-0446
Email: dustin_sawyer@rockriverlab.com
https://rockriverlab.com/pages/Soil-Analysis.php

Additional information: https://datcp.wi.gov/Documents/NMSoilManureLabs.pdf

Plant Tissue Analysis Labs in Wisconsin

Rock River Laboratory
710 Commerce Drive
PO Box 169
Watertown, WI 53094
Phone: (920) 261-0446
Email: dustin_sawyer@rockriverlab.com
https://rockriverlab.com/pages/Rock-River-Laboratory-Plant-Tissue-Analysis.php

Dairyland Laboratories
709 W Meadow St
Stratford, WI 54484
Phone: (715) 687-9997
Email: info@dairylandlabs.com
https://www.dairylandlabs.com/agronomy-services/plant-tissues

Additional information: https://ipcm.wisc.edu/blog/2018/08/plant-tissue-analysis-an-in-season-nutrient-check/

Plant Tissue Analysis

Plant tissue analysis is valuable for helping to guide nutrient management decisions when used in conjunction with soil samples taken from the same areas. Clippings are analyzed for nutrient concentration in the plant. These values are compared to a critical level range indicating deficiency, sufficiency, or excess. Monitor the following for tissue analysis: turfgrass quality, clipping yield, and performance. Record and analyze these variables to help guide future nutrient management decisions. Two to four tests per year is common on greens and one to two tests per year on tees and fairways.

Best Management Practices

- Tissue samples may be collected during regular mowing
- Do not collect tissue after any event that may alter nutrient analysis
- Place tissue in paper bags; do not use plastic
- If possible, allow tissue samples to air dry before mailing them
- Poor quality turfgrass that is of concern should be sampled separately from higher quality turfgrass
- When turfgrass begins to show signs of nutrient stress, a sample should be collected immediately
- More frequent tissue sampling allows more accurate assessment of turfgrass nutrient status and how it changes over time
- The quantity of tissue analysis should be based on individual site needs; two to four site tests per year are common on greens while one to 2 tests per year are common on fairways and tees
- Keeping tissue tests from previous years will allow for observation of changes over time
- Tissue testing can provide good evidence of the impact of nutrient management programs

Water Sampling

The largest input to turfgrass is often water applied through irrigation. Impacts of water quality can have significant impacts on soil nutrients, soil structure, and nutrient availability. Water tests, along with soil sampling, will provide the greatest level of understanding to the proper ratios of applied nutrients required. Keep accurate records to show impact from the NMP. Managing a spreadsheet of sampling over time assists in understanding long-term impact on soil and plant health.

Reference Water Quality and Surface Water Management for additional BMPs.

Soil Properties Map

The University of Wisconsin-Madison Turfgrass Science has developed step-by-step guidance for obtaining maps of soil properties for the golf course NMP as required for compliance with NR-151:

- Video guidance: https://www.youtube.com/watch?reload=9&v=7naJusJ_TYw
- Document guidance: https://cdn.shopify.com/s/files/1/0145/8808/4272/files/A3876.pdf
- Source for obtaining maps of soil properties: https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

Surface Water and Groundwater Management Areas

The NMP must identify Type I and Type II surface water management areas (SWMAs). Type I are represented by areas on slopes within a specific distance from a lake or perennial stream or river. These are environmentally sensitive areas due to potential for runoff down the slopes. The following guidelines should be followed:

- Water-soluble fertilizer should be used within Type 1 SWMAs
- Fertilizers containing 50% or less slow-release N should be used
- Indicate area on a map
- Describe area including site, location, size, and restrictions in a table

Type II SWMAs are designed to protect areas within 20 feet of any navigable water, including intermittent streams that are navigable. The following guidelines should be followed:

- Only liquid N and P may be applied, at a rate of no more than 2 lbs N/1000 ft2 annually
- Drop spreaders can be utilized to apply granular fertilizer to putting greens and surrounds within 20 feet of a waterbody
- Indicate area on a map
- Describe area including site, location, size, and restrictions in a table

Groundwater management areas (GMAs) are designed to protect areas in which potential for groundwater contamination is relatively high. These exist where Hydrologic Group A2 soils occur, or where depth to water table is less than 12 inches, or depth to bedrock is less than 20 inches. This data may be found on soil survey maps. The following guidelines should be followed:

- Fertilizers with at least 50 percent slow-release N should be used
- Indicate area on a map
- Describe area including site, location, size, and restrictions in a table.

Examples and assistance identifying SWMAs: https://cdn.shopify.com/s/files/1/0145/8808/4272/files/A3876.pdf

The DNR recommends different fertility rates based on land use designation. Three designated land use areas include: high-traffic areas, low traffic areas, and newly established turfgrass. These areas are recommended per the DNR Turf Nutrient Management Technical Standard (1100) guidance.

High traffic turfgrass areas

High traffic turfgrass areas are defined as having more than ten users per acre per week and are regularly mowed and irrigated. Reference Table 1 for P applications by soil test interpretation and Table 2 for maximum annual N applications which vary by land use and soil type.

Table 1. Phosphorus interpretations and recommendations for Bray-1 and Mehlich-3 soil tests for high-traffic turfgrass areas

Use	Phosphorus soil test level					Phosphorus fertilizer recommendations	
	Mehlich-3		Bray-1		Interpretation		
	ppm	lbs/acre	ppm	lbs/acre		lbs P_2O_5/1,000 ft^2	lbs P_2O_5/acre
General high traffic	0–15	0–30	0–12	0–24	Very low	5	260
	16–30	30–60	13–25	25–50	Low	3.5	175
	31–45	61–90	26–37	51–74	Medium	2	100
	46–60	91–120	38–50	75–100	Optimal	1	65
	> 60	> 120	> 50	> 100	Very high	0	0
Sand tees & greens	0–6	0–12	N/A[1]	N/A	Very low	3	130
	7–12	13–24	N/A	N/A	Low	2	90
	1–18	25–36	N/A	N/A	Medium	1	45
	19–24	37–48	N/A	N/A	Optimal	0.5	20
	> 24	> 48	N/A	N/A	Very high	0	0
Mineral soil tees & greens	0–6	0–12	N/A	N/A	Very low	5	220
	7–12	13–24	N/A	N/A	Low	3.5	150
	13–18	25–36	N/A	N/A	Medium	2	90
	19–24	37–48	N/A	N/A	Optimal	1	45
	> 24	> 48	N/A	N/A	Very high	0	0
Fairways	0–15	0–30	N/A	N/A	Very low	6	260
	16–30	30–60	N/A	N/A	Low	4	175
	31–45	61–90	N/A	N/A	Medium	2.5	100
	46–60	91–120	N/A	N/A	Optimal	1.5	65
	> 60	> 120	N/A	N/A	Very high	0	0

[1]Use the Bray-1 soil test interpretations for general high-traffic areas.

Table 2. Maximum recommended N for various high-traffic turfgrass areas according to soil type

Soil type	Land use	Annual maximum allowable N lbs N/1000 ft^2	Single application maximum** lbs N/1000 ft^2
Sand*	Athletic field	10	1
	Fairway	8	1
	General high-traffic area	8	1
	Putting green	8	1
	Tee box	10	1
Native or mineral soil	Athletic field	8	1
	Fairway	5	1
	General high-traffic area	5	1
	Putting green	5	1
	Tee box	8	1

* Over 70% of the root zone is composed of sand.

** Up to 2 lbs N/1000ft^2 may be used if the product is 100% natural organic or biosolid. Most org based fertilizers contain P and their use is not allowed unless a need for P is indicated by a soil

Source: https://cdn.shopify.com/s/files/1/0145/8808/4272/files/A3876.pdf

Low traffic turfgrass areas

Low traffic turfgrass areas are defined as having fewer than ten users per acre per week and also include areas that are not mowed, regardless of use. Reference Table 3 for P applications. There are no land use or soil type adjustments for N and P guidelines for low traffic areas. N applications on low-traffic turfgrass areas should not exceed 4 lbs N/1000 ft2 annually when clippings are removed. When clippings are returned, not more than 3 lbs N/1000 ft2 should be applied unless the turf area is three years old (or less), in which case up to 4 lbs N/1000 ft2 may be applied.

Newly established turfgrass

The establishment period is identified as the 12-month period following seeding or installation of sod. If soil testing prior to establishment is not practical, apply no more than 1 lb N/1000 ft2 using a starter fertilizer and document why tests were not obtained. If a soil test is obtained, or if levels are known from a prior sampling, follow P guidelines as shown in Table 4. Note different interpretations for seeded and sodded areas.

Table 3. Phosphorus interpretations and recommendations for Bray-1 and Mehlich-3 soil tests for low-traffic turfgrass areas

Phosphorus soil test level					Phosphorus fertilizer recommendations	
—Mehlich-3—		—Bray-1—		Interpretation		
ppm	lbs/acre	ppm	lbs/acre		lbs P_2O_5/ 1000 ft^2	lbs P_2O_5/ acre
0–10	0–20	0–5	0–10	Very low	3	131
11–15	21–30	6–10	11–20	Low	2	87
16–25	31–50	11–15	21–30	Medium	1	44
26–35	51–70	16–20	31–40	Optimal	0	0
> 35	> 70	> 20	> 40	Very high	0	0

Source: https://cdn.shopify.com/s/files/1/0145/8808/4272/files/A3876.pdf

Table 4. Soil test phosphorus interpretations and recommendations for Bray-1 and Mehlich-3 soil tests for newly established areas

Turf establishment	Phosphorus concentrations					Phosphorus fertilizer recommendations	
	—Mehlich-3—		—Bray-1—		Interpretation		
	ppm	lbs/acre	ppm	lbs/acre		lbs P_2O_5/ 1000 ft^2	lbs P_2O_5/ acre
Newly seeded area	0–25	0–50	0–15	0–30	Very low	3	131
	26–50	51–100	16–30	31–60	Low	2	87
	51–75	101–150	31–45	61–90	Medium	1	44
	76–100	151–200	46–50	91–100	Optimal	0	0
	> 100	> 200	> 50	> 100	Very high	0	0
Newly sodded area	0–20	0–40	0–10	0–20	Very low	3	131
	21–40	41–80	11–20	21–40	Low	2	87
	41–60	81–120	21–30	41–60	Medium	1	44
	61–80	121–160	31–40	61–80	Optimal	0	0
	> 80	> 160	> 40	> 80	Very high	0	0

Table 5. Maximum recommended N applications for newly established areas

Soil type	Annual maximum allowable N lbs N/1000 ft^2	Single application maximum** lbs N/1000 ft^2
Sand*	10	1
Native or mineral soil	6	1

*Over 70% of the root zone is composed of sand.

**Up to 2 lbs N/1000ft^2 may be used if the product is 100% natural organic or biosolid.
Most organic-based fertilizers contain P and their use is not allowed unless a need for P is indicated by a soil test.

Source: https://cdn.shopify.com/s/files/1/0145/8808/4272/files/A3876.pdf

Nutrient Management Terminology

- *Grade or analysis is the percent by weight of Nitrogen (N), Phosphorous fertilizer (P2O5) and Potassium fertilizer (K2O) that is guaranteed to be in the fertilizer*
- *A complete fertilizer contains N, P2O5, and K2O*

Label

- The label is intended to inform the user about the contents of the fertilizer which, if understood and followed, will result in little to no environmental risk
- The fertilizer label may contain:
- Brand
- Grade
- Manufacturer's name and address
- Guaranteed analysis
- "Derived from" statement
- Net weight

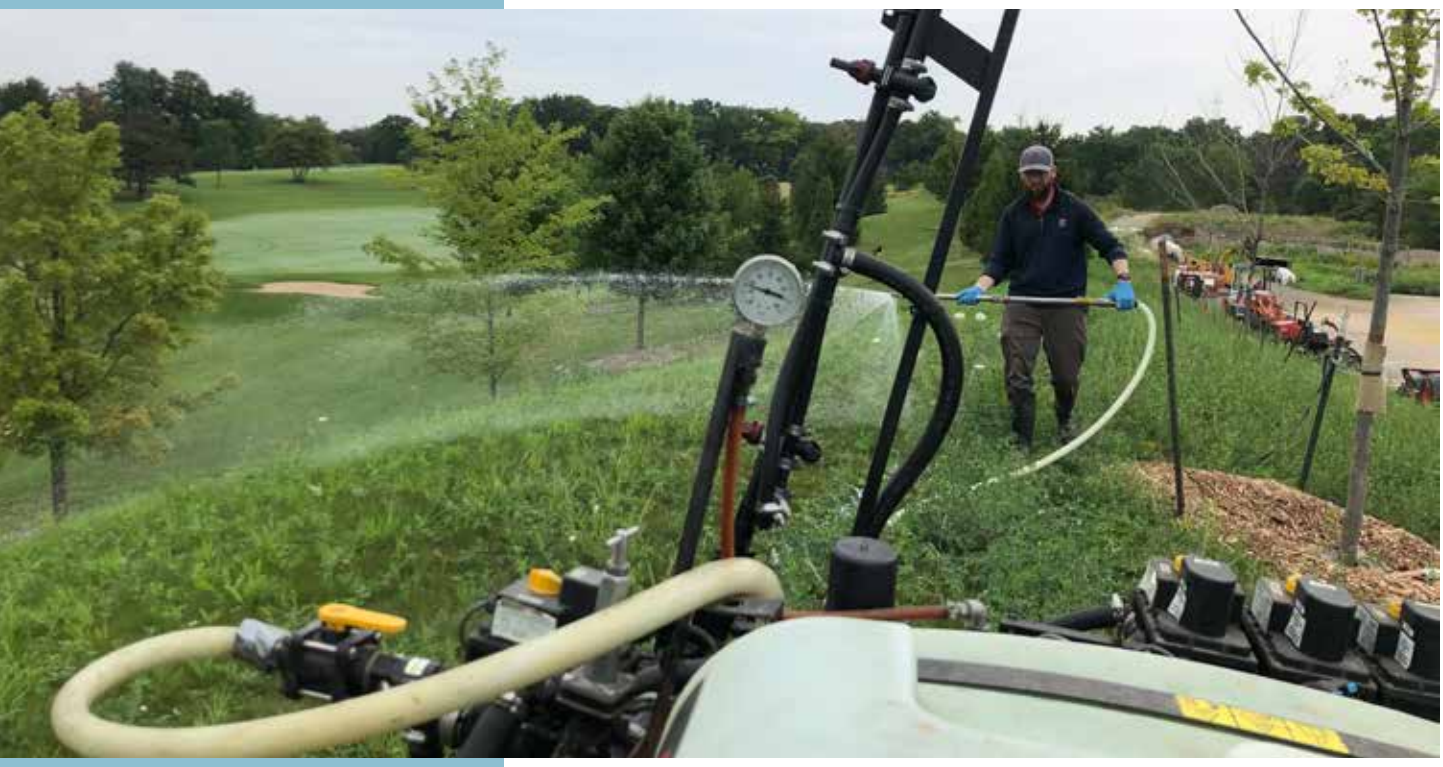
Fertilizers Used in Golf Course Management

There are 17 nutrients essential for turfgrass growth. The components of fertilizers are important to understand in order to make informed decisions and appropriate applications. Nutrients are separated into two categories: macronutrients & micronutrients. Turfgrasses obtain oxygen, hydrogen, and carbon from the atmosphere and water, the remainder are obtained primarily through roots in the soil. (some may be obtained by foliar applications).

Macronutrients include nitrogen, carbon, oxygen, phosphorous, potassium, calcium, magnesium, and sulfur – these are required in relatively large amount.

Micronutrients such as iron, manganese, zinc, boron, molybdenum, copper, chlorine, and nickel are usually required in lower amounts.

Consult with University of Wisconsin-Madison Turfgrass Science for fertilizer sufficiency ranges in the location.



Macronutrients

Macronutrients are required in greater quantities and include Nitrogen (N), Phosphorous (P), and Potassium (K). N is required in the greatest quantity after carbon, hydrogen, and oxygen. Understanding the role of each within the plant provides a greater understanding of why these nutrients are important for proper turf management.

Role of Nitrogen

- N is typically required in greater quantities by turfgrasses than any other element except carbon (C), hydrogen (H), and oxygen (O). N plays an important role in numerous plant functions including being an essential component of amino acids, proteins, and nucleic acids.
- The goal of all applied nutrients is to maximize plant uptake while minimizing nutrient losses; understanding each process will increase ability to make sound management decisions and increase profitability while reducing environmental risk
- To aid in this, understand the fate and transformation of N along with the release mechanisms and factors affecting N release from various N sources

Nitrogen Processes

Mineralization	microbial mediated conversion of organic N into plant-available NH_4
Nutrification	microbial-mediated conversion of NH4 to NO3
Denitrification	microbial mediated conversion of NO3 to N gas; this primarily occurs in low-oxygen environments and is enhanced by high soil pH
Volatization	conversion of NH4 to NH3 gas
Leaching	downward movement of an element below the rootzone
Runoff	lateral movement of an element beyond the intended turfgrass location

Understanding how certain N sources should be blended and applied is essential. In many cases, N sources are applied without regard to how they are released. Each N source is unique and should be managed accordingly. Applying a polymer coated urea in the same manner as a sulfur coated urea greatly reduces the value of the polymer coated urea. Similarly, applying a 2 lb rate of N from an ammonium sulfate may cause burning but on the other hand, applying a 2 lb rate of a polymer coated urea may not yield the quick response of an ammonium sulfate urea. Rate, release curve, application date, location, seasonality, and turfgrass species should all be considered in the nutrient application decision.

Know & Understand Nitrogen Sources

- *Soluble Nitrogen Sources: Urea (46-0-0), Ammonium nitrate (34-0-0), Ammonium sulfate (21-0-0), Diammonuim phosphate (18-46-0), Monoammonium phosphate (11-52-0), Calcium nitrate (15.5-0-0), Potassium nitrate (13-0-44)*
- *Slow-Release Nitrogen Sources: An N-containing fertilizer where the release of N into the soil is delayed either by requiring microbial degradation of the N source, by coating the N substrate which delays the dissolution of N, or by reducing water solubility of the N source. These include Sulfur-coated urea, Polymer/resin-coated, Isobutylene diurea, Urea-formaldehyde, Urea-formaldehyde reaction products, Natural organic*
- *Urease inhibitors: Reduce the activity of the urease enzyme resulting in a reduction of volatilization and increase in plant available N*
- *Nitrification inhibitors: Reduce the activity of nitrosomonas bacteria which are responsible for the conversion of NH4 to NO2. This reduced activity results in reduction of N lost via denitrification and an increase in plant available N*

Role of Phosphorous

Phosphorous (P) is essential for plant growth and is involved in the transfer of energy within the plant. The role of phosphorous is important in seed germination, seedling vigor, and rooting responses. It can be abundant in some soils and is a major contributor to eutrophication of water bodies. It should never be added to turf without a specific reason. Deficiency symptoms include slow growth and weak stunted plants. Initially, dark green color may be observed. Later, lower leaves may turn reddish at the tips and then the color may progress down the blades. Soil and tissue testing will be the best tools to arrive at requirements and sufficient application rates.

P FERTILIZER SOURCES:

- Diammonium phosphate
- Concentrated super phosphate
- Monoammonium phosphate
- Natural organics

Role of Potassium

Potassium (K) is an essential element directly involved in maintaining the water status of the plant, turgor pressure of cells, and opening and closing of the stomata. K needs to be maintained at sufficient levels because of its major "health" influence strengthening the turf plant against the stresses of cold, heat, drought, disease, and traffic wear. K is a key driver of osmoregulation which has been documented to increase stress tolerance. It is very mobile in the plant, and soluble and mobile throughout the soil profile. Deficiency symptoms include interveinal yellowing of older leaves, plus rolling and burning of the leaf tip. Tissue concentrations of less than one percent are considered deficient.

K FERTILIZER SOURCES:

- Potassium sulfate
- Potassium chloride
- Potassium nitrate

Secondary Macronutrients

Secondary macronutrients are essential to plant function and are required in amounts less than N, P, and K, but more than micronutrients. These include calcium (Ca), magnesium (Mg), and sulfur(S). These elements can be vital when low quality water is applied as a water source.

Role of Secondary Macronutrients

Calcium (Ca)	• Primary component of cell walls and structure. • Found in gypsum, limestone, and calcium chloride.
Magnesium (Mg)	• Central ion in the chlorophyll molecue and chlorophyll synthesis. • Found in S-Po-Mg, dolomitic limestone, and magnesium sulfate.
Sulfur (S)	• Metabolized into amino acid, cysteine, used in various proteins and enzymes. • Found in ammonium sulfate, elemental sulfur, gypsum, potassium sulfate.

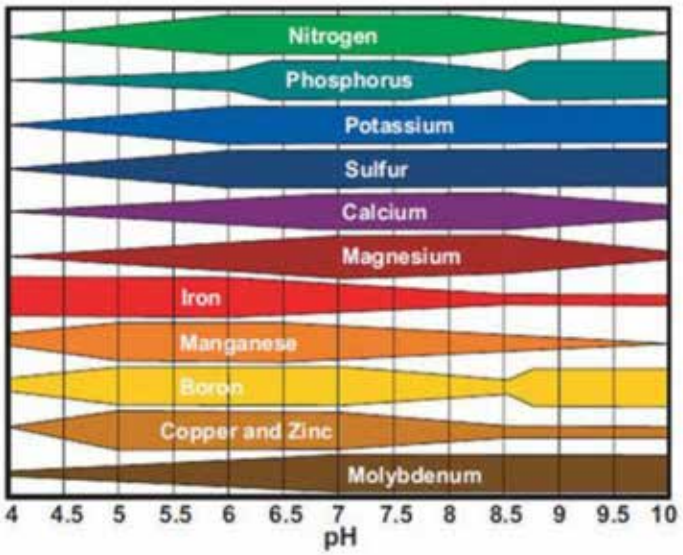
Micronutrients

Micronutrients are as essential for proper turfgrass health as macronutrients, but in very small quantities compared to macronutrients. Micronutrients include (Fe), manganese (Mn), boron (B), copper (Cu), zinc (Zn), molybdenum (Mo), and chlorine (Cl).

Role of Micronutrients

Iron (Fe)	• Is part of catalytic enzymes and is required for chlorophyll synthesis • Affects photosynthesis, nitrogen fixation, and respiration
Manganese (Mn)	• Involved in photosynthesis • Required as a cofactor for ~35 enzymes • Lignin biosynthesis depends on Mn
Boron (B)	• Found in the cell wall: probably required for the structural integrity of the cell wall.
Copper (Cu)	• Cu-protein is involved in photosynthesis • Cofactor for variety of oxidative enzymes.
Zinc (Zn)	• Structural component of enzymes • Protein synthesis requires Zn • Carbohydrate metabolism affected by Zn
Molybdenum (Mo)	• Primarily related to nitrogen metabolism • Structural and catalytic functions of enzymes.
Chlorine (Cl)	• Required for oxygen-evolving reactions of photosynthesis • Also appears to be required for cell division in both leaves and shoots.

Nutrient Availability Relative to Soil pH
In Wisconsin, a pH of 5.5-8.2 is ideal because it provides the greatest availability of all essential nutrients for turfgrass.



Source: R. Goldy, Michigan State University Extension

Soil pH

Identifying and maintaining pH levels is important for turfgrass growth. Soil pH is the result of chemical reactions that take place in the soil and affect the degree of acidity or alkalinity of a soil solution. Nutrient availability, along with flora and fauna activities, are closely associated with soil pH.

The optimum soil pH for turfgrass in Wisconsin is in the range of 5.5 to 8.2. Kentucky bluegrass does best with a pH between 6.5 to 7.0 while ryegrass can tolerate a slightly lower pH. The soil pH is usually a function of precipitation in a region which induces more leaching of Ca, Mg, and K ions which are replaced with H and Al ions. Other factors that affect soil pH are parent material of the soil, organic matter content of the soil, and fertilizing practices. Nitrogen applications generally have an acidifying affect because of the release of H ions.

At extreme pH values, certain essential nutrients become less available, while others become more available leading to excessive availability. At highly acidic levels of pH, there is a decrease in microbial activity which can lead to decreased mineralization and decomposition of organic matter causing potential loss of favorable soil structure, and excessive thatch buildup.

Correcting Acidic Soils

When soil test shows an acidic soil, the following materials are most common:

- Calcitic limestone- $CaCO_3$
- Dolomitic limestone- $CaMg(CO_3)_2$

Soil tests are the only way to determine if the turf soil requires lime. The rate required for liming materials is partly determined by soil texture. Soils with more clay and silt require more lime than sandier soils. Soils with higher organic matter content may also require more lime than a soil with a lower organic matter content. To increase soil pH, apply a liming material (calcium carbonate, calcium oxide, dolomitic limestone) that contains Ca and neutralize acidity.

Lime moves slowly through the soil profile at a rate of 0.5 inch to 1 inch per year. It may take two or more years for the lime to increase the pH of the root zone. Test soil every two years to determine pH and make corrective applications. It is important to apply corrective measures before pH drops too low. Fall applications are best as are applications during aeration to move lime more quickly into the root zone.

Correcting Soil Alkalinity

To lower soil pH, products containing elemental sulfur (calcium sulfate, magnesium sulfate, potassium sulfate) should be applied. It is critical to understand the site's soil nutrient balance before making applications. Applications should be tailored to correct imbalances.

Best Management Practices

- Maintain a pH in the range of 5.5 to 8.2 to optimize nutrient availability and reduce fertilizer requirements
- To increase soil pH, apply a liming material (calcium carbonate, calcium oxide, dolomitic limestone) that contains Ca or Ca/Mg and neutralizes acidity
- To lower soil pH, products containing Sulfur(S) should be applied
- In some cases, utilizing injection pumps into irrigation water to address pH can be beneficial

Biostimulants to Reduce Environmental Stress

By definition a biostimulant is an organic material that when applied in small quantities, enhances plant growth and development. They are said to increase the activity of some physiological plant processes. On fine turfgrasses these products are marketed as soil amendments or as an additive to fertilizers. In general, they are used to reduce environmental stress effects of all kinds on grasses allowing them to withstand the rigors of heat, cold, drought, dollar spot, nematodes, high salinity levels, and elevated UV light intensities. They have also been shown to improve grass growth and root development.

Many materials have been shown to have biostimulant effects such as seaweed extracts, humic acids, triazole fungicides, amino acids, potassium silicate, and salicylic acid. Products that contain acibenzolar, various pigments, fosetyl and cytokinins also have stress reducing properties.

Best Management Practices

- *Seek out the best biostimulants by reviewing data from university studies, independent research, and talking with peers*
- *Include amino acids and products containing humic acids and cytokinins, such as seaweed extracts in sprays on fine turf*
- *Begin spraying stress reducing biostimulants just prior to the onset of the hottest months of the summer to condition turf to withstand the rigors of the busy, stressful season*
- *Use biostimulants regularly as an additive to spoon feeding fertility programs for highly stressed turf such as putting greens*
- *When using biostimulants, mineral fertility inputs can be reduced which will help to improve environmental conditions*

Application & Management

Calibration & Equipment

Calibrating application equipment is necessary to accurately measure how much fertilizer is being applied. Calibration and preventative maintenance should be administered in accordance with manufacturer's recommendations or when wear or damage is suspected. Sprayer and metering pumps on liquid systems need to be calibrated regularly. Proper calibration reduces environmental risk and improves cost savings. Include dates of calibration and names of employees conducting calibration in the NMP.

Choose the appropriate spreader for a given fertilizer material. Spreader types include walk-behind rotary, drop spreader, bulk rotary or pendulum type spreaders, and spray. For example, granular fertilizer is usually applied with a rotary spreader. When applying it near waterways, cart paths, or other non-target areas, always use a deflector shield to prevent inappropriate distribution. An example of the wrong spreader choice includes applying sulfur-coated urea through a drop spreader, this could damage its coating and lead to an application of soluble urea.

Foliar feeding and liquid fertilization (fertigation) involve the use of a soluble nutrient. Fewer total pounds are applied at any one time, nutrients are used more rapidly, and deficiencies are corrected in less time. Frequent "spoon feeding" is effective for avoiding accidental fertilizer losses to the environment while also reducing the potential for spikes or low growth rates that impact play, turf recovery, clipping yield, weed establishment, disease outbreaks, and aesthetics.

Area & Timing

Incorporate a general fertilizer application schedule by area into the NMP showing the amounts of N and P to be applied during each month of the growing season. Incorporate an overview of routine procedures for establishment, overseeding, and re-establishment of turf areas into the NMP. (i.e. how divots are filled, or practice tees managed) Include timing and fertility practices for seeding.

The reduced height-of-cut and excessive traffic damage on putting greens results in an increased need for growth prompting an increase in nutrition needs. Tees and landing areas often have higher fertility requirements than fairways and roughs because they suffer constant divot damage. Fairways and roughs often require fewer nutrient inputs because of increased height-of-cut, less damage, and clipping return.

Avoid applying fertilizer to soils that are at, or near, field capacity or following rain events that leave soils wet. Do not apply fertilizer when the National Weather Service has issued a flood warning or if heavy rains are likely.

Record-Keeping

Keep accurate records of fertilization (including date, location, fertilizer applied, rates, grade, N source, percentage of slow-release N, form, and applicator) and include within the NMP. Reference record-keeping example at https://cdn.shopify.com/s/files/1/0145/8808/4272/files/A3876.pdf

Storage & Transport

Proper fertilizer storage, loading, and clean-up are important to reduce environmental risk. Load fertilizer into application equipment away from wells or surface water bodies. If a hard surface pad is not available, a tarp can be spread to collect spillage. Clean up spilled material immediately and apply as fertilizer; keeping in mind that if using a granular fertilizer, spilled material could be contaminated with debris, and not sprayable. If fertilizer is deposited on cart paths, parking lots or other impervious surfaces, sweep the material onto the turf to be properly absorbed.

Overall Site Map

A comprehensive map should be included in the NMP which details the turfgrass area. It should include general fertilized areas, soil test locations, SWMAs, GMAs, and any other key areas on the site.

NR-151 NMP Example Site Map

Source: https://cdn.shopify.com/s/files/1/0145/8808/4272/files/A3876.pdf

Fertilizer Spill-Response Plan

A spill response plan should be incorporated within the NMP and communicated to employees periodically. The plan should include:

- *Spills involving 250 lbs or more of dry or 25 gallons of liquid fertilizer must be immediately reported to the DNR 24-hour spills hotline: 1-800-943-0003*
- *Spills of lesser amounts are exempt from reporting unless there is adverse impact or threat to the air, lands, or waters of the state; this applies as a single discharge or accumulated from past discharges*

Source: https://cdn.shopify.com/s/files/1/0145/8808/4272/files/A3876.pdf

Integrated Pest Management

Section 8

IPM utilizes a range of pest management tactics, including cultural, physical, biological and chemical controls to reduce risks to human health and the environment. IPM focuses on pest identification, understanding lifecycles, pest-resistant plant selection, setting acceptable thresholds, and applying biological and other less toxic alternatives to chemical pesticides whenever possible.

IPM looks beyond a single-solution approach to pest prevention and management. It is important for golf course superintendents to know what IPM is and how to implement it for each pest group (arthropods, nematodes, diseases, and weeds) in order to grow and maintain healthy turfgrass. Superintendents must be well-versed in pest identification, pest lifecycles and/or conditions that favor pests, and the various control methods available.

5 Key Steps for IPM

1. Scouting, Identification, Monitoring
2. Setting "Action Level" or Thresholds
3. Making Decisions - control method(s)/timing
4. Evaluation
5. Education

Best Management Practices

- Rotate chemicals and modes of action to reduce resistance in pests; always follow label instructions
- Always adhere to local, state, and federal regulations for pesticide applications, restricted use pesticides (RUP), and biological controls; proper records of pesticide applications should be kept according to local, state, or federal requirements
- Establish a written IPM plan. Monitor, observe, and document turf conditions regularly (daily, weekly, or monthly, depending on the pest), scouting which pests are present, how damaging they are, determining pest thresholds, and necessary control strategies
- Collect soil samples annually to assess soil fertility and pH; proper soil pH and fertility help prevent diseases and promote plant health to reduce potential for insect and weed invasion
- Identify key pests and determine the pest's lifecycle to know which life stage to target
- Use cultural, mechanical, or physical methods to prevent problems from occurring (for example, prepare the site, select resistant cultivars) and reduce pest habitat (for example, by reducing the thatch layer that can harbor many disease pests)
- Decide which pest management practice is appropriate and carry out corrective actions; direct control where the pest lives or feeds
- When they are necessary, chemical pesticide applications should be carefully chosen for effective and site-specific pest control with minimal environmental impact
- Use properly timed preventive chemical applications only when professional judgment indicates they are likely to control the target pest effectively; use cues such as soil temperature, growing degree days, and predictive models to properly time preventative applications
- Determine whether the corrective actions used previously have reduced or prevented pest populations, were economical, and minimized risks; an effective way to do this is to maintain a non-treated 'check' area and record differences in the health of treated versus non-treated areas. Record and use this information when making similar decisions in the future
- Maintain a supply of PPE for use when working on pesticide application equipment; required PPE differs depending on the pesticide and required PPE for each pesticide will be listed on the pesticide label

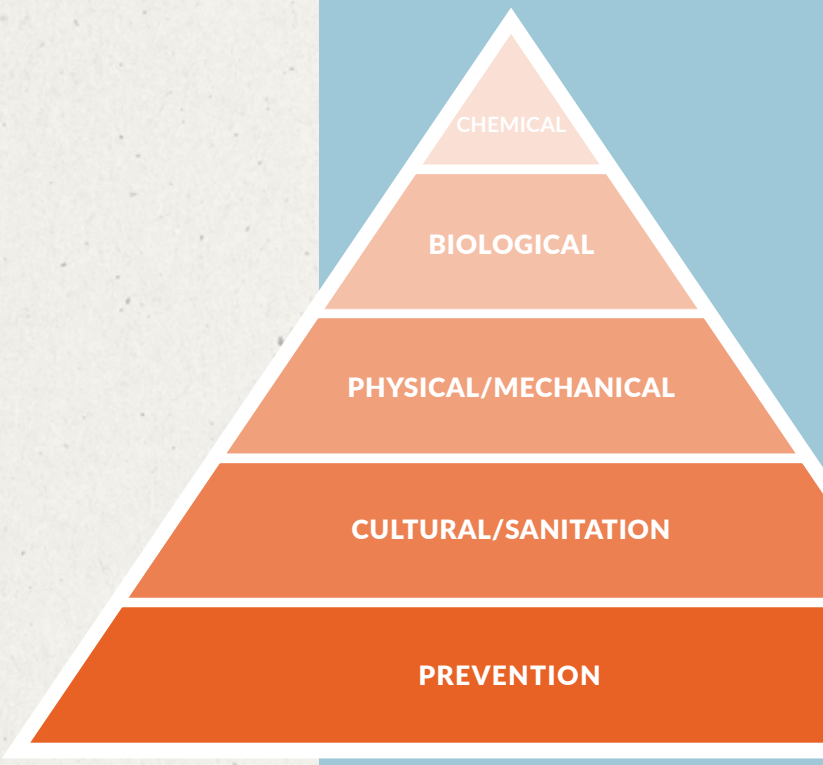
INTEGRATED PEST MANAGEMENT (IPM) IS A SYSTEMS APPROACH WHICH COMBINES SCIENCE-BASED STRATEGIES TO PREVENT AND MANAGE PESTS.

Written IPM Plan

A written IPM plan is an important tool for ensuring guidance is clear and all team members have a common understanding of the pest management approach. All five steps of IPM should be included in the plan, together with information about who is responsible; pest action thresholds; communication systems and a pesticide-use hierarchy. Decisions to implement pest control actions should be based on current or historic detection of the pest and/or damage occurrence, and not on a scheduled, preventive insecticide-based treatment regimen. Very often basic agronomic steps (altering fertilizer use or changing watering habits, etc.) can prevent further pest outbreaks without the use of insecticide-based treatment regimes.

Best Management Practices

- Develop a written IPM plan integrating ownership/ roles, guidelines for scouting, monitoring, thresholds, decision-making, evaluation, and education to cover five core areas as needed:
  - Prevention
  - Cultural/Sanitation interventions
  - Physical/Mechanical interventions
  - Biological interventions
  - Chemical interventions
- Observe and document turf conditions regularly, noting which pests are present, so informed decisions can be made regarding how damaging the pests are and what control strategies are necessary
- Decide which pest management practice(s) are appropriate and carry out corrective actions
- Log corrective actions to determine if they have reduced or prevented pest populations and minimized risks; use this information when making similar decisions in the future



IPM Pyramid
Aim to make the greatest impact through prevention and other passive interventions, with biological and chemical interventions kept to the minimum level required for effective pest management.

Scouting and Monitoring

Scouting is an important activity which should be included in the IPM written plan. Scouting is an exercise where golf course superintendents and staff regularly inspect all course areas to identify pest damage and population prevalence. This important activity should be included when developing a written IPM plan and may include several methods, including visual inspection, soil sampling, soap flushes, and insect trapping.

Monitor, observe, and document the presence and development of pests regularly - anything from daily to monthly depending on the pests.

Best Management Practices

- Train golf course personnel to observe and document turf conditions regularly (daily, weekly, or monthly, depending on the pest), noting which pests are present and key activities on key plants
- Train personnel to determine the pest's lifecycle and know which life stage to target
- Use monitoring information to make informed decisions regarding how damaging pests are and what control strategies are necessary
- Look for symptoms of the pest. These may include mushrooms, appearance of weeds, animal damage, insect frass, webbing, chlorosis, dieback, growth reduction, defoliation, mounds, or tunnels
- Determine the damage; problem areas might include the edges of fairways, high traffic areas, shady areas, or poorly drained areas
- Document when the damage occurred; note how different weather conditions affect outbreaks throughout the year; note the time of day, year, and flowering stages of nearby plants
- Map pest outbreak locations (including number of insects per unit area, disease patch size, and percent of area affected) to identify patterns and susceptible areas for future target applications and ultimate pesticide reductions

Pest Thresholds

A pest-control strategy should be used only when the pest is causing or is expected to cause more damage than what can be reasonably and economically tolerated. For this reason, it is important to set thresholds, based on turf health, economic, and aesthetic concerns; take into account the importance of minimizing chemical intervention whenever possible.

Aesthetic thresholds concern the appearance of the course and are subjective, driven by consumer preference. Educating golfers and maintenance personnel is an important part of any IPM plan as this can raise tolerance of minor aesthetic damage without compromising plant health, play, and aesthetics.

A control strategy should be implemented that reduces pest numbers to an acceptable level while minimizing harm to non-targeted organisms. When a pesticide application is deemed necessary, its selection should be based on effectiveness, low toxicity to non-target species, cost, and site characteristics (such as proximity to sensitive areas or areas which slope toward waterbodies).

Best Management Practices

- IPM planning should consider turf health, economic costs, and aesthetic thresholds
- Use of pest thresholds can help guide application decisions and associated education activities, while minimizing economic and environmental costs
- Use preventive chemical applications only when professional judgment indicates that properly timed preventive applications are likely to control the target pest effectively while minimizing the economic and environmental costs; use environmental cues to properly time preventative chemical applications

Record-Keeping

Scouting results should be recorded to develop a historical record and allow for identification of patterns in pest activity together with IPM successes and failures. This information should be used to inform future pesticide use.

Recording pesticide applications is essential and with restricted use pesticides, required by law - the most common reason for applications receiving fines in Wisconsin is incomplete record-keeping. Contact your local Wisconsin DATCP environmental enforcement specialist if you have questions regarding what pesticide application records you are legally required to maintain.

DATCP Environmental Enforcement Specialists: https://datcp.wi.gov/Pages/Programs_Services/EnforcementInspection.aspx

Best Management Practices

- Document, identify, and record pest activities with the plant and location information
- Determine the pest's lifecycle and know which life stage to target (for an insect pest, whether it is an egg, larva/nymph, pupa, or adult)
- Determine whether the corrective actions reduced or prevented pest populations, were economical, and minimized risks; record and use this information when making similar decisions in the future
- Observe and document turf conditions regularly (daily, weekly, or monthly, depending on the pest), noting which pests are present, so intelligent decisions can be made regarding how damaging they are and what control strategies are necessary
- Licensed pesticide applicators in Wisconsin must keep a record of each pesticide application for which that license is required, reference full requirements: https://datcp.wi.gov/Documents/HTCLandscape.pdf

Pest Groups

Disease

Plant pathogens can disrupt play by damaging and destroying intensely managed turf. Golf course superintendents should first start with correctly identifying the disease. This often requires sending samples to diagnostic clinics. Contact the Turfgrass Diagnostic Lab (TDL) supported by the University of Wisconsin-Madison Plant Pathology, Horticulture, Soil Science, and Entomology departments: https://tdl.wisc.edu/

Superintendents should be aware of multiple methods for tackling disease and reducing outbreaks. Organic layer management, fertility programs, water management, and mowing height selection are some of the tools that can support reductions in turf disease occurrence and impact. Disease outbreaks are less likely to occur on well-managed turfgrass and those that do occur are less likely to be severe when turf is healthy because it has better recuperative potential.

Common Turfgrass Diseases in Wisconsin

- Snow Molds *(Microdochium nivale and Typhula spp.)*
- Necrotic Ring Spot *(Ophiosphaerella korrae)*
- Fairy Rings *(many mushroom-forming fungi)*
- Summer Patch *(Magnaporthe poae)*
- Dollar Spot *(Clarireedia spp.)*
- Red Thread *(Laetisaria fuciformis)*
- Rust *(Puccinia spp., Uromyces spp.)*

Reference for additional information: http://bit.ly/3pgEGWX

Best Management Practices

- Correctly identify the disease pathogen; for support diagnosing and managing turfgrass diseases contact the TDL: http://tdl.wisc.edu/
- Ensure that proper cultural practices that reduce turfgrass stress are used
- Minimize conditions that produce stressful environments for turf (for example, improve airflow and drainage, reduce, or eliminate shade)
- The appropriate (most effective) preventive fungicide can be applied to susceptible turfgrasses when unacceptable levels of disease are likely to occur
- Record and map disease outbreaks and identify trends that can help guide future treatments and focus on changing conditions in susceptible areas to reduce disease outbreaks
- Leave non-treated 'check' plots to determine how effective your management program is compared to a non-treated area

Weeds

Weed infestations can harm turfgrass, negatively impacting plant life and playing surface. Weeds can be spread via seeds often carried on footwear, clothing, or blown in from other areas or vegetatively through tubers, corms, rhizomes, stolons, creeping stems, or bulbs. They compete with turfgrass for space, water, light, and nutrients. Weeds also act as hosts for disease, nematodes, and insects and can cause allergic reactions and skin irritants for people.

Best Management Practices

- Select appropriate turf species or cultivars that are adapted to the prevalent environmental conditions to reduce weed encroachment that may lead to bare soils
- Adopt or maintain cultural practices that protect turfgrass from environmental stresses such as shade, drought, and extreme temperatures
- Address improper turf management practices, apply proper nutrient management, utilize proper mowing height and frequency, soil aeration, and address physical damage and compaction from excessive traffic
- Mowing heights should be adjusted to a point where the turfgrass canopy is dense enough to suppress weeds and short enough to provide good playing conditions
- Avoid scalping; it reduces turf density, increasing weed establishment
- Weed-free materials should be used for topdressing
- Proper fertilization is essential for turfgrasses to sustain desirable color, growth density, and vigor and to better resist diseases, weeds, and insects
- Ensure correct identification of weeds and then record and map weed infestations to help identify site specific issues for preventative actions

Reference additional turfgrass weed control methods and strategies:

https://wisconsinturfgrassassociation.org/wp-content/uploads/2015/07/2015-Field-Day-Guide.pdf

How to Avoid Herbicide Resistance in Weeds

- Rotate herbicides and modes of action; use the recommended rate
- Use mechanical weed control methods
- Scout regularly for weeds - know your weeds! Respond quickly when herbicide resistance is suspected and control escaping weeds as needed; do not allow them to produce seed
- Practice prevention. Do not move weed seed around; clean equipment between course areas and reduce footfall in weed prone areas

Source: https://ipcm.wisc.edu/blog/2020/04/new-2020-pest-management-fast-facts-available-online/

Common Insect Pests in Wisconsin

- Chinch bug
- Greenbug
- Northern masked chafer
- European chafer
- Black cutworm
- Japanese beetle
- Sod webworms
- Ticks

Additional information: https://learningstore.extension.wisc.edu/collections/diseases-weeds-insects-other-problems-c91

Common Vertebrate Pests in Wisconsin

- Common moles
- Star-nosed moles
- Voles
- Gophers
- Ground squirrels
- Chipmunks
- Skunks

Information on managing common vertebrate pests: https://cdn.shopify.com/s/files/1/0145/8808/4272/files/A3714.pdf

Insects

Insects can seriously harm turfgrass and cause significant disruption to play. To determine the best course of action it is important to correctly identify the responsible insect pest and its lifecycle. This may involve sending samples to diagnostic clinics. Entomologists and other specialists from the University of Wisconsin-Madison TDL can provide assistance with pest identification: https://tdl.wisc.edu/

Another good resource is the University of Wisconsin-Insect Diagnostic Lab: https://insectlab.russell.wisc.edu/

For regular updates on Wisconsin pests sign up to the WDATCP Wisconsin Pest Bulletin at: https://datcpservices.wisconsin.gov/pb/index.jsp

Best Management Practices

- Correctly identify the insect pest. For support diagnosing and managing turfgrass insect pests contact the Insect Diagnostic Lab: https://insectlab.russell.wisc.edu/
- Utilize proper cultural practices to reduce turfgrass stress
- Correct conditions that produce stressful environments for turf (e.g., improve airflow and drainage, reduce or eliminate shade, etc.)
- Insecticide use may be integrated into an overall management strategy for a golf course; the appropriate (most effective) preventive insecticide can be applied to susceptible turfgrasses when unacceptable levels of insect damages are likely to occur
- Record and map insect outbreaks. Identify trends to help guide future treatments and focus on changing conditions within susceptible areas to reduce insect outbreaks

Nematodes

Plant-parasitic nematodes are microscopic roundworms which are difficult to control. They cause damage to susceptible turfgrasses by weakening the root system, making it less efficient in uptake of nutrients and water and therefore more susceptible to environmental stresses. Over time, turf affected by nematodes thins out and, with severe infestations, may die.

The roots of turfgrasses under nematode attack may be very short, with few, if any, root hairs, or they may appear dark and rotten. Turfgrasses usually begin showing signs of nematode injury as they experience additional stresses, including drought, high temperatures, low temperatures, and wear.

Best Management Practices

- If nematode activity is suspected, it is recommended to test a combination of soil and turfgrass roots to understand the extent of the problem; test with an experienced nematologist
- The application of a nematicide on golf course turf should always be based on assay results
- Divert traffic away from areas that are stressed by insects, nematodes, diseases, or weeds
- Increase mowing height to reduce plant stress associated with nematodes, root-feeding insects, disease outbreaks, or peak weed-seed germination
- Contact the Turfgrass Diagnostic Lab for assistance in finding a diagnostic laboratory that specializes in turfgrass nematode assays

Beware of Invasive Species!

Invasive, or non-native, species which are alien to Wisconsin's ecosystem can cause harm to native species or possibly human health. The Emerald Ash Borer (EAB) is an insect native to Asia that is an extremely serious pest with a confirmed presence in Wisconsin counties. The EAB typically kills a tree within one to three years. It could have a significant impact on the tree composition.

In addition, Buckthorn and Canada thistle are species that grow to dominate a plant community, decreasing diversity and disrupting the ecosystem. Take care to watch for and prevent issues with these species.

Additional information on EAB and other pests in Wisconsin: https://hort.extension.wisc.edu/topics/other/pests/

Source: https://dnr.wi.gov/news/images/slideshows/weekly-news/20150407_eab/

Friendly Fungi

Endophyte-enhanced Turfgrass Cultivars to Fight Insect Pests

Endophytes, in relation to turfgrass, are intercellular fungi that form symbiotic relationships with turf species. Turf species that commonly benefit from endophytes are perennial ryegrass, tall fescue, and fine fescue. Endophytes survive by utilizing energy produced by the plant and in return provide numerous benefits like deterring Surface feeding insects, resisting heat stress, and fighting dollar spot - which can aid in reductions of water use and pesticides.

Source: https://turf.umn.edu/news/endophytes-friendly-fungi-turf-grass

Controls

Cultural Controls & Turfgrass Selection

Cultural controls aim to make the environment less suitable for insect pests through disrupting lifecycles while promoting both turf density and health, in balance with providing a high-quality playing surface. Cultural controls include cultivar selection, mowing, aeration, surface cultivation, topdressing, and rolling.

A key part of IPM, which can assist in minimizing pesticide usage, is the selection of pest-resistant cultivars or plant species. Species grown outside of the areas where they naturally thrive are more prone to pest problems therefore plants should be selected according to the planting conditions and managed under conditions like their intended use (for example, not exceeding mowing height limitations that a grass was bred for). Selecting turfgrasses and other landscape plants which are appropriate for the eco-region of the golf course helps minimize irrigation requirements, fertilization needs, and pesticide use.

Reference the National Turfgrass Evaluation Program http://www.ntep.org/ for help with cultivar selection. When using the NTEP website, be sure to select sites in or near Wisconsin to find the best performing turfgrasses.

Turfgrass Species Characteristics

Source: http://cag.uconn.edu/documents/Turfgrass-IPM-manual-s.pdf

Species	Mowing Height (inches)	Mowing Quality	Nutrient Needs	Pest Potential	Thatch Tendency	Recuperative Potential
Kentucky bluegrass	1-2.5	4	med-high	med-high	med-high	3-4
Roughstalk bluegrass	0.5	3	med	low-med	low-med	3
Supina bluegrass	0.2	3	high	low-med	med-high	3-4
Canada bluegrass	3-4	1	low	low	low	3
Annual bluegrass	0.3	3	high	high	med-high	3
Creeping bentgrass	0.25	3	high	high	high	3-4
Colonial bentgrass	0.25	3	low-med	med-high	med-high	1-2
Velvet bentgrass	0.2	3	low-med	med-high	med-high	1
Redtop	0.5-3	2	low	low	low-med	1
Creeping red fescue	1.5-2.5	1	low	low-med	med-high	1-2
Chewings fescue	1-2.5	1	low	low-med	med-high	1-2
Sheep fescue	2-3	1	low	low-med	low	1
Hard fescue	2-3	1	low	low-med	low	1
Tall fescue	1.5–3	3	med	low-med	low	1-2
Perennial ryegrass	1.5–2	2-3	med-high	med-high	low	3
Annual ryegrass	1.5–2	2-3	med-high	med-high	low	3
Zoysiagrass	.5-1	2	low-med	low	high	3-4

Mowing Quality and Recuperative Potential: 1 = Poor 2 = Fair 3 = Good 4 = Excellent

Best Management Practices

- Select the most suitable turfgrass for existing conditions and one that adheres to design specifications
- Use proper cultural, mechanical, or physical methods to prevent problems, reduce pest habitat, practice good sanitation, pruning, dethatching
- Ensure proper soil management, including drainage, layering, and managing surface matter accumulation
- Maintain sharp cutting edges to avoid stress
- Varying mowing pattern encourages vertical growth, increases tolerance from wear, and minimizes soil compaction
- Avoid use of turfgrass in heavy shade and select shade-adapted grasses for areas receiving partial sun or shaded areas
- Minimize traffic in shaded areas to protect turfgrasses from injury and soil compaction
- Prune understory and adjust irrigation scheduling to reduce pest and disease pressures by correcting dead spots and air-circulation issues
- Where practical, reduce fertilizer applications and foot traffic in shaded areas to protect turfgrasses and trees from injury and soil compaction
- Understand the ET of turfgrass and landscape plants at the facility; use this to optimize irrigation
- Educate builders, developers, golf course and landscape architects, sod producers, golfers and others on which plants are best suited to their areas

Additional information on cultural practices and other IPM strategies: https://ecommons.cornell.edu/bitstream/handle/1813/44517/reducing-chemical-golf-NYSIPM.pdf

Cultural Practice	Disease	Response	References
Fertilization	Anthracnose	Weekly applications of nitrogen at 0.1 lb./1,000ft2 reduced disease severity.	Inguagiato et al., 2008
		Maintaining a foliar N concentration equal or greater than 3.4% reduced anthracnose severity.	Inguagiato and Guillard, 2016
	Brown patch	Brown patch was more severe in plots treated with nitrogen, but nitrogen did not affect fungicide performance.	Fidanza and Dernoeden, 1996
	Dollar spot	Dollar spot was less severe in plots treated with nitrogen.	Williams et al., 1996
	Pythium blight	Pythium blight severity increased with nitrogen application.	Moore et al., 1963
	Red thread	Disease was more severe in nitrogen-deficient turf.	Cahill et al., 1983
	Summer patch	Patch severity was reduced with application of ammonium sulfate compared with calcium nitrate.	Thompson et al., 1995
	Take-all patch	Acceptable levels of control were achieved in plots treated with ammonium chloride.	Dernoeden, 1987
Mowing	Anthracnose	Anthracnose severity was reduced with increased mowing height.	Inguagiato et al., 2009
	Brown patch	Clipping removal had no effect on disease.	Settle et al., 2001
	Dollar spot	Morning mowing reduced disease.	Ellram et al., 2007, Williams et al., 1996
		Clipping removal had no effect on disease.	Williams et al., 1996
	Pythium blight	Clipping removal had no effect on disease.	Settle et al., 2001
Irrigation	Anthracnose	Minimizing drought stress, while avoiding continuous high soil water content reduced disease severity.	Roberts et al., 2011
	Brown patch	Daily irrigation did not affect brown patch.	Settle et al., 2001
		Irrigation reduced brown patch severity.	Rowell, 1951
		Daily irrigation reduced brown patch severity on perennial ryegrass.	Jiang et al., 1998
	Pythium blight	Daily irrigation aggravated Pythium blight in some cases.	Settle et al., 2001
Other	Anthracnose	Light-frequent or heavy-infrequent sand topdressing resulted in lower anthracnose severity.	Inguagiato et al., 2012
		Lightweight rolling every other day reduced anthracnose.	Roberts et al., 2012
		Shallow verticutting did not affect anthracnose severity.	Inguagiato et al., 2008
	Dollar spot	Rolling to remove dew reduced disease.	Williams et al., 1996
		Dew displacement reduced disease.	Ellram et al., 2007
		Dew displacement improved efficacy of chlorothalonil.	McDonald et al., 2006
		Lightweight rolling daily reduced dollar spot.	Giordano et al., 2012.

Table adapted from A Practical Guide to Turfgrass Fungicides. Latin, 2011. American Phytopathological Society. St. Paul, MN.

Effect of various cultural practices on turfgrass diseases.

Source: Best Management Practices for New England Golf Courses

Biological Controls

Biological controls refer to utilizing natural enemy predators (e.g. lady bugs) and parasitoids (e.g. tiny stingless wasps) to suppress insect pest populations. Virtually all pests have natural enemies. Appropriate introduction and management of natural enemies can effectively control many pests in a safe and economical manner. The intent of biological control is not to eradicate pests, but to keep them at tolerable levels at which they cause no appreciable harm.

Biological control products for disease and weed management exist, but aren't used widely due to their lack of efficacy. However, research into improved biological control strategies continues and may yield improved biocontrols in the near future.

Although birds, mammals, frogs, and other higher animals can be important as natural enemies, they can rarely be effectively managed for biological control.

Minimizing impact to bees and beneficial arthropods is also an important part of IPM. Pollinators should be included in scouting and monitoring, as well as decision making around pest control strategies as they can be negatively impacted if they are not considered before selecting and application of pesticides. Avoid pesticides labelled as 'highly toxic to bees' whenever possible.

Biological Controls: 3 Broad Approaches

- **Importation:** Carefully screened natural enemies introduced into a target area to become permanently established and provide continuous biological control of the pest; follow Federal/State regulations
- **Augmentation:** Increasing natural enemy numbers typically through purchasing and releasing via commercial vendors
- **Conservation:** Protecting natural enemies through conserving habitat and providing necessary resources for life, growth, and reproduction

Additional information: https://cdn.shopify.com/s/files/1/0145/8808/4272/files/NCR581.pdf

Common Beneficial Insects (Natural Enemies) in Wisconsin

- Pirate bugs
- Assassin bugs
- Damsel bugs
- Stink bugs
- Praying mantis
- Ground beetles
- Lady beetles
- Rove beetles
- Lacewings
- Hoverflies
- Flesh flies
- Tachinid flies
- Yellow jacket
- Ichneumonid wasps
- Braconid wasps
- Chalcid wasps

Information about these natural enemies can be found here: https://vegento.russell.wisc.edu/natural-enemies/

Best Management Practices

- Develop a sound understanding of the relationships between pests, their natural enemies, and the environment
- Identify existing pests and determine which beneficial insects can serve as natural predators
- Where possible modify areas of the golf course to attract natural predators, provide habitat, and protect them from pesticide applications
- Install a diverse environment including flowering plants that can provide parasitoids with nectar, or sucking insects (aphids, mealybugs, or soft scales) with a honeydew source
- Avoid applying pesticides to roughs, driving ranges, or other low-use areas to provide a refuge for beneficial organisms
- When using pesticides, minimize injury and damage by following label directions
- Follow label information concerning the application of pesticides when plants may be in bloom; avoid applying pesticides during bloom season when pollinators are active
- If flowering weeds are prevalent, control them before applying insecticides
- Use the latest spray technologies, such as drift-reduction nozzles to remove and decrease off-site (target) translocation of pesticide

More information on biological controls:
https://vegento.russell.wisc.edu/ipm/biological-control/
https://bit.ly/34yDMx1
https://cdn.shopify.com/s/files/1/0145/8808/4272/files/NCR581.pdf

The Environmental Protection Agency has identified alternatives to conventional pesticides.

Reduced Risk Pesticides for Use on Golf Course Turf

Fungicides	Herbicides	Insecticides
boscalid	penoxsulam	clothianidin *neonicotinoid
penthiopyrad	carfentrazone-ethyl	*chlorantraniliprole*
trifloxystrobin	mesotrione	*cyantraniliprole*
fludioxonil	bispyribac-sodium	fipronil
azoxystrobin		spinosad

Source: http://bit.ly/38IoDLd

Reduced Risk Pesticides

- Low impact on human health
- Lower toxicity to non-target organisms (birds, fish, plants)
- Low potential for groundwater contamination
- Low use rates
- Low pest resistance potential
- Compatibility with IPM practices

Biopesticides

- Derived from natural materials (e.g.; animals, plants, bacteria, certain minerals)
- Usually inherently less toxic than conventional
- Generally affect only target pest & closely related organisms
- Often effective in small quantities & decomposes quickly, resulting in lower exposures & pollution
- Compatibility with IPM practices

For more information:
https://www.epa.gov/pesticide-registration/conventional-reduced-risk-pesticide-program
https://www.epa.gov/ingredients-used-pesticide-products/what-are-biopesticides

Conventional Pesticides

IPM does not preclude the use of pesticides but ensures they are used only when necessary and with the lowest levels of risk to humans or the environment. Pesticides should be used only when the pest is causing or is expected to cause more damage than what can be reasonably and economically tolerated.

Pesticides should be evaluated on the following items prior to utilization:

- Effectiveness against the pest
- Mode of action
- Life stage of the pest
- Personnel hazards
- Non-target effects
- Potential off-site movement
- Cost
- Effect on desired turf

The Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) regulates pesticide manufacturing, use, and distribution of EPA-registered pesticide products in Wisconsin. For some pesticide uses it is necessary to gain special registration.

Information about pesticide products in Wisconsin and registration is available here: https://datcp.wi.gov/Pages/Programs_Services/PesticideProducts.aspx

For information about Wisconsin Pesticide Product Restrictions refer to: https://docs.legis.wisconsin.gov/code/admin_code/atcp/020/30

Best Management Practices

- Always follow the directions on the label; these have been developed based on the chemistry, biological effects, and environmental fate of the pesticide
- Train employees in proper pest identification and pesticide selection techniques
- Choose the product most appropriate for the problem or pest
- Select a product that is labeled for the site it will be used at
- Mix only the quantity of pesticide needed to avoid disposal concerns, protect non-target organisms, and save money
- Spot-treat pests whenever appropriate
- Make note of any environmental hazards and groundwater advisories included on the label
- Rotate pesticide modes-of-action to reduce the likelihood of resistance
- Consider use of the DriftWatchTM which makes information about nearby sensitive crops available to prevent damage from drifting pesticide applications: https://wi.driftwatch.org/

IPM principles include proper record-keeping of pest control activity to establish proof of use, application of protocols, and refer to past infestations in order to select best future course of action.

Reference Responsible Pesticide Management for additional information regarding pesticide usage and regulations.

Responsible Pest Management

Section 9

Pesticides contain active ingredients (the component that targets the pest) and inert ingredients such as solvents, surfactants, and carriers. Both the active and inert ingredients are regulated by federal, state, and local laws because of environmental and health concerns.

PESTICIDES MAY BE USED AS ONE ELEMENT IN AN INTEGRATED PEST MANAGEMENT (IPM) STRATEGY, ALONGSIDE BIOLOGICAL CONTROLS, CULTURAL METHODS, PEST MONITORING, AND OTHER APPLICABLE PRACTICE.

When a pesticide application is deemed necessary, its selection should be based on:

- Effectiveness
- Method and frequency of application
- Potential toxicity to non-target species
- Cost
- Site characteristics
- Pesticide solubility
- Persistence
- Packaging and labeled for the site it will be used at
- Safety of the applicator
- Equipment available for application

Wisconsin Regulation of Pesticides

Wisconsin Department of Agriculture, Trade and Consumer Protection (WDATCP)

Has primary responsibility for pesticide use and control in the state including certification and licensing of pesticide applicators.

Wisconsin Department of Natural Resources (WDNR)

Has responsibility for pesticide use involving "waters of the state" and the control of birds and mammals.

Any wet area below the ordinary high-water mark of a surface water (marsh, creek, stream, river, pond, lake, etc.) is considered to be a water of the state.

Wisconsin Emergency Management (WEM)

Has responsibility for helping communities evaluate preparedness for response to accidental releases of hazardous compounds, including some pesticides.

Individual Applicators

Have responsibility for becoming familiar with, and adhering to, all laws and regulations related to pesticide usage. All commercial applicators and any person using restricted use pesticides (RUPs) must participate in the University of Wisconsin Pesticide Applicator Training (PAT) and become certified and possibly licensed. More information: https://fyi.extension.wisc.edu/pat/

Wisconsin Pesticide Regulations

A restricted use pesticide (RUP) is a pesticide that is designated as such due to potential adverse effects on the environment, the applicator, or bystanders, which warrants added restrictions. Anyone who wants to purchase and use a RUP must be a certified applicator.

In addition, in Wisconsin, no person may distribute, sell, offer for sale or use any pesticide product containing any of the following active ingredients:

- 2,4,5-trichlorophenoxyacetic acid (2,4,5-T)
- 2-(2,4,5-trichlorophenoxy) propionic acid (Silvex)
- Aldrin
- Chlordane
- Dieldrin
- Heptachlor

It is the joint responsibility of the person in control of golf course maintenance and the applicator to ensure the application complies with regulations and that correct recordkeeping is maintained.

There are also regulations concerning the required signage and communications when pesticides are used in golf course settings. All pesticide applications on golf courses must be posted. Permanent warning signs may be used, but golf course superintendents must also post restricted entry interval (REI) warning signs when a defined REI time is listed on the pesticide label. Note that an REI of 'when dry' is not considered a defined interval and does not require an REI warning sign.

Permanent warning signs must be conspicuously posted at each of the following locations:

- At or near the place where golfers register to play the course
- At or near the first tee of every nine holes
- At every point on the golf course boundary at which the non-golfing public is permitted to enter the golf course by means of a road, sidewalk, path or other established thoroughfare

Best Management Practices

- Comply with all Federal, Environmental Protection Agency (EPA) and Wisconsin State laws and regulations
- Select the least toxic pesticide with the lowest exposure potential and use reduced risk pesticides where appropriate
- Follow all directions on pesticide's labeling
- Follow all instructions on the pesticide label – including sprayer calibration, mixing, and use of Personal Protective Equipment (PPE)
- Ensure facilities for storing, handling and mixing are properly sited, designed, constructed, and operated
- Develop an emergency response plan including procedures to control, contain, collect, and store spilled materials
- Create a record for each application of a RUP; maintain record for two years

More information specific to golf courses:

https://datcp.wi.gov/Documents/HTCLandscapeApplications.pdf

A full list of pesticides registered in Wisconsin, including RUPs:

http://www.kellysolutions.com/wi/

In the case of a pest control treatment project with a pollutant discharge to a water of the state specific permits are required from the WDNR. More information:

https://dnr.wisconsin.gov/topic/Wastewater/AquaticPesticides.html

Wisconsin State Legislature on pesticide use:

https://docs.legis.wisconsin.gov/statutes/statutes/94/68

https://docs.legis.wisconsin.gov/code/admin_code/atcp/020/29.pdf

Personal Protective Equipment (PPE) & Human Health Risk

Pesticides belong to numerous chemical classes that vary greatly in toxicity. The degree of potential risk to human health depends on both the pesticide toxicity and the level of exposure- i.e., the amount of product and length of time involved with any contact. PPE is used for protection against chemicals contacting the person loading, mixing, and spraying the chemical. The pesticide label will provide guidance on the minimum required PPE, it is important to read the label thoroughly before any use. Users must always use at least the minimum PPE required but may also choose to use more PPE than required on the label.

There are four toxicity levels, indicated by pesticide signal words that help provide indicators for what level of risk is present when applying:

UNIVERSITY OF WISCONSIN-EXTENSION

TABLE 1. Toxicity categories of pesticides.

	Toxicity category			
Measure of toxicity	**I Highly toxic**	**II Moderately toxic**	**III Slightly toxic**	**IV Relatively nontoxic**
Oral LD_{50} (mg/kg)	0–50	50–500	500–5,000	>5,000
Dermal LD_{50} (mg/kg)	0–200	200–2,000	2,000–20,000	>20,000
Inhalation LC_{50} (mg/l)				
gas/vapor (ppm)	0–200	200–2,000	2,000–20,000	>20,000
dust/mist (µg/l)	0–2,000	2,000–20,000	20,000–200,000	>200,000
Eye effects	corrosive	irritation for 7 days	irritation for 7 days	none
Skin effects	corrosive	severe irritation	moderate irritation	mild irritation
Signal word/symbol	DANGER or DANGER/POISON[a] with skull & crossbones	WARNING	CAUTION	CAUTION

Abbreviations: mg/kg = milligrams per kilogram; ppm = parts per million; < = less than; > = greater than; mg/l = milligrams per liter

[a]Products assigned to Category I due to oral, inhalation, or dermal toxicity (as distinct from eye and skin local effects) also must have the word "poison" and the "skull and crossbones" symbol on the label.

Source : https://cdn.shopify.com/s/files/1/0145/8808/4272/files/A3714.pdf

Best Management Practices

- Employers are legally responsible for supplying applicators with the PPE as listed on the label
- Clearly post landscape warning signs when applying pesticides. Follow the landscape pesticide applications to golf courses guidance from WDATCP: https://datcp.wi.gov/Documents/HTCLandscapeApplications.pdf
- Ensure that PPE is sized appropriately for each person using it
- Make certain that PPE is appropriate for the chemicals used
- Choose PPE based on standards, not just the least expensive
- Store PPE where it is easily accessible, but not in the pesticide storage area
- Employees who apply pesticides should not wear facility uniforms home where they may come into contact with children
- Provide laundering facilities or uniform service for employee uniforms; employees will need to wash clothes that may have pesticide residues on them; washing requires the use of hot water with clothes that are suspected to have pesticide residues; run another empty load once the clothes are washed
- The federal Occupational Safety and Health Administration (OSHA) requires employers to fit-test workers annually who must wear tight-fitting respirators
- When using respiratory protects ensure compliance with Occupational Safety and Health Administration (OSHA) 1910.134 Respiratory Protection Program
- Provide employees access to Safety Data Sheets (SDS) of the products being used

Application, Storage & Transport, Emergency Response, Record-Keeping

Responsibilities of Pesticide Owners, Users, or Handlers

Pesticide owners, users and handlers all have a responsibility to fully understand the risks and guidance around any pesticide being used. It is important that anybody involved with pesticide use or management is appropriately trained and certified where required. The Wisconsin Pesticide Law mandates that any person using RUPs, and all commercial applicators, complete training and certification through the UW-Pesticide Applicator Training (PAT) program.

Training and certification are separate and different entities are involved. The PAT program provides training and educational materials for people to become certified: https://fyi.extension.wisc.edu/pat/

Certification (passing an exam) is overseen and regulated by the DATCP.

There are several different certification categories, including Turf and Landscape.

- Applicators need to complete this WDATCP license application: https://datcp.wi.gov/Documents/ComPestAppLicense.pdf
- Additional license requirements and information: https://datcp.wi.gov/Documents2/PesticideLicensingFactSheet.pdf
- https://datcp.wi.gov/Pages/Licenses_Permits/CommercialApplicator.aspx
- Also reference the Pesticides Applications Compliance Checklist: https://datcp.wi.gov/Documents/HTCLandscape.pdf
- Information on EPA Federal Worker Protection Standards, communications, and training: https://www.epa.gov/pesticide-worker-safety

Sprayer Calibration

Calibration of sprayer equipment is critical to good pesticide management. Pesticide application equipment must be properly calibrated to mitigate environmental and human health risks relating to pesticide use and spray technicians must always be experienced, licensed, and properly trained.

Best Management Practices

- Use an appropriately sized applicator for the size of area being treated
- Minimize off-target movement by using properly configured application equipment
- Calibrate all application equipment at the beginning of each season (at a minimum) or after equipment modifications
- Check equipment daily when in use
- Walk-behind applicators should be re-calibrated for each person making the application to take into consideration their walking speed, etc.
- Always use recommended spray volumes for the targeted pest to maximize efficacy
- Keep pressure at the setting recommended by the nozzle manufacturer
- Use low-volatility herbicides when possible

Common Turf Application Equipment

Equipment	Dry or Liquid	Use	Comments
Low Pressure Boom Sprayer	L	Large areas, Golf courses	Can cover large areas in short time.
Backpack/Hand Can	L	Spot Treatment	Durable, portable, easy to use. Difficult to keep the pressure up. Difficult to control uniform application.
Hand Gun	L	Small lawns and larger turf areas	Covers large area quickly. Very little maintenance needed.
Spreaders	D	Lawns and turf area	Can cover larger area more quickly with rotary than drop spreader.

Source: Adapted from Integrated Pest Management for Turf and Ornamentals, Edited by Anne R. Leslie (1994).

Environmental Fate and Transport

'Environmental fate' refers to the destiny of any chemical, biological substance or pollutant after release into the environment. Pesticides, wherever they are applied, have the potential to interact with wildlife or migrate into surface and subsurface waters. Environmental fate information is included on pesticide labels and indicates where a pesticide travels following introduction and likely exposure levels for non-target organisms (soil, water, air, plants, and animals).

A key environmental consideration concerns the runoff and leaching potential of a selected pesticide – i.e., the extent and direction of any likely cross contamination from the application site to nearby areas. Prior to application, it is therefore important to consider the specific characteristics of each site.

Key issues include:

- Proximity to surface water
- The water table and well-heads
- Soil type
- Prevailing winds
- Presence of endangered species

Environmental hazards related to a pesticide are listed on pesticide product labels. "Environmental Hazards" are found under the general heading "Precautionary Statements," which provides language advising the user of the potential hazards to the environment and off target organisms – found under three headings: general environmental hazards, non-target toxicity, and endangered species protection.

Example of Pesticide Label

Source: https://cdn.shopify.com/s/files/1/0145/8808/4272/files/A3714.pdf

Best Management Practices

- Select pesticides that have a low drift, runoff, and leaching potential; labels provide warnings about these potential issues with each product
- Before applying a pesticide, evaluate site-specific characteristics, particularly relating to water sources, surface water, water table, and well-heads, soil type and wind direction
- Understand site characteristics that are prone to leaching losses (for example, sand-based putting greens, coarse-textured soils, shallow water tables)
- Select pesticides with reduced impact on pollinators and natural pest predators
- Select pesticides that, when applied according to the label, have no known effect on endangered species present on the facility

Wisconsin's Groundwater law (ATCP 31) created two guidelines to limit pesticides in groundwater which include enforcement standards (maximum chemical levels allowed in groundwater) and preventive action limits (set as a percentage of the enforcement standard). The DATCP provides monitoring for pesticides including groundwater from private wells and surface water.

Additional information: https://datcp.wi.gov/Pages/Programs_Services/SurfaceGroundwaterMonitoring.aspx

Pesticide Transportation, Storage, and Handling

As pesticides pose their greatest risk when in concentrated form it is essential to follow all storage, transportation, and handling guidance on product labels. The location, design and operation of storage facilities all have a role in minimizing risks related to pesticides. Improper storage of pesticides is a form of misuse and it is therefore important to carefully review and comply with storage information on labels.

The key risks to human health and the environment when considering pesticide storage and transportation are focused on potential spills, contaminated run off or fire. Storage facilities must be properly sited, designed, constructed, and operated in order to minimize these risks. To mitigate water contamination risks pesticide storage facilities should be at least 400 feet downhill from drinking water supplies; 200 feet from surface water and should not be placed within the 100-year floodplain.

Best Management Practices

- Storage facilities should be a lockable concrete or metal building with sufficient access to allow fire department approach
- Storage facilities should facilitate the secure, dry, and temperature-controlled storage of pesticides, in line with label guidance
- Personnel should have easy access to PPE, stored outside of the pesticide area
- Snow cover in storage areas should be considered in terms of run-off risk
- Store, mix, and load pesticides away from sites that directly link to surface water or groundwater
- Storage facility floors should be watertight and sealed with a chemical resistant paint; the floors should have a continuous sill to retain spilled materials and no drains, although a sump may be included
- Sloped ramps should be provided at the entrance of storage facilities to allow the use of wheeled handcarts for moving material in and out of the storage area safely
- Shelving and surfaces in the pesticide storage and transportation should never be made of wood as wood surfaces can absorb spilled pesticides; all shelving should be made of sturdy plastic or reinforced metal, painted to avoid corrosion
- Automatic exhaust fans and an emergency wash area are recommended
- Light and fan switches should be located outside the building, so that both can be turned on before staff enter the building and turned off after they leave the building
- Avoid temperatures less than 40°F or greater than 100°F inside the pesticide storage facility
- Do not transport pesticides in the passenger section of a vehicle and never leave pesticides unattended during transport
- Place a spill containment kit in the storage area, in the mix/load area, and on the spray rig
- Fire extinguishers suitable for chemical fires should be readily available
- The local fire department should be informed about the storage unit, what it contains, and where it is located

Pesticide Inventory

Pesticides degrade over time, so it is important to only mix the amount required for use at any time and to avoid storing large quantities of pesticides for long periods. When bringing in new product, date the labels to be able to identify the oldest in inventory. Adopt the "first in–first out" principle, using the oldest products first to ensure that the product shelf life does not expire. This will reduce the amount of pesticide waste product which needs to be disposed of.

Best Management Practices

- Do not purchase pesticides in greater quantities than needed and avoid purchasing large quantities of pesticides that require storage for greater than six months
- Following the "first in–first out" principle to ensure oldest products are used first and minimize quantities of expired stock
- Utilize computer software systems to record inventory and use, when possible
- Consult inventory when planning and before making purchases
- Store flammable pesticides separate from those that are non-flammable
- Store liquid materials below dry materials to prevent leaks from contaminating dry products
- SDS and copies of labels for all pesticides on hand should be kept in an easily identifiable location, outside the pesticide storage facility
- Make sure all containers are labelled correctly and arranged so the labels are clearly visible Immediately replace any damaged or missing labels
- Maintain inventory copies off site for review in case of fire to help containment issues

Pesticide Mixing/Loading/Washing

Handling open pesticide containers, measuring pesticide materials, or working with pesticide application equipment presents an exposure risk to the handlers and the environment. PPE is an important part of minimizing this risk and must be worn, in line with label guidance, prior to opening of pesticide packages.

Pesticide leaks or spills, if contained, will not percolate down through the soil into groundwater or run off the surface to contaminate streams, ditches, ponds, and other waterbodies. One of the best ways to manage this issue is to ensure the chemical mixing center (CMC) is properly designed and constructed.

Mixing is an important part of proper spraying application. It is essential that all staff involved fully understand what is being sprayed and which chemicals can be mixed. The specific mixing and sequence of mixing instructions on the label should be followed - the most common accidents occur due to staff misunderstanding mixing rates, becoming distracted and/or mixing the wrong materials. If uncertain, a jar test should be prepared to make sure the chemicals are compatible. A jar test is a simple method of using small samples of the mixture and mixing in a small jar. This will allow observation of the reaction and make sure a complete mixture can be achieved.

Best Management Practices

- Loading pesticidesand mixing them with water or oil diluents is recommended over an impermeable (watertight) surface, so that spills can be collected and managed
- The mixing station surface should offer easy cleaning and the recovery of spilled materials
- Mixing and loading sites should have secondary containment
- Pump the sump dry and clean it at the end of each day
- Liquids and sediments should be removed from the sump and properly managed and disposed of
- Apply liquids and sediments from the sump the same as a pesticide, strictly following label instructions
- Sweep up solid materials and use as intended
- Rinsate may be applied as a pesticide (preferred) or stored for use as makeup water for the next compatible application - caution: do not mix herbicide rinsate with other products
- Collect wash water (from both inside and outside the application equipment) and use it as a pesticide in accordance with the label instructions

Be Prepared for Emergencies

A mixing and loading pad is required per Wisconsin law if more than 1,500 pounds of pesticide active ingredients are mixed or loaded at any one site in a calendar year. Or if mixing and loading occurs within 100 feet of a well or surface water. Mixing or loading pesticides is never permitted within eight feet of a well or surface water (with the exception of labeled aquatic applications).

Source:
https://cdn.shopify.com/s/files/1/0145/8808/4272/files/A3714.pdf

Find detailed information about spill containment requirements here:
https://datcp.wi.gov/Pages/Programs_Services/AgriculturalChemicalStorageAndContainment.aspx

Additional information:
https://datcp.wi.gov/Documents/HTCLandscape.pdf

Pesticide Container Disposal

Pesticide containers, if not rinsed and disposed of properly, can cause a risk to human health and environment. As such federal law (FIFRA) considers that a pesticide container is not legally empty until properly triple rinsed and requires pesticide applicators to rinse all empty pesticide containers before taking other container disposal steps. Containers for non-liquid pesticides (bags, drums, bottles) need to be triple-rinsed or have the ends removed and all product removed from the container before disposal. Unrinsed pesticide containers are considered hazardous waste and improper disposal can result in fines and/or criminal penalties. Once properly rinsed, however, pesticide containers can be handled and disposed of as non-hazardous waste.

DATCP manages an annual grant program for counties and municipalities wishing to collect unwanted pesticides. Businesses with agricultural pesticides may be eligible for up to 50 percent subsidy on disposal costs. More information: https://datcp.wi.gov/Pages/Programs_Services/CleanSweep.aspx

Best Management Practices

- It is illegal to dispose of excess pesticides by dumping them on the ground; while pesticides are broken down to non-toxic compounds by microorganisms, excessive amounts applied to the soil can “overload” this natural system and contaminate drinking water
- Refer to the label for disposal requirements
- Rinse containers during the mixing and loading process and add rinsate water to the finished spray mix
- When a pesticide container is empty fill it up with water three times, each time pouring the rinse water into the spray tank when preparing the solution for final application; this is called triple rinsing and is important to remove chemical residues
- Puncture or crush empty and rinsed pesticide containers and dispose of according to the label
- It is against the law to use empty pesticide containers for another function

Emergency Preparedness and Spill Response

It is essential to have an emergency preparedness plan in place to ensure that if an accident occurs it is clear which steps to take to mitigate human health effects and environmental impact. Emergency preparedness plans should have copies stored close to pesticide storage facilities and should be shared with local police and fire departments.

Anyone who spills fertilizers or pesticides is legally responsible for cleaning up the spill if it harms or threatens to harm public health or the environment, regardless of the amount of the spill.

Report pesticide or fertilizer spills immediately to the WDATCP Spills Hotline if the amount is:

- 250 pounds or more of dry fertilizer
- 25 gallons or more of liquid fertilizer
- Enough pesticide to cover one acre or more if applied at label rates

Additional information on spills and the Wisconsin Spill Law: https://cdn.shopify.com/s/files/1/0145/8808/4272/files/A3714.pdf

Contact the DATCP Agricultural Chemical Cleanup Council at (608) 224-4500 or email datcpaccp@wisconsin.gov.

Best Management Practices

- Develop a golf course facility emergency preparedness plan that includes procedures to control, contain, collect, and store spilled materials
- Maintain copies in English and any other language commonly used by employees
- Ensure an adequately sized spill containment kit is readily available
- Designate a spokesperson who will speak on behalf of the facility should an emergency occur
- Seek advice from local authorities – policy and fire departments - on ways to improve the plan
- Have emergency contact information clearly visible at the storage facility and offsite

Be Prepared for Emergencies

Be sure to always prominently post important telephone numbers:

Wisconsin Emergency Spills Hotline:
(800) 943-0003

National Response Center:
1-800-424-8802

EPA Great Lakes:
1-312-353-2000

National Pesticide Information Center
(http://npic.orst.edu/)
1-800-858-7378

CHEMTREC, for emergency information on hazards or actions to take in the event of a spill: https://www.chemtrec.com/

Pesticide Record-Keeping

Pesticide-specific record-keeping can be required by Federal or state rule, in addition to the pesticide label. Pesticide applicators who have a private applicator license or certificate are required to maintain records of their applications of RUPs under the Food, Agriculture, Conservation and Trade Act of 1990: https://www.ams.usda.gov/rules-regulations/pesticide-records/understanding.

Anyone using a RUP, or anyone required to be licensed as a commercial applicator must maintain records of their pesticide applications under Wisconsin State Law ATCP 29.

Records must contain:

1. Product name
2. EPA registration number
3. Concentration or amount applied per area and total quantity applied
4. Date and time of application (time application began, and time application ended)
5. Location of land/legal property description
6. Site treated
7. Total acres or volume of area treated
8. Location of mix/load site
9. Applicator name and license number and/or person supervising the application
10. Who the application was made on behalf of (if applicable)

Records should also contain:

1. Pest treated
2. Wind direction and velocity and air temperature
3. ID number of application equipment
4. Spray permit number for regulated herbicides applied in a regulated county
5. Documentation to verify training of persons working under the supervision of a licensed pesticide applicator

A Wisconsin record-keeping form may be accessed at: https://fyi.extension.wisc.edu/pat/files/2018/01/recordkeeping-form.pdf

Additional information:

https://fyi.extension.wisc.edu/pat/pat-tools/

https://datcp.wi.gov/Documents/HTCLandscape.pdf

Best Management Practices

- Records must be recorded within 14 days of application and maintained for two years for RUP applications per Federal requirements
- Records must be kept accessible and available for copying and must be maintained at the applicator's primary place of business as designated on the applicator's pesticide license
- Records of application must be made available for inspection upon request
- Keep a backup set of records in a safe, but separate storage area
- Use records to monitor pest control efforts and to plan future management actions

There are several resources available to assist with record-keeping, covering everything from inventory through to planning and reporting. Examples include:

- GreenKeeper https://www.greenkeeperapp.com/marketing/
- OnLink https://onlink.com/
- PeRK https://cropwatch.unl.edu/unl-releases-perk-20-pesticide-recordkeeping-app
- Playbooks for Golf https://goplaybooks.com/coverage.html
- Sparks https://sparks2.com/

Date of Application _____ / _____ / _____
Month Day Year

Check if product is a Restricted-Use Pesticide ☐

PESTICIDE APPLICATION RECORD

Applicator Information

Name _____ Business Phone (___) _____

Certification No. _____ (Exp. Date ___ /___ /___) License No. _____

Address _____
Route or Street

_____ _____ _____
City State Zip

Client (if any)

Name _____ Business Phone (___) _____

Address _____
Route or Street

_____ _____ _____
City State Zip

Treated Site

Specific Location of Application Site _____
You can attach a map for location and/or use maps generated by spray rig software.

Crop, commodity, or site of Application _____

Mixing / Loading Location _____

Pesticide Product(s) Applied

Product Name	EPA Reg. #	Concentration or amount applied per area	Total quantity applied or total area treated

Start and end time of application: **Start** ___ : ___ AM/PM **End** ___ : ___ AM/PM

Use the back of this form for notes on the application such as weather conditions.

Note that pesticide-specific recordkeeping can be required by state rule or the pesticide label. Examples are: soil fumigants, structural fumigant FMPs and the new dicamba pevsticides with specific record keeping requirements such as Engenia.

Maintenance Operations

Section 10

Maintenance operations and facilities should support employee wellness, safety, productivity, and performance. Facilities should include areas for employee training, equipment maintenance, and storage of chemicals, fertilizers, fuel, plus other maintenance items.

Regulatory Considerations

Early engagement amongst developers, designers, community groups, and permitting agencies is essential to constructing a golf maintenance and storage facility. Local and regional regulations may be in place by municipality or county. Consult the proper regulatory officials to determine requirements.

It is important to ensure proper handling and storage of pesticides and petroleum-based products to reduce human, environmental, and economic risks including the potential for serious injury to operators or bystanders, environmental contamination, fines, and cleanup costs. Resources for state regulations are noted in each subsection.

Wisconsin's statewide recycling program is governed by Wisconsin Statutes, Chapter 287 and related administrative rules found in Wisconsin Administrative Code (Chapters NR 542 to 549). For an overview of the state program reference: https://dnr.wisconsin.gov/topic/Recycling/law.html

MAINTENANCE OPERATIONS PROTOCOLS SHOULD BE IN PLACE TO MINIMIZE ENVIRONMENTAL IMPACT AND PROMOTE THE HEALTH AND SAFETY OF INDIVIDUALS.

Wisconsin Emergency Contact Numbers

Poison Control Center: 1-800-222-1222 (National)
24-hour Emergency Spill Reporting: 1-800-943-0003
https://dnr.wisconsin.gov/topic/SmallBusiness/Spills.html

Golf Course Maintenance Facility Design

Benefits of a well-designed and constructed facility.

- Efficient storage and traffic flow of equipment and personnel
- Reduced time to manipulate equipment within and around buildings
- Reduced damage and repair costs to equipment
- Maximum preventative maintenance on equipment
- Maximum cleanliness with minimal labor to sustain
- Reduced utility and energy bills
- Peak employee morale and optimal safety
- Positive atmosphere for safety and operational training
- Reduced worker compensation claims (planning and construction with worker safety in mind)
- Potential reduction in insurance premiums due to reduced environmental liability
- Opportunity to attract and/or retain top quality employees

Employee Restroom/Locker Room/ Shower

Design restrooms to promote superior personal hygiene, ensuring they are easy to clean with adequate space/amenities to serve employees simultaneously. The locker room (if available) should be adjacent to restrooms and incorporate full-length lockers with at least one shower.

A dry deck type material can be used on portions of the floor to prevent slippage and spread of bacteria. Both of these rooms should be insulated and climate controlled. Hand blowers are recommended instead of paper towels.

Source: Hawai'i Golf Course Maintenance Handbook of Best Management Practices, 2019

Maintenance Facility

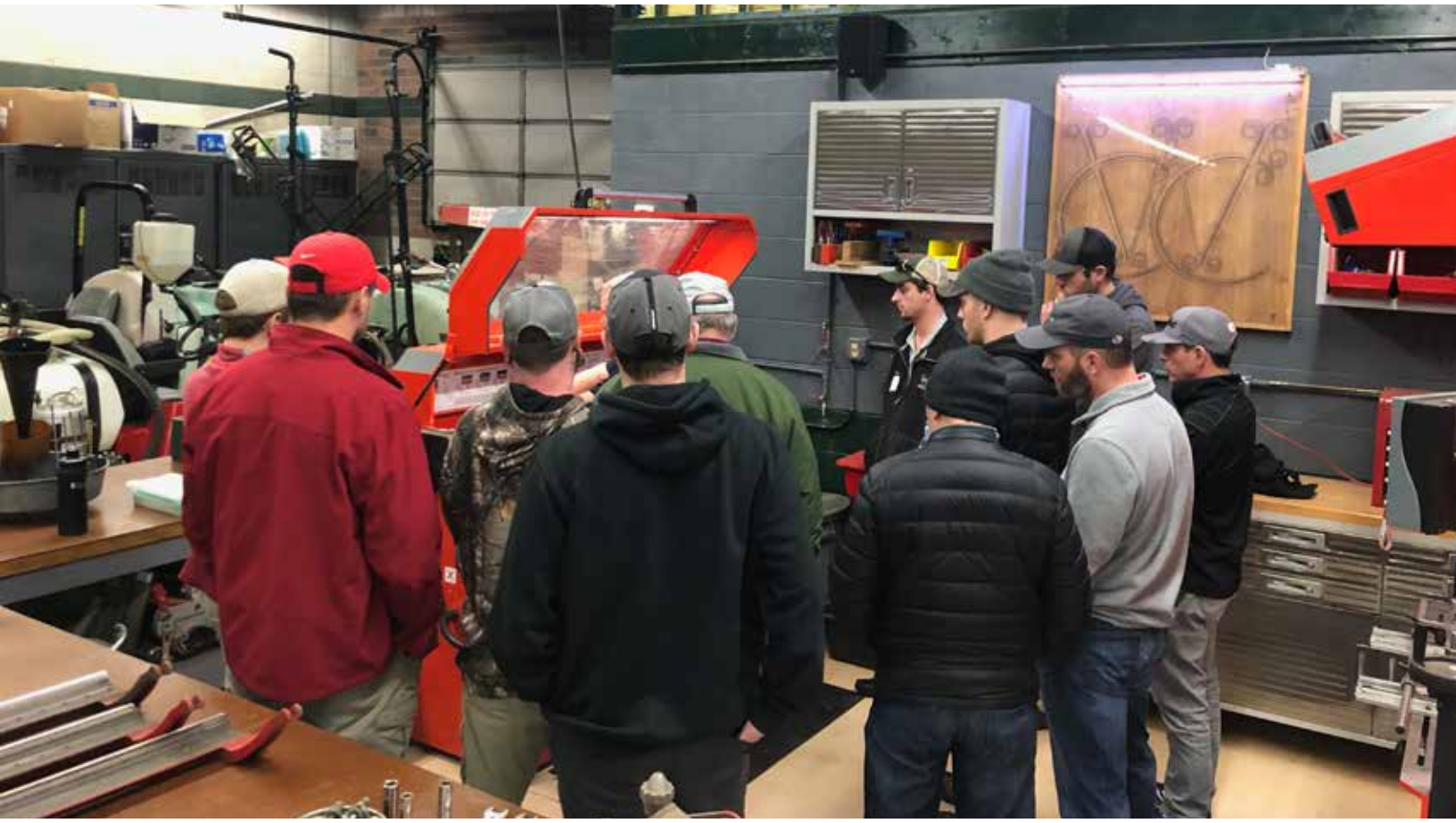
Maintenance facilities should accommodate dining and break areas for staff, storage for equipment and supplies, and the mechanic's areas. All areas should be properly ventilated and well-lit. Numerous activities should be considered to support water, energy, and cost reductions:

- Restrict water flow to the maximum necessary for adequate use
- Use automatic shutoffs on faucets
- Install 1.5-gallon tanks on toilets
- Use motion detectors to turn on lights when staff is present

Employee Break Room and Training Area

Maintenance facilities should include an employee lunch/break room, which often serves as a professional training area for technical education. The area should be clean, organized, and provide a relaxed atmosphere. The size of the golf course operation and number of maintenance crew employees will determine the appropriate size of the lunchroom. There should also be adequate space for administrative and managerial offices as well. Important items to include:

- Adequate tables/chairs for dining and training
- Microwave oven (reduces time for meal preparation)
- One adequate-sized (energy saver) refrigerator
- Drinking water with dispenser, coffeemaker, refreshment vending machine
- Kitchen area with sink, water, sufficient cabinet area
- Adequate space including light, easy-to-clean colors/walls
- Organized food and utensil storage with labeled containers and easy-to-access shelves
- Erasable or electronic communication board
- Air conditioned and insulated, with overhead fans for air flow



Mechanics Workshop and Office

Equipment is serviced and repaired in the mechanics workshop – it must be designed with adequate space for oil changes, reel grinding, and other jobs. An assortment of lifts (portable, flush floor mounted and beam supported) should be utilized, when available, to assist with moving equipment and minimizing risk of injury. If practicable, an overhead lube center (grease/oil dispensers supported by compressed air and connected to bulk drums) reduces the need for floor space and stores drums out of the work area. Empty gas cans, towels and miscellaneous supplies can be stored in cabinets throughout the shop. A sink and hand dryer should be available in the shop. Ensure combustible products are stored in fire resistant cabinets.

Large work benches provide ease for working at waist level and can decrease risk of back injury. An air-conditioned office with desk, computer, files, phone, and storage should be adjoining.

Storage Areas

Chemical Storage

An IPM Control Center is a lockable concrete or metal building designed for storage of pesticides. It should be located away from other buildings, especially fertilizer storage facilities.

The fertilizer storage structure should be large enough to facilitate logistics, allowing a small forklift to deliver fertilizer by pallet. If the building is constructed of metal, then the metal should be protected from degradation by fertilizer (such as adding painted plywood around the walls). When maintaining the building, employing a dehumidifier can help protect fertilizer from water absorption.

Best Management Practices

- Place appropriate warning signs within and outside of storage buildings
- Store PPE away from pesticide storage in an easily accessible area
- Follow all PPE statements on pesticide labels
- Develop an emergency response plan and educate personnel regarding emergency procedures on a regular basis
- Individuals conducting emergency chemical cleanups should be properly trained under requirements of the Occupational Safety and Health Administration (OSHA)
- Detailed records of current pesticide inventory should be maintained in the storage facility
- SDS for chemicals stored onsite should be readily accessible and stored separately from the storage room
- Follow a "first in, first out" principle to rotate products into use and ensure products do not expire. Do not store large quantities of pesticides or chemicals for long periods
- Store chemicals in original containers; never store in containers that might be mistaken as packaging for food or drink
- Arrange containers so labels are clearly visible
- Securely fasten loose labels to ensure containers and associated labels are kept together; damaged labels should be replaced immediately
- Store flammable pesticides separate from nonflammable
- Store liquid materials below dry materials to prevent leaks from contaminating dry products

- Incorporate impervious floors sealed with chemical-resistant paint within chemical storage buildings
- Floors of chemical storage buildings should have a continuous sill to contain spills and should not have a drain; a sump is acceptable
- Shelving should be fabricated from plastic or reinforced metal (painted to avoid corrosion); at least six feet off the floor; wood shelving should never be used.
- Automatic exhaust fans and an emergency wash area should be provided
- Explosion-proof fan and lighting may be required
- Ventilation design must be integrated; locate fan and light switches outside the building entrance to facilitate ventilation before staff enters the building
- Ensure oil containers and small fuel containers (service containers) are properly labeled and stored within the facility
- For information about constructing chemical mixing facilities, reference the Midwest Plan Service book, Designing Facilities for Pesticide and Fertilizer Containment (revised 1995); the Tennessee Valley Authority (TVA) publication, Coating Concrete Secondary Containment Structures Exposed to Agrichemicals (Broder and Nguyen, 1995); and USDA–NRCS Code 703

Reference Responsible Pesticide Management for additional pesticide storage BMPs.

Soil Storage

The soil storage area should be covered with a roof to prevent rain or moisture from reaching the soil and wind from dispersing weed seeds into topdressing. The area could be located in proximity to the fertilizer storage area. Deliveries may be deposited outside storage bins and pushed into the bin with a front-end loader.

Block walls that separate sand, topdressing, and rock should be filled solid with concrete. Ceiling fans can help reduce moisture retention, when the storage area is located inside.

Equipment Maintenance & Storage

Equipment storage and maintenance facilities should be designed to prevent accidental discharge of chemicals, fuels, or contaminated wash water from reaching water sources. Properly storing and maintaining equipment also extends the useful life of machines and reduces repairs. Maintenance and preventative maintenance should be completed according to manufacturer's specifications and recommendations. It is important that communication of equipment-related issues occurs regularly between the equipment operator and equipment manager. Record-keeping for maintenance and repairs (date, operator, maintenance administered, any issues, etc.) is a must for equipment maintenance. Ensure that operators have been properly trained on equipment usage and maintenance; establish ongoing training programs. Ensure all safety devices are in working order.

A list of necessary equipment to properly maintain the golf course must be developed. Maintain a parts inventory and determine proper storage location, include clear labeling for inventory. The size of the equipment is important to determine space requirements. Each piece of equipment should have a designated spot, delineated with colored lines when possible, indicated with its name or number, and parked in the same spot daily. Proper location provides for identification if a leak (oil, hydraulics, etc.) develops and increases accountability for optimal operating conditions.

Facility logistics planning should allow for equipment to be moved in and out of the storage area without unnecessary shuffling of equipment. Overhead doors located on both sides of the equipment storage area can allow for ease when moving equipment (entering or exiting the building) and provide air flow. Overhead fans in the equipment storage area facilitate air flow and help reduce moisture.

Waste oil from equipment should be collected and stored in a container set on containment. If stored outside, there should be a roof over the container and a valve in the bottom to release rainwater.

The equipment maintenance and storage areas provide an excellent location for the shop compressor, eliminating the loud running sound in a personnel work area.

Best Management Practices

- Store and maintain equipment in a covered area with a sealed impervious surface to limit risk of fluid leaks and facilitate early detection of small leaks that may require repair
- Seal floor drains unless they are connected to a holding tank or sanitary sewer with permission from the local wastewater treatment plant
- Store pesticide and fertilizer application equipment in areas protected from rainfall to prevent discharge into soil or water
- Store solvents and degreasers in lockable metal cabinets away from ignition sources in a well-ventilated area; these products are generally toxic and highly flammable; never store them with fertilizers or in areas where smoking is permitted
- Keep an inventory of solvents and SDS for materials onsite, in a different location that is easily accessible in case of an emergency
- Keep basins of solvent baths covered to reduce emissions of volatile organic compounds
- When possible, replace solvent baths with recirculating aqueous washing units; soap and water or other aqueous cleaners are often as effective as solvent-based products and present a lower risk to the environment
- Always use appropriate PPE when working with solvents
- Never allow solvents or degreasers to drain onto pavement or soil, or discharge into waterbodies, wetlands, storm drains, sewers, or septic systems
- Collect used solvents and degreasers in containers clearly marked with contents and date
- Blow off equipment with compressed air to reduce damage to hydraulic seals

Equipment Washing

Equipment washing guidelines should be established to reduce potential for residues to reach surface waters, groundwater, drainage pipes, or storm sewers. The residues from washing equipment include grass clippings, soil, soap, oil, fertilizer, and pesticides. A contained, impervious area should be dedicated for washing down equipment. It should be kept clean. Closed loop water recycling systems with a proven track record should be utilized. Captured wash water may be used as a dilute pesticide per label instructions.

Grass clippings are important to address when washing mowers. Blow clippings off mowers using compressed air before washing to conserve water and so that clippings do not enter the wash water recycling system. Clippings can be collected and composted or disposed of in a designated debris area.

For equipment with possible pesticide residue, BMPs should be followed to ensure that wash water does not become a pollution source.

Best Management Practices

- Brush or blow off grass clippings from equipment using compressed air before washing
- Wash equipment on an impervious surface (concrete or asphalt pad) that collects the wash water Once collected material dries, dispose properly
- Wash equipment with a bucket of water and a rag to minimize the amount of water used and use only the minimal amount of water required to rinse the machine
- Use spring-loaded spray nozzles to reduce water usage when washing
- Minimize use of detergents and use only those which are biodegradable, non-phosphate
- Consider a closed-loop wash water recycling system
- Do not discharge wash water to surface water, groundwater, or susceptible/leachable soils either directly or indirectly through ditches, storm drains, or canals; never discharge to a septic tank
- Never discharge to a sanitary sewer system without written approval from the appropriate entity
- Washing areas for equipment not contaminated with pesticide residues should drain into oil/water separators before draining into sanitary sewers or holding tanks
- Do not wash pesticide-application equipment on pads with oil/water separators; do not wash near wells, surface water, or storm drains
- Do not wash equipment on a pesticide mixing and loading pad; keep grass clippings and debris from becoming contaminated with pesticides
- Solvents and degreasers should be used over a basin that collects used material

Wisconsin Waste Management Regulatory Resources

DNR Waste and Recycling Overview
https://dnr.wi.gov/files/PDF/pubs/wa/WA422.pdf

Hazardous Waste Disposal
https://dnr.wisconsin.gov/topic/Waste/Hazardous.html

Wisconsin Recycling Guidelines
https://dnr.wi.gov/files/PDF/pubs/wa/WA422.pdf

Wisconsin Composting Rules and Regulations
https://dnr.wisconsin.gov/topic/Recycling/regs.html

For emergency (only) information on hazards or actions to take in the event of a spill, call CHEMTREC, at (800) 424–9300. CHEMTREC is a service of the Chemical Manufacturers Association. For information on whether a spilled chemical requires reporting, call the CERCLA/RCRA help line at (800) 424–9346.

Waste Handling

Proper waste management is important for the health and safety of the public, in addition to conserving natural resources within the state of Wisconsin. Current statewide recycling efforts divert 1.7 million tons of materials out of Wisconsin landfills annually, which results in reduced energy use and pollution. A golf course maintenance facility generates a variety of waste materials including fluorescent or LED lights, glass containers, plastic, tires, metal, paper products, solvents, chemical containers, batteries, used oils, used or contaminated fuel, paints, aluminum cans, and wood. A proper recycling and waste removal program must be deployed to maintain health and safety, plus reduce waste to landfills.

Additional information: https://dnr.wisconsin.gov/topic/Recycling/facts.html

The waste disposal area should be located away from normal employee activity, but close enough to be utilized properly. Proper access for waste pick-up vehicles should be incorporated into the design and location.

Best Management Practices

- Measure waste levels and implement source reduction practices to reduce the amount of waste generated in the first place
- Have separate areas designated and labeled for recyclables and waste
- Educate staff and guests on items which may be recycled; identify ways to increase recycling efforts, including proper signage and communications
- Operate equipment properly, adhering to preventative maintenance and manufacturer guidelines to avoid need for repair and prolong lifecycle, minimizing replacement needs
- Source environmentally preferred products when possible
- Purchase quantities that can be used prior to the expiration date or within six to 12 months of purchase
- Label containers for the purpose of storing oils, solvents, degreasers, and fuels
- Never dispose of waste down storm drains
- Collect used oil, oil filters, and antifreeze in separate marked containers and recycle them as directed by local and state authorities
- Antifreeze may be considered hazardous waste by state or local laws and should be handled accordingly; commercial services are available to collect and recycle antifreeze
- Properly manage used batteries and fluorescent bulbs as Universal Waste and recycle as soon as feasible
- Recycle used tires
- Consult an expert in composting for optimal design and processes
- Utilize DNR guidelines for hazardous waste disposal and collection services
- Local laws and regulations related to disposal of hazardous waste products may vary; become familiar with local laws related to disposal/recycling of these materials

Hazardous Materials Disposal

Ensure all containers are sealed, secured, and properly labeled. Use only FDEP-approved, licensed contractors for disposal.

Wisconsin hazardous waste information and assistance locating local collection services:

https://datcp.wi.gov/Pages/Programs_Services/CleanSweep.aspx

https://datcp.wi.gov/Documents/CleanSweepSchedule.pdf

Pesticide Containers

Empty pesticide containers are classified as hazardous wastes if not properly rinsed. Federal law (FIFRA) requires pesticide applicators to triple-rinse all empty pesticide containers before taking other container disposal steps. Under the federal Resource Conservation and Recovery Act, or RCRA, a pesticide container is not empty until it has been properly rinsed. The improper disposal of a hazardous waste can result in fines and/or criminal penalties. Pesticide containers that have been properly rinsed can be handled and disposed of as nonhazardous solid waste.

Reference https://datcp.wi.gov/Documents/HTCLandscape.pdf and Responsible Pesticide Management for additional BMPs for waste generated from pesticide activities.

Used Oil, Antifreeze, and Lead-Acid Batteries

Collect used oil, oil filters, and antifreeze in separate marked containers and recycle them. Oil filters should be drained (puncturing and crushed) and transported to a place that recycles used oil or to a hazardous waste collection site. Antifreeze must be recycled or disposed of as a hazardous waste using commercial collection services. Do not mix used oil with used antifreeze or sludge from used solvents.

Lead-acid storage batteries are hazardous waste; used acid from these batteries contains high levels of lead and must be disposed of as hazardous waste, unless the acid is contained within a battery being recycled. Make sure caps are in place to contain the acid and store batteries on an impervious surface, under cover if possible. Used lead-acid batteries must be recycled to be exempt from hazardous waste regulations.

Solvents and Degreasers

Routine discharge of small amounts of solvents over time can create environmental and liability consequences, due to accumulation of contaminants in soil or ground water. The EPA and FDEP can deem a “small quantity generator” of hazardous waste based on disposal of as little as 25 gallons per month of used solvents, triggering regulatory reporting requirements. Whenever practical, replace solvent baths with recirculating aqueous washing units (which resemble heavy-duty dishwashers). Soap and water or other aqueous cleaners may be as effective as solvent-based ones.

Using compressed air to blow off equipment instead of washing with water can be easier on hydraulic seals and lead to fewer oil leaks. Store solvents and degreasers in lockable metal cabinets in an area away from ignition sources (i.e., welding areas or grinders), and provide adequate ventilation. They are generally toxic and highly flammable. Never store them with pesticides or fertilizers, or in areas where smoking is allowed. Keep basins or cans of solvent covered to reduce emissions of volatile organic compounds and fire hazards. Keep an inventory of solvents stored and the SDS for each on premise, but not in the solvent storage area. Emergency response equipment recommended by the solvent manufacturer should be kept in an easily accessible place near the storage area, but not inside the area itself.

Follow OSHA signage requirements. Always wear appropriate PPE, especially eye protection, when working with solvents. Never allow solvents to drain onto pavement or soil, or discharge into waterbodies, wetlands, storm drains, sewers, or septic systems. Solvents and degreasers should be used over a collection basin or pad that collects all used material. Most solvents can be filtered and reused.

Store collected material in marked containers until it can be recycled or legally disposed of. Solvent disposal organizations provide solvent washbasins that drain into recovery drums and pickup service to recycle or properly dispose of drum contents. Collect used solvents and degreasers, place them into containers marked with contents and date, prior to pick up. Never mix used oil or other liquid material with used solvents. Use only FDEP-approved, licensed contractors.

Composting

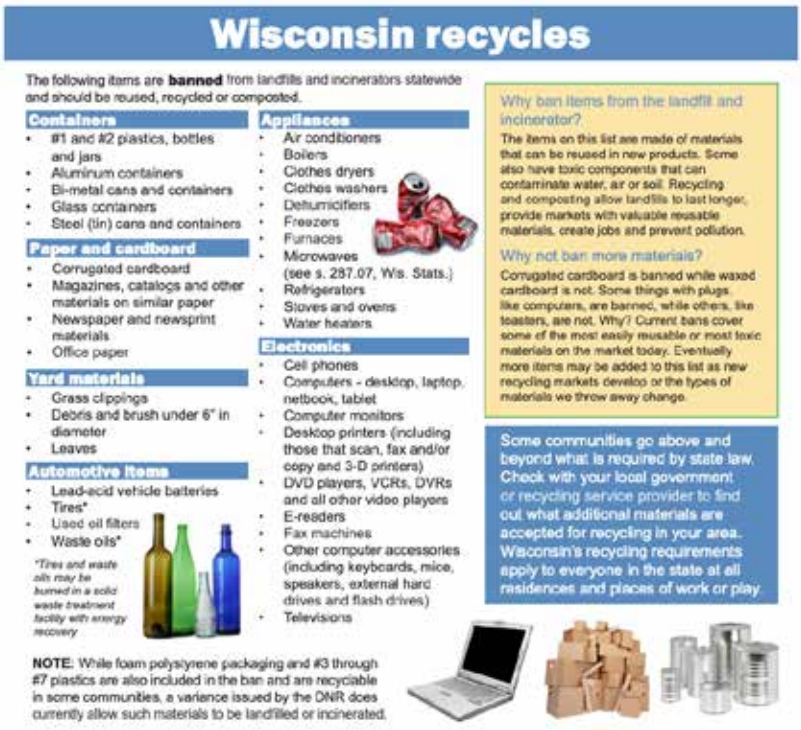
Most composting on the golf course is green waste which includes grass clippings and debris, such as leaves, or routine, healthy landscape trimmings that would normally go to a landfill. Composted materials can be used effectively to improve the soil for topdressing, non-putting surface areas, and donated or sold to offsite vendors. Do not compost diseased material.

In addition, the clubhouse food and beverage department may engage in food waste composting.

More information on composting in Wisconsin:
https://dnr.wisconsin.gov/topic/Recycling/compost.html

Recycling: Paper, Plastic, Aluminum, Glass, and More

Paper, cardboard, #1 and #2 plastics, aluminum, and glass should be recycled. Electronics may also be recycled through local providers which may be found through the DNR at https://dnr.wisconsin.gov/topic/Ecycle. Containers for recycling aluminum cans and plastic bottles should be placed in convenient locations on the golf course.



Wisconsin recycles

The following items are **banned** from landfills and incinerators statewide and should be reused, recycled or composted.

Containers
- #1 and #2 plastics, bottles and jars
- Aluminum containers
- Bi-metal cans and containers
- Glass containers
- Steel (tin) cans and containers

Paper and cardboard
- Corrugated cardboard
- Magazines, catalogs and other materials on similar paper
- Newspaper and newsprint materials
- Office paper

Yard materials
- Grass clippings
- Debris and brush under 6" in diameter
- Leaves

Automotive items
- Lead-acid vehicle batteries
- Tires*
- Used oil filters
- Waste oils*

*Tires and waste oils may be burned in a solid waste treatment facility with energy recovery

Appliances
- Air conditioners
- Boilers
- Clothes dryers
- Clothes washers
- Dehumidifiers
- Freezers
- Furnaces
- Microwaves (see s. 287.07, Wis. Stats.)
- Refrigerators
- Stoves and ovens
- Water heaters

Electronics
- Cell phones
- Computers - desktop, laptop, netbook, tablet
- Computer monitors
- Desktop printers (including those that scan, fax and/or copy and 3-D printers)
- DVD players, VCRs, DVRs and all other video players
- E-readers
- Fax machines
- Other computer accessories (including keyboards, mice, speakers, external hard drives and flash drives)
- Televisions

NOTE: While foam polystyrene packaging and #3 through #7 plastics are also included in the ban and are recyclable in some communities, a variance issued by the DNR does currently allow such materials to be landfilled or incinerated.

Why ban items from the landfill and incinerator?

The items on this list are made of materials that can be reused in new products. Some also have toxic components that can contaminate water, air or soil. Recycling and composting allow landfills to last longer, provide markets with valuable reusable materials, create jobs and prevent pollution.

Why not ban more materials?

Corrugated cardboard is banned while waxed cardboard is not. Some things with plugs, like computers, are banned, while others, like toasters, are not. Why? Current bans cover some of the most easily reusable or most toxic materials on the market today. Eventually more items may be added to this list as new recycling markets develop or the types of materials we throw away change.

Some communities go above and beyond what is required by state law. Check with your local government or recycling service provider to find out what additional materials are accepted for recycling in your area. Wisconsin's recycling requirements apply to everyone in the state at all residences and places of work or play.

Wisconsin Recycles!

Golf courses can do their part by recycling, reusing, or composting the below items.

Additional information:
https://dnr.wi.gov/files/PDF/pubs/wa/WA422.pdf

Fuel Storage Requirements and Regulations

Federal: EPA

http://bit.ly/3phP8Oc

Wisconsin: DATCP

https://datcp.wi.gov/Documents/RegulationASTLessThan5000Gallons.pdf

https://datcp.wi.gov/Documents/StorageTankRegistrationFactSheet.pdf

https://datcp.wi.gov/Pages/Programs_Services/PetroleumHazStorageTanks.aspx

https://docs.legis.wisconsin.gov/code/admin_code/atcp/090/93

Fuel Facilities

Fueling facilities should be designed, constructed, maintained and monitored to local or state codes. Proper fueling sites have impervious surfaces, spill containment and recovery facilities, located away from surface waters and water wells. Floor drains should be eliminated or removed unless they drain to containment storage tanks or pits.

Check codes for regulations on storage tanks; aboveground storage tanks (AST) is the preferred storage method because it is easier to monitor for leakage. An underground storage tank (UST) must have leak detection monitoring for compliance. Leaks or spills must be contained or cleaned up immediately. Title 40, Section 112 of the Code of Federal Regulations (CFR) requires a Spill Prevention Control and Countermeasure (SPCC) plan for facilities with total aboveground petroleum product storage (i.e., new oil, used oil and fuel) capacity in excess of 1,320 gallons. SPCC plans can help minimize the potential for a petroleum leak or spill to occur and mitigate environmental impacts. SPCC regulations generally require secondary containment for filling and dispensing operations; alternatives are allowed if secondary containment is impractical.

Best Management Practices

- Locate fuel storage tanks above ground, on impervious surfaces under roofed areas, when possible
- Areas should be equipped with spill containment and recovery facilities
- Keep a log of fuel added and discharged
- Visually inspect the tank for leaks and document in an inspection log
- Place automatic shut off valves away from the tanks in case of emergency
- Post “No Smoking” signs near the fueling facility
- Properly and clearly label fuel storage tanks


MANITOWOC LIFTS
Do not fall back into bad habits
CAUTION

Labor & Staffing

Section 11

Wisconsin golf course maintenance departments provide full-time and seasonal work for a diverse workforce across the state. Talent acquisition is conducted through collaborating with local municipalities, school systems, workforce development boards, and community programs.

Engaging educational institutions is a priority. Whether through supporting scholarships for local college students or hosting field trips for elementary, junior high, and high schools to explore golf courses from a science, math, biology, and learning perspective – these levels of engagement are important to begin to develop future generations of golf maintenance professionals. Superintendents frequently hire students from local schools and universities for full-time or part-time employment and internships. A BMP in this process is creating a system for continuous labor supply through developing multi-level local and state relationships to secure an active labor pool. Through creation of a working system, the ability to secure qualified job candidates becomes turn-key, saving both time and financial resources.

Once employees are hired, it is crucial to create a culture of inclusiveness, teamwork, learning, training, and professional development. This is important for reducing turnover, creating motivation, and increasing productivity.

In Wisconsin, seasonal hiring ramps up during summer months, which can be met with labor shortages. Labor supply is influenced by demographic, economic, technological, educational, and societal factors. BMPs provide strategies for overcoming labor shortages and minimizing training and recruiting costs, plus lowering turnover and associated expenses.

GOLF COURSES IN WISCONSIN ENRICH THE LIVELIHOODS OF INDIVIDUALS AND DRIVE ECONOMIC IMPACT THROUGH WORKFORCE DEVELOPMENT AND JOB CREATION.


GATOR
JOHN DEERE

Regulatory Considerations

Regulatory requirements and guidance pertain to wages, work hours, licenses, safety training, and more. Every employer shall post in a conspicuous place upon its premises, a workplace poster regarding federal and state laws. Requirements may be found at: https://dwd.wisconsin.gov/dwd/workplace-posters/.

Additional resources:

The Wisconsin Department of Workforce Development (DWD) Equal Rights Division enforces Wisconsin's wages, hour requirements, and licenses: https://dwd.wisconsin.gov/er/

Wisconsin Civil Rights and Labor Standards: https://dwd.wisconsin.gov/er/laborstandards/laws.htm

Wisconsin Department of Workforce Development: https://dwd.wisconsin.gov

Wisconsin Labor Standards: https://dwd.wisconsin.gov/er/laborstandards/

OSHA training: https://www.osha.gov/training/outreach

GCSAA labor guidance: https://www.gcsaa.org/advocacy/compliance/labor

Department of Labor youth and labor: https://www.dol.gov/general/topic/youthlabor

Golf courses must work in synergy with state and federal agencies to ensure compliance in all areas of equal rights including labor standards and civil rights. Promoting awareness, educating on state and federal laws, including minimum wage laws, and engaging staff regularly helps ensure a safe, compliant environment. Safety practices and OSHA training must be kept up to date. Written and accessible operating standards, employee handbooks, proper workplace injury reports, PPE, and worker's compensation programs should also be in place.

Best Management Practices

- Adhere to all federal and state hiring regulations and requirements
- Provide ongoing OSHA and safety training; post required signage
- Communicate written operating standards in multiple languages and through various formats
- Educate on PPE and proper safety precautions when operating equipment or handling chemicals
- Understand current golf maintenance labor data, including expenses, retention, and turnover rate
- Develop relationships within the community through a variety of school and government-based programs to diversify workforce
- Utilize social media, newspapers and other platforms to communicate opportunities and ongoing workplace culture
- Lean on multiple recruiting pipelines to integrate diversity and inclusion into hiring practices
- Sponsor events, host meetings with key community influencers including school administration, chambers of commerce, parents
- Promote workplace culture through social media and digital platforms
- Utilize the Wisconsin Job Center to post positions at the single-largest source of qualified candidates - http://www.wisconsinjobcenter.org/recruiting/
- Understand and explore H2B process for seasonal employees
- Create interview processes using internal teams, multi-step screening processes, EEOC compliant interview questions, and tracking or rating systems to ensure the best quality hires
- Develop an effective, formal, and consistent onboarding process to help employees acclimate to the work environment
- It is important to have a growth and development plan for each and every employee, one that they have a voice in creating and are excited about
- Utilize OTJ services from workforce development boards to create entry level training for new hires; incorporate mentoring with team members
- Create a statewide Apprenticeship program with unified standards that can be adopted at the facility level; where students may take courses related to the profession as a way of enhancing what is being learned on the job
- Develop relations with the local school systems, vocational schools, community colleges, and universities; provide continuing education opportunities
- Build relationships with post-secondary institutions to offer continued education and training through certificate programs, 2- and 4-year programs and masters programs

Recruiting and Hiring

When recruiting a team, it is important to find the right person, not just fill a seat. Finding the right person can require time and expenses, however filling the position with the wrong candidate costs even more. The Human Capital Benchmarking Report from the Society for Human Resource Management indicates that the average cost-per-hire is $4,129.00.

Reference for average cost-per-hire:

https://www.shrm.org/hr-today/trends-and-forecasting/research-and-surveys/Documents/2016-Human-Capital-Report.pdf

Understanding Golf Course Labor Data

It is important to understand existing workplace culture, barriers, and operational data. Conduct an operational audit through a third party or input data from monthly tracking systems including digital job boards, GPS tracking systems, time studies, and other performance metrics such as engagement surveys. Once annual data is entered, it should be designated as the baseline year to measure against in subsequent years.

Utilize Multiple Resources for Recruiting

Creating structured hiring systems including recruitment, interviewing, and onboarding will boost the quality and quantity of leads, plus improve efficiency. Hire individuals from specific target groups who have consistently faced significant barriers to employment. Connecting with vocational rehabilitation programs, veteran-based programs, JobCorps, and underrepresented segments will help improve diversity and inclusion.

Identify potential employee candidates using:

- Public workforce systems
- Vocational rehabilitation
- Veteran-based programs
- School systems
- Chamber of Commerce
- Ex-Offender programs
- Retirees
- Staffing agencies
- H2B

Public Workforce Systems: Local Workforce Development (LWD) Boards

The DWD provides a public workforce system that supports local and regional economic development, plus the education and training of Wisconsin's workforce. There are 11 LWD boards in Wisconsin. These government funded programs help employers recruit, develop on-the-job training and financial reimbursement programs, and provide access to job fairs and job seekers.

Additional information:
https://jobcenterofwisconsin.com/presentation/Employers/Default.aspx

Vocational Rehabilitation

Recruit and retain employees with disabilities through Wisconsin's Department of Vocational Rehabilitation (DVR). This no cost program provides additional talent pipelines to recruit qualified workers, build diversity, connect golf courses to experts on the American Disabilities Act, and to access workforce planning resources.

At any given point, DVR has 16,000 individuals with potential candidates who want to work.

Additional information:
https://dwd.wisconsin.gov/dvr/
https://aapd.com
https://abilityjobfair.org
https://disabilityin.org

Veteran Programs

The Vets Ready Employer Initiative serves to encourage employers to build a support system within their workplace, hire and retain more veterans, and connect to veterans in the community and their families. Every year the DWD will recognize businesses who have gone above and beyond for the veteran workforce. Businesses are separated into three categories – small, medium, large – and either receive a gold or silver certification.

Additional information:
https://jobcenterofwisconsin.com/veterans/

The DWD, is committed to advancing employment opportunities for Wisconsin veterans through targeted business engagement, service and commitment to the veteran community.

Additional information:
https://dwd.wisconsin.gov/veterans/

School Systems

Golf course superintendents are uniquely positioned to provide career development and exploration opportunities. School systems provide valuable resources for recruitment. Superintendents should reach out to guidance counselors, work-study and co-op coordinators, and athletic coaches to reach students for potential employment. Volunteering for career awareness programs as early as kindergarten will help build relations. Also connect with career and technical education programs or centers, in addition to local affiliates of organizations like Future Farmers of America (FFA). These BMPs help to create talent pipelines through youth outreach and development opportunities.

Additional information:
https://dpi.wi.gov/cte

Chambers of Commerce

There are 265 Chambers of Commerce in the state of Wisconsin. These organizations provide exceptional networking opportunities for golf course superintendents to share employment opportunities, participate in outreach events, and conduct meet-and-greets. These organizations can provide opportunities to meet with influencers in the community, civic organizations (Rotary, Kiwanis, Lions), and industry-centric conferences as well.

Additional information:
https://www.wmc.org/chamber-of-commerce/local-chambers-of-commerce/

H2B Temporary Workers

The H-2B temporary non-agricultural program allows U.S. employers who meet specific regulatory requirements to bring foreign nonimmigrant workers to the U.S. to fill temporary nonagricultural jobs. Before requesting H-2B classification from the U.S. Citizenship and Immigration Services (USCIS), the employer must apply for and receive a temporary labor certification for H-2B workers from the U.S. Department of Labor (DOL).

The H2B Program Process

Step 1
Employer Obtains a Prevailing Wage Determination (PWD) from the National Prevailing Wage Center (NPWC) using the Application for Prevailing Wage Determination (ETA Form 9141) PWD may also be submitted by mail to the following address:

U.S. Department of Labor
Employment and Training Administration
Office of Foreign Labor Certification
National Prevailing Wage Center
1341 G Street, NW- Suite 201
Washington, DC 20005- 3105
ATTN: PWD Request

Step 2
Employer Conducts Pre-Filing Recruitment: File a job order no more than 120 calendar days prior to the employer's date of need with the State Workforce Agency (SWA) serving the area of intended employment. The job order must be open and available for recruitment purposes for a minimum of 10 days. The list of SWA contacts can be found here.

Publish two print advertisements for the position(s), one of which must be on a Sunday. Advertisements must be placed during the period of time the job order is active.

Job order and print advertising must contain:

- Employer's name and contact information to allow applications to send resumes
- Geographic area of employment to allow applicants to be aware of travel requirements and where applicant will likely have to reside to perform the services or labor
- If transportation to the worksite is provided by the employer, the advertising must say so
- Description of job opportunity including duties to apprise applicants of services or labor to be performed and the duration of the job opportunity
- Work hours and days, expected start and end dates of employment, and whether or not overtime will be available
- Wage offer or offers in the event of multiple wage offers
- Disclose the position is temporary, and the total number of job openings the employer intends to fill

Step 3
Employer submits an application and provides the following documentation to the Chicago National Processing Center (NPC):

- Completed ETA Form 9142B, https://www.dol.gov/sites/dolgov/files/ETA/oflc/pdfs/ETA_Form_9142B.pdf - Application for Temporary EmploymentCertification
- Completed ETA Form 9142 - Appendix B https://www.dol.gov/sites/dolgov/files/ETA/oflc/pdfs/ETA_Form_9142B_APPENDIX.pdf
- Completed recruitment report
- Any applicable supporting documentation (documentation substantiating temporary need is recommended)

Electronic Filing:
Employers may submit the H-2B application electronically via the Department's iCERT Portal System. Read the H-2B iCert Quick Start Guide and H-2B iCERT User Manual before completing and submitting an H-2B application. The online help provides step-by-step instructions for completing and submitting the H-2B application electronically. For resources and information, visit: http://www.foreignlaborcert.doleta.gov/h2ah2b_icert_rollout.cfm

Mail Filing:
Mail the application package to the Chicago NPC:
U.S. Department of Labor
Employment and Training Administration
Office of Foreign Labor Certification
Chicago National Processing Center
11 West Quincy Court
Chicago, IL 60604- 2105
ATTN: H-2B Program Unit

Additional H2B information:
http://bit.ly/37E6m25
https://www.foreignlaborcert.doleta.gov/h-2b.cfm

How to Calculate Turnover Rate

The number of employee separations / total number of employees x 100

Example: Company A had 5 total separations in the month of January. Company A had a total of 100 employees in January.

5 / 100 = 0.05 x 100 = 5% turnover in the month of January

Turnover calculator: http://bit.ly/3haII0l

Creating an Effective Onboarding Process

- Document the process so it's standard for each new hire and update that process as changes are made
- Assign an onboarding buddy or core staff member to help new hires feel welcome and connected
- Determine how success is measured for each employee, the teams, the organization, and customers
- Determine specific tasks that will help new hires learn the culture at the golf course, starting on day one
- Consider a structured first day including welcome, team breakfast, HR orientation discussing organizational benefits, bonus structure, forms and paperwork, tour of the facilities, career pathing, ride-along with manager, recap of the day, and reflection of upcoming weeks
- Blend initial training and development with hands-on training, social interaction, and checklists of task completion
- Reinforce the basics to build a foundation that can lead to job competence and mastery
- Ensure social cohesion by empowering employees to feel respected and valued, and that they are part of the team
- Onboarding process should be at least 90 days
- Provide Q&A sessions at 30, 60, 90-days to provide constructive and timely feedback

Create a Positive Interview Process

- Gut instinct alone isn't a reliable predictor of successful work performance or job retention. Interviews are the best tool when making strategic hiring decisions.
- Create an interview team including HR and assistant managers or key staff
- Create a grading system to rate candidates that ensures a consistent process
- Understand acceptable and unacceptable inquiries for interviews and employment applications through the EEOC guidelines
- Ask behavioral interview questions that can reveal how a candidate's past performance can predict future performance
- Use STAR method to create a consistent interview process (Situation, Task, Action, Result)
- Communicate with job applicants every step of the way and treat every applicant with the same care and consideration as a cherished customer
- The candidate experience throughout the hiring process is a vital part of creating a great employer brand

References to EEOC guidelines: https://www.eeoc.gov/laws-guidance-0

Retention

Retaining employees impacts bottom-line results, an average cost to replace a worker is 30 percent of the annual salary. Retention also directly impacts the quality of management throughout the organization. It is important to track turnover metrics regularly to establish retention goals, improve communications with management staff, and help control or reduce costs.

Onboarding

The onboarding process should be an ongoing process, rather than a one-day or one-week "event". Create a team to design an onboarding process that is customizable and relevant to a changing workforce. Consider different approaches for the various segments of the team.

The goal of any onboarding process is to help employees acclimate to the work environment, so they can value and recognize the opportunity, which helps result in employee motivation, productivity, job satisfaction, and loyalty.

Additional resources for calculating turnover costs: https://www.shl.com/en/customers/turnover-roi-calculator

Training

Upskilling the workforce will pay dividends for as long as employees stay in business. Employees who bring value and are assets will leave if they stop learning and growing. Training leads to longevity more than it results in turnover. Employees value opportunities for personal development and growth often as much as they do a salary increase.

On-the-Job Training (OJT)

OJT can be developed internally or alongside the local workforce development boards for new hires focused on safety training, introductory job skills, and employability skills. OJT provides an opportunity to align mentors with new team members. In addition, developing these programs offers reimbursement opportunities for employers to help compensate for the costs associated with training and loss of production for newly hired employees.

OJT can assist employers who are looking for well-trained staff with specialized skills.

There is an ability to receive up to 50 percent of wages reimbursed for OTJ training. Seek assistance from a professional workforce consultant to learn more.

Apprenticeships

Apprenticeship offers a unique workforce solution for both employers and job seekers. Employers provide on-the-job training, while also receiving related instruction. This is customizable training to the needs of employer in comparison to traditional post-secondary education and internships.

Youth apprenticeship can be offered to juniors and seniors in high school for one or two-years. During the apprenticeship, students take courses related to the profession as a way of enhancing what is being learned on the job. Youth apprenticeship is a great way to build talent pipelines from youth into skilled and credentialed journey workers. In addition, work study programs can be utilized to connect students to career pathways and college credit programs.

Reference for additional information: https://dwd.wisconsin.gov/apprenticeship/

Continued Education

States support workforce development through various grant programs facilitated by partners, including community colleges. Connect with local community college staff to learn about services and potential collaboration. Be flexible and integrate employees into on-the-job training, whether through internal or external programs.

The following post-secondary institutions offer turf, landscape, or horticulture programs.

Fox Valley Technical College

1825 N. Bluemound Drive
Appleton, WI 54912
P: 920-735-5600

Gateway Technical College

3520 30th Avenue
Kenosha, WI 53144
P: 262-564-2200

University of Wisconsin-Madison

Madison, WI 53706
P: 608-263-2400
www.turf.wisc.edu

Milwaukee Tech College

700 W. State Street
Milwaukee, WI 53233
P: 414-297-6282

University of Wisconsin - Platteville

1 University Plaza
Platteville, WI 53818
P: 608-342-1491

University of Wisconsin - River Falls

410 S. 3rd Street
River Falls, WI 54022
P: 715-425-3911

Energy Conservation

Section 12

Energy conservation is an important initiative in Wisconsin. The state legislature has a number of energy goals, including increased energy efficiency, increased use of renewable energy, and reduction of atmospheric carbon dioxide by increasing the amount of forested land in the state. The State of Wisconsin Department of Administration's Office of Sustainability and Clean Energy established a goal in 2019 to achieve 100 percent carbon-free electricity consumption by 2050. This will be a collaborative effort with the Public Service Commission of Wisconsin (PSC) and the DNR.

The GCSAA Golf Course Environmental Profile, Phase II, Vol. V (GCSAA 2017), estimates that turf maintenance accounts for 47 percent of energy use at a golf facility, with total facility uses encompassing clubhouses, swimming pools, tennis courts, and various other operations. The study identifies six major energy sources for golf course use: electricity, gasoline, diesel, natural gas, propane, and heating oil. All of these sources are utilized in Wisconsin.

Lower energy consumption can generate efficiencies and cost savings up to 25 percent. Reductions in energy use and facility costs support stewardship and sustainability efforts of the state.

WISCONSIN SUPERINTENDENTS CAN WORK TOWARD ACHIEVING ENERGY REDUCTIONS THROUGH IMPLEMENTING BMPS WHICH DRIVE BEHAVIORS AND PROCESSES, IMPROVE PRODUCT EFFICIENCIES, ENCOURAGE OPTIMAL DESIGN, SUPPORT INNOVATIVE SOLUTIONS, AND PROMOTE EDUCATION.

Best Management Practices

- Measure annual energy use for electricity, natural gas, gasoline, and diesel; propane, and heating oil input data from monthly utility statements, utilizing 2 years of data
- Set baseline year to track improvements and future reductions; determine carbon footprint when practicable
- Analyze data to identify efficiencies, prioritize reduction targets and set attainable goals; monitor metrics regularly to confirm compliance
- Share data to ensure success and to identify other areas that need improvement
- Prioritize opportunities and establish steps to implement initiatives, identify resources, projected energy and cost savings; incorporate all stakeholders to increase ownership
- Establish and communicate position statement and energy policy; relate to guests, members, community
- Audit and replace lighting and irrigation component use to identify efficiency opportunities
- Identify opportunities for product rebates and incentives with local suppliers: https://www.focusonenergy.com/business
- Ensure efficient operation and maintenance of pump station, irrigation pumps, controls, components; utilize manufacturer data to fine tune specifications and optimize conservation.
- Incorporate energy efficiency and conservation measures into location, design, construction; collaborate with stakeholders to prioritize energy conservation
- Explore onsite solar and electric vehicle charging stations when practicable; stay up-to-date with Wisconsin legislation on renewables
- Communicate with utility provider, insurance company, regulatory officials
- Adhere to state regulations, use guidelines from U.S. Green Building Council (LEED certification program)
- Educate, train, motivate employees on energy efficiency practices

Data Analysis

The first step in managing energy at a golf course is understanding consumption. Conduct an energy audit through a third party or input data from monthly utility bills, receipts, and statements into a spreadsheet. Once annual data are entered, it should be designated as the baseline year to measure against in subsequent years. When practicable, conduct a carbon footprint analysis using total energy consumption to determine emissions, consult an expert if needed.

Install meters and gauges and ensure they are operating properly on property. If feasible, track energy used by the pump station separately; it accounts for the most significant energy use on the course. When practicable, segregate data on meters by area including maintenance buildings, clubhouse, tennis facilities, pools, or additional amenities for optimal monitoring and control.

Energy Use Conversion Factor

To understand aggregate energy used on a golf course for electricity, natural gas, gasoline, diesel, propane, and heating oil, a conversion factor to BTU for each energy input may be used. (reference chart footnote 12 GCSAA 2017* US Department of Energy)

Analyzing Data & Setting Energy Reduction Goals

Look at consumption metrics by month, area, day of week, and time of day. Factors to consider during analysis year-over-year, by month, or quarterly include:

- Electricity utilization during peak hours 7 a.m. to 4 p.m.
- Unusually high temperatures creating increased HVAC usage - summer season between June and September
- Periods of drought causing increased irrigation
- Seasonality resulting in switches between energy sources
- Alterations to landscape or building renovations
- Faulty or damaged equipment

Look for trends or spikes which could be caused by faulty equipment, leaks, or peak utilization. Tracking these numbers will allow for a quicker response in repairs.

Equipment maintenance does impact energy use and needs to be considered when analyzing data. Equipment maintenance and replacement schedules have to be considered along with reviewing what energy is used (e.g., switching to hybrid diesel-electric fairway mowers vs. hydraulic diesel motors may change energy use composition). Equipment inventory should be conducted on a regular basis; logging date of operation, total energy used, issues, and operational hours. This will help support future capital expenditures.

After establishing priorities, determine annual goals for energy use versus prior year. Goals for energy conservation could encompass initiatives related to infrastructure, equipment, behavior, processes, and agronomic practices. Aim for SMART goals which are Specific, Measurable, Attainable, Relevant, and Timely. Share goals with employees at monthly meetings and post them in a clearly visible area.

Energy Use Intensity

Energy use intensity, or EUI, expresses a building's energy use as a function of its size or other characteristics. It's calculated by dividing the total energy consumed by the building in one year (measured in kBtu or GJ) by the total gross floor area of the building. A low EUI signifies good energy performance. EUI helps to benchmark and gauge the effect of renovations and expansion within clubhouses or other built environments. Example benchmarks and conversion data may be found at www.energystar.gov.

Calculating a Golf Course Carbon Footprint

An effective way to understand the environmental impact of energy use at a golf facility is through calculating a carbon footprint. It allows all energy sources used at a facility to be entered into a common currency that can be tracked and monitored. By understanding which activities emit the greatest amount of carbon, superintendents may take corrective actions to reduce emissions and increase efficiencies.

Golf courses also provide positive benefits for the environment through carbon sequestration. The plants on a golf course assimilate carbon from the atmosphere during photosynthesis, some of which is eventually stabilized in the soil, in the form of soil organic matter. Carbon sequestration helps offset carbon emissions, the net difference on a golf course reflects your overall footprint.

There are resources available for calculating your carbon footprint. For more information contact:

UW-Madison Turfgrass Program

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Monitoring, Tracking, and Communication

Establish a tracking mechanism to monitor energy use regularly. At a minimum, create a spreadsheet detailing units of measurement, energy used by day, month, meter or department, rates, weather, and energy conversion factors. There are tools and software services available for tracking, such as Energy Star. If feasible, particularly at resort facilities, consider energy management software which can provide robust data and controls, incorporating intelligent building automation systems and monitoring. Calculate savings achieved through energy reductions to track progress and support energy efficient capital investments.

Analyze data weekly or monthly to confirm progress toward goal attainment and note inefficiencies, spikes, or issues. Establish performance parameters to optimize irrigation pumps. Communicate results with employees on a weekly basis and post signage showing monthly progress to goal attainment to encourage teamwork and innovation, address opportunity areas, and reward successes. Consider scorecards and/or benchmarking performance between departments, or against similar-sized facilities.

Behavior

An energy management plan (EMP) moves priorities forward by aligning stakeholders around common goals. It creates structure, accountability, and a timeline. It is a continuous improvement process centered around the concept of “Plan-Do-Check-Act” which incorporates a roadmap, implementation, monitoring, and adjustments. The goals of an EMP often intersect with other BMPs, increasing impact across areas. For example, an effective preventive maintenance program can improve equipment efficiency and reliability. Irrigation efficiencies, leak detection, and monitoring can improve energy performance. Conversely, energy management practices can help lower maintenance, increase equipment life, and lower emissions.

Recommendations for energy efficiency opportunities come from a variety of sources, including reference materials, industry success stories, staff, consultants, or energy providers. Include relevant stakeholders and key management ‘champions’ as part of the energy management team. This includes employees responsible for a specific job or task, managers, and departments influential in decision-making or processes. Effective engagement of stakeholders and champions will drive efficiencies, reduce bottlenecks, and positively impact departments.

What to Include in EMP: Prioritizing, Determining Steps, Assigning Tasks

Focus efforts by choosing the top three to five energy conservation opportunities based on analysis or energy audit. Infrastructure updates, equipment replacement, behavioral changes and agronomic practices can all be priority initiatives completed by each facility. Benefits should be considered with long- and short-term costs to properly designate priority initiatives by energy source (electricity, fuel, etc.)

Establish steps to implement by identifying:

- Resources needed (capital expenses, acquiring products/systems, communications, etc.)
- Departments involved
- Projected energy reductions
- Estimated cost savings
- Timeframe

Accountability and teamwork can be maximized when all task owners have priorities aligned.

Implementation

Tie EMP progress to overall energy reduction goals. Communication and engagement should happen on several levels.

- Engage energy management team weekly and/or monthly to review progress
- Engage leadership team regularly to provide updates to support investment decisions and show progress
- Communicate with all staff regularly, including updates to employees within stakeholders' departments
- Share EMP conservation highlights and achievements with members and guests

Energy Management Tip!

Create a checklist of energy reduction behavioral best management practices for the clubhouse, golf maintenance facility, and other buildings on property. This can be used as a self-audit and guide toward continuous improvement.

Policy and Performance Guidelines

Employees and guests should be able to recognize that energy conservation is a priority within the operation. Behavior changes will have to take place and will take time. The facility should have a commitment to following a set standard on energy conservation.

The turf department should include goals around irrigation systems, pump stations, landscaping and the broader framework of the operation.

Behavioral Practices: Lighting, HVAC, Irrigation/Water, and Equipment

Heating, ventilating, air conditioning (HVAC) may account for 40 to 50 percent of total electricity usage for a building (e.g., clubhouse). Lighting may account for more than 20 percent of total electricity used in a building. Hot water within facilities is used for showers, hand-washing, and restaurant operations. Miscellaneous equipment, such as office equipment, can represent more than 20 percent of electricity used in a building.

Turning off devices and administering a regular maintenance program will help lower electricity expenses. Keeping mechanical systems clean improves HVAC efficiency by 10 to 20 percent.

The pump station is the largest user of energy during the summer months for golf course maintenance. The pump station should be professionally engineered, and regularly maintained, with monitoring devices to show abnormal flow, increased pressure or substantial gallon variances from the central computer. To minimize power consumption and protect the pipes in ground the pumps should be variable frequency drives (VFD). Power surges will happen due to demand and the system should be engineered to allow a variance and keep operating. The actual field heads should be audited annually (at a minimum) to show discrepancies and fine-tune efficiency.

Irrigation should be scheduled during off peak hours. Newer systems have remote monitoring of pumps and flow to identify problems before they escalate.

Golf Club Energy Reduction Best Management Practices Behavioral Checklist

Lighting	Y/N	HVAC	Y/N	Irrigation/Water	Y/N	Equipment	Y/N
Conduct a lighting audit		Clean & change air filters regularly		Maintain plumbing fixtures/ piping to avoid losses		Check electricity meters at least once per month	
Arrange interior space to optimize natural light & comfort zones		Utilize ceiling fans		Run irrigation early in the morning or late at night		Operate machines according to manufacturers' recommendations for energy efficiency	
Initiate 'lights off' employee awareness campaign		Ensure HVAC units have proper ventilation		Repair leaks		Avoid automatically turning on kitchen equipment when arriving in morning	
Display reminders & visual management signage		Turn off air/set heating at minimum in unoccupied rooms		Check insulation on hot water pipes to reduce heat losses		Consider temperature of kitchen rooms when installing or relocating refrigerators/freezers	
Code light switches (labels or color) to switch on only those needed		Close exterior doors when not in use		Check laundry room equipment regularly for leaks		Turn off food & beverage equipment when not in use	
Reduce general lighting during daytime				Water less area, apply hand watering		Do not exceed oven preheating times	
Turn exterior lighting on only at night; utilize timekeepers				Evaluate cleaning practices (dry vs. wet washing)		Open refrigerators & freezers only when necessary	
Train staff & invite guests/ members to get involved						Defrost refrigerators & clean door seals monthly	
Maintain routine preventive maintenance on lighting equipment						Fill dishwashers & washing machines to maximum capacity	
Turn off lights in unoccupied rooms						Use low temperature wash cycles & avoid overloading dryers	
Limit pool lighting that is not required for safety						Conduct regular PM on equipment, vehicles	
						Run washer/dryer during off peak hours	
						Do not leave televisions on standby	
						Switch off equipment (copiers, computers, printers, coffee) when not in use	
						Charge golf carts & equipment during off-peak hours (evening/early a.m.)	
						Encourage car sharing; designate EV parking & charging stations	
						Source products locally to reduce logistics/transportation fuel consumption	
						Log equipment use including hours operated, length of use, patterns to determine efficiencies (e.g., shift to off-peak hours, minimize use per week, etc.)	

Source: Radius Sports Group, LLC. 2019

Energy Management Tip!

Create a checklist of energy reduction product selection best management practices for the clubhouse, golf maintenance facility, and other buildings on property. This can be used as a self-audit and guide toward continuous improvement. Sample checklist on the opposite page.

Equipment and Materials Efficiencies

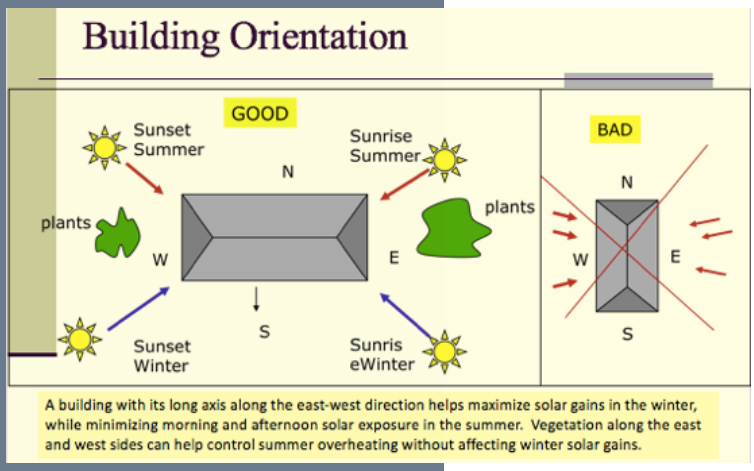
Evaluate new technologies, products, or upgrades that improve efficiencies through meetings with suppliers. Examine fuel types, level of energy required, and use of alternative energy or fuels. Shifting to hybrid mowers and electric golf carts helps reduce fuel consumption and lowers greenhouse gas emissions.

For new equipment purchases throughout the club, consider programs like Energy Star or the EPA's WaterSense program for product labeling to identify products with high energy efficiency.

Additional resources for calculating turnover costs: https://www.shl.com/en/customers/turn-over-roi-calculator

Design

Renovations and new construction provide an opportunity to integrate energy saving efficiencies into the plans. Engaging partners early will allow all parties to design the finished product within the club's energy conservation goals. Architects and contractors can also be held to standards focusing on energy reductions during the project.



Source: Energy for Sustainability, Randolph & Masters, 2008.

Investment determinations should be focused on integrating energy conservation measures.

Energy Considerations During Design

- Building location
- Building orientation
- Course slope
- Vegetation
- Materials used (e.g. thermal conductivity, best material for cooling, etc.)
- Lifecycle assessment on materials
- Technology/smart building automation
- Monitoring systems
- Programmable scheduling and controls

In planning for construction, source locally when practicable. Heavy or bulky materials will take significantly less resources if traveling a small distance. This reduces embodied energy (energy used in the extraction, production, transportation and construction of a building material) to lower the carbon footprint. Energy conservation measures and suppliers may be found through the US Green Building Council, including details on the LEED framework and certification for highly energy efficient, green buildings; also the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, or ASHRAE for energy efficiency standards and guidelines.

Golf Club Energy Reduction Best Management Practices Product Selection Checklist

Lighting	Y/N	HVAC	Y/N	Irrigation/Water	Y/N	Equipment	Y/N
Install LED lighting and/or retrofit devices		Install energy-efficient air conditioning/chiller equipment		Install shower flow restriction devices to reduce water usage		Choose programmable thermostats	
Replace less efficient T12s with low-wattage T8 & T5 lamps with electronic ballasts		Install HVAC fans & pumps with variable frequency drives (VFDs) that control pump speeds		Install insulation on water heater tanks and pipe		Install onsite photovoltaic solar panels for onsite electricty generation	
Replace incandescent bulbs with CFLs which use less energy & last longer		Install window film to reduce air/heat loss		Install energy efficient water-heating equipment		Install National Electrical Manufacturers Association's (NEMA) premium efficiency-rated pump motors	
Replace fluorescent light exit signs with LEDs		Maximize envelope efficiency; choose high performance insulation systems		Install aerators to reduce demand for hot water		Install solar/geothermal pumps for pools	
Install induction lighting in hard-to-reach places & public facilities		Add insulation for windows & doors, such as weather stripping & thresholds		Install water-saving devices (flow regulators, water flow sensors, self-closing taps, low-flush toilets)		Select a well-engineered pump station with variable frequency drives (VFDs) to minimize water & energy use	
Install pulse-start metal halide & high-pressure sodium lamps in spaces with prolonged use & high ceilings		Utilize energy management systems		Install prescriptive irrigation systems to manage use & detect leaks		Select hybrid equipment including fairway mowers	
Add occupancy sensors or programmable timers		Decrease daytime thermostat setting		Audit irrigation system		Choose electric or battery-powered golf carts	
Install light tubes & natural light maximizers		Install a night setback system to lower room temperature at night		Install localized devices (micro- sprinklers, drip irrigation) for plants & ornamentals		Choose Energy Star rated equipment for clubhouse operations	
		Install an economizer to use outdoor air for cooling		Incorporate native plants to reduce water & energy use			
		Install a timer on supply air fans		Install rooftop solar thermal panels for water heating			
		Install double-glazed windows		Incorporate drought resistant, salt tolerant turf (e.g., paspalum) to lower irrigation needs			
		Shade windows from sun to limit HVAC needs (awnings, automatic louvres, curtains, blinds, screens, heat reflecting sheets, trees)					
		Incorporate a green roof with vegetation or cool roof (white or cool colored)					

Source: Radius Sports Group, LLC. 2019

Wisconsin Solar Site Considerations

Location (roof or ground mounted), area, orientation and tilt, shading

- Preferred orientation allows for south facing
- 35-to-45-degree roof tilt
- Clear access to the sun for most of the day unobstructed by trees
- Adequate space on roof or property
- A roof in good condition

Onsite Solar Electricity Generation

An increasing number of golf clubs are installing solar to provide onsite electricity. When evaluating benefits and costs, look at the long-term effect and payback period, in addition to employee and community well-being.

Information for Solar Investment Tax Credits and incentives for businesses: https://www.revenue.wi.gov/Pages/Businesses/incentives-finder.aspx
https://focusonenergy.com/renewablefunding
http://www.energy-grants.net/wisconsin-energy-grants-rebates-loans-incentives/

Education

Educating and engaging employees is an important part of driving energy efficiencies. Making it fun and enjoyable will encourage participation. Tips and quizzes help keep it relevant and weekly challenges with rewards help motivation. Continuous education may be completed through email, signage, and stakeholder meetings.

Succeses should be celebrated. During weekly staff training a small portion can be dedicated to energy to keep it relevant year-round. Suggestion boxes for stakeholders and guests can help support continuous improvement.

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