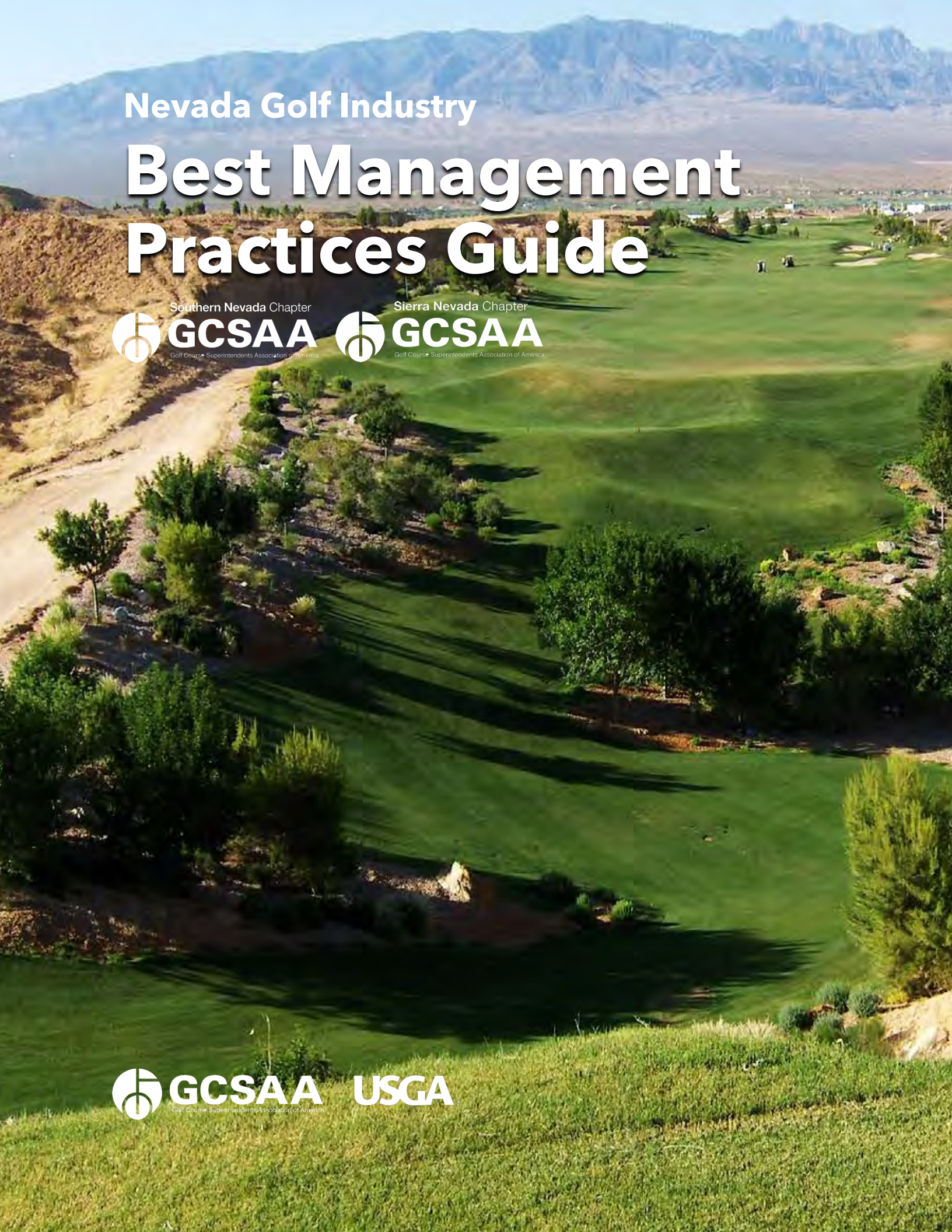


Nevada Golf Industry

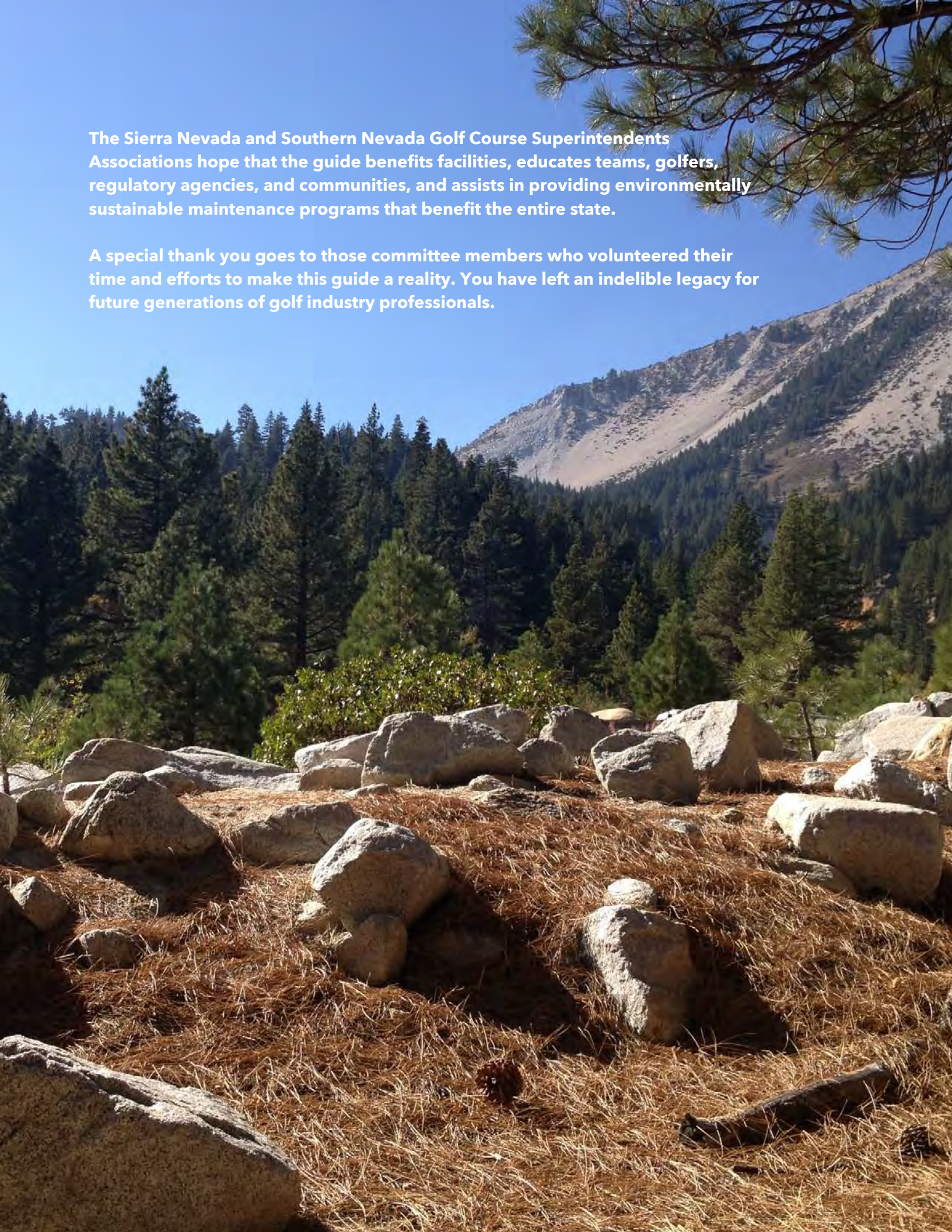
Best Management Practices Guide

Southern Nevada Chapter GCSAA Golf Course Superintendents Association of America

Sierra Nevada Chapter GCSAA Golf Course Superintendents Association of America

GCSAA Golf Course Superintendents Association of America

USGA



The Sierra Nevada and Southern Nevada Golf Course Superintendents Associations hope that the guide benefits facilities, educates teams, golfers, regulatory agencies, and communities, and assists in providing environmentally sustainable maintenance programs that benefit the entire state.

A special thank you goes to those committee members who volunteered their time and efforts to make this guide a reality. You have left an indelible legacy for future generations of golf industry professionals.

Introduction

While long recognized for its world class resorts and casinos, Nevada is home to 88 golf facilities ranging from municipal courses to the 26th ranked golf course in the United States, Shadow Creek Golf Club (Golf Digest's *America's 100 Greatest Golf Courses*). These facilities generate $1.981 billion in total economic output, produce over 17,500 direct, indirect and induced jobs and contribute more than $138 million in state and local tax revenue. They serve as a significant driver of tourism to the Silver State, with traveling golfers spending an estimated $744.3 million on golf-related activities.

The state is home to two PGA Tour events including the Barracuda Championship played at Montreux Golf and Country Club in Reno and the Shriners Hospitals for Children Open played at TPC Summerlin in Las Vegas. Additionally, Edgewood Tahoe Golf Club in Stateline is host to the always popular American Century Celebrity Golf Championship.

With the growing popularity of the game in the state, an increased focus on regulatory concerns and courses looking to maximize both their financial and social returns, the Sierra Nevada and Southern Nevada Golf Course Superintendents Associations have partnered with the Golf Course Superintendents Association of America (GCSAA), the Environmental Institute for Golf (EIFG), the PGA Tour and the United States Golf Association (USGA) to develop and implement a best management practices (BMP) guide that will assist superintendents and operators with managing facilities throughout the expansive and diversified state.

With input from golf course superintendents, academia, environmental consultants, state and local regulatory agencies and golf industry experts, the Nevada BMP Committee (see Acknowledgement page) created a guide that addresses sustainable golf course operations in all areas of the state ranging from the Sierra Nevada Mountains in the north to the Mojave Desert in the south.

The committee worked with Radius Sports Group, a Reno, Nevada-based sustainability consulting firm, to develop the guide. Radius' understanding of environmental compliance, state regulations, and corporate responsibility was critical to the success of the guide.

The guide contains 13 sections: planning, design, and construction; irrigation; water management plan; nutrient management; cultural practices; integrated pest management; pesticide management; pollinator protection; maintenance operations; landscape; energy; air quality control; community outreach.

Each section contains principles, best management practices and regulatory considerations, as well as a guideline for requirements to meet and exceed expectations.

Acknowledgments

The Nevada BMP Committee in conjunction with the Sierra Nevada GCSA and Southern Nevada GCSA would like to thank the following individuals for volunteering their time and organizations for their support to complete the Nevada Golf Industry BMP Guide. Your efforts will guide and influence future generations of superintendents and operators and ensure golf's ability to operate in the state. Thank you to superintendents across the state who provided photo contributions.

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Golf Course Superintendents Association of America

The 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 17,000 members in more than 72 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 BMP 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".

Key

Each section is color coded to indicate BMPs that are Required, Recommended, or Exceeds with a corresponding checklist. The guide is produced in an online digital format that allows golf course superintendents to make modifications to meet the agronomic requirements and compliance needs of golf courses relative to their location in the state. Access is free of charge for GCSAA members and the guide may be printed in PDF or Word format.

Table of Contents

1.0 Planning, Design and Construction

> The construction phase of any industry's infrastructure poses the greatest risk of ecosystem alteration. With proper planning and design, golf facilities can be constructed and maintained with minimal impact to existing wildlife and their habitat. Furthermore, facilities should be designed and constructed to maximize energy efficiency.

Regulatory Issues

Local and state regulations may be in place in your location. Early engagement among developers, designers, local community groups, and permitting agencies is essential to designing and constructing a golf facility that minimizes environmental impact and meets the approval process.

Planning

Selecting a Team of Qualified Stakeholders

- **Golf course architect**
- **Golf course superintendent**
- **Clubhouse architect**
- **Irrigation engineer**
- **Environmental engineer**
- **Energy analyst**
- **Economic consultant**
- **Civil engineer**
- **Soil scientist**
- **Geologist**
- **Golf course builder**
- **Legal team**

Principles

Proper planning will minimize expenses resulting from unforeseen construction requirements. Good planning provides opportunities to maximize/integrate environmentally favorable characteristics into the property. This often requires the involvement of golf course architects, golf course superintendents, civil engineers, soil scientists, agronomists, irrigation designers, ecologists, etc.

Best Management Practices

- Assemble a qualified team
- Determine objectives
- Complete a feasibility study
    - ✓ Are needs feasible given existing resources?
    - ✓ Financial
    - ✓ Environmental
    - ✓ Water
    - ✓ Energy
    - ✓ Labor
    - ✓ Materials
    - ✓ Governmental regulatory requirements/restrictions
- Select an appropriate site capable of achieving the needs of stakeholders, with minimal adverse effects to the existing environment.
- Identify strengths and weakness of selected site.
- Identify any rare, protected, endangered, or threatened plant or animal species on the site.

Design

Principles

Proper design will meet the needs of the stakeholders, protect the locations environmental resources, and be economically sustainable.

Best Management Practices

- Retain a qualified golf course superintendent/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.
- Design the course to minimize the need to alter or remove existing native landscapes. The routing should identify the areas that provide opportunities for restoration.
- Design the course to retain as much natural vegetation as possible. Where appropriate, consider enhancing existing vegetation through the supplemental planting of native vegetation/materials next to long fairways, out-of-play areas, and along water sources supporting fish and other water-dependent species. Using decorative or crushed rock can help define course borders and out of play areas, when feasible.
- Design out-of-play areas to retain or restore existing native vegetation where possible. Nuisance, invasive, and exotic plants should be removed and replaced with native species that are adapted to that particular site.
- Design the course to take into consideration the likelihood of flash flooding and ensure proper water flow into, around, through or away from the golf course.
- Plant only certified turfgrass.
- Decide if bunkers will contain drainage.
- Consider bunker entry and exit points to help reduce wear patterns and create adequate space for ingress/egress points on greens, tees, fairways, and bunkers.
- Select the proper color, particle size, and shape of sand for bunkers that meets your needs.
- Define play and non-play maintenance boundaries.
- Consider water harvesting practices to reuse run-off water.

Greens: Getting it Right!

- **Select a location that has adequate sunlight to meet plant specific needs and provides sufficient drainage.**
- **Choose a green size and sufficient number of hole locations that is large enough to accommodate traffic and play damage, but not so large that it is not sustainable with your resources.**
- **Select an appropriate root-zone material as designated by the USGA.**
- **Consider the number of bunkers as it relates to resources available for daily maintenance.**
- **Greens should be irrigated separately from surrounding turf.**
- **Select a turf species/variety that meets the needs of the stakeholders while adhering to the principle of "right plant, right place" to help reduce irrigation and nutritional inputs.**

Construction

Principles

Construction should be completed with care to minimize environmental impact and financial ramifications caused by poor construction techniques.

Best Management Practices

- Conduct a pre-construction conference with stakeholders.
- Schedule construction to maximize turfgrass establishment and site drainage.
- Use environmentally sound construction techniques.
- Use soil stabilization techniques to minimize soil erosion via wind or water and maximize sediment containment.
- Maintain a construction progress report and communicate the report to the proper permitting agencies.
- Use only qualified contractors experienced in special requirements of golf course construction.
- Schedule construction and turf establishment to allow for the most efficient progress of work, while optimizing environmental conservation and resource management.
- Temporary construction compounds should be built in a way that minimizes environmental impacts.

Grow-In

Principles

Turfgrass establishment is a unique phase in turfgrass growth, which can require greater quantities of water and nutrients than established turfgrasses. Operations and timing should be considered carefully to minimize environmental risk.

Best Management Practices

- Properly prepare and clear establishment area of pests (weeds, pathogens, etc.).
- Ensure erosion and sediment control devices are in place and properly maintained.
- Sprigs should be "knifed-in" and rolled to hasten root establishment.
- Sod should be top dressed to fill in gaps between sod pieces to hasten establishment and provide a smoother surface and help reduce moisture loss.
- Use appropriate seeding methods for your conditions. When using sod, nutrient applications should be delayed until sod has sufficiently rooted.
- Fertilizers should be withheld until after seed has germinated to reduce likelihood of run off.
- When using sprigs, application rates for nitrogen, phosphorous, and potassium should correspond to percent ground cover (i.e., increasing rate as ground coverage increases.)
- Slow-release nitrogen or light, frequent soluble-nitrogen sources should be used.
- Nutrients should be applied in foliar or granular formulations to turf surface. Incorporating nutrients into the root zone does not result in more rapid establishment.
- Mow when sod has knitted-down, sprigs have rooted at 2nd to 3rd internode, and seedlings have reached height one-third greater than intended height-of-cut; hastens establishment.

Erosion and Sediment Control

Principles

Erosion and sediment control are a critical component of construction and grow-in. Soil carried by wind and water erosion transports contaminants, which can dislodge on entering water bodies.

Best Management Practices

- Develop a working knowledge of erosion and sediment control management. Follow Nevada specifications including types of acceptable structures, materials, and design features.
- Implement strategies to control sediment, minimize topsoil loss, protect water resources, reduce disruption to wildlife, plant species, and designed environmental resource areas.
- Hydro-seeding or hydro-mulching offer soil stabilization.

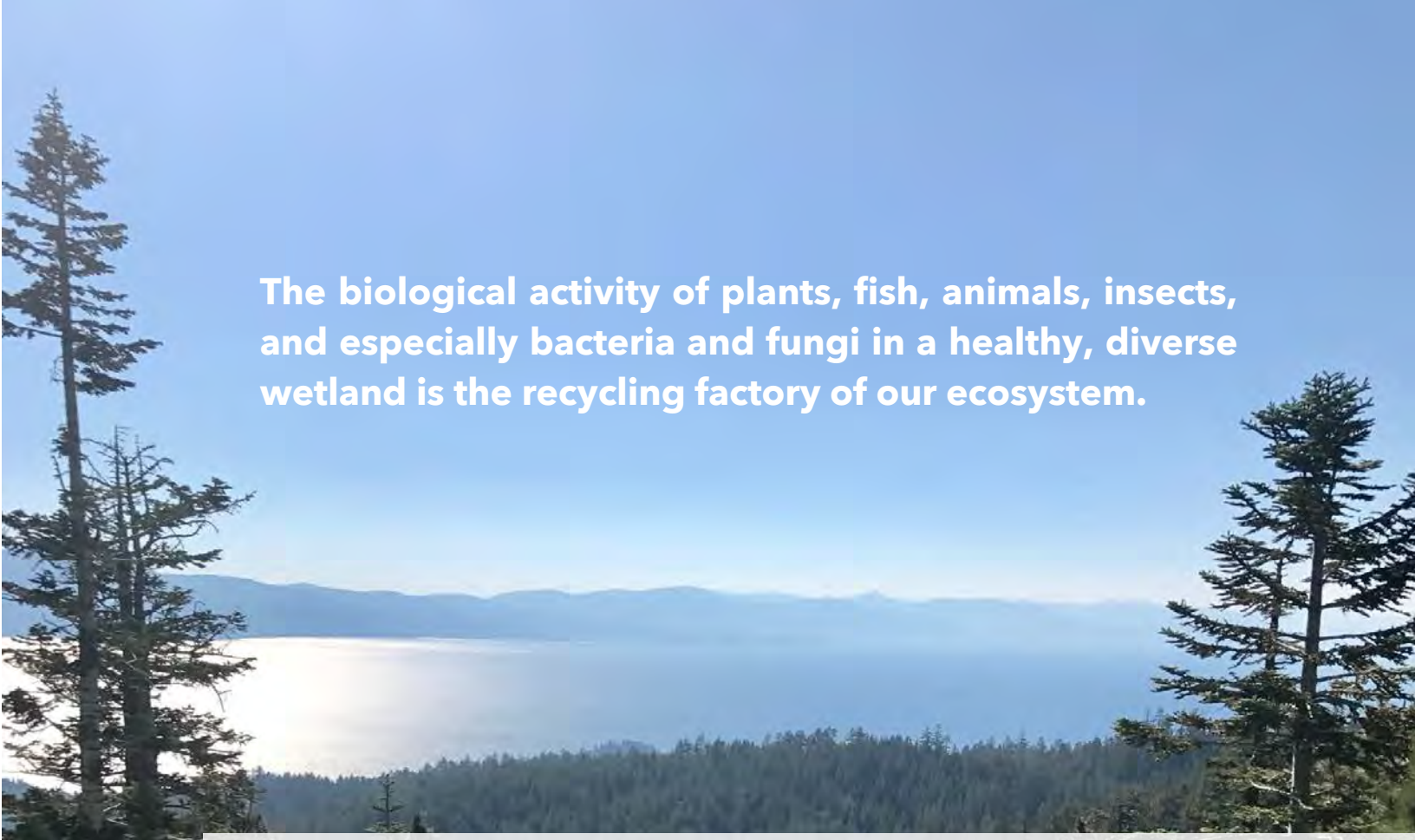
Drainage

Principles

- Adequate drainage is necessary for growing healthy grass.
- A high-quality BMP plan for drainage addresses the containment of runoff, adequate buffer zones, and filtration techniques in the design and construction process to achieve acceptable water quality.
- Drainage of the golf course features is only as good as the system's integrity. Damaged, improperly installed, or poorly maintained drainage systems will result in inferior performance that negatively impacts play and increases risks to water quality.

Best Management Practices

- 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 but should discharge through pretreatment zones and/or vegetative buffers to help remove nutrients and sediments.
- Drainage should discharge through proper drainage and stormwater management devices, for example, vegetative buffers, swales, etc.
- The drainage system should be routinely inspected to ensure proper function.



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.

Wetlands

Principles

- Most states consider wetlands as "waters of the state," a designation that carries significant legal ramifications. Permitting requirements for wetlands can have multiple overlapping jurisdictions of federal, state, and local agencies. 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 act as filters for pollutant removal and as nurseries for many species of birds, insects, fish, and other aquatic organisms.
- When incorporated into 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 need to be permitted to be an integral part of the stormwater management system.

Best Management Practices

- Ensure that proper permitting has been obtained before working on any wetlands.
- Ensure that wetlands have been properly delineated before working in and around any wetlands.

Surface Water:
Stormwater, Ponds, Lakes

Sustainability Benefits of Golf Course Natural Capital

Not all stormwater on a golf course originates there, some may be from adjoining lands, including residential or commercial developments. Golf courses naturally filter stormwater, removing waterborne pollutants and enhancing wildlife habitat.

Principles

- Water that does not infiltrate into the soil and runs across the land surface as runoff from either irrigation or precipitation is the causal agent of no -point source pollution.
- Controlling stormwater on a golf course is more than preventing the flooding of facilities and play areas, it also includes storing irrigation water, controlling erosion and sediment, and addressing aesthetic and playability concerns.

Best Management Practices

- Stormwater treatment is best accomplished by a "treatment train" approach, in which water is conveyed from one treatment to another by conveyances that themselves contribute to the treatment.
- Eliminate or minimize as much directly connected impervious area (DCIA) as possible.
- When feasible both physically and financially water holding ponds should be connected to the course drainage system to help slow water movement to allow contaminants to precipitate from suspension. These ponds will require regular maintenance to function properly (sediment removal).
- Use vegetated swales to slow and infiltrate water and trap pollutants in the soil, where they can be naturally destroyed by soil organisms.
- 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.
- Maximize the 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.
- 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.
- Southern Nevada Health District – "Individual Sewage Disposal Systems and Liquid Waste Management Regulations" – (https://www.southernnevadahealthdistrict.org).

Maintenance Facilities

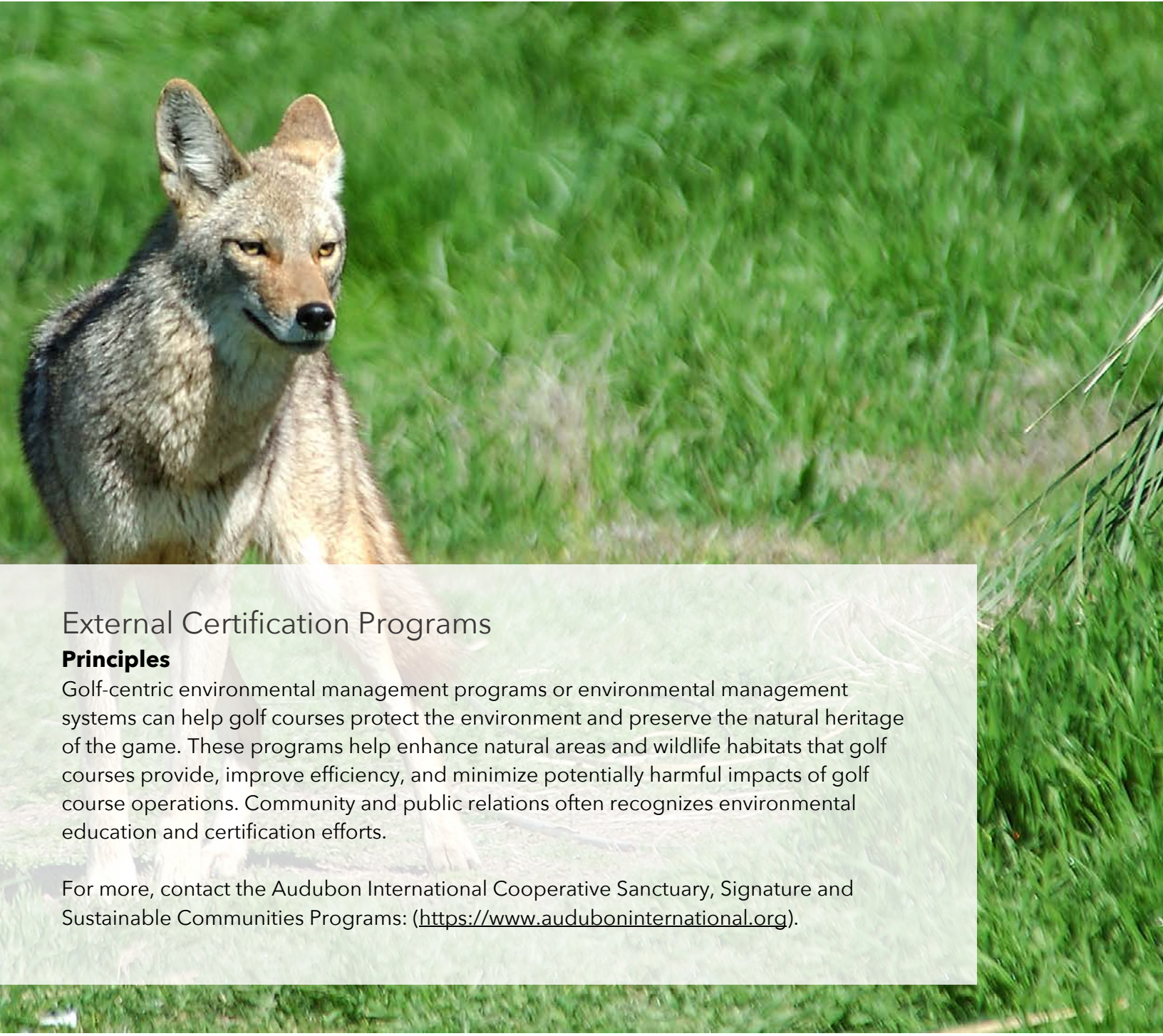
Principles

The maintenance facilities must incorporate BMPs to minimize potential for contamination of soil and water resources. The pesticide mixing and storage facility, the equipment wash pad, and the fuel center are focal points. Work with the Southern Nevada Health Department to design and construct in order to meet common requirements:

- Battery Storage
- Parts washer location and maintenance
- Label all partial containers of chemicals and ensure proper disposal.
- Verify wash rack discharges into sewer line and not back into the environment (https://www.southernnevadahealthdistrict.org/permits-and-regulations/facility-design-assessment-permitting/plan-review-information/clark-county-sanitation-district-criteria-interceptor-requirements/).
- Confirm brush or non-composted course materials are not being stored longer than 24 hours.
- Ensure proper tire storage and disposal.
- Safeguard that oil filters are drained for 24 hours and crushed prior to disposal
- Keep Hazardous Materials (SDS) and Fire Department Manifests, 2 copies, 1 in Maintenance Operations Office and 1 in Golf Operations Office.

Best Management Practices Checklist

- ☐ Design and build pesticide storage structures to keep pesticides secure and isolated from the surrounding environment.
- ☐ Store pesticides in a roofed concrete or metal structure with a lockable door.
- ☐ Construct floors of seamless metal or concrete sealed with a chemical-resistant paint.
- ☐ Ensure that flow from floor drains does not discharge directly to the ground and that drains are not connected to the sanitary sewer line or septic system.
- ☐ Equip the floor with a continuous curb to retain spilled materials.
- ☐ Do not store pesticides near burning materials or hot work (welding, grinding), or in shop areas.
- ☐ Provide storage for personal protective equipment (PPE) where it is easily accessible in the event of an emergency, but do not store in the pesticide storage area.
- ☐ In constructing a concrete mixing and loading pad, it is critical that the concrete have a water-to-cement ratio no higher than 0.45:1 by weight.
- ☐ Maintain a Chemical Spill Kit on site.
- ☐ Clean up spills immediately! Mechanical Protection Guidelines [PDF, 996.4KB] 1994, manual describing how to deploy booms, barriers and other mechanical protection devices during a spill response. (http://www.response.restoration.noaa.gov)
- ☐ Ensure that workers always use all personal protection equipment as required by the pesticide label and are provided appropriate training.
- ☐ Any material that collects on the pad must be applied as a pesticide according to the label or disposed of as a (potentially hazardous) waste according to state laws and regulations.
- ☐ Always store nitrogen-based fertilizers separately from solvents, fuels, and pesticides, since many fertilizers are oxidants and can accelerate a fire. Ideally, fertilizer should be stored in a concrete building with a metal or other type of flame-resistant roof.
- ☐ Sweep up any spilled fertilizer immediately.
- ☐ Each piece of equipment should have an assigned parking area. This allows oil or other fluid leaks to be easily spotted and attributed to a specific machine so that it can be repaired.
- ☐ Use a service to remove the old solvents and dispose of them properly.
- ☐ Design pesticide storage to keep pesticides secure and isolated from the environment.
- ☐ Provide adequate space and shelving to segregate herbicides, insecticides, and fungicides.
- ☐ Use shelving made of plastic or reinforced metal. Keep metal shelving painted.
- ☐ Provide appropriate exhaust ventilation and an emergency wash area.
- ☐ Always place dry materials above liquids, never liquids above dry materials.
- ☐ Never place liquids above eye level.
- ☐ Locate operations well away from groundwater wells and areas where runoff may carry spilled pesticides into surface waterbodies.
- ☐ Do not build new facilities on potentially contaminated sites.
- ☐ An open building must have a roof with a substantial overhang (minimum 30° from vertical, 45° recommended) on all sides.
- ☐ The sump should be small and easily accessible for cleaning.
- ☐ Assess the level of training and supervision required by staff.
- ☐ Always store fertilizers in an area that is protected from rainfall. The storage of dry bulk materials on a concrete or asphalt pad may be acceptable if the pad is adequately protected from rainfall and from water flowing across the pad.
- ☐ Do not wash equipment unnecessarily.
- ☐ Clean equipment over an impervious area, and keep it swept clean.
- ☐ Brush or blow equipment with compressed air before, or instead of, washing.
- ☐ Use spring shutoff nozzles.
- ☐ Use a closed-loop recycling system for wash water.
- ☐ Recycle system filters and sludge should be treated and disposed appropriately.
- ☐ Use solvent-recycling machines or water-based cleaning machines to cut down on the use of flammable and/or toxic solvents.



External Certification Programs

Principles

Golf-centric environmental management programs or environmental management systems can help golf courses protect the environment and preserve the natural heritage of the game. These programs help enhance natural areas and wildlife habitats that golf courses provide, improve efficiency, and minimize potentially harmful impacts of golf course operations. Community and public relations often recognizes environmental education and certification efforts.

For more, contact the Audubon International Cooperative Sanctuary, Signature and Sustainable Communities Programs: (https://www.audubonintemational.org).

Best Management Practices

- Obtain and review materials to ascertain whether the facility should or could seek certification.
- Work with staff to establish facility goals that lead to certification.
- Usually requires several phases to complete the requirements to achieve certification
- Establish goals to educate members about the certification program.
- Present to owners to determine if they want to pursue and discuss required changes to operations, facilities and design to facilitate certification requirements. No need to proceed if you do not have backing from the principals.

Wildlife Considerations

Principles

- Golf courses occupy large land areas, generally in urban areas, providing critical links between urban and rural/natural environments.
- Maintaining wildlife habitat on golf courses better maintains biological diversity, which is especially important in the urban environment.
- Most golfers enjoy observing non-threatening wildlife as they play the game.

Best Management Practices

Required | **Recommended** | **Exceeds**

- ☐ Identify the different types of habitat specific to the site.
- ☐ Identify the habitat requirements (food, water, cover, space) for identified wildlife species.
- ☐ Identify species on the site that are considered threatened or endangered by the federal or state government, including species the state deems "of special concern."
- ☐ Preserve critical habitat.
- ☐ Identify and preserve regional wildlife and migration corridors.
- ☐ Avoid or minimize crossings of wildlife corridors. Design unavoidable crossings to accommodate wildlife movement.
- ☐ Design and locate cart paths to minimize environmental impacts. Construct the paths of permeable materials, if possible.
- ☐ Remove nuisance and exotic/invasive plants and replace them with native species that are adapted to a particular site.
- ☐ Maintain clearance between the ground and the lowest portion of a fence or wall to allow wildlife to pass, except in areas where feral animals need to be excluded.
- ☐ Retain dead tree snags for nesting and feeding sites, provided they pose no danger to people or property.
- ☐ Construct and place birdhouses, bat houses, and nesting sites in out-of-play areas.
- ☐ Plant butterfly gardens around the clubhouse and out-of-play areas.
- ☐ Retain riparian buffers along waterways to protect water quality and provide food, nesting sites, and cover for wildlife.
- ☐ Minimize stream or river crossings to protect water quality and preserve stream banks.
- ☐ Retain riparian buffers along waterways to protect water quality, provide food, nesting sites, and cover for wildlife.

Financial Capital Plan | How to Budget for Approvals

Principles

Golf Course Construction and Maintenance operations are extremely site and end-user specific. For example, the budgetary requirements are vastly different between a nine-hole municipal course and a high-end PGA tournament hosting facility. Because each facility could have extremely different resources these are a few questions to consider when making a budget for your facility.

Best Management Practices

- "Grow-In" budget should be separate from regular maintenance budget due to fertilizer and chemical requirements are increased during establishment.
- Size of area that will require maintenance.
- Areas that will be "naturalized"
- Topography of area that will require maintenance, highly sloped areas may require special equipment to maintain.
- Number and types of equipment needed.
- Number of Personnel required, Regular Payroll, Overtime Payroll, Vacation Payroll, Payroll Taxes
- Potential Employee pool (locals) skilled or unskilled and training required.
- Varieties of Turf to be managed for the environment. Cool season turf may require more chemical inputs than warm season turf.
- Operating expenses to include, Insecticides, Herbicides, Fungicides, Fertilizers, Sand, Seed/Sod, Equipment repairs and maintenance, Equipment Rental, Small Equipment, General Supplies, Postage/Freight, Telephone/Cable/Internet, Uniforms, Licenses or Permits, Gasoline and Lubricants, Irrigation Parts/Repairs, Hand Tools, Vehicle Expense, Security, Water/Sewer, Refuse removal, Roads/Paths Maintenance, Extraordinary Expenses
- Overseeding requirements.
- Water resources, effluent or potable, water holding capacity.
- Irrigation system, HDPE statistically fewer repairs than PVC.
- Educational opportunities for superintendent and training for staff.
- Professional organizations and certification programs.

2.0 Irrigation

> The purpose of this section is to identify BMPs related to water use that conserve and protect water resources, demonstrating responsible environmental stewardship.

The supplemental use of water for course play and non-play areas is essential to supporting healthy turfgrass and landscape plant health. It is also necessary to sustaining optimal course playability, aesthetics, marketability, and club membership participation.

It is important to keep in mind that, while new technology makes many tasks easier or less labor-intensive, the principles discussed in this section are important to understand and apply to protect water quality and quantity and surrounding natural resources.

Additionally, irrigation BMPs may provide an economic, regulatory compliance, and environmental stewardship advantage to those who consider them part of their irrigation management plan. BMPs are not intended to increase labor or place an undue burden on the owner/superintendent. If applied appropriately, BMPs can help stabilize labor cost, extend equipment life, and limit repair and overall personal and public liability.

Behaviors associated with BMPs cost little-to-nothing to implement in a daily course water-use plan. Other advantages to using BMPs include reduced administrative management stress, improved employee communication and direction, and effective facilities training procedures. Working with an Irrigation Architect or Certified Irrigation Auditor may prove useful.

Irrigation BMP Benefits

- **Conserving the water supply while maintaining acceptable salt balances**
- **Protecting existing water quality**
- **Demonstrating responsible environmental stewardship**
- **Maintaining optimal ball roll and playing conditions**
- **Saving water and electricity**
- **Increasing pump and equipment life longevity**
- **Retaining knowledgeable and effective employees**

Water Management Approaches

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.

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 (water rights), permitting guidelines, and other requirements allowed by regulators, including water budgets.
- Reference additional Best Management Practices for Regulatory Considerations on the Las Vegas Valley Water District Website https://www.lvvwd.com/customer-service/water-service/service-rules.html.
- Superintendents have a responsibility to adhere to water-quality standard rules regarding groundwater and surface water flows resulting from the removal of water for irrigation use.

Best Management Practices

- ☐ Develop an annual water budget for the golf course that differentiates the cool season and warm season grass periods.
- ☐ 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 maximum efficiency.
- ☐ 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.
- ☐ Look for ways to increase efficiency and reduce energy use associated with irrigation systems and practices, such as cleaning filters, leveling sprinkler heads, checking for distribution patterns and testing for irrigation uniformities.
- ☐ 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); if using reuse water the water budget must include watering to keep soil salinity levels below threshold values.

Irrigation Water Suitability

Principles

- Golf course designers and managers should endeavor to identify and use alternative supply sources to conserve freshwater drinking supplies, promote plant health, and protect the environment.
- The routine use of potable water supply is not a preferred practice; therefore, 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 waterbodies or flows on, near, and under the property. These maybe helpful to properly design a course's stormwater systems, water features, and to protect water resources.
- When necessary, water system treatment options should be included in the budget to address water quality and equipment maintenance, this would include removal of specific ions and adjusting pH.

Best Management Practices

- ☐ Reclaimed, effluent, and other non-potable water supply mains must have a thorough cross-connection and backflow prevention device in place and operating correctly. The Nevada Department of Environmental Protection (https://ndep.nv.gov/)
- ☐ Post signage in accordance with local utility and state requirements when reclaimed water is in use as required by Effluent Management Plans, Regulatory Agencies, and water providers
- ☐ Monitor the quantity of water withdrawn to avoid aquatic life impairment.
- ☐ Identify appropriate water supply sources that meet seasonal and bulk water allocations for grow-in and routine maintenance needs.
- ☐ Follow Discharge Monitoring Report (DMR) requirements quarterly when using reclaimed water https://ndep.nv.gov/uploads/water-wpc-resources-publications-docs/wts1b-rev-10-2017.pdf
- ☐ Account for the nutrients in effluent (reuse/reclaimed) water when making fertilizer calculations. Part of the nitrogen loading annual reporting for golf courses using reclaimed water.
- ☐ Monitor reclaimed water tests regularly for dissolved salt content.
- ☐ Effluent Management Plans (or Reclaimed Water Management Plans) should have a section on Spill Reporting & Response Guidelines
- ☐ Use alternative water supplies/sources that are appropriate and sufficiently available to supplement water needs.
- ☐ Use salt-tolerant varieties of turf and plants to mitigate saline conditions resulting from alternative water supply or source. Minimize foliar spray to canopy of shrubs and trees.
- ☐ Amend 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. Winter time is an ideal time to achieve adequate leaching to maintain a favorable salt balance
- ☐ Monitor salt buildup in the soil using salinity sensors.
- ☐ Routinely monitor shallow groundwater table of freshwater for saltwater intrusion or contamination of heavy metals and nutrients.
- ☐ Work toward achieving a long-term average of 0.15 along with a Christiansen Uniformity coefficient of 0.85 while growing salt tolerant grasses to reduce salts; where practical, use reverse-osmosis filtration systems to reduce chlorides (salts) from saline groundwater.

References:
Stormwater/Water Quality Section for additional Best Management Practices.

Spill Reporting via the Hotline or an online reporting form:
https://nevadaenvironmentalactivities.ndep.nv.gov/Spill/ReportForm.aspx

NDEP's Publications & Technical Guidance (e.g. golf courses, which apply reclaimed water):
https://ndep.nv.gov/water/water-pollution-control/resources/publications-technical-guidance

Water Conservation and Efficient Use Planning

Principles

- Document actual watering practices, especially to show savings in water use over averages. Communication should be maintained with water managers, golf course members, and the public to explain what you are doing and why.
- BMPs and educational programs are necessary to change the public's mind-set toward the inevitable changes in water-related issues.

Collaboration and Conservation

Potable water supplies in Nevada are limited, and demand continues to grow. Our challenge is to find solutions to maintain the quality of golf while using less water. Collaboration with partners such as the Desert Research Institute (DRI) can help with this aspect of the BMP. For example, reducing irrigation water use by improving irrigation scheduling.

- Some courses are being designed using a "target golf" concept that minimizes the acreage of irrigated turf. Existing golf courses can make an effort to convert out-of-play areas of turf to naturally adapted native plants, grasses, or ground covers to reduce water use and augment the site's aesthetic appeal.
- The Southern Nevada Water Authority offers rebates to end users who reduce water consumption and/or improve irrigation efficiency. The Water Smart Landscapes Rebate (https://www.snwa.com/rebates/wsl/index.html) and the Smart Irrigation Controller Rebate (https://www.snwa.com/rebates/clock/index.html) are two examples.

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 are options which require minimal 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.
- ☐ During a drought, closely monitor soil moisture levels. Whenever practicable, irrigate at times when the least amount of evaporative loss will occur.
- ☐ Control invasive plants or plants that use excessive water.

Irrigation System Design

Principles

- A well-designed irrigation system should operate at peak efficiency to reduce energy, labor and natural resources.
- Irrigation systems should be properly designed and installed to improve water use efficiency.
- An efficient irrigation system maximizes water use, reduces operational cost, conserves supply and protects water resources.

Best Management Practices

- ☐ Design should account for optimal distribution efficiency and effective root-zone moisture coverage. Target 65 to 75 percent or greater Distribution Uniformity (DU) or 0.85 Christiansen Uniformity Coefficient.
- ☐ Application rate must not exceed the infiltration rate, ability of the soil to absorb and retain water applied during any one application. Conduct saturated hydraulic conductivity tests to understand field variability for insight into irrigation run duration before runoff occurs.
- ☐ Consider water storage capacity to ensure water is not lost from the root zone due to lack of capacity and gravity loss; and water added by irrigation is able to be utilized so it does not drain out of the root zone.
- ☐ The design operating pressure must not be greater than the available source pressure; it must account for peak-use times and supply line pressures at final buildout for the entire system.
- ☐ System should be flexible enough to meet site's peak water requirements and allow for operating modifications to meet seasonal irrigation changes or local restrictions.
- ☐ Design should account for need to leach out salt buildup on greens from poor-quality water sources with access to freshwater.
- ☐ Construction and materials must meet existing standards and criteria; only qualified specialists should install the irrigation system.
- ☐ Permanent irrigation sprinklers and other distribution devices should be spaced according to manufacturer's recommendations and individual valve and head control. Check line and head spacing against blueprints within the first month after installation to request adjustments from installation company.
- ☐ Distribution devices and pipe sizes should be designed for optimal uniform coverage.
- ☐ First and last distribution device should have no more than 10 percent difference in flow rate; usually corresponds to ~20 percent difference in pressure.
- ☐ Design water supply systems (i.e.; wells, pipelines) 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.
- ☐ Flow velocity must be 5 feet per second or less.
- ☐ Pipelines should be designed to provide the appropriate pressure required for maximum irrigation uniformity. Installing pressure gages throughout the entire irrigation system (pump to head) is recommended.
- ☐ Pressure-regulating or compensating equipment must be used when system pressure exceeds manufacturer's recommendation.
- ☐ Equipment with check valves must be used in low areas to prevent low head drainage.
- ☐ Use part-circle or adjustable heads to avoid overspray of impervious areas (i.e. roadways/sidewalks); required by many Effluent Management Plans, Regulatory Agencies, and water suppliers.
- ☐ Turf and landscape areas should be zoned separately (hydrazones). Specific use areas zoned separately; greens, tees, primary roughs, secondary roughs, fairways, native, trees, shrubs, etc.
- ☐ Design should allow the putting surface and slopes and surrounds to be watered independently.
- ☐ Design package should include a general irrigation schedule with recommendations and instructions on modifying the schedule for local climatic soil and growing conditions. It should include base ET rate for the location. If possible a weather station should be installed with capability to assess environmental demand (Penman Monteith equation).
- ☐ Construction must be consistent with the design; designer must approve any design changes before construction.
- ☐ Prior to construction, underground cables, pipes, and other obstacles must be identified, and locations flagged.
- ☐ Spacing should be based on average wind conditions during irrigation.
- ☐ For variable wind directions, triangular spacing is more uniform than square spacing.
- ☐ Distribution equipment (i.e. sprinklers, rotors, micro-irrigation devices) in a given zone must have the same precipitation rate.
- ☐ Heads for turf areas should be spaced for head-to-head coverage.
- ☐ Isolation valves should be installed in a manner that allows critical areas to remain functional.
- ☐ Manual quick-coupler valves should be installed near greens, tees, bunkers so they can be hand-watered during droughts.
- ☐ Install part-circle heads along lakes, ponds, and wetlands margins.
- ☐ Ensure heads are set at level ground and not on slopes.
- ☐ Update multi-row sprinklers with single head control to conserve water and to enhance efficiency.
- ☐ Incorporate multiple nozzle configurations to add flexibility and enhance efficiency/distribution.
- ☐ Conduct ongoing individual head irrigation audit.

Irrigation Pumping System

Principles

- Pump stations should be sized to provide adequate flow and pressure. They should be equipped with control systems that protect distribution piping, provide for emergency shutdown necessitated by line breaks, and allow maximum system scheduling flexibility.
- Variable frequency drive (VFD) pumping systems should be considered if dramatically variable flow rates are required, if electrical transients (such spikes and surges) are infrequent, and if superintendent has access to qualified technical support.
- Design systems for energy conservation.

Best Management Practices

Required **Recommended** **Exceeds**

- ☐ The design operating pressure must not be greater than the available source pressure.
- ☐ The design operating pressure must account for peak-use times and supply-line pressures at final buildout for the entire system.
- ☐ Maintain the 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 also have high- and low-pressure sensors that shut down the system in case of breaks and malfunctions. Consider variations in elevation.
- ☐ Pumps should be sized to provide adequate flow and pressure.
- ☐ The wet well should have an adequately sized intake screen to allow for maximum flow.
- ☐ Pumps should be equipped with control systems to protect distribution piping.
- ☐ System checks and routine maintenance on pumps, valves, programs, fittings, and sprinklers should follow the manufacturer's recommendations.
- ☐ 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.
- ☐ Conduct quarterly pump station preventative maintenance.

Irrigation System Program and Scheduling

Principles

- Irrigation scheduling must take plant water requirements, hydraulic conductivity and storage capacity, and soil infiltration capacity into account to prevent excess water use that could lead to leaching and runoff (although leaching to maintain favorable salt balance is appropriate).
- Plant water needs are determined by evapotranspiration (ET) rates, recent rainfall, recent temperature extremes and soil moisture.
- Irrigation should not occur on a calendar-based schedule but should be based on ET rates and soil moisture replacement. Run a simple, daily water balance based on precipitation, ET, soil water storage and drainage to determine irrigation need.
- 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, or to periodically flush the soil profile with water to avoid salinity issues in the root zone.
- Responsible irrigation management conserves water and reduces nutrient and pesticide movement.
- Time-clock-controlled irrigation systems preceded computer-controlled systems, and many are still in use today. Electric/mechanical time clocks cannot automatically adjust for changing ET rates. Frequent adjustment is necessary to compensate for the seasonal needs of individual turfgrass areas.

Best Management Practices

- ☐ An irrigation system should have rain sensors to shut off the system after 0.25 to 0.5 inch of rain. Computerized systems allow a superintendent to call in and cancel the program if determined that the course has received adequate rainfall; required by many Effluent Management Plans, Regulatory Agencies, and water providers.
- ☐ Install emergency shutdown devices to address line breaks as required by many Effluent Management Plans, Regulatory Agencies, and water providers.
- ☐ Irrigation quantities should not exceed the available moisture storage in the root zone. Ideally, moisture storage is monitored in terms of soil water content as well as suction or water potential.
- ☐ Irrigation rates should not exceed the maximum ability of the soil to absorb and hold the water applied at any one time unless leaching for salinity control is the objective.
- ☐ Account for nutrients in effluent supply when making fertilizer calculations.
- ☐ Irrigation should occur in the early morning hours before air temperatures rise and relative humidity drops.
- ☐ Base plant water needs should be determined by ET, recent rainfall and temperature extremes, and soil moisture.
- ☐ Use mowing, verticutting, aeration, nutrition, and other cultural practices to control water loss and to encourage conservation and efficiency. Nitrogen stimulates growth which is associated with higher ET rates – reducing nitrogen can be used as an effective water conservation option - savings have to be captured by reducing water applications and the grass should be visually assessed for color, density and water stress.
- ☐ Visually monitor for localized dry conditions or hot spots to identify poor irrigation efficiency or a failed device.
- ☐ The reliability of older clock-control station timing depends on the calibration of the timing devices; this should be done periodically, but at least seasonally.
- ☐ Reducing dry spots and soil compaction improves water infiltration, which reduces use and runoff in other areas.
- ☐ Avoid use of a global setting; make adjustments to 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.
- ☐ Use computed daily ET rate to adjust run times to meet the turf's moisture needs.
- ☐ Manually adjust automated ET data to reflect wet and dry areas on the course.
- ☐ Use soil moisture sensors to assist in scheduling or to create on-demand irrigation schedules; e.g. soil water suction or potential measurements (e.g. by using tensiometers).
- ☐ Install control devices to allow for maximum system scheduling flexibility.
- ☐ Generally, granular fertilizer applications should receive 0.25 inch of irrigation to move the particles off the leaves while minimizing runoff.
- ☐ Irrigation schedule should coincide with other cultural practices (for example, the application of nutrients, herbicides, or other chemicals).
- ☐ Use predictive models to estimate soil moisture and the best time to irrigate.
- ☐ Use multiple soil moisture sensors to reflect soil moisture levels.
- ☐ Install soil moisture sensors in the root zone for each irrigation zone to enhance timer-based run times. Use tensiometers in tree basins to asses soil water status and direction of water movement (upward vs. downward).
- ☐ Place soil moisture sensors in a representative location within irrigation zone; install soil moisture sensor in the driest zone of the system. Wired soil moisture systems should be installed to prevent aerification damage.
- ☐ Periodically perform an irrigation audit.

Turf Drought Response

Principles

- The presence of visual symptoms of moisture stress is a simple way to determine when irrigation is needed.
- Use a soil moisture meter to determine moisture needs of greens and tees.
- Managers of golf greens cannot afford to wait until symptoms occur, because unacceptable turf quality may result.
- Be prepared for extended drought/restrictions by developing a written drought management plan.

Reference Water Conservation Section for additional BMPs.

Best Management Practices

- ☐ Create a drought management plan for the facility that identifies steps to reduce irrigation/water use and protects critical areas, etc. as required by many Effluent Management Plans, Regulatory Agencies, and water providers.
- ☐ Waiting until visual symptoms appear before irrigating is a method best used for low-maintenance areas, such as golf course roughs and possibly fairways.
- ☐ Use soil moisture meters to determine moisture thresholds and plant needs. This will require knowing how the soil varies on the course as each soil type will have a different soil moisture threshold and each plant species will have a different threshold.
- ☐ Soil moisture monitoring with water suction/potential sensors may provide early warning signs for drought symptoms. Water suction/potential is a direct measure for water stress of the plants.
- ☐ Over-irrigating (keeping the soil profile close to or at water saturation most of the time) fosters shallow rooting (no deep rooting possible due to the lack of oxygen when the soil is saturated); irrigating too shallow encourages shallow rooting, increases soil compaction, and favors pest outbreaks.
- ☐ For golf greens and tees, the majority of roots are in the top several inches of soil.
- ☐ For fairways and roughs, use infrequent, deep irrigation to supply sufficient water for plants and to encourage deep rooting.
- ☐ Proper cultural practices such as mowing height, mechanical cultivation, irrigation frequency, and irrigation amounts should be employed to promote healthy, deep root development and reduce irrigation requirements.
- ☐ Use appropriate turfgrass species adapted to the location of the golf course being managed.
- ☐ Consider use of wetting agents (if areas show hydrophobicity and runoff occurs quickly) to make water more efficient.

Irrigation System Quality

Principles

- Irrigation system maintenance on a golf course involves four major efforts: calibration or auditing, preventive maintenance (PM), corrective maintenance, and record keeping.
- Personnel charged with maintaining any golf course irrigation system face numerous challenges. This is particularly true for courses with older or outdated equipment.
- Good system management starts with good preventive maintenance (PM) procedures and recordkeeping. Maintaining a system is more than just fixing heads.
- Corrective maintenance is simply the act of fixing what is broken. It may be as simple as cleaning a clogged orifice, nozzle replacement, and proper sizing or as complex as a complete renovation of the irrigation system.
- As maintenance costs increase, the question of whether to renovate arises. Renovating a golf course irrigation system can improve system efficiencies, conserve water, improve playability, and lower operating costs.

Best Management Practices

Required **Recommended** **Exceeds**

- ☐ 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, programs, fittings, and sprinklers should follow the manufacturer's recommendations.
- ☐ The system should be inspected daily 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.
- ☐ Systems need to be observed in operation at least weekly. 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.
- ☐ 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 changes, as this could be an early sign of system corrosion, well problems, or declining irrigation water quality.
- ☐ 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.
- ☐ Document equipment run-time hours. Ensure that all lubrication, overhauls, and other preventive maintenance are completed according to the manufacturer's schedule.
- ☐ Gather together all of the documentation collected as part of the PM program, along with corrective maintenance records for analysis.
- ☐ Correctly identifying problems and their costs helps to determine what renovations are appropriate.
- ☐ Collecting information on the cost of maintaining the system as part of system overall evaluation, allows for planning necessary upgrades, replacement etc. and comparison after changes are made.

Pond Location and Design

Principles

- Understanding natural lake processes and accommodating them in the design and management of a pond can create significant aesthetic value and reduce operational costs.
- Lakes and ponds have several distinct defining characteristics. Their size, shape, and depth may all affect how they respond to various environmental inputs.
- Most golf courses plan their lakes and water hazards to be a part of the stormwater control and treatment system. This usually works well for all concerned. However, natural waters may not be considered treatment systems and must be protected.
- Lakes and ponds may be used as a source of irrigation water. It is important to consider these functions when designing and constructing the ponds.
- Careful design may significantly reduce future operating expenses for lake and aquatic plant management.

Reference Water Conservation Section for additional Best Management Practices.

Best Management Practices

- ☐ Consult with a qualified golf course architect, working in conjunction with a stormwater engineer, to develop an effective stormwater management system that complies with the requirements of the water management district/department or other permitting agency.
- ☐ 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.
- ☐ 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

Principles

- Successful pond management should include a clear statement of goals and priorities to guide the development of the BMP necessary to meet those goals. Some of the challenges facing superintendents in maintaining the quality of golf course ponds are as follows:
    - Low Dissolved Oxygen (DO)
    - Sedimentation
    - Changes in plant populations
    - Nuisance vegetation
    - Maintenance of littoral shelves
    - Vegetation on the lakeshore
- 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 for the manager 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.
- 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.
- Pond leaks should be controlled and managed properly.
- Use an expert in aquatic management to help develop and monitor pond management programs.

Best Management Practices

- ☐ Maintain appropriate silt fencing and BMP on projects upstream to reduce erosion and the resulting sedimentation.
- ☐ 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.
- ☐ Prevent overthrowing fertilizer into ponds. Practice good fertilizer management to reduce nutrient runoff into ponds, which causes algae blooms and ultimately reduces DO levels.
- ☐ Dispose of grass clippings where runoff will not carry them back to the lake.
- ☐ Maintain water flow through lakes, if they are interconnected.
- ☐ Manipulate water level to prevent low levels resulting in warmer temperatures and lowered DO levels.
- ☐ Reduce the frequency of mowing at the lake edge and collect or direct clippings to upland areas.
- ☐ Establish a special management zone around pond edges.
- ☐ Encourage clumps of native emergent vegetation at the shoreline.
- ☐ Establish wetlands where water enters lakes to slow water flow and trap sediments

Pond Water-Level Monitor

Principles

Evaporation losses are higher in some regions than others and vary from year to year and within the year. However, evaporative losses could approach 6 inches per month during the summer. Aquatic plants are more difficult to control in shallow water.

Best Management Practices

- ☐ A pond should hold surplus storage of at least 10 percent.
- ☐ 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 recommended depth of pond.

Metering

Principles

- 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 actually 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 irrigation 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– both downstream and upstream per the manufacturer's recommendations– to prevent turbulence and bad readings.
- ☐ Flow meters can be used to determine how much water is applied.

Irrigation Leak Detection

Principles

- **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 more downtime for older systems. A good preventive maintenance program is very important.**

Best Management Practices

Required | **Recommended** | **Exceeds**

- ☐ Monitor water meters or other measuring devices for unusually high or low readings to detect possible leaks or other problems in the system. Make any needed repairs.
- ☐ An irrigation system should also have high and low-pressure sensors that shut down the system in case of breaks and malfunctions.
- ☐ The system should be monitored daily for malfunctions and breaks. It is also a good practice to log the amount of water pumped each day.
- ☐ Ensure that control systems provide for emergency shutdowns caused by line breaks and allow maximum system scheduling flexibility.
- ☐ 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.

System Maintenance

Principles

- Course owners/superintendents do routine maintenance to ensure water quality and responsible use of the water supply.
- System checks and routine maintenance include: pumps, valves, programs, fittings, and sprinklers.
- To ensure that it is performing as intended, an irrigation system should be calibrated regularly by conducting periodic irrigation audits to check actual water delivery and nozzle efficiency.

Best Management Practices

- ☐ Inspect the backflow device to determine that it is in place and in good repair.
- ☐ 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 and flow should be evaluated to determine that the correct nozzles are being used and that the heads are performing according to the manufacturer's specifications.
- ☐ Catch-can tests should be run to determine the uniformity of coverage and to accurately determine irrigation run times.
- ☐ Inspect for interference with water distribution.
- ☐ Inspect for broken and misaligned heads.
- ☐ Check that the rain sensor is present and functioning.
- ☐ Examine turf quality and plant health for indications of irrigation malfunction or needs for scheduling adjustments.
- ☐ Schedule documentation; make adjustments and repairs on items diagnosed during the visual inspection before conducting pressure and flow procedures.
- ☐ Pressure and flow rates should be checked at each head to determine the average application rate in an area.
- ☐ Catch-can testing should be conducted on the entire golf course to ensure that the system is operating at its highest efficiency.
- ☐ Conduct an irrigation audit annually to facilitate a high-quality maintenance and scheduling program for the irrigation system.
- ☐ Irrigation audits should be performed by trained technicians.

Preventive Maintenance

Regular system maintenance and updates supports proper operations, energy efficiencies, cost reduction, and conservation.

- In older systems, inspect irrigation pipe and look for fitting breaks caused by surges in the system.
- Install thrust blocks or joint restraints 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. 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.
- Maintain air-relief and vacuum-breaker valves.
- Systems need to be observed in operation at least weekly to detect controller or communication failures, stuck or misaligned heads, and clogged or broken nozzles.
- Check filter operations frequently; operating properly prolongs life of system and reduces pumping costs.
- Keep records of filter changes, as this could be an early sign of system corrosion, well problems, or declining irrigation water quality.
- 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 the 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.
- Monitor and record the amount of water being applied, including system usage and rainfall. By tracking this information, you can identify areas where minor adjustments can improve performance.
- 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.
- 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 the 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 benefits both financial and management.

Winterization and Spring Startup

Principles

Winterization of the irrigation system is important to protect the system and reduce equipment failures resulting from freezing.

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.
- Conduct a catch-can test to audit the system.
- 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.
- Recharge irrigation in the spring with water and inspect for corrective maintenance issues.
- Ensure proper irrigation system drainage design.

Sensor Technology

Principles

- To prevent excess water use, irrigation scheduling should take into account plant water requirements, recent rainfall, recent temperature extremes, and soil characteristics.
- 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 in representative locations and maintained to provide the information necessary for making good irrigation management decisions. i.e. by providing input for a water balance model.
- Rain gauges are necessary measurement tools to track how much rain has fallen at a specific site on the golf course. On some courses, more than one station may be necessary to get a complete measure of rainfall or evaporation loss. The use 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. Models, however, are only as effective as the amount of data collected and the number of assumptions made.
- It is best to have an on-site weather station to daily access weather information and ET to determine site specific water needs.

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.
- Irrigation rates should not exceed the maximum ability of the soil to absorb and hold the water applied in any one application.
- Irrigation should not occur on a calendar-based schedule but should be based on ET rates and soil moisture replacement.
- Computerized control systems should be installed on all new course irrigation systems to help ensure efficient irrigation application. These allow for timing adjustments at every head.
- Rain shut-off devices and rain gauges should be placed in open areas to prevent erroneous readings.
- Use multiple soil moisture sensors/meters for accuracy and to capture spatial variability of the soil to reflect soil moisture levels over the entire golf course.

Maintained Turf Areas

Principles

Courses should use well-designed irrigation systems with precision scheduling 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.

Best Management Practices

- The irrigation system should be designed and installed so that the putting surface, slopes, and surrounding areas can be watered independently.
- Account for nutrients in effluent supply when making fertilizer calculations.
- Install part-circle heads that conserve water and reduce unnecessary stress to greens and surrounds.
- Avoid use of a global setting; make adjustments to 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.
- Use computed daily ET rate to adjust run times to meet the turf's moisture needs.
- Manually adjust automated ET data to reflect wet and dry areas on the course.
- Install rain switches to shut down the irrigation system if enough rain falls in a zone.
- Use soil moisture sensors to bypass preset or to create on-demand irrigation schedules.
- Permanent irrigation sprinklers and other distribution devices should be spaced according to the manufacturer's recommendations.
- Spacing should be based on average wind conditions during irrigation.
- Triangular spacing is more uniform than square spacing.
- Periodically perform catch-can uniformity tests.
- Reducing dry spots and soil compaction improves water infiltration, which in turn reduces water use and runoff in other areas.
- Irrigation should occur in early morning hours before air temperatures rise and relative humidity drops; also plant water uptake sets around sunrise. I.e. the smaller the temporal gap between irrigation water application and water uptake by the plants, the less water loss due to drainage.
- Base plant water needs on evapotranspiration rates, recent rainfall, recent temperature extremes and soil moisture.
- Use mowing, verticutting, aeriation, wetting agents, nutrition, and other cultural practices to control water loss and to encourage conservation and 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.
- Install in-ground (wireless) soil moisture sensors or use hand-held moisture meters in the root zone for each irrigation zone to enhance scheduled timer-based run times.
- An irrigation system should also have high- and low-pressure sensors that shut down the system in case of breaks and malfunctions.
- Place soil moisture sensors in a representative location of the irrigation zone.
- Install soil moisture sensors in the driest irrigation zone of the irrigation system.
- Wireless soil moisture systems should be installed to prevent damage from aeration.

Non-Play and Landscape Areas

Principles

- Map any environmentally sensitive areas such as sinkholes, wetlands, or flood-prone areas, and identify species classified as endangered or threatened by federal and state governments, and state species of special concern.
- Natural vegetation should be retained and enhanced for non-play areas to conserve water.
- The most efficient and effective watering method for non-turf landscape is micro-irrigation.
- Older golf courses may have more irrigated and maintained acres than are necessary. 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 transitioned into non-play areas.

Best Management Practices

- Designate 50% to 70% of the non-play area to remain in natural cover according to "right-plant, right-place," a principle of plant selection that favors limited supplemental irrigation and on-site cultural practices.
- Incorporate natural vegetation in non-play areas.
- 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.

Wellhead Protection

Principles

- 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 is often a local health department or state department of environmental quality.
- When installing new wells, contact the regulating authority to determine the permitting and construction requirements and the required isolation distances from potential sources of contamination (http://water.nv.gov/waterrights.aspx).
- 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.
- Licensed water-well contractors may be needed to drill new wells to meet state requirements, local government code, and water management districts' well-construction permit requirements.

Best Management Practices

- Use backflow-prevention devices at the wellhead, on hoses, and at the pesticide mix/load station to prevent contamination of the water source.
- Properly plug abandoned or flowing wells.
- Surround new wells with bollards or a physical barrier to prevent impacts to the wellhead.
- Inspect wellheads and the well casing at least annually for leaks or cracks; make repairs as needed.
- Maintain records of new well construction and modifications to existing wells.
- Obtain a copy of the well log for each well to determine the local geology and how deep the well is; these factors will have a bearing on how vulnerable the well is to contamination.
- Sample wells for contaminants according to the schedule and protocol required by the regulating authority.
- 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.

Check regulatory requirements/groundwater protection Nevada Environmental Protection Agency (https://www.epa.gov/nv).

3.0 Water Management Plan

> Nevada golf course superintendents understand that water is a critical natural resource which must be conserved and protected. BMPs address efficient water use and quality through responsible water management planning.

Regulatory Considerations

Golf course owners and superintendents should investigate regulatory requirements that may exist in their location to protect surface and groundwater quality. The Nevada Department of Environmental Protection's (NDEP) mission is to sustain healthy ecosystems and contribute to a vibrant economy. The NDEP is responsible for the protection and monitoring of surface and ground water. Its programs help ensure clean lakes, streams, rivers, and drinking water.

The monitoring process includes permitting for discharges that may impact surface, and ground waters. For more information on state programs visit: https://ndep.nv.gov/water

Become familiar with all regulatory requirements prior to construction or renovation projects. Establish working relationships with regulatory agencies.

Best Management Practices

- ☐ Owners and Superintendents should establish working relationships with: watershed management officials, local utility, and state regulatory agencies.
- ☐ Determine permitting requirements, consult with regulating agencies prior to performing cultural practices to determine an approved management plan.
- ☐ Determine reporting requirement to regulating agencies, frequency, and data required.
- ☐ Golf course owners are responsible for Total Maximum Daily Loading (TMDLs), mitigation, and watershed basin management action plans (BMAP).
- ☐ Wetlands are protected areas; consult with federal and state agencies before altering natural aquatic areas.
- ☐ Constructed wetlands should have an impervious bottom to prevent groundwater contamination.
- ☐ Studies of water supplies are needed for irrigation systems, including studies of waterbodies or flows on, near, and under the property are needed to properly design a course's storm water system and water features to protect water resources.
- ☐ Secondary environmental effects on surface water and groundwater from the chemical control of vegetation should be monitored and recorded.

https://pubs.usgs.gov/fs/2009/3093/
https://www.snwa.com/where-southern-nevada-gets-its-water/groundwater/nevada- water-law.html
http://water.nv.gov/waterrights.aspx

Site Analysis

Principle

A site analysis will examine the site and surrounding areas to determine which of the following components apply. For example, if there is a likelihood of drought or flood management issues: is there potential for surface or groundwater contamination from nutrient or pesticide applications and are the potential receptors (well, facility water supply, hydrologic features, biological resources) that may have a potential impact? The site analysis starts with a comprehensive geo-technical and engineering report, that identifies the site's physical attributes, and location, aesthetics, watershed, and groundwater assessments, as well as other environmental considerations. Clark County Regional Flood Control District resources can provide a great deal of assistance in this process; http://www.ccrfcd.org/rainfall.htm.

Learning as much as you can about your site can help avoid environmental issues in the future. http://www.xyht.com/wp-content/uploads/2016/01/PUTTAR-over-revers-slope-cont.jpg

Best Management Practices

- ☐ Inventory turf, landscape, and lake/aquatic features
- ☐ Indicate impervious surfaces, such as buildings, parking lots, or pathways.
- ☐ Locate and identify the best strategies to protect wellheads.
- ☐ Identify average, 50 and 100-year rain events for the region.
- ☐ Identify position of property in relation to its watershed.
- ☐ Develop comprehensive layered map of the golf course.
- ☐ Identify overall goals and qualify concerns of the local watershed.
- ☐ Identify position of property in relation to its watershed.
- ☐ Indicate surface water and storm water flow patterns.
- ☐ Indicate major drainages and catch basins that connect to local surface water bodies.
- ☐ Identify and understand depth to water tables and soil types.

Water Conservation

Principles

The desert southwest is subject to extended droughts, and sporadic precipitation. Water sources and reservoirs are often recording record low flow and storage during these times. Golf course owners and superintendents should have standard Conservation measures that will help maintain economic viability and establish credibility in the community.

The USGA provides tools to assist in managing water on a golf course.
http://www.usga.org/course-care/water-resource-center/water-management-plans.html

Conservation and Drought Planning are critical to the long-term success of the golf industry and the communities in which golf courses operate. For a template to help visit: http://www.usga.org/content/usga/home-page/course-care/water-resource-center/water-management-plans.html

Best Management Practices

- ☐ Set a water efficiency goal, Planning process and Water conservation approach
- ☐ Site assessment/information to help make informed decisions
- ☐ BMP strategies for water-use efficiency and conservation-current and future
- ☐ Develop a formal Conservation Plan that is approved by course officials.
- ☐ Develop a formal Drought Management Plan approved by course officials (USGA)
- ☐ Educate: community, course officials and staff on Conservation efforts, and Drought Management Plan
- ☐ Adopt the use of technologies that will assist in the efficient application of water: weather stations, soil moisture sensors, rain sensors.

https://www.google.com/search?q=GOLF+COURSE+WATER+CONSERVATION&source=lnms&tbm=isch&sa=X&ved=0ahUKEwirs8-Lt5niAhXYJjQIHSRtB5AQ_AUIDygC&biw=1904&bih=908#imgrc=0aQ5GoTbVXw4GM:

Water Management

In the context of water moving on and through the golf course, water management must be the first consideration during any construction or redesign activity. Planning for times when there is too much water or too little water will prevent reactionary decision-making. Storm water is the conveying force behind what is called nonpoint source pollution. Nonpoint pollution, which is both natural and caused by humans, comes not from a pipe from a factory or sewage treatment plant, but from daily activity. Pollutants commonly found in storm water 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.

Things to Consider:

Flood Management
- **Modification to course during wet or flood conditions**
- **Management of flood waters**

Drought Management
- **Modifications to course operations during extended dry periods**

Storm-water Capture

Principles

- The control of storm water on a golf course is more than just preventing the flooding of the clubhouse, maintenance, and play areas. In addition to controlling the amount and rate of water leaving the course, it involves storing irrigation water, controlling erosion and sediment, enhancing wildlife habitat, removing waterborne pollutants, and addressing aesthetic and playability concerns
- When the golf course is properly designed, rain and runoff captured in water hazards and storm water ponds may provide most or all the supplemental water necessary under normal conditions, though backup sources may be needed during drought conditions.
- Capture systems should be considered part of the overall treatment.
- Storm water capture is desirable where the lowest quality of water is needed to conserve potable water, maintain hydrologic balance, and improve water treatment.
- The USGA has a tool kit to assist in Drought Planning: https://www.google.com/search?q=usga+drought&rlz=1C1GGRV_enUS751US752&oq=USGA+Drought&aqs=chrome.0.69i59j0l2j69i60j0l2.4111j1j8&sourceid=chrome&ie=UTF-8# http://jwzunino.com/wp-content/uploads/2015/11/North-Las-Vegas-Wash-Trail-3.jpg
- Assist in flood management by incorporating hydrologic features, and biological resources into golf course design to store flood waters, increase infiltration and improve water quality.

Best Management Practices

- ☐ Have comprehensive plans in place ready for use that address Flooding or Drought.
- ☐ Implement no or low maintenance vegetative buffer strips around surface waters.
- ☐ Utilize vegetative filter strips in conjunction with water filtration basins.
- ☐ Inspect irrigation pumps, filtration systems, conveyances and control devices to prevent/correct system issues.
- ☐ Install berms and swells to capture pollutants and sediments from runoff before it enters the irrigation storage pond.
- ☐ A backup source of water should be incorporated into the management plan.
- ☐ Ensure that no discharges from pipes go directly to water.
- ☐ Minimize impacts to the site hydrology during construction or renovations.
- ☐ Most golf courses plan their lakes and water hazards to be a part of the storm water control and treatment system. However, natural waters of the state cannot be considered treatment systems and must be protected.
- ☐ Minimize impacts to the site hydrology during construction or renovations.
- ☐ Golf course storm water management should include "natural systems engineering" or "soft engineering" approaches that maximize the use of natural systems to treat water.
- ☐ Employ 'Green Infrastructure" design concepts in parking lots and around hardscapes such as depressed parking lot islands with curb cuts that can catch and filter water: https://www.epa.gov/green-infrastructure/green-infrastructure-design-and-implementation
- ☐ Install water-intake systems that use horizontal wells placed in the subsoil below the storage basin; use a post pump to filter particulate matter. https://www.lid-stormwater.net/

Surface Water Monitoring

It may be in the best interest of the facility to document water quality in preconstruction, (new course) or background water quality (upgradient monitor well or stream sample) to observe conditions without influence of facility operations. Establish an appropriate monitoring (new course) or background water quality (upgradient monitor well or stream sample) to observe conditions without influence of facility operations. Establish an appropriate monitoring network and sampling program to collect representative data downgradient of site (monitor wells) and surface water flowing off site to document observed changes in water quality which may or may not be attributed to operations.

Data can be used to review facility operations to modify nutrient application rate or water use to increase cost effectiveness and reduce chance of impacts to the environment.

Monitoring may be required as part of regulatory permit or may be used to manage and protect the facility from claims of impacts to the environment or to private water supplies.

Principles

- 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.
- Monitoring is used to determine whether outside events are changing the water quality entering the golf course, or whether the golf course is having a positive, neutral, or negative effect on water quality. It also provides a body of evidence on the golf course's environmental impact.
- A water-quality monitoring plan should be prepared to ensure the ongoing protection of groundwater and surface-water quality after construction has been completed. The same sites should be monitored during the preconstruction phase, although the monitoring plan can be modified based on site-specific conditions.
- Sampling parameters are determined based on golf course operation and basin-specific parameters of concern (these may be identified by local/state Total Maximum Daily Load (TMDL) Programs). Typically, samples should be analyzed for nutrients, pH and alkalinity, sediments, and suspended solids, dissolved oxygen (DO), heavy metals, and any pesticides expected to be used on the golf course.
- Ongoing, routine water sampling provides meaningful trends over time. A single sample is rarely meaningful in isolation.
- Post-construction sampling of surface-water quality should begin with the installation and maintenance of golf course turf and landscaping. Samples should be collected a minimum of three times per year.
- If there is 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 during the wet and dry seasons 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.
- 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.
- However, even if the data is only for proprietary use and is not reported to any regulatory agency, it is strongly recommended that a certified laboratory be used, and all QA/QC procedures followed.

A good water quality monitoring plan pre and post construction provides valuable information that will assist in the day to day operation of the golf course.

Best Management Practices

- ☐ Establish baseline water quality levels, pre-construction if possible.
- ☐ Seasonal sampling program (four samples per-year) is recommended.
- ☐ Identify appropriate sampling locations and sample at the same locations.
- ☐ Follow recommended sample collection and analytical procedures, a good resource is the Southern Nevada Water Authority's Water Quality and Research Group: https://waterqualitysnwa.com/
- ☐ Implement corrective procedures if indicated in water quality monitoring reports.
- ☐ Calibrate equipment regularly
- ☐ Use appropriate type of applicator or spreader for fertilizer.
- ☐ Use IPM principles to limit excess use of pesticides.

Water Quality Protection Pond and Lakes

An aquatic plant management strategy should address the intended uses of the waterbody to maintain water quality. Proper documentation of the site's physical attributes and location, the presence of invasive or weedy species, aesthetics, watershed and groundwater assessments, and other environmental considerations.

Principles

- Accommodate natural lake processes in the construction of lakes and ponds; include herbaceous and woody vegetation and emergent and submerged shoreline plants to reduce operational costs.
- Use integrated pest management (IPM) strategies and native or naturalized vegetation wherever practical.

Best Management Practices

- ☐ Outline goals and priorities to guide the development of the BMP necessary to support the lake/aquatic management plan.
- ☐ Develop a separate comprehensive management plan for lake/aquatic features, including areas that drain, flow and surround the features. Include irrigation, fertilization, pesticide application rates equipment used and frequency
- ☐ Use dyes and aeration to maintain appropriate light and DO levels.
- ☐ Avoid the use of trimmers along the edge of the water body.
- ☐ Mow lake and pond collars at a higher height to slow and filter overland flow to waterbodies.
- ☐ Apply appropriate herbicides to minimize damage to non-target littoral plantings.
- ☐ Select algaecides containing hydrogen peroxide instead of copper or endothall to treat high populations of phytoplankton.
- ☐ Maintain a narrow band of open water at the pond edge to control the expansion of plants into more desirable littoral plantings.
- ☐ Spot-treat filamentous algae or frequently remove algae by hand to prevent lowering oxygen concentrations in water.
- ☐ Establish DO thresholds to prevent fish kills (occur at levels of 2 mg/l), for example, use artificial aeration (diffusers).
- ☐ Reduce stress on fish; keep DO levels above 3 mg/l
- ☐ Use appropriate aquatic herbicides to prevent turf injury, protect water quality and wildlife habitat.
- ☐ Apply fertilizer and reclaimed (reuse) irrigation/fertigation appropriately to avoid surface water and groundwater contamination.
- ☐ Apply algaecides to small areas to prevent fish mortality; do not treat the entire pond at once.
- ☐ Irrigation should not directly strike or run off to waterbodies, and no-fertilization buffers should be maintained along water edges.
- ☐ Determine which sites will be analyzed and use reputable equipment and qualified technicians.
- ☐ Demonstrate responsible land and water use practices based on water data.
- ☐ Define data values appropriately based on the associated BMP used to protect water quality.
- ☐ Record observations of fish, wildlife, and general pond conditions.
- ☐ Superintendents should monitor designated waters in their area for the persistence of toxic herbicides and algaecides in the environment.
- ☐ Secondary environmental effects on surface water and groundwater from the chemical control of vegetation should be monitored and recorded.
- ☐ Locate littoral shelves at the pond's inlets and outlets to reduce problems with the playability and maintainability of a water hazard.
- ☐ Coordinate construction/renovation activities to minimize the amount of disturbed area and possible risk of contamination via runoff.
- ☐ Plan construction/renovation activities in phases to limit soil disruption and movement.
- ☐ Remove excess sediments to reduce irrigation system failures.]
- ☐ Treat dredged materials as a toxic substance. Avoid contact with turf.
- ☐ Locate littoral shelves at the pond's inlets and outlets to reduce problems with the playability and maintainability of a water hazard.

Pond and Lakes

Principles

- Outline goals and priorities to guide the development of the BMP necessary to support the lake/aquatic management plan.
- Lakes and ponds may also be used as a source of irrigation water.
- It is important to consider these functions when designing and constructing the ponds. Peninsular projections and long, narrow fingers may prevent mixing. Ponds that are too shallow may reach high temperatures, leading to low oxygen levels and promoting algal growth and excess sedimentation.
- An aquatic plant management strategy should address the intended uses of the waterbody to maintain water quality. Proper documentation of the site's physical attributes and location, the presence of invasive or weedy species, aesthetics, watershed and groundwater assessments, and other environmental considerations.
- Only licensed individuals or contractors should be allowed to select and apply aquatic pesticides.
  http://public.media.smithsonianmag.com/legacy_blog/marsh.jpg

Best Management Practices

- ☐ Use IPM principles to limit excess use of pesticides
- ☐ Install swales and slight berms where appropriate around the water's edge, along with buffer strips, to reduce nutrients and contamination.
- ☐ Design storm water treatment trains to direct storm water across vegetated filter strips (such as turf grass), through a swale into a wet detention pond, and then out through another swale to a constructed wetland system.
- ☐ Ensure that no discharges from pipes go directly to water.
- ☐ Eliminate or minimize directly connected impervious areas.
- ☐ Use vegetated swales to slow and infiltrate water and trap pollutants in the soil, where they can be naturally destroyed by soil organisms.
- ☐ Establish DO thresholds to prevent fish kills (occur at levels of 2 mg/l), for example, use artificial aeration (diffusers).
- ☐ Reduce stress on fish; keep DO levels above 3 mg/l.
- ☐ Select algaecides containing hydrogen peroxide instead of copper or endothall to treat high populations of phytoplankton.
- ☐ Determine which sites will be analyzed and use reputable equipment and qualified technicians.
- ☐ Demonstrate responsible land and water use practices based on water data.
- ☐ Define data values appropriately based on the associated BMP used to protect water quality.
- ☐ Record observations of fish, wildlife, and general pond conditions.
- ☐ Institute buffers and special management zones.

Water Quality Sampling Program

Principles

Because every golf course environment is unique, in terms of location, geology, water source, climate and construction. All these factors should be considered when developing a monitoring plan. A comprehensive geo-technical report will determine how surface and ground water will move across and through the course. Climate conditions will influence concentration levels of soil constituents, course drainage, vegetative cover and fertilizer rates.

- Monitoring is the method used to determine whether outside events are impacting the water quality entering the golf course, or whether the golf course is having a positive, neutral, or negative effect on water quality. It also provides a body of evidence on the golf course's environmental impact.
- If possible, installation of monitoring wells above and below gradient, to determine the impact of the golf course.
- A water quality monitoring plan should be prepared to ensure the ongoing protection of groundwater and surface-water quality after construction is completed. The same sites should be monitored during the preconstruction phase, although the monitoring plan can be modified based on site-specific conditions.
- Sampling parameters are determined based on golf course operation and basin-specific parameters of concern (these may be identified by local/state Total Maximum Daily Load [TMDL] Programs). Typically, samples should be analyzed for: basic chemistry (Cation Anion), nutrients, pH and alkalinity, sediments, suspended solids, dissolved oxygen (DO), heavy metals, and any pesticides expected to be used on the golf course.
- Ongoing, routine water sampling provides meaningful trends over time. A single sample is rarely meaningful in isolation.
- 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 during the wet and dry seasons 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.
- Sampling parameters should be determined based on golf course operation and any basin-specific parameters of concern (identified by the TMDL program or local regulators).
- Golf courses should also sample for macroinvertebrates as determined useful by water quality specialists.

Water Quality Monitoring

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

- ☐ Use IPM principles to limit excess use of pesticides.
- ☐ Coordinate construction/renovation activities to minimize the amount of disturbed area and possible risk of contamination via runoff.
- ☐ Plan construction/renovation activities in phases to limit soil disruption and movement.
- ☐ Sod, sprig, or reseed bare or thinning turf areas.
- ☐ Mulch areas under tree canopies to cover bare soil.
- ☐ Avoid the use of trimmers along the edge of the water body.
- ☐ Mow lake and pond collars at 2 inches or higher to slow and filter overland flow to water bodies.
- ☐ Remove excess sediments to reduce irrigation system failures.
- ☐ Locate littoral shelves at the pond's inlets and outlets to reduce problems with the playability and maintainability of a water hazard.

Parameters, Collection, and Analysis

A water quality monitoring program must include monitoring of surface water, groundwater, and pond sediments. It should be implemented in three phases: background, construction, and long-term management.

Principles

- Sampling of all watershed ingress and egress points is important to know what is coming into the property to identify potential impacts and baseline of water quality data.
- The purpose of quality assurance/quality control (QA/QC) is to ensure that chemical, physical, biological, microbiological, and toxicological data are appropriate and reliable, and are collected and analyzed using scientifically sound procedures.
- It is strongly recommended that a certified laboratory be used even if the data are only for proprietary use and are not reported to any regulatory agency
- QA/QC procedures should be followed. Golf course management must have good data to make good decisions, and if a golf course should ever want to produce data for an agency or in court to defend the facility from unwarranted charges, those data must meet QA/QC standards to be defensible as evidence.

Best Management Practices

- ☐ Seek professional assistance from an environmental specialist to design an appropriate water sample collection strategy.
- ☐ Determine what sites will be analyzed and use reputable equipment and qualified technicians.
- ☐ Demonstrate responsible land and water use practices based on water data.
- ☐ Define data values appropriately based on the associated BMP used to protect water quality.
- ☐ Record observations of fish, wildlife, and general pond conditions.
- ☐ Quality of surface water on facility- up gradient sampling
- ☐ Quality of surface water flowing off site – down gradient sampling
- ☐ Runoff from excess nutrient/pesticide application
  https://i.ytimg.com/vi/5bMKKfessOI/maxresdefault.jpg

Aquatic Plants

Phytoplankton, which give water its green appearance, 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 (emerged 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. 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. Floating plants suppress phytoplankton because they absorb nutrients from the pond water and create shade.

Principles

- The use of aquatic plants to improve the appearance of a pond (aqua scaping) can be included as part of the overall landscape design.
- 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 storm water management and are also often a source of irrigation water.

Best Management Practices

- A comprehensive management plan should include strategies to control growth of nuisance vegetation that can negatively affect a ponds water quality and treatment capacity.
- Properly designed ponds with a narrow fringe of vegetation along the 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.
- Frequently remove filamentous algae by hand and/or frequently apply algaecide to small areas of algae (spot treatment).
- Encourage clumps of native emergent vegetation at the shoreline.
- To reduce the risk of oxygen depletion, use an algaecide containing hydrogen peroxide instead of one with copper or endothall.

https://nepis.epa.gov/Exe/ZyNET.exe/9100UIEA.TXT?ZyActionD=ZyDocument&Client=EPA&Index=Prior+to+1976&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C70thru75%5CTxt%5C00000015%5C9100UIEA.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL

Wetland Protection and Monitoring

Wetlands in Nevada provide critical habitat for the state's wildlife and aquatic species, many of which are wetland or spring dependent. Wetlands perform other services, such as water polishing (nutrient cycling), regulating flooding, drought, and ground water recharge. The Las Vegas Wash Committee can provide helpful information to establishing and maintaining a wetland on your golf course: https://www.lvwash.org/html/

Principles

- Several states protect wetlands as waters of the state by rule of law. Wetlands act both as filters for pollutant removal and as nurseries for many species. Many people do not realize the vital role they play in purifying 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. While wetlands do pose a special concern, their mere presence is not incompatible with the game of golf. With care, many golf holes have been threaded through sensitive areas, and with proper design and management golf can be an acceptable neighbor.
- 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 storm water management system.

Best Management Practices

- ☐ Establish wetlands where water enters lakes to slow water flow and trap sediments.
- ☐ Maintain appropriate silt fencing and BMP 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 non-tidal and tidal wetlands.
- ☐ Establish and maintain a 100-foot riparian buffer around wetlands, springs, and spring runs.

https://i.ytimg.com/vi/d7sNchTX6EU/maxresdefault.jpg

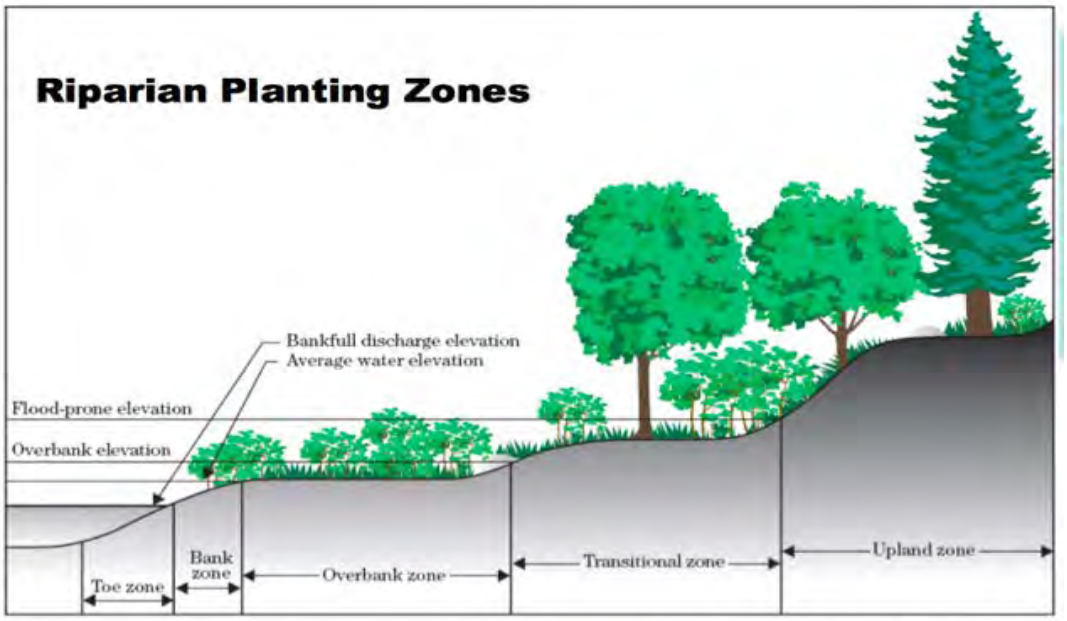
Buffer Zones

Principles

- 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 provide a triple play of water quality benefits, pleasing aesthetics, and habitat/food sources for wildlife. As discussed above, it is important to continue these plantings into the water to provide emergent vegetation for aquatic life, even if the pond is not used for storm water treatment.
- Effective BMP in these areas include filter and trap sediment, site-specific natural/organic fertilization, and limits on pesticide use, primarily focusing on the control of invasive species.
- Golf course storm water management should include "natural systems engineering" or "soft engineering" approaches that maximize the use of natural systems to treat water.

Best Management Practices

- Institute buffers and special management zones.
- Riparian buffer areas are above the high-water mark and should be unfertilized and left in a natural state.
- Aerate shallow lakes less than 6 feet in depth to maintain acceptable DO levels.
- Where applicable, aerate at night to control oxygen depletion in any pond.
- Install desirable plants to naturally buffer DO loss and fluctuation.
- Reduce the frequency of mowing at the lake edge and collect or direct clippings to upland areas.
- Dispose of grass clippings where runoff and wind will not carry them back to the lake.
- 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.
- Use turf and native plantings to enhance buffer areas. Increase height of cut in the riparian zone to filter and buffer nutrient movement to the water.
- Practice good fertilizer management to reduce the nutrient runoff into ponds that causes algae blooms and ultimately reduces DO levels.
- Use a deflector shield to prevent fertilizer and pesticide spills from contacting surface waters.
- Apply fertilizer and pesticides based on the effective swath; keep application on target and away from buffers or channel swales.
- Use a swale and berm system to allow for resident time (ponding) for water to infiltrate through the root zone to reduce lateral water movement to the surface water body.
- Maintain a riparian buffer to filter the nutrients in storm water runoff.



Source: US Department of Agriculture

Best Management Practices

Required | **Recommended** | **Exceeds**

- ☐ An appropriate-sized buffer (steeper slope requires great buffer width) of turf mowed at a higher cut and minimally fertilized with enhanced-efficiency fertilizers can provide an effective buffer. As a rule, stream buffers should be three to five time the average width of the channel width, with a minimum of 20 feet. For other Wetlands a minimum of 25 feet should be used as a buffer width.
- ☐ Use plant buffers with native species to provide pleasing aesthetics, habitat, and food sources for wildlife.
- ☐ Ideally, littoral zones should have a slope of about 1 foot vertical to 6-10 foot horizontal.
- ☐ Encourage clumps of native emergent vegetation at the shoreline.
- ☐ Control invasive plant species
- ☐ Nutrient rich runoff encourages alga blooms and other phytoplankton; apply appropriate fertilizer rates and application setbacks.
- ☐ Reverse-grade around the perimeter to control surface water runoff into ponds and reduce nutrient loads.
- ☐ Planting on slopes with less than a 6-foot horizontal to a 1-foot vertical may not be as successful over the long term.
- ☐ Construct random small dips and ridges of a few inches to a foot to promote diversity within the plant community and provide a healthier and more productive littoral zone.
- ☐ All or most of the out-of-play water bodies should have shoreline buffers planted with native or well-adapted noninvasive vegetation to provide food and shelter for wildlife.
- ☐ Manipulate water levels to prevent low levels that result in warmer temperatures and lowered DO levels.
- ☐ Ideally, littoral zones should have a slope of about 1 foot vertical to 6-10 foot horizontal.
- ☐ Dredge or remove sediment to protect beneficial organisms that contribute to the lake's food web and overall lake health. https://i.pinimg.com/originals/d3/f8/42/d3f84219667a324c2d4d769d47e0b34e.jpg

Sediment Monitoring

Principles

During construction and/or renovation, temporary barriers and traps must be used to prevent sediments from being washed off-site into water bodies. 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

- Use shoreline grasses to prevent bank erosion.
- Match vegetative cover type to the area being covered.
- Use dry detention basins/catchments to buffer flooding and excessive runoff that may contain sediment.
- 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 water body but should discharge through pretreatment zones and/or vegetative buffers to help remove nutrients and sediments.
- Maintain a vegetative cover on construction sites until it is ready for construction.

Floodplain Restoration

Principles

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

Best Management Practices

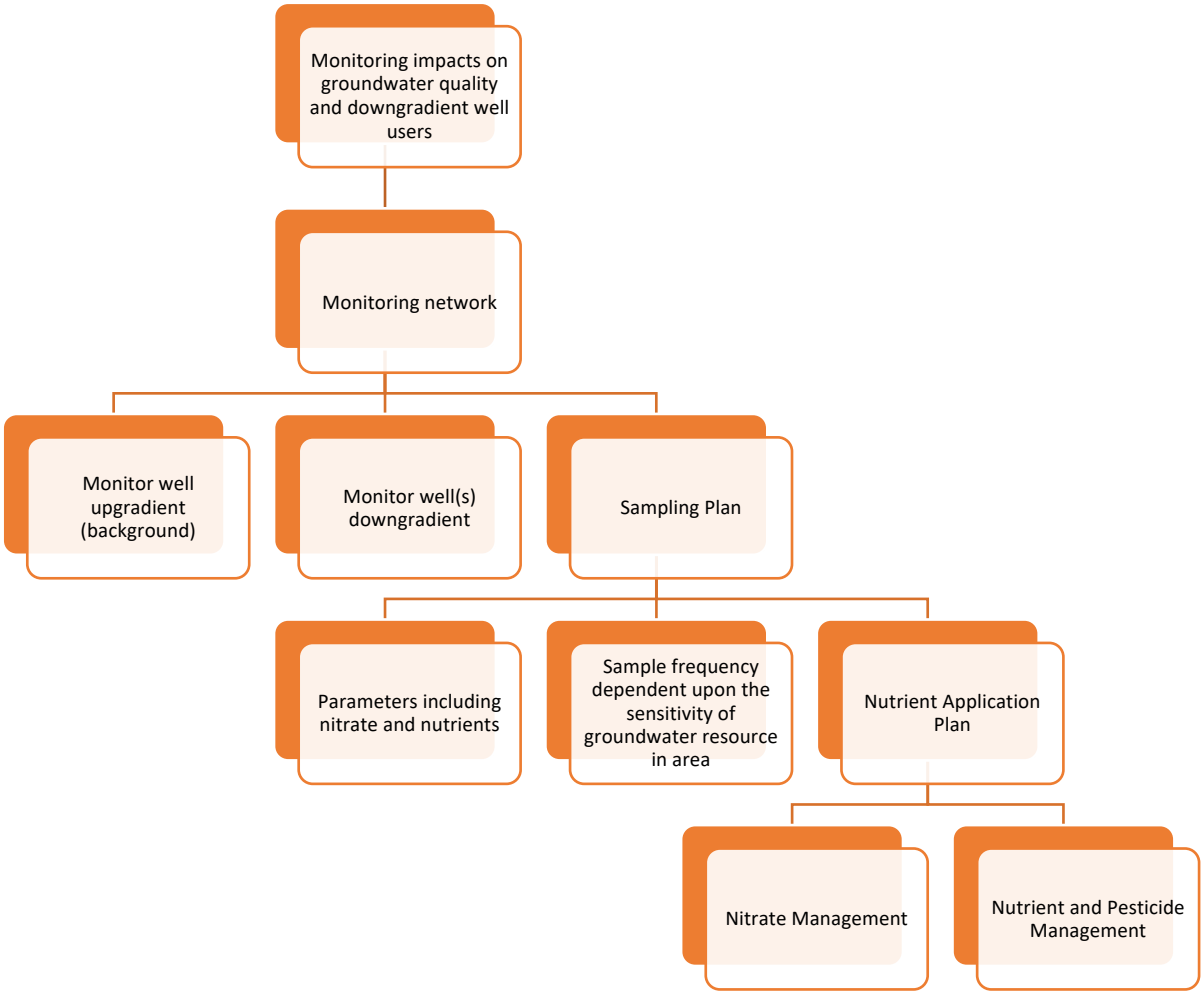
- ☐ Install stream buffers to restore natural water flows and flooding controls.
- ☐ Install buffers in play areas to stabilize and restore natural areas that will attract wildlife species.
- ☐ Install detention basins to store water and reduce flooding at peak flows.

Groundwater Monitoring

Principles

Knowing the quality of the groundwater before and after it crosses the golf course can provide valuable information, in terms of alternate resources, fertilizer application planning, and community trust.

Best Management Practices



Plan to effectively manage use of nutrients application rates on the facility to manage cost and limit impacts to environment from over application.

Additional Resources:
Nevada Department of Environmental Protection https://ndep.nv.gov/
Clark county Department of Air Qualityhttp://www.clarkcountynv.gov/airquality/Pages/default.aspx
Clark County Regional Flood Control http://www.ccrfcd.org/
https://www.epa.gov/hwp
https://water.usgs.gov/wsc/management.html
https://acwi.gov/monitoring/index.html
https://www.lid-stormwater.net/
https://waterqualitysnwa.com/
https://www.lvwash.org/html/

References:

1. Carrow, R.N., R.R. Duncan and C. Waltz. 2005a. Best Management Practices(BMP) for turfgrass water conservation. GCSAA workshop workbook (www.georgiaturf.com)
2. Gross, P. 2013 Developing a Drought-Emergency Plan. Green Section Record Vol. 51 (14) July 2013 TGIF Record Number 223630.
3. Jeffrey Clark. 2012, A Hydrologic Approach to Environmental Golf and Hazard Design within the Wildcat Creek Watershed. Kansas State University.
4. Gary Libby, Donald F. Harker, Kay Harker and Jean Mackay. 2004. Managing Wetlands on Golf Courses. Wiley & Sons.

4.0 Nutrient Management

> Proper nutrient management plays a key role in the reduction of environmental risk and increases course profitability, while at the same time allowing for the generation of good and healthy turf conditions.

Among other benefits, applied nutrients increase the available pool of nutrients and allow turfgrass to recover from damage, increase its resistance to stress, and increase its playability. However, the increase in available nutrients also increases the potential risk of environmental impact. Excess nutrients may move beyond the turfgrass via leaching or runoff, which may directly impact our environment and shallow water quality. Other organisms also respond to increases in nutrients and, in some cases, these organisms may deleteriously alter our ecosystem. The goal of a proper nutrient management plan should be to apply the minimum necessary nutrients to achieve an acceptable playing surface and apply these nutrients in a manner that maximizes plant uptake.

Regulatory Considerations

Principles

- Designing a nutrient management plan that optimizes turfgrass growth and performance while minimizing risk within the golf course's unique ecosystem.
- Depending on your location, regulatory agencies (federal, state, local or tribal) policies.
- In general, if your location is regulated by nutrient policies (such as nutrient management plans), then your nutrient BMP will be designed according to these policies.

Best Management Practices

- Contact federal, state, local and tribal organizations for regulatory agency policies.

Soil Testing

Principles

- Soil testing provides foundational information for nutrient management.
- Through proper sampling and laboratory analysis, the interpretation of results and appropriate recommendations will provide for optimal turfgrass management.
- Record keeping and regular soil testing makes managing nutrient applications more efficient.
- Consult local Cooperative Extension specialist for turfgrass and soil recommendations and to understand appropriate test methods and values for the location https://www.unce.unr.edu/.

Best Management Practices

- Accurate and consistent sampling is essential for useful soil test information over time.
- Schedule soil testing regularly and seasonally to understand the turfgrass use of nutrients.
- Divide course into logical components i.e. greens, fairways, tees, roughs, etc., for each hole.
- A minimum of 10 to 15 soil samples should be randomly taken from each section and blended together to provide a representative, uniform soil sample.
- Each sample should be taken from same depth and representative of effective rooting depth.
- Use a laboratory extractant which is appropriate for your soils.
- For high pH soils, the Olsen Test for Phosphorus would be most appropriate.
- The same extractant must be used for each test to compare soil test results over time.
- A soil test provides a prediction of plant's response to an applied nutrient.
- If location has correlation data between a given nutrient applied to soil and a response to that nutrient by turfgrass, then recommendations may provide expected results.
- If location does not have correlation data, then soil test recommendations may be little value.
- Keeping soil tests from prior years will allow you to observe changes over time.
- This practice can provide good evidence of the impact of your nutrient management plan.

Plant Tissue Analysis

Principles

- Because of the mobility and conversion of elements within the soil; soil sampling can be less predictable than tissue testing. Tissue testing provides a precise measurement of nutrients within the plant. Tissue test sufficiency ranges are only as good as the correlation data of a given element to an acceptable quality level of a given turfgrass. Typically, tissue correlation data are more prevalent than soil test correlation data and, therefore, programs designed around tissue testing may provide more reliable results.
- Proper sampling techniques at regular and consistent intervals for tissue testing, and record keeping provide a good measurement for maintaining healthy turfgrass.

Best Management Practices

- Tissue samples may be collected during regular mowing.
- Do not collect tissue after any event that may alter the nutrient analysis. Events may include fertilization, topdressing, pesticide applications, etc.
- Place tissue in paper bags, do not use plastic bags.
- Allow tissue samples to air-dry at your facility 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 a more accurate assessment of your turfgrass nutrient status changes over time.
- The quantity of tissue analysis you choose to use is entirely up to you and your needs. However, two to four tests per year are common on greens and one to two tests per year are common on tees and fairways.
- Keeping tissue tests from prior years will allow you to observe changes over time.
- Tissue testing can provide good evidence of the impact of your nutrient management plan.

Fertilizers Used in Golf Course Management

Principles

Understanding the components of fertilizers, the fertilizer label, and the function of each element within the plant are all essential in the development of an efficient nutrient management program. Knowledge of the turfgrass growth in relation to temperature and climate will help in determining the amounts, frequency of application and types of nutrient elements needed to produce good quality healthy turfgrass without over fertilization.

Terminology

- Grade or analysis is the percent by weight of Nitrogen (N), Phosphorous fertilizer (P_2O_5) and Potassium fertilizer (K_2O) that is guaranteed to be in the fertilizer.
- A complete fertilizer contains N, P_2O_5, and K_2O.
- The laws governing the labeling of fertilizer vary greatly among states. Consult your Nevada Cooperative Extension specialist regarding the laws in your location. https://www.unce.unr.edu/ http://www.unce.unr.edu/publications/files/ho/2005/sp0510.pdf#search=%22fertilizer%20labeling%22

Label

The label is intended to inform the user about 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/address**
- ✓ **Guaranteed analysis**
- ✓ **"Derived from" statement**
- ✓ **Net weight**

BEST

24-4-12 MINI with UMAXX

STABILIZED NITROGEN

DESCRIPTION: A PREMIUM MINI-SIZED 2:1 RATIO OF NITROGEN TO POTASH FERTILIZER WITH UMAXX® STABILIZED NITROGEN FOR LONG LASTING DEEP GREEN COLOR!

BENEFITS: BEST® 24-4-12 MINI with UMAXX

- Uses UMAXX* (stabilized nitrogen) which produces even growth and long lasting turf color!
- Contains sulfate of potash to aid where excess chloride is a concern.
- Produces turf response that can last up to 12 weeks.
- Contains a BEST® homogeneous pellet for even nutrient distribution, which virtually eliminates the possibility of iron stains on concrete and cart paths.

HOMOGENEOUS BEST PELLETS

APPLICATION RATES:

	Lbs. of Actual Nitrogen desired per 1,000 sq.ft.	Lbs. of BEST 24-4-12 MINI with UMAXX To Apply per 1,000 sq.ft.	Lbs. of BEST 24-4-12 MINI with UMAXX To Apply per Acre
Turfgrass	.50	2.1	91
*Recommended Rate	.75*	3.1*	135*

PRODUCT COVERAGE: ONE 50-LB. BAG COVERS 12,000 TO 24,000 SQ. FT.
2 TO 3 1/2 50-LB. BAGS COVER ONE ACRE

SPREADER SETTINGS:

Listed Settings Will Approximately Apply the Recommended Rate

BEST® Pro	5A
Spyker / BEST® Models 34, 44, 64	4.2
Earthway	15
Lesco	1
Scotts R-8A (Cone 7)	0
Lely 1250 / Vicon	visit www.bestfertilizer.com

Rates are for spreading one time across in one direction

SGN 150

NOTE: Spreader settings are guidelines only. Spreaders should be checked for accuracy.

APPLICATION PRECAUTIONS:

- Apply to dry turf or foliage and irrigate thoroughly immediately after application.
- Iron and other plant nutrients can cause staining of sidewalks. Sweep walkways prior to irrigation. Walkways should be dry at time of application.
- Keep away from pools, ponds, etc. Do not contaminate potable water.

GUARANTEED ANALYSIS:

TOTAL NITROGEN (N)	24.00%
6.30% Ammoniacal Nitrogen	
17.70% Urea Nitrogen*	
AVAILABLE PHOSPHATE (P_2O_5)	4.00%
SOLUBLE POTASH (K_2O)	12.00%
Sulfur (S)	10.40%
Iron (Fe)	1.60%
Manganese (Mn)	0.25%

Derived from Urea, Monoammonium Phosphate, Ammonium Sulfate, Sulfate of Potash, Iron Oxysulfate and Manganese Oxysulfate.

*17.7% Urea Nitrogen stabilized with dicyandiamide and N-(n-butyl) thiophosphoric triamide.

UMAXX is a registered trademark of Agrotain International.

This product should not be stored more than 90 days before use. Product set up may result when stored longer than 90 days or in extremely humid areas.

74054_24412minimaxx_R2-16-2011

PACKAGE SIZE: 50-LB.(22.68 Kg.) BAGS

HANDLING PRECAUTIONS: CAUTION: KEEP OUT OF REACH OF CHILDREN
MSDS: See Reverse HARMFUL IF SWALLOWED — DO NOT INHALE

bestfertilizer.com Spread The Word Simplot

Macronutrients

Macronutrients are required in the greatest quantities and include nitrogen (N), phosphorus (P), and potassium (K).

Understanding the role of each macronutrient within the plant should provide you with a greater understanding of why these nutrients play such a key role in proper turfgrass management. The goal of all applied nutrients is to maximize plant uptake while minimizing nutrient losses. Understanding each process will increase your ability to make sound management decisions and ultimately leads to an increase in course profitability and a reduction in environmental risk.

The role of nitrogen (N)

Nitrogen is required by the plant in greater quantities than any other element except carbon (C), hydrogen (H), and oxygen (O). Nitrogen plays a role in numerous plant functions including an essential component of amino acids, proteins and nucleic acids.

Fate and transformation of N

Nitrogen processes

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

Understanding how certain N sources should be blended and applied is an essential component in an efficient nutrient management plan. In many cases, N sources are applied without regard to their release characteristics. This is an improper practice and increases the risk of negative environmental impact. Each N source (particularly slow-release forms) is unique and therefore should be managed accordingly. Applying a polymer-coated urea in the same manner one would apply a sulfur-coated urea greatly reduces the value of the polymer-coated urea. Similarly, applying 2 pounds of N from ammonium sulfate may cause burning, while applying 2 pounds of N from certain polymer-coated

urea's may not provide the desired turfgrass response. Rate, application date, location, and turfgrass species all should be included in your nutrient application decision. In our high pH desert soils, as much as 50 percent of the nitrogen from straight urea may be lost in the atmosphere due to volatilization.

Advantages and Disadvantages of Soluble Nitrogen Sources

Advantages:

- High in total nitrogen
- Rapid initial color and growth response
- Help to maintain satisfactory nitrogen levels if applied frequently in small amounts
- Minimum temperature dependence for availability
- Can be applied in granular or liquid forms
- Low cost per unit of N

Disadvantages:

- High potential for foliar burn, especially at higher rates and temperatures
- Potential undesirable growth surge
- Relatively short residual plant response, so frequent applications are needed, which increases labor costs
- Greater potential for Nitrogen loss from volatility, leaching and runoff

Soluble Nitrogen Sources

- **Urea (46-0-0)**
- **Ammonium nitrate (34-0-0)**
- **Ammonium sulfate (21-0-0)**
- **Diammonium phosphate (18-46-0)**
- **Monoammonium phosphate (11-52-0)**
- **Calcium nitrate (15.5-0-0)**
- **Potassium nitrate (13-0-44)**

Slow-release Nitrogen Sources

A slow-release N source is any 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 the water solubility of the N source.

- **Sulfur-coated urea**
- **UMAXX and UFLEX urea**
- **Polymer/resin-coated**
- **Isobutylidene diurea**
- **Urea-formaldehyde reaction products**
- **Natural organic**

Urease and Nitrification Inhibitors

- **Urease inhibitors reduce the activity of the urease enzyme resulting in a reduction of volatilization and an increase in plant-available N.**
- **Nitrification inhibitors reduce the activity of *Nitrosomonas* bacteria, which are responsible for the conversion of NH_4 to NO_2. This reduced activity results in a reduction of N lost via denitrification and an increase in plant-available N.**

The role of phosphorous (P)

Phosphorus can be a growth-limiting factor for many unintended organisms and is a major contributor to eutrophication of water bodies. Thus, proper timing and rates should be implemented to reduce the risk of off-site movement of phosphorus.

Phosphorus forms high-energy compounds that are used to transfer energy within the plant. Phosphorus may remain in an inorganic form or may become incorporated into organic compounds. Phosphorous application rates should be based upon soil test results derived from documented correlations demonstrating a turf response to soil test phosphorous levels.

- *P deficiency symptoms*
    - Initially, reduced shoot growth and dark green color may be observed
    - Later, lower leaves may turn reddish at the tips and then the color may progress down the blade
- *P sufficiency ranges*

Consult your Nevada Cooperative Extension specialist for sufficiency ranges in your location.

https://www.unce.unr.edu/

P fertilizer sources

- **Diammonium phosphate**
- **Concentrated superphosphate**
- **Monoammonium phosphate**
- **Superphosphate**
- **Triple Superphosphate**
- **Natural organics**

The role of potassium (K)

Potassium is of no environmental concern, but can be an economic concern, particularly when over-utilized. Generally, potassium concentrations in turfgrass tissue are about 1/3 to ½ that of nitrogen.

K is not a component of any organic compound and moves readily within the plant. K is a key component of osmoregulation which has been documented to increase stress resistance.

- *K deficiency symptoms*

Except under severe, documented deficiencies, K may not have an observable influence on turfgrass quality. Yellowing of older leaves followed by tip dieback and scorching of leaf margins have been reported.

- *K sufficiency ranges*

Consult your Nevada Cooperative Extension specialist for sufficiency ranges in your location.

https://www.unce.unr.edu/

K fertilizer sources

- **Potassium sulfate**
- **Potassium chloride**
- **Potassium nitrate**
- **Potassium thiosulfate**
- **Potassium phosphate**

Secondary Macronutrients

Secondary macronutrients are essential to plant function and are required in quantities less than N, P, and K, but more than micronutrients. These include calcium (Ca), magnesium (Mg), and sulfur (S).

Calcium (Ca)	Primarily a component of cell walls and structure. Consult Nevada Cooperative Extension specialist for sufficiency ranges in your location. Found in gypsum, limestone, and calcium chloride.
Magnesium (Mg)	Central ion in the chlorophyll molecule and chlorophyll synthesis. Consult Nevada Cooperative Extension specialist for sufficiency ranges in your location Found in S-Po-Mg, dolomitic limestone, and magnesium sulfate.
Sulfur (S)	Metabolized into amino acid, cysteine, used in various proteins and enzymes. Consult Nevada Cooperative Extension specialist for sufficiency ranges in your location Found in ammonium sulfate, elemental sulfur, gypsum, potassium sulfate.

Micronutrients

Understanding the role of each micronutrient within the plant should provide you with a greater understanding of why these nutrients play such a key role in proper turfgrass management.

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

Consult your Nevada Cooperative Extension specialist for micronutrient sufficiency ranges in your locat

Iron (Fe)	Part of the catalytic enzymes and required for chlorophyll synthesis. It affects photosynthesis, N fixation, respiration. Contributes to normal, rich green color of turf.
Manganese (Mn)	Involved in photosynthesis. Required as a co-factor for ~35 enzymes. Lignin biosynthesis depends on Mn.
Boron (B)	Used in photosynthesis, important for protein synthesis, necessary for growth. Found in the cell wall, supports integrity of the wall.
Copper (Cu)	The Cu-protein plastocyanin is involved in photosynthesis. Copper is a co-factor for a variety of oxidative enzymes.
Zinc (Zn)	Structural component of enzymes. Required for protein synthesis. Affects growth and carbohydrate metabolism.
Molybdenum (Mo)	Primarily related to nitrogen metabolism. Affects structural and catalytical functions of enzymes.
Chlorine (Cl)	Required for the oxygen-evolving reactions of photosynthesis. Appears to be required for cell division in both leaves and shoots.

Soil pH

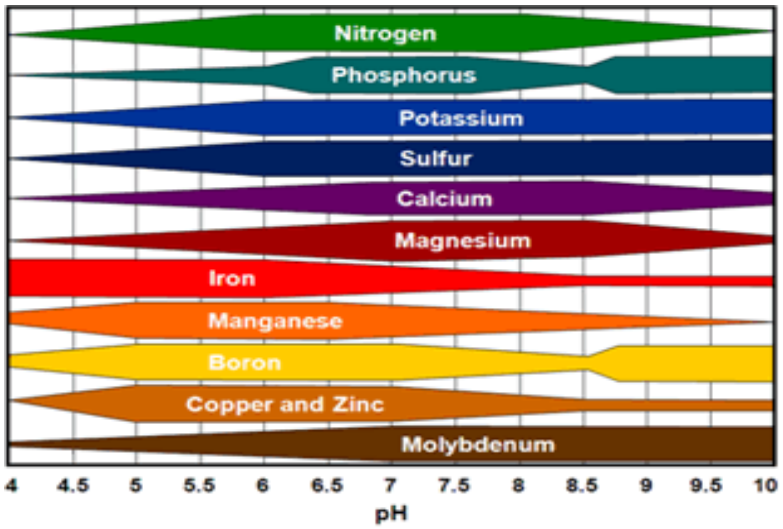
Principles

Identifying pH levels may be the most important soil test result for turfgrass managers. In most cases, a pH of 6.3 is ideal because it provides the greatest probability of micronutrient availability. Soil pH adjustments may occur slowly and are most often only temporary.

Best Management Practices

- To increase soil pH, apply a liming material (calcium carbonate, calcium oxide, dolomitic limestone) that contains Ca^{2+} and neutralizes acidity.
- To lower soil pH, products containing elemental sulfur should be applied.

In some cases, utilizing injection pumps into irrigation water to address pH can be beneficial. A sulfur burner may also be useful in adjusting pH and removing bicarbonates in irrigation water.



Source: Nick E. Christians, Aaron J. Patton, Quincy D. Law. 2017. Fundamentals of Turfgrass Management. Wiley & Sons.

Nutrient Management

Principles

- Within each state, environmental conditions vary greatly including differences among soils, topography, rainfall, and temperature.
- Understand the importance of application timing for effective use of applied nutrients.
- In Nevada, higher elevation cool season turfgrasses have different nutrient requirements than the low desert warm season turfgrasses that are commonly over-seeded in the winter with a cool season grass. These differences require that a nutrient management plan be flexible enough to allow turfgrass managers to address their unique needs.
- The objective of nutrient applications is plant uptake and corresponding desirable response.
- Soil amendments, like gypsum and sulfur, applied to desert turfgrasses are intended to remediate excess sodium conditions in soils are encouraged.

Best Management Practices

- Apply nutrients when turfgrass is actively growing.
- Apply slow-release N fertilizers at the appropriate time of year to maximize the products' release characteristics. For example, an application of slow-release N to warm-season turfgrasses in fall may not be as effective as the same application applied in early summer because of the prolonged release time in fall.
- Follow N application rate recommendations based on tissue test and soil test results and historic records that demonstrate turf response and performance.
- N application rates from slow-release materials should take into consideration release rate of chosen material. If insufficient material is applied, the desired response may not be observed.
- Consult your Nevada Cooperative Extension specialist for efficient N:K in your location.
- The reduced height of cut and excessive traffic damage on putting greens results in an increased need for growth leading to an increase in nutrition.
- Tees and landing areas often have higher fertility requirements than fairways and roughs because they suffer constant divot damage.
- Fairways and roughs often require less nutrient inputs than other locations because of their increased height of cut, less damage, and clipping return.
- Exercise caution when applying nutrient applications during turfgrass establishment as these applications are particularly susceptible to loss via leaching and runoff.
- Provide appropriate rates and products to minimize N loss without reducing turfgrass establishment.
    - Increased water applications
    - Increased nutrients to hasten establishment
    - Reduced root mass
- Be aware of the different types of spreaders and understand advantages and disadvantages.
- Not all fertilizers can be spread with every spreader. For example, if sulfur-coated urea was spread through a drop spreader, the sulfur coating could be damaged, essentially leading to an application of soluble urea. Choose appropriate spreader for a given fertilizer material. (walk-behind rotary, drop spreader, bulk rotary, spray)
- Calibration reduces environmental risk and increases profitability.
- Proper fertilizer storage, loading, and clean-up reduce environmental risk.
- Avoid applying fertilizer to soils at or near field capacity or following rains that leave soils wet.
- Do not apply fertilizer when the National Weather Service has issued a flood or tropical storm warning, or if heavy rains are likely.

5.0 Cultural Practices

> Certain cultural practices such as mowing, verticutting, and rolling are necessary to provide a high-quality playing surface, while others like aerification are required to enhance plant health.

Cultivation practices are an important part of golf course turf management. Heavily used areas such as putting greens often deteriorate because of compacted soil, thatch accumulation, and excessive use. Soil problems from active use are usually limited to the top three inches of the soil profile and should be actively managed to enhance turf health and improve nutrient and water uptake.

Unlike annual crops, which offer the opportunity for periodic tilling of the soil profile to correct problems like soil compaction that might develop over time, turfgrass does not offer opportunities for significant physical disturbance of the soil without disrupting the playing surface.

Mowing

Principles

- Mowing is the most basic yet most important cultural practice to consider when developing a management plan.
- The mowing practices implemented on a facility will have an impact on turf density, texture, color, root development, and wear tolerance.
- Mowing practices affect turfgrass growth. Frequent mowing will increase shoot density and tillering. It will also decrease root and rhizome growth as a result of plant stress associated with removal of leaf tissue.
- Infrequent mowing results in alternating cycles of vegetative growth followed by scalping, which further depletes food reserves of the plants.
- Proper mowing height is a function of the species/cultivar being managed and the intended use of the site. Other factors influencing mowing height include mowing frequency, shade, mowing equipment, time of year, root growth, and abiotic and biotic stress. www.usga.org/content/usga/home-page/course-care/forethegolfer/2018/understanding-mowing- \heights.html
- Maintaining an optimal root-to-shoot ratio is critical. Turfgrass plants that are mowed too low will require a substantial amount of time to provide the food needed to produce shoot tissue for future photosynthesis. If turf is mowed too low in one event, an imbalance occurs between the remaining vegetative tissue and the root system, resulting in more roots being present than the plant needs physiologically. As a result, the plants will slough off the unneeded roots. Root growth is least affected when no more than 30% to 40% of leaf area is removed in a single mowing. http://archive.lib.msu.edu/tic/tgtre/article/1996feb1a.pdf
- Failure to mow properly will result in weakened turf with poor density and quality.

TYPICAL MACHINES USED FOR MOWING

Figure 1 https://www.toro.com/en/golf/greensmowers/greensmaster-flex-series
Figure 2 https://www.toro.com/en/golf/greensmowers/greensmaster-triflex-series
Figure 3 https://www.toro.com/en/golf/fairway-mowers/reelmaster-5010-h
Figure 4 https://www.toro.com/en/golf/rough-mowers/groundsmaster-4500

Best Management Practices

- Mowing frequency should increase during periods of rapid growth and decrease during dry, stressful periods. It's best to mow when the turf is dry if applicable. (PICTURES IN BLUE)
- If turf becomes too tall, it should not be mowed down to the desired height all at once. Such severe scalping reduces turf density and can result in a dramatic reduction in root growth. Tall grass should be mowed frequently, and height gradually decreased until desired height of cut is achieved. (http://www.usga.org/content/usga/home-page/course-care/regional-updates/southeast-region/2017/scalping--can-it-be-avoided-.html)
- Shade affects turfgrass growth by filtering out photosynthetically active radiation. As a result, turfgrass plants respond by growing upright in an effort to capture more light to meet their photosynthetic needs. As a result, mowing height should be increased by at least 30% to improve the health of turf grown in a shaded environment. (https://plantscience.psu.edu/research/centers/turf/extension/factsheets/shade)
- The use of the plant growth regulators has been shown to improve overall turf health when used as a regular management tool for growing grass in multiple situations. (https://turf.unl.edu/pdfctarticles/kreuser-green-section.pdf)
- Environmental stresses such as prolonged cloudy weather or drought can have a significant impact on turf health. Increase mowing heights as much as use will allow in order to increase photosynthetic capacity and rooting depth of plants.
- Use proper mowing equipment and maintaining sharp cutting units is key
- Reel mowers are ideally suited for maintaining turfgrass stands that require a height of cut below 1.5 inches. They produce the best quality when compared to other types of mowers.
- Dull reel blades and bed knives can damage grass, affecting after cut appearance and the long-term health of the plant. (Toro advantage Zach, https://www.toroadvantage.com/equipment/sharp-cutting-units-give-you-a-critical-edge/)
- Rotary mowers, when sharp and properly adjusted, deliver acceptable cutting quality for turf that is to be cut above 1 inch in height. Dull blades will result in shredding of leaf tissue, increasing water loss and the potential for disease development. (Toro advantage Zach, https://www.toroadvantage.com/equipment/sharp-cutting-units-give-you-a-critical-edge/)
- Flail mowers are most often used to maintain utility turf areas that are mowed infrequently and do not have a high aesthetic requirement.
- Mowing patterns influence both the aesthetic and functional characteristics of a turf surface.
- Turfgrass clippings are a source of nutrients, containing 2% to 4% nitrogen on a dry-weight basis, as well as significant amounts of phosphorus and potassium.
- Nutrients contained in clippings can be sources of pollution and should be handled properly.
- Clippings should be returned to the site during the mowing process unless the presence of grass clippings will have a detrimental impact on play. Cases when clippings should be removed include times when the amount of clippings is so large that it could smother the underlying grass or on golf greens where clippings might affect ball roll.
- Collected clippings should be disposed of properly to prevent undesirable odors near play areas and to prevent fire hazards that can occur when clippings accumulate. Consider composting clippings or dispersing them evenly in natural areas where they can decompose naturally without accumulating in piles.

Recommended Minimum Mowing Heights, by Area

Recommended Minimum Golf Course Mowing Heights, by Area (in inches)

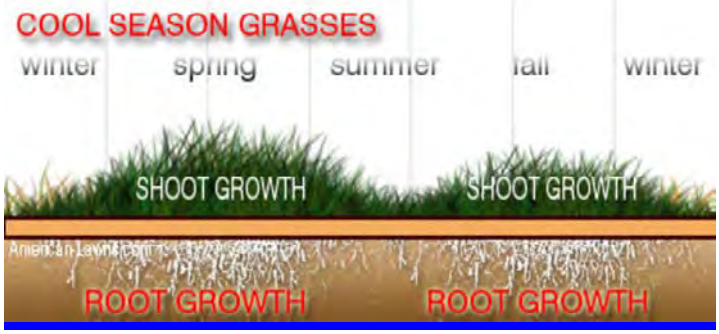
Turf Species	Greens Healthy Maintenance	Greens Tournament Play	Tees, Collars, Approaches	Fairways
Creeping bentgrass	0.125	0.090	0.250	0.350
Hybrid bermudagrass	0.125	0.100	0.375	0.375
Common bermudagrass	–	–	0.500	0.500
Zoysiagrass	–	–	0.400	0.500
Perennial ryegrass	–	–	0.375	0.375
Kentucky bluegrass	–	–	0.500	0.625

Recommended Mowing Heights for Roughs (in inches)

Kentucky bluegrass	Perennial ryegrass	Tall fescue	Fine fescues	Bermudagrass
1.0 – 6.0	1.0 – 6.0	2.0 – 6.0	2.5 – 6.0	0.75 – 2.5

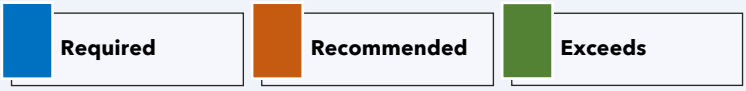
Source: http://www.marylandgolfbmp.org/height-of-cut/

Joey Young, Texas Tech Turfgrass Science
http://ttuturf.blogspot.com/2018/02/spring-lawn-management-101-fertilizer.html



https://myturfandgarden.com/content/Cool-Season-Program.asp

Best Management Practices



Greens

- ☐ Highest Demand surface on any property. Can range in area and grass species, usually the lowest mowed turf ranging from .085" to .150". greens surfaces can be mowed upward to 7 times a week and can be lowered depending on expectations.
- ☐ As well as mixing in topdressing/rolling to help turf stress and ball roll consistency. With such high demands for greens turf, mower sharpness and mower care are the highest priorities. Even The slightest wrong height or mower error can be a glaring issue.
- ☐ Daily Checking of height and quality of cut
  http://grounds-mag.com/golf_courses/grounds_maintenance_putting_greens_speed/

Tees

- ☐ Mowing heights can range from .25" to 1" most instances this is used to best create a surface that can handle excessive traffic and closely mimic the fairways for consistency.
- ☐ In high growth periods mowing tees 3 or more times may be needed to keep up with grass demands. In slow growth periods you may want to reduce to 2 or less mowing's a week. Ideally, these are recommended – based on what is practicable for your operation (resources – equipment/manpower).
- ☐ Regular verticutting/grooming/brushing to enhance the turf to high level surface.

Fairways

- ☐ Mowing heights can range from .25" to 1" most instances this is used to best create a surface that can handle excessive traffic and closely mimic the tee surface for consistency.
- ☐ In high growth periods mowing fairways 3 or more times may be needed to keep up with grass demands. In slow growth periods you may want to reduce to 2 or less mowing's a week. Ideally, these are recommended – based on what is practicable for your operation (resources – equipment/manpower).
- ☐ Regular verticutting/brushing to help stand the plants up to great a tight surface which the ball can sit up on.

Rough

- ☐ Rough can be your largest turf area to mow, and how you choose to mow this area can depend on what you have for rough.
- ☐ Cool Season grasses in high stress periods will be at a higher height from 1.5' to 3.5 inches with most likely 1 to 2 mows a week, depending on your total area. Warm season grasses can have a much wider range based on your clubs demands. Rough heights can range from 3/4" to 3 inches.
- ☐ Both recommended practices will vary depending on resources. Regular mowing will help eliminate scalping. For warm season grasses a lot of what you do can be based off of your overseed practices.

Cultivation

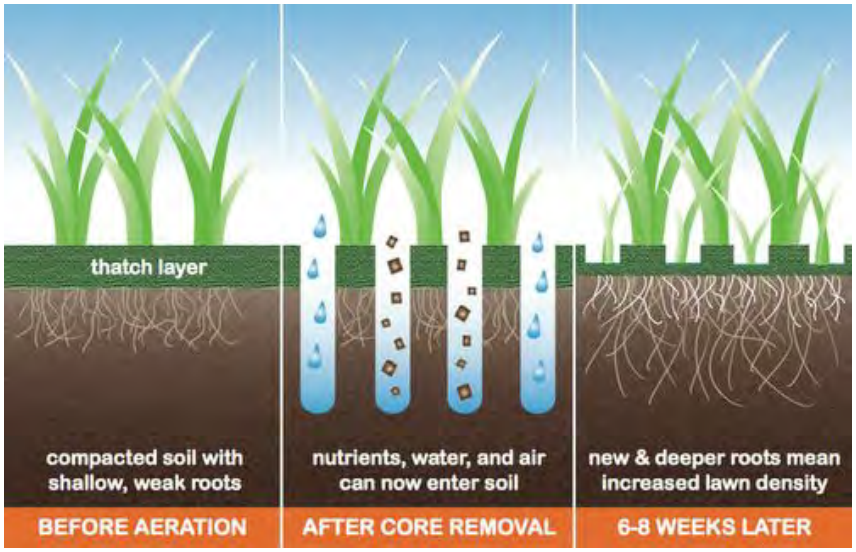
Principles

Cultivation goals include relief of soil compaction, thatch/organic matter reduction, and improved water and air exchange.

- Cultivation involves disturbing the soil or thatch through the use of various implements to achieve important agronomic goals https://www.usga.org/course-care/forethegolfer/why-do-golf-courses-aerate-so-much-.html
- Some cultivation techniques will result in disturbance of the playing surface that can require significant time for recovery. Examples include core aerification with sand topdressing to fill open aerification holes at upwards of 14 days to recover. https://www.golfcourseindustry.com/article/turf-management--to-aerate--or-not-to-aerate--that-is-the-question/
- Solid tine aerification can provide quicker healing time, but not every golf course is the same. http://www.usga.org/content/usga/home-page/course-care/regional-updates/central-region/2018/solid-tine-aeration-order-of-operations.html
- Needle tine aerification is a very popular way to infuse air into the soil profile. Quick recovery time in most cases. Most turf managers use this during peak season to help the plants and playing surface endure the high stress levels of traffic, mowing, and rolling. https://www.golfcourseindustry.com/article/gci0812-micro-aerification-benefits/
- Frequency of cultivation should be based on traffic intensity and level of soil compaction.
- Core aerification is effective at managing soil compaction and aiding in improvement of soil drainage.
- Accumulation of excessive thatch and organic matter will reduce root growth, encourage disease, and create undesirable playing conditions.
- Light and frequent applications of sand will smooth the playing surface, control thatch, and potentially change the physical characteristics of the underlying soil when done in conjunction with core aerification.

Best Management Practices

- Core aerification involves removal of small cores or plugs from the soil profile.
    - Cores are usually 0.25 to 0.75 inch in diameter.
    - Annual core aerification programs should be designed to remove 15%-20% of the surface area.
    - High-traffic areas may require a minimum of two to four core aerifications annually.
- Core aerification should be conducted only when grasses are actively growing to aid in quick recovery of surface density.
- Vary depth of aerification events by incorporating varying length tines to prevent development of compacted layers in the soil profile as a result of cultivation. gsrpdf.lib.msu.edu/ticpdf.py?file=/2000s/2001/010708.pdf
- Solid tines cause less disturbance to the turf surface and can be used to temporarily reduce compaction and soften surface hardness during months when the growth rate of grasses has been reduced. Benefits of solid-tine aerification are temporary because no soil is removed from the profile.
- Slicing and spiking reduce surface compaction and promote water infiltration with minimal surface damage.
- Slicing is faster than core aerification but is less effective. Slicing is best accomplished on moist soils.
- A spiker can break up crusts on the soil surface, disrupt algae layers, and improve water infiltration.
- Vertical mowing (verticutting) can be incorporated into a cultural management program to achieve a number of different goals. The grain of a putting green can be reduced by setting a verticutter to a depth that just nicks the surface of the turf. Deeper penetration of knives will stimulate new growth by cutting through stolons and rhizomes while removing accumulated thatch.
- Verticutting depth for thatch removal should reach the bottom of the thatch layer and extend into the surface of the soil beneath the thatch.
- Dethatching with a verticutter is an aggressive practice that is not recommended on golf putting greens because of the damage that occurs and the extensive recovery time required.
- Initiate vertical mowing when thatch level reaches 0.25 to 0.5 inch in depth. Shallow vertical mowing should be completed at least monthly on putting greens to prevent excessive thatch accumulation. http://www.usga.org/course-care/2013/05/the-how-and-why-of-vertical-mowing-greens-21474855829.html
- Groomers, or miniature vertical mowers attached to the front of reels, are effective at improving management of grain and improving plant density through cutting of stolons.
- Top-dress the playing surface with sand following core aerification and heavy vertical mowing to aid in recovery of turf. Rates will vary from 0.125 to 0.25 inch in depth and will depend on the capacity of the turf canopy to absorb the material without burying the plants.
- Light, frequent applications of topdressing sand on putting greens can smooth out minor surface irregularities, aiding in the management of thatch accumulation. http://www.usga.org/course-care/forethegolfer/2017/topdressing-and-quality-putting-greens-go-together-like-peas-and.html
- Use only weed-free topdressing materials with particle size similar to that of the underlying root zone.
- Use of finer materials can result in layering and can have a negative impact on water infiltration.
- Daily rolling of putting surfaces following mowing can increase putting speeds by roughly 10%, allowing for improved ball roll without lowering height of cut.
- Deep-drill aerification creates deep holes in the soil profile through use of drill bits. Soil is brought to the surface and distributed into the canopy. Holes can be backfilled with new root-zone materials if a drill-and-fill machine is used. These machines allow replacement of heavier soils with sand or other materials in an effort to improve water infiltration into the soil profile. www.istrc.com/documents/ISTRCDisplacementChart.pdf
- To minimize potential for compaction caused by rolling, use light weight rollers. gsr.lib.msu.edu/article/foy-time-10-2-15.pdf



Source: http://www.meridiangolfclub.com/greens-aerification-process-detail

Best Management Practices

Required | Recommended | Exceeds

Greens

- ☐ Regular needle tine with regular topdressing, try to do anything to get air release in the soil.
- ☐ One core aerification with sand filled holes a year, one larger solid tine aerification with sand filling the holes a year. Mix in an occasional needle tine (as needed). Consistent topdressing will aid in the dilution of thatch.
- ☐ Two core aerifications a year sand filled holes, large solid tine with one of the core aerifications. Needle tine regularly (2x a month). Consistent topdressing to help with dilution of thatch.

Tee & Fairways

- ☐ Core aerification once a year, light verticutting.
- ☐ 2 core aerification events a year, regular verticutting weather dependent.
- ☐ 2/3 core aerification events a year, regular too aggressive verticutting, with the potential to top-dress tees/fairways.

Overseeding Warm-Season Turfgrass

Principles

- The fundamental purpose of overseeding is to establish a temporary cool-season grass into the warm-season base for improved color and playability during the fall and winter when the warm-season grass enters dormancy.
- Overseeding increases the need for irrigation and routine mowing and may result in significant thinning of the base grass during spring transition. Consider reduced seeding rates to minimize impact on warm season base.
- Consider partial overseeding as opposed to wall-to-wall. Do what's best for your facility and expectations.
- Successful overseeding programs require year-long planning.
- Successful overseeding incorporates all aspects of root-zone cultivation and weed control in an effort to maintain health of warm-season turfgrass while allowing successful establishment of overseeded cool-season grass species.

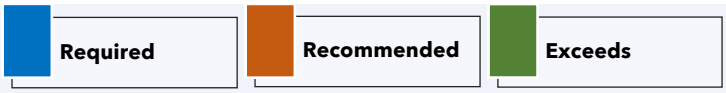
The timing of overseeding is critical to success; if it's too hot, you have reduced germination and competition from your warm season grass; if it's too cold, the turf never has time to mature prior to frost.

https://www.usga.org/content/usga/home-page/course-care/regional-updates/west-region/2018/a-famed-professor-retires--overseeding-and-warm-season-grasses.html

Best Management Practices

- Good seed-to-soil contact is important for germination. but not required, some have shifted to using seed/topdressing to get desired results. Ryegrass roots find their way to the soil.
- Reduce or eliminate fertilization of the base grass three to four weeks before the planned seeding date to minimize growth and competition.
- Core-aerify the soil four to six weeks before the planned overseeding date to open turf canopy and aid in uniform establishment of overseeded grass.
- Select grass species/cultivars adapted to desired use, note disease resistance and spring transition traits. Cultivars with improved heat tolerance can delay spring transition and create increased competition for water, nutrients, and light with the warm-season turfgrass base.
- Irrigate newly planted overseed to maintain constant moisture levels, not allowing the soil surface to dry out. Gradually reduce irrigation once the seedlings have been mowed.
- Do not fertilize with nitrogen immediately before or during establishment of overseed as the N may encourage warm-season turfgrass competition and increase disease potential.
- Move hole locations on putting greens daily during establishment to minimize damage to seedlings from foot traffic.
- Reduce fertilizer rates in spring to slow growth of overseeded grass. Once warm-season turfgrass regrowth is apparent, restore fertilizer applications to stimulate growth of the warm-season turfgrass. (https://www.usga.org/content/usga/home-page/course-care/regional-updates/west-region/2017/a-tough-time-of-year-for-overseeded-golf-courses.html)
- Colorants (dyes and pigments) can be used to provide winter color to dormant grasses. (https://www.usga.org/course-care/regional-updates/west-region/a-southwestern-course-switches-from-overseeding-to-turf-colorant.html
- Overseeding practices can generate significant dust that may require dust control measures.

Fall



- ☐ Light scalp with the help of a PGR before overseed to help keep base grass at bay while seedlings germinate. Also keeping constant moisture to allow the seed to germinate and not dry out. Once germination has happened and mowing will happen, you would be recommended would start at higher height, slowly working down to desired height for the cooler months.
- ☐ Lighter rates of seed per acre, plus a turf colorant or other means of fertilization to keep the plant growing and green as the bases grass heads for dormancy.
- ☐ Make sure that you are in the right temps to minimize water usage and increase the population of desired overseed grass. Turf colorants, fertilizer to help maximize color for all your guests to enjoy.

Spring

- ☐ Lower mowing heights to manage playability as well as provide sunlight for the base grass to start to recover.
- ☐ With lowering height, if you can light verticuting to thin the overseed grass and open the canopy for as much help to recover the base grass.
- ☐ After all the previous cultural practices, to clean up any remaining overseed grass you may want to choose to spray out the remaining grasses. There are several selections to choose from. Recently light and frequent rates of these chemicals can help make the transition slow helping the appearance provided to the customer.

Shade and Tree Management

Principles

- In general, most turfgrasses perform best in full sun.
- Excessive shade reduces photosynthesis and air circulation, thus increasing the susceptibility of the turf to pest and disease problems.
- Trees planted too close to cart paths may damage the cart path as trees mature.

Best Management Practices

- Prune tree limbs and roots as needed to reduce competition for sunlight, water, and nutrients.
- Limbs may be chipped for reuse as mulch to help retain moisture around trees and plants.
- Where practicable, explore opportunities for composting green waste.
- When possible, trees located near closely mowed areas such as tees and greens should be removed, or their canopy should be thinned to promote good turf growth.
- Understand the variability in sun angles at different times of the year and how this affects turf health. https://www.uaex.edu/media-resources/news/june2018/0601_Turfgrass_shade_research.aspx
- Conduct a shade audit to identify problem areas.
- Conduct a tree survey that identifies each tree's location, species, health, life expectancy, safety concerns, value and special maintenance requirements. https://www.usga.org/content/usga/home-page/course-care/usga-sustainability/tree-management.html

References

1. USGA Green Section www.usga.org/content/usga/home-page/course-care/forethegolfer/2018/understanding-mowing-heights.html
2. Chris Hartwiger, Director, Course Consulting Service, Scalping Can it Be Avoided.
3. http://www.usga.org/content/usga/home-page/course-care/regional-updates/southeast-region/2017/scalping--can-it-be-avoided-.html
4. www.usga.org/content/usga/home-page/course-care/2013/05/the-how-and-why-of-vertical-mowing-greens-21474855829.html
5. Richard J. Hull. 2000. Turfgrass Trends. Volume 5, Issue 2.

6.0 Integrated Pest Management

> A comprehensive IPM program will ensure a healthy environment for people who use the golf course, neighbors who live in proximity, and animals that live on the golf course.

The philosophy of Integrated Pest Management (IPM) was developed in the 1950s because of concerns over increased pesticide use, environmental contamination, and the development of pesticide resistance. The objectives of IPM include reducing pest management expenses, conserving energy, and reducing the risk of pesticide exposure to people, animals, and the environment. Its main goal, however, is to reduce pesticide use by using a combination of tactics to control pests, including cultural, biological, genetic, and chemical controls.

IPM Plan

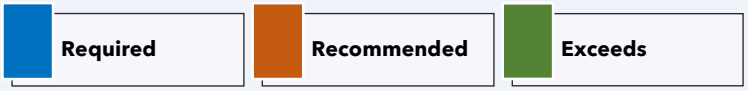
Principles

IPM is a management plan that uses a variety of control measures to keep turfgrass pest populations below levels that are economically and aesthetically damaging, without creating a hazard to people and the environment. IPM aims to reduce conventional pesticide use, when feasible, by using a combination of tactics to control pests, including cultural, biological, genetic, and chemical controls. This Best Management Practices guide in its simplest form is the foundation to an IPM plan.

IPM plans include six (6) basic components:

1. **Scouting and Monitoring**
2. **Selecting Thresholds**
3. **Making Decisions**
4. **Education**
5. **Proper Timing and Spot Treatment**
6. **Evaluation**

Best Management Practices
Scouting and Monitoring Program



- ☐ A consistent monitoring program that documents pest groups including insect, weed, and disease populations, as well as resulting damage throughout the golf course will be the foundation of your IPM plan.
- ☐ Train all personnel to observe and document turf conditions regularly each day while conducting normal tasks.
- ☐ Train spray technicians to understand the pest's life cycle, and to know which life stage to target.
- ☐ Train spray technicians to determine whether corrective actions reduced or prevented pest populations.
- ☐ Record and use this information for future decision making.

Selecting Thresholds

- ☐ IPM is commonly used in agricultural crop production, where economic thresholds for key pests have been determined. Pest levels exceeding the sites threshold warrant treatment.
- ☐ Injury and damage threshold levels are quantitative and qualitive for the golfer and superintendent as obvious visual turfgrass impairments. Create and develop quantitative and qualitative injury or damage threshold levels for key pests, diseases, and weeds in turf for greens, fairways, tees and roughs.
- ☐ Be flexible in setting thresholds. Depending on the time of year, tournament scheduling, etc., thresholds may need to change.

Making Decisions

- ☐ Scouting records and thresholds help in decision-making; decide which pest management practice (mechanical, chemical, biological) is appropriate and carry out corrective actions.
- ☐ Select the pesticide that provides the most control while presenting the least possible hazard to people, wildlife and the environment.
- ☐ Establish a written IPM plan.

Education

- ☐ Communicate and educate course officials, employees, and golfers about IPM strategies that are being utilized on the golf course and why they are being used.
- ☐ Golfers are sensitive and often intolerant of any injury or damage to turf that could affect the appearance and or playability of the turf.
- ☐ Train employees on proper pest identification, pesticide selection, and application techniques; entomologists and other specialists are available from NDOA and other extension agencies for assistance with pest identification.
- ☐ Send communications to neighboring property owners or homeowners' associations to educate on the golf course's involvement in IPM and best management practices.
- ☐ Provide newsletters, fliers, or brochures about environmental goals and progress the golf course is taking to meet environmental objectives.
  http://agri.nv.gov/Resources/Staff_Listings/Plant_Industry_-_Entomology/

Proper Timing and Spot Treatment

- ☐ Based on monitoring records determine optimum timing for the most effective control. Map pest outbreak locations to identify patterns and susceptible areas for future targeted spots applications.

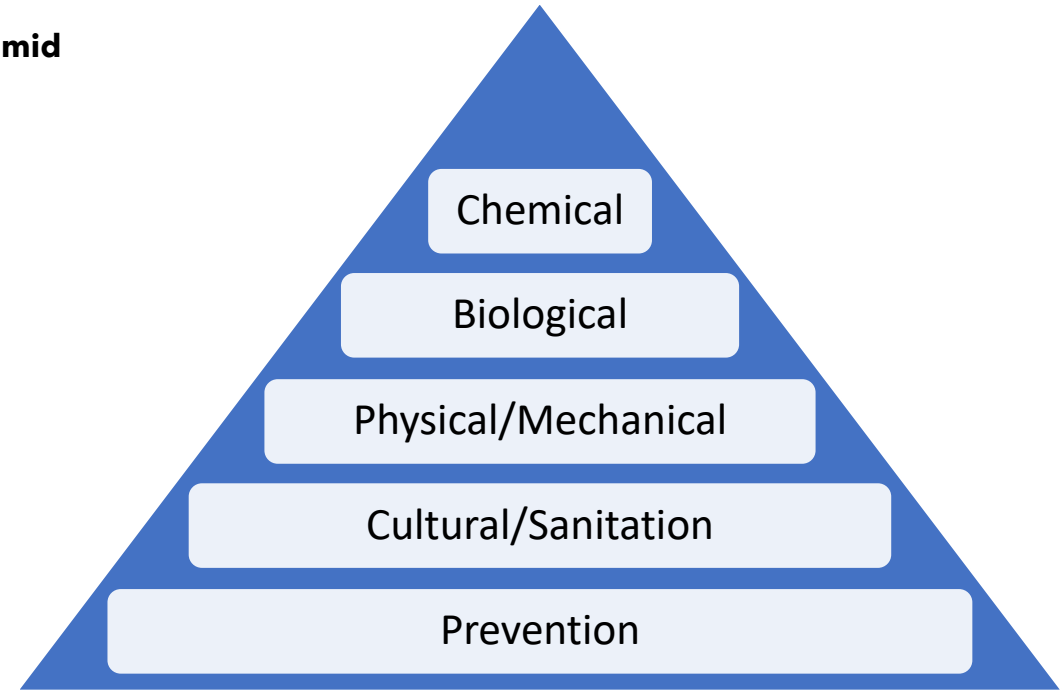
Evaluation

- ☐ Always evaluate effectiveness of control measure, and adjust thresholds, and monitoring schedules accordingly.

- ☐ Record keeping is critical and should include:
  - Date and time of application
  - Name of applicator
  - Weather conditions at time of application
  - Target pest
  - Severity of infestation
  - Pesticide used
  - Adjuvant/surfactant if used
  - Area and location treated
  - Application equipment (nozzles, pressure, speed)

Control Strategies

IPM Pyramid



Best Management Practices

Required | Recommended | Exceeds

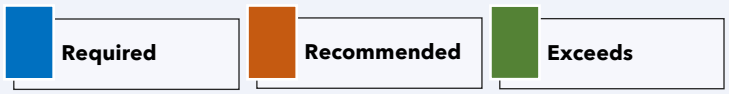
- ☐ Species and Cultivar Selection - match local environmental and playing conditions. Species grown outside of their zone of adaptation are more prone to pest problems.
- ☐ Mowing Practices - mowing height are directly related to turfgrass species and growth rate. Raise the mowing height of cut to provide more leaf surface for photosynthetic activity.
- ☐ Irrigation Practices - properly water turf is more resistant to insects and diseases.
- ☐ Fertility Management - fertilization must be scheduled to meet nutritional and growth needs of the plant. Reduce fertilizer applications in shaded areas.
- ☐ Thatch Control - cultural practices can prevent excessive thatch build up.
- ☐ Root Zone Management-improving soil characteristics can have a positive impact on turfgrass health.
- ☐ Traffic control - rotate traffic patterns by planned movement of hole and tee markers. Distribute cart and foot traffic over wide areas. Reduce traffic in shaded areas to protect turfgrass and trees from injury and soil compaction.
- ☐ Tree Management - increase light penetration and air circulation through tree canopy by selectively thinning and pruning.
- ☐ Alternative Pest Control - introduce natural enemies of pests to the turfgrass environment. Avoid applying pesticides to roughs, driving ranges, or other low-use areas to provide a refuge for beneficial organisms.

Regulatory Considerations

Principles

- Record keeping of pesticide use may be required by law. Record-keeping is required to comply with the federal Superfund Amendments and Reauthorization Act (SARA, Title III). IPM principals suggest that you keep records of all pest control activity.
- Certain pesticides are classified as restricted-use pesticides. Very few pesticides in this category are used for turf maintenance, certain record-keeping requirements apply.
- See Pesticide section for additional information.

Best Management Practices



- ☐ Know and understand Federal, State and tribal regulations for pesticide use.
- ☐ Proper records of pesticide applications should be kept according to local, state, or federal requirements. (See Pesticide Management Section)
- ☐ Use records to establish proof of use and follow-up investigations of standard protocols.

Additional Resources:
A Guide to Environmental Stewardship on the Golf Course, Audubon International, Selkirk NY,1996.
http://agri.nv.gov/Pest-Control/
https://www.usga.org/course-care/audubon-sanctuary-program-4f48d5a0.html

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7.0 Pesticide Management

> A Pesticide use should be part of an overall pest management strategy that includes biological controls, cultural methods, pest monitoring, and other applicable practices, referred altogether as IPM.

When a pesticide application is deemed necessary, its selection should be based on effectiveness, toxicity to non-target species, cost, site characteristics, and its solubility and persistence in the environment.

Regulatory Considerations

Principles

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

Best Management Practices

- ☐ READ, UNDERSTAND, AND FOLLOW ALL LABEL DIRECTIONS. IT'S THE LAW!
- ☐ Only apply pesticides that are legally registered at all levels of jurisdiction.
- ☐ Only apply pesticides that are legally registered for use on the facility (for example, do not apply pesticides labeled for agricultural uses even though they may have the same active ingredient).
- ☐ Apply according to manufacturer recommendations as seen on label.

NEVADA STATE DEPARTMENT OF AGRICULTURE
Main Office
405 S. 21st Street 2300 McLeod Street
Sparks, Nevada 89431-5557
(775) 353-3601

Due to ongoing pesticide and regulation changes, The Nevada Department of Agriculture assumes no liability for suggested pesticide use, control techniques, or regulation changes. For Nevada's most current pest control NAC regulations go to: http://www.leg.state.nv.us/NAC/NAC-555.html

For current NRS regulations visit: http://www.leg.state.nv.us/NRS/NRS-555.html

Nevada Department of Agriculture: http://www.agri.nv.gov
University of Nevada Cooperative Extension: http://www.unce.unr.edu

Human Health Risks

Principles

Pesticides belong to numerous chemical classes that vary greatly in their toxicity. The human health risk associated with pesticide use is related to both pesticide toxicity and the level of exposure. The risk of a very highly toxic pesticide may be very low if the exposure is sufficiently small. Each pesticide label will provide information on personal protective equipment needed (PPE), first aid, as well as include a precautionary statement and pesticide signal word. The label is the law, and each applicator should read the label in its entirety prior to mixing, loading or applying a pesticide. Safety Data Sheets (SDS) also contain relevant information such as precautionary and first aid treatment. Safety Data Sheets should be used in conjunction with the pesticide label.

Best Management Practices

- Select the least toxic pesticide with the lowest exposure potential.
- Know the emergency response procedure in case excessive exposure occurs.

Poison Control Center

The American Association of Poison Control Centers (AAPCC) supports our nation's 57 Poison Control Call Centers through a single toll-free phone number. All local poison control centers in the United States use this national number although calls are routed through different centers depending on geographic location. Nevada calls are routed through the **Rocky Mountain Poison Control Center** which also services call from Hawaii and Montana.

This national hotline number connects to experts in poison control **National Poison Control 1-800-222-1222.**

For the full text of the Code of Federal Regulations (CFR) TITLE 40 - Protection of Environment; CHAPTER I – Environmental Protection Agency; SUBCHAPTER E – Pesticide Programs; PART 170 – Worker Protection Standard, go to: http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title40/40cfr170_main_02.tpl

Shelf Life

Principles

- Pesticides degrade over time. Do not store large quantities of pesticides for long periods.
- Utilize computer software systems to record inventory and use.

Best Management Practices

- Avoid purchasing large quantities of pesticides that require storage for greater than six months.
- Adopt the "first in–first out" principle, using the oldest products first to ensure that the product shelf life does not expire.
- Many states offer "amnesty" days in order to eliminate potential public health and environmental hazards from cancelled, suspended, and unusable pesticides that are being stored.
- Ensure labels are on every package and container.
- Consult inventory when planning and before making purchases.
- Ensure that labels remain properly affixed to their containers.
- Consult inventory when planning applications and before making purchases.

Pesticide Container Recycling/Waste Disposal

Improper disposal of waste pesticides may result in surface or groundwater pollution. The Nevada Department of Agriculture's (NDA) pesticide waste disposal program gives pesticide users the opportunity to properly discard unwanted pesticide products. This is a safe way to protect the environment from pesticide pollution and contamination. Similarly, pesticide containers will deteriorate over time. Leaking containers can result in pesticide exposure to people, pets, wildlife, and the environment. Avoid costly cleanups or pesticide exposure by removing and disposing of unwanted pesticide products. For more information on the pesticide container recycling and waste disposal programs, please find the fact sheets at: http://agri.nv.gov/Outreach/Publications/

What Products can be Recycled?

Acceptable products include:

- **insecticides**
- **fungicides**
- **herbicides**
- **rodent baits**
- **other pesticides**

For information contact:
Bret Allen, Environmental Scientist II
775-353-3715
bret.allen@agri.nv.gov
agri.nv.gov/ES

Nevada Department of Agriculture
405 21st Street • Sparks, NV 89431

Please call the State of Nevada recycling hotline for all other recycling inquiries:
1-800-597-5865.

Unused or Expired Pesticides

Unusable, expired, or unwanted pesticides are referred to as waste pesticides. Many pesticides are banned or no longer used, including DDT, chlorpyrifos, and diazinon, and they can all be disposed of safely through the NDA Environmental Services program.

Environmental Fate and Transport

Principles

Environmental characteristics of a pesticide can often be determined by the environmental hazards statement found on pesticide product labels. The environmental hazards statement (referred to as "Environmental Hazards" on the label and found under the general heading "Precautionary Statements") provides the precautionary language advising the user of the potential hazards to the environment from the use of the product. The environmental hazards generally fall into three categories: (1) general environmental hazards, (2) non-target toxicity, and (3) endangered species protection.

Best Management Practices

- Select pesticides that have a low runoff and leaching potential.
- Apply when weather conditions favor best results.
- Before applying a pesticide, evaluate the impact of site-specific characteristics (for example, proximity to surface water, water table, and well-heads; soil type; prevailing wind; etc.) and pesticide-specific characteristics (for example, half-lives and partition coefficients)
- Select pesticides with reduced impact on pollinators.
- Select pesticides that, when applied according to the label, have no known effect on endangered species present on the facility.

Pesticide Transportation, Storage, and Handling

Principles

Storage and handling of pesticides in their concentrated form poses the highest potential risk to ground or surface waters. For this reason, it is essential that facilities for storing and handling these products be properly sited, designed, constructed, and operated.

Best Management Practices

- Store, mix, and load pesticides away from sites that directly link to surface water or groundwater.
- Store pesticides in a lockable concrete or metal building that is separate from other buildings.
- Locate pesticide storage facilities from other types of structure to allow fire department access.
- Storage facility floors should be impervious and sealed with a chemical-resistant paint.
- 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 to allow the use of wheeled handcarts for moving material in and out of the storage area safely.
- Shelving should be made of sturdy plastic or reinforced metal.
- Metal shelving should be kept painted to avoid corrosion. Wood shelving should never be used, because it may absorb spilled pesticides.
- Automatic exhaust fans and an emergency wash area should be provided. Explosion-proof lighting may be required. 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 temperature extremes inside the pesticide storage facility.
- Personal protective equipment (PPE) should be easily accessible and stored immediately outside the pesticide storage area.
- Do not transport pesticides in the passenger section of a vehicle.
- 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.

Emergency Preparedness and Spill Response

Principles

Accidents happen. Advance preparation on what to do when an accident occurs is essential to mitigate the human health effects and the impact on the environment.

Best Management Practices

- Develop a golf course facility emergency response plan which includes procedures to control, contain, collect, and store spilled materials.
- Prominently post "Important Telephone Numbers" including CHEMTREC, for emergency information on hazards or actions to take in the event of a spill.
- 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.
- Host a tour for local emergency response teams (for example, fire fighters, etc.) to show them the facilities and to discuss the emergency response plan. Seek advice on ways to improve the plan.

Emergency Phone Numbers

CHEMTREC Emergency Hotline (material safety information, spills, leaks)
(800) 424-9300

National Poison Center Hotline
(800) 222-1222

Washoe Poison Center (outside Clark, Nye Counties) (800) 222-1222
Rocky Mountain Poison Center (Clark, Nye Counties) (800) 222-1222

Phone Numbers for Pesticide Safety and Information

University of Nevada Cooperative Extension
(775) 784-1931

Nevada Department of Agriculture
Reno... (775) 353-3600
Las Vegas... (702) 668-4590
Elko... (775) 738-8076

United States Department of Agriculture, Pesticide Records Branch
(703) 330-7826

National Pesticide Information Center (NPIC)
(800) 858-7378
npic.orst.edu

Pesticide Record Keeping

Principles

Maintaining accurate records of pesticide-related activities (for example, purchasing, storage, inventory, applications, etc.) is essential.

Best Management Practices

- Keep and maintain records of all pesticides used to meet legal (federal, state, and local) reporting requirements.
- Use records to monitor pest control efforts and to plan future management actions.
- Use electronic or hard-copy forms and software tools to properly track pesticide inventory and use.
- Develop and implement a pesticide drift management plan.
- Keep a backup set of records in a safe, but separate storage area.
- Accurate records provide and establish proof of use and follow-up investigation of standard protocols regarding:

Restricted-use Pesticide Record-Keeping Requirements

- ✓ **Date and time of the application**
- ✓ **Certified applicator's name**
- ✓ **Brand or product name**
- ✓ **EPA registration number**
- ✓ **Total amount of undiluted material applied**
- ✓ **Areas treated (Acres or square feet treated)**
- ✓ **Crop, commodity, or site**
- ✓ **Location of the application**
- ✓ **Pest treated**
- ✓ **Start and finish temperatures**
- ✓ **Wind speed and direction**
- ✓ **Weather conditions at the time of the application**
- ✓ **(trade name, active ingredient, amount of formulation, amount of water)**
- ✓ **Adjuvant/surfactant and amount applied if used**
- ✓ **Application equipment**
- ✓ **Additional remarks, such as the severity of infestation or life stage of the pest**
- ✓ **Follow up to check the effectiveness of the application**

Recording Spot Treatments

Spot applications with herbicides are often used to control noxious weeds. Spot herbicide treatments applied to a total area of less than 1/10 of an acre in the same day require the following records:

- Date of application
- Certified applicator's name
- Brand or product name
- EPA registration number
- Total amount applied
- Spot application followed by location of application.
- Date of application

Sprayer Calibration

Principles

Properly calibrated application equipment is paramount to mitigating environmental and human health concerns.

Best Management Practices

- Personally, ensure spray technician is experienced, licensed or certified, and properly trained.
- Minimize off-target movement by using properly configured application equipment.
- Properly calibrate all application equipment at the beginning of each season (at a minimum) or after equipment modifications.
- Check equipment daily when in use.
- Use recommended spray volumes for the targeted pest to maximize efficacy.
- Calibration of walk-behind applicators should be conducted for each person making the application to take into consideration their walking speed, etc.

Types of Sprayers

Principles

Various types and sizes of application equipment are readily available. The size of the equipment (tank size, boom width, etc.) should be matched to the scale of the facility.

Best Management Practices

- Use an appropriately sized applicator for the size of area being treated.
- Equipment too large in size requires greater volumes to prime the system. This can result in significant waste that must be properly handled.

Inventory

Principles

Do not store large quantities of pesticides for long periods. Adopt the “first in–first out” principle, using the oldest products first to ensure that the product shelf life does not expire.

Best Management Practices

An inventory of the pesticides kept in the storage building and the Safety Data Sheets (SDS) for the chemicals used in the operation should be accessible on the premises, but not kept in the pesticide storage room itself.

Leaching Potentials

Principles

Weakly sorbed pesticides (compounds with small Koc values) are more likely to leach through the soil and reach groundwater. Conversely, strongly sorbed pesticides (compounds with large Koc values) are likely to remain near the soil surface, reducing the likelihood of leaching, but increasing the chances of being carried to surface water via runoff or soil erosion.

Best Management Practices

- Understand pesticide sorption principles so that appropriate decisions can be made.
- Understand site characteristics that are prone to leaching losses (for example, sand-based putting greens, coarse-textured soils, shallow water tables).
- Identify label restrictions that may pertain to your facility.
- Avoid using highly water-soluble pesticides.
- Exercise caution when using spray adjuvants that may facilitate off-target movement.

Mixing/Washing Station

Principles

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 containment methods is the use of a properly designed and constructed chemical mixing center (CMC).

Best Management Practices

- Loading pesticides and mixing them with water or oil diluents should be done over an impermeable surface (such as lined or sealed concrete), so that spills can be collected and managed.
- Mixing station surface should provide for easy cleaning and the recovery of spilled materials.
- Pump the sump dry and clean it at the end of each day. Liquids and sediments should also be removed from the sump and the pad whenever pesticide materials are changed to an incompatible product (that is, one that cannot be legally applied to the same site).
- Apply liquids and sediments as you would a pesticide, strictly following label instructions.
- Absorbents such as cat litter or sand may be used to clean up small spills and then applied as a topdressing in accordance with the label rates or disposed of as a waste.
- Sweep up solid materials and use as intended.

Disposal

Principles

Wash water from pesticide application equipment must be managed properly, since it contains pesticide residues.

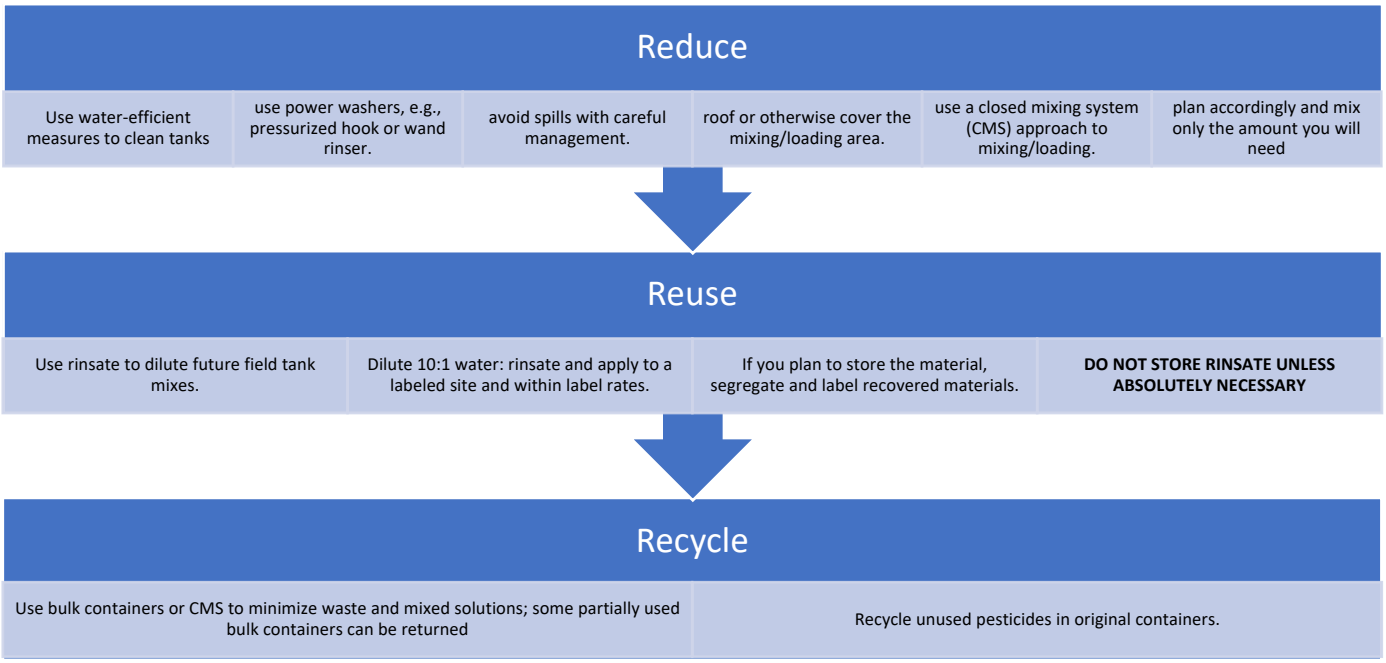
Best Management Practices

- Collect wash water (from both inside and outside the application equipment) and use it as a pesticide in accordance with the label instructions.
- The rinsate may be applied as a pesticide (preferred) or stored for use as makeup water for the next compatible application.

How to Manage Rinsate

Rinsate is the mixture of water that's contaminated with low concentrations of pesticide products. It may come from: rinsed containers; sumps; cleanout water or leftover tank mix; previously stored rinsate; and/or spill cleanups. Rinsate becomes a waste problem when it cannot be recycled or reused at the pesticide operation site. Pesticide equipment requires periodic cleaning and rinsing to keep vital equipment components in good working condition and when switching from one pesticide to another. Improper management of rinsate has great potential for contaminating surface and ground water. The best way to eliminate this problem is to perform all interior and exterior rinsing in modern pesticide mixing and loading facilities equipped with a concrete rinse pad and rinsate-collection pit. However, disposal of the rinsate collected in the pit or recovery system could become a major problem. This is why it is important to reduce the amount of rinsate to a minimum. If possible, reuse the rinsate when preparing the next batch of tank mixture. Make sure all the dirt and debris in the rinsate are filtered out before adding the rinsate to the spray tank. The small amount of solids left should be dried and taken to a hazardous waste disposal site or pesticide collection event. The chart below gives some tips to manage rinsate effectively.

Rinsate 3 R's



For more information on how to manage pesticide rinsate, contact the Nevada Department of Agriculture in Sparks at (775) 353-3715 or Las Vegas at (702) 668-4590. Visit our web site at: http://www.agri.nv.gov

Pesticide Container Management

Principles

The containers of some pesticides are classified as hazardous wastes if not properly rinsed and are subject to rules and regulations. 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. Federal law (FIFRA) and some state laws require pesticide applicators to rinse all empty pesticide containers before taking other disposal steps. Reference the Resource Conservation and Recovery Act (RCRA) for more information.

Best Management Practices

- Rinse pesticide containers immediately in order to remove the most residue.
- Rinse containers during mixing and loading and add rinsate water to the finished spray mix.
- Rinse emptied pesticide containers by either triple rinsing or pressure rinsing.
- Puncture empty and rinsed pesticide containers, crush cap, and dispose of separately according to the label.

Personal Protective Equipment

Principles

Exposure to pesticides can be mitigated by practicing good work habits and adopting modern pesticide mix/load equipment that reduces potential exposure. Personal Protective Equipment (PPE) statements on pesticide labels provide the applicator with important information on protecting himself/herself.

Best Management Practices

- Provide adequate PPE for all employees who work with pesticides (including equipment technicians).
- Ensure PPE is sized appropriately for each person using it.
- Make certain that PPE is appropriate for chemicals used.
- Ensure PPE meets rigorous testing standards.
- Store PPE where easily accessible, not in pesticide storage area.
- Forbid employees who apply pesticides from wearing facility uniforms home.
- Provide laundering facilities or uniform service for employee uniforms.
- The federal Occupational Safety and Health Administration (OSHA) requires employers to fit test workers who must wear tight-fitting respirators.
- Meet requirements for OSHA 1910.134 Respiratory Protection Program.

The Worker Protection Standard (WPS) requires agricultural employers take steps to reduce risk of pesticide-related illness and injury to pesticide handlers. Any producer that employs non-family members to work in areas where pesticides have been applied or employs individuals to mix and load pesticides must comply with federal WPS. Employers are required to provide:

- Pesticide safety training
- Specific application information
- Restricted entry information
- Decontamination sites with supplies
- PPE
- Emergency assistance

The Worker Protection Standard applies to all general- and restricted-use pesticides that are used on cropland.

8.0 Pollinator Protection

> Protecting bees and other pollinators is important to the sustainability of agriculture. Nevada crops which rely on pollinators include alfalfa, apples, pears, and apricots. BMPs help protect pollinators to support a healthy agricultural system.

Photo Courtesy of Bayer Bee Care

Most flowering plants need pollination to reproduce and grow fruit. While some plants are pollinated by wind, many require assistance from insects and other animals. In the absence of pollinators, many plant species, including the fruits and vegetables we eat, would fail to survive.

The western honeybee (*Apis mellifera*) is one of the most important pollinators in the United States. Hundreds of other bee species, including the bumble bee (*Bombus* spp.), also serve as important pollinator species.

Common Threats to Pollinators

- Insecticides: Drift to non-target locations is a potentially significant threat to pollinators. Pollinators may drink water sources containing insecticide residue or dew on recently treated plants. Several classes of insecticides may be injurious to pollinators and include organophosphorus pesticides (e.g., chlorpyrifos), carbamates (e.g., carbaryl), neonicotinoids (e.g., imidacloprid) and pyrethroids (e.g., permethrin).

- Habitat Modification: Depending on the amount and type of vegetation around the course and the manner in which it is controlled (mowing, cutting, grazing, use of herbicides, etc.), nectar and/or pollen sources for pollinators may be temporarily or permanently reduced.

- Colony Collapse Disorder is a phenomenon generally described by worker bee abandonment of healthy hives, leaving a helpless queen, nurse bees, and larvae to die without access to nectar and pollen. This disorder is thought to be due to a combination of improper insecticide use, changing climates, parasites, and urban development.

Pesticides are products designed to control pests (for example, insects, diseases, weeds, nematodes, etc.). Pesticides and other plant growth products, including plant growth regulators, surfactants, biostimulants, etc., are used in golf course management.

Pesticide applicators, including those on golf courses, need to be mindful of the impact that pesticides have on pollinator species and their habitat.

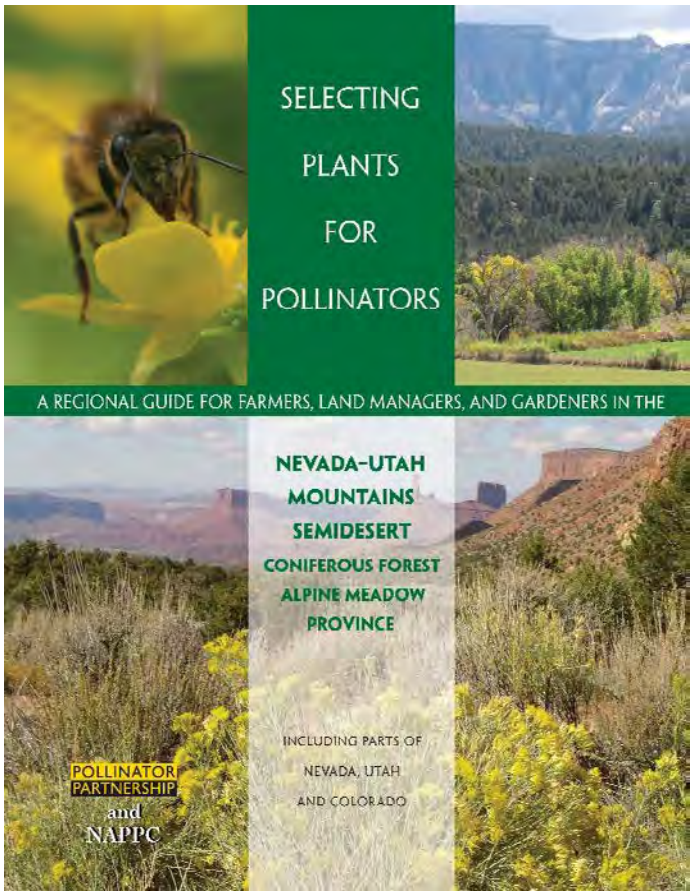
Regulatory Considerations

Principles

- Pollinator-protection language is a label requirement found on pesticide labels; follow the label, it is the law. If the pesticide is highly toxic to bees, the following language is on the label: "This product is highly toxic to bees and other pollinating insects exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees or other pollinating insects are visiting the treatment area." Information on Neonicotinoid Pesticide labeling is available at https://www.epa.gov/pollinator-protection/new-labeling-neonicotinoid-pesticides
- Pesticide applicators must be aware of honeybee toxicity groups and able to understand precautionary statements. Information on Risk Assessment is available at https://www.epa.gov/pollinator-protection/pollinator-risk-assessment-guidance
- Recordkeeping may be required by law in order to use some products. IPM principles suggest that you keep records of all pest control activity so that you may refer to information on past infestations or other problems to select the best course of action in the future. An effective IPM program employs a combination of practices that control pests and minimize risks to pollinators and other beneficial insects.
- In 2016 the Nevada Department of Agriculture released a Nevada Managed Pollinator Protection Plan (MP3) to reduce pesticide exposure to bees through timely communication and coordination among key stakeholders, including beekeepers, pesticide applicators and landowners. NAC 555.470 requires any pest control licensee who intends to apply any pesticide known to be harmful to bees give 24 hours advance-notice to any apiarist having bees on the land or adjacent land by telephone or in person. More information on the state MP3 is available at http://agri.nv.gov/uploadedFiles/agrinvgov/Content/Plant/Entomology/nevada_pollinator_protection_plan_final.pdf
- The Nevada Department of Agriculture provides a map of bee colonies/locations. Registration of colonies is voluntary, so not all sites will be included. The Colony Map can be accessed at http://agri.nv.gov/Plant/Entomology/Colony_Map/ and further instructions are provided.
- The NAPPC and the Pollinator Protection Partnership produce a guide on pollinators and pollinator habitat development and management. The guide discusses in detail the various pollinators in Nevada including bees, butterflies, moths, beetles, flies and birds. Access to the guide is available at: https://www.pollinator.org/PDFs/Guides/NevadaUtahrx1FINAL.pdf

Best Management Practices

- Proper records of all pesticide applications should be kept according to local, state, or federal requirements.
- Use records to establish proof of use and follow-up investigation of standard protocols regarding:
  - Date and time of application (Spray at night or in early morning/late evening)
  - Name of applicator
  - Person directing or authorizing the application
  - Weather conditions at the time of application
  - Target pest
  - Pesticide used (trade name, active ingredient, amount of formulation, amount of water)
  - Adjuvant/surfactant and amount applied, if used
  - Area treated (acres or square feet) and location
  - Total amount of pesticide used
  - Application equipment
  - Additional remarks, such as the severity of the infestation or life stage of the pest
  - Follow-up to check the effectiveness of the application



- Those applying pesticides, and who make decisions regarding their applications should be able to interpret pollinator protection label statements. Label language for bees and other insect pollinators can be found in one or more of the following sections of the label: Environmental Hazards, Directions for Use and the Protection of Pollinators box. In addition, there may be a bee hazard icon alerting the user to pollinator precautions.
- Those applying pesticides should be aware of honeybee biology. Information is available through the Pollinator Partnership website at: http://pollinator.org/learning-center/bee-issues#hblife
- Those applying pesticides should understand the various routes of exposure (outside the hive and inside the hive).
- Those applying pesticides should understand the effects of pesticides on bees.

Pollinator Habitat Protection

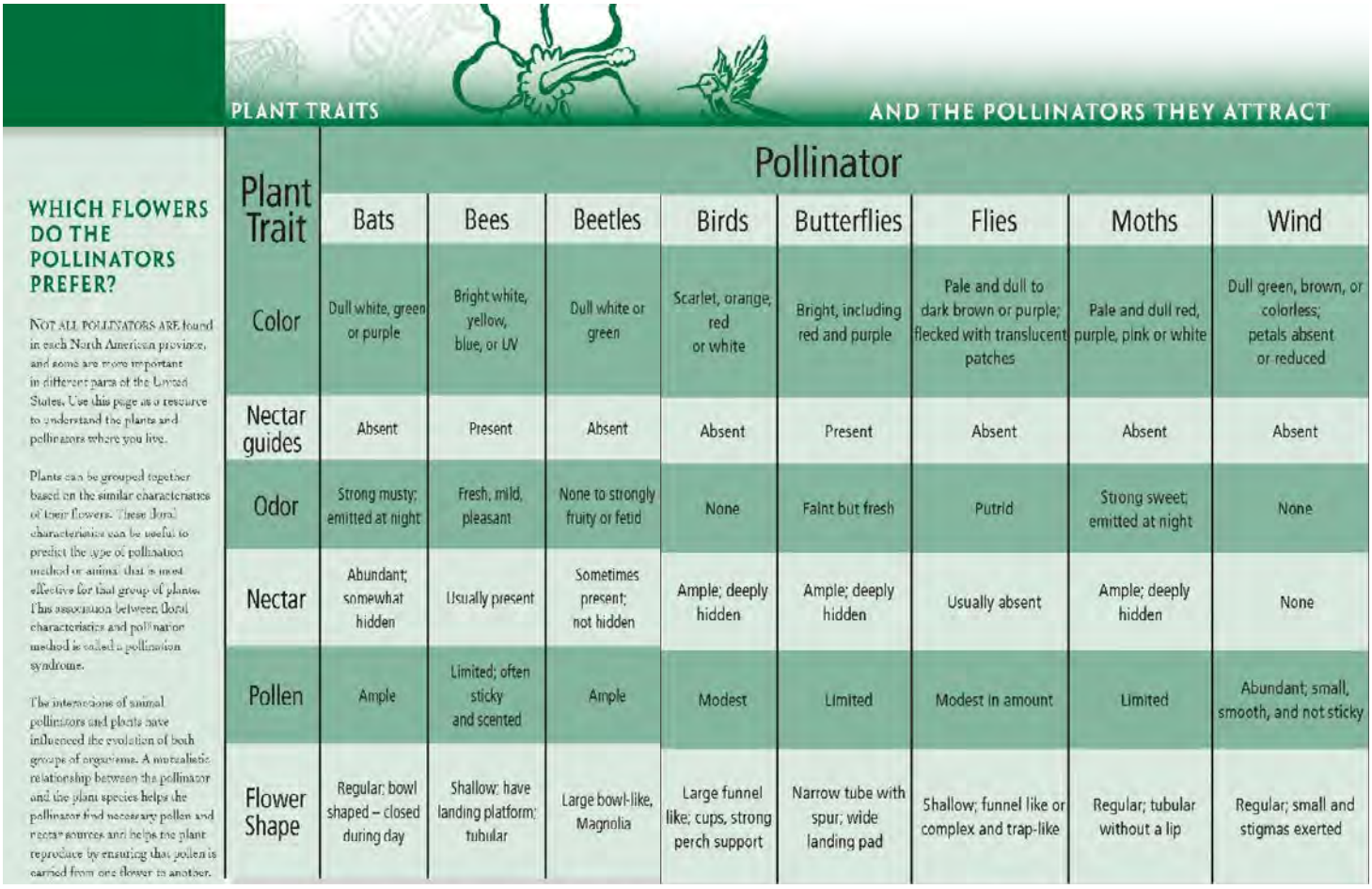
Principles

- It is important to minimize the impacts of pesticides on bees and beneficial arthropods. Pesticide applicators must use appropriate tools to help manage pests while safeguarding pollinators, the environment, and humans.
- Be mindful of pollinators; when applying pesticides, focus on minimizing exposure to non-target pollinators in play and non-play course areas.
- Pollinators require a diversity of flowering species to complete their life cycle. Pollinator habitat contains a diversity of wildflower species of different colors and heights, with blossoms throughout the entire growing season.
- The United States Golf Association (USGA) provides a guide on creating a habitat for pollinator insects: (https://www.xerces.org/wp-content/uploads/2008/10/making_room_for_pollinators_usga1.pdf).

Monarch Butterfly. Photo courtesy of the Xerces Society

Best Management Practices

- Follow label information directing the application of pesticide when the plant may be in bloom. Avoid applying pesticides during bloom season.
- Stay on target by using coarse-droplet nozzles, and monitoring wind to reduce drift.
- Do not apply pesticides when pollinators are active.
- Before applying a pesticide, scout/inspect the area for both harmful and beneficial insect populations and use pesticides only when a threshold of damage has been indicated.
- Mow flowering plants (weeds) before insecticide application.
- If flowering weeds are prevalent, control them before applying insecticides.
- Use insecticides that have a lower impact on pollinators.
- Use latest spray technologies, such as drift-reduction nozzles to prevent off-site (target) translocation of pesticide.
- Avoid applications during unusually low temperatures or when dew is forecast.
- Use granular formulations of pesticides that are known to be less hazardous to bees.
- Consider lures, baits, and pheromones as alternatives to insecticides for pest management.
- Develop pollinator habitat and/or enhance existing utilizing native species when possible. Species that attract pollinators in Nevada: http://www.pollinator.org/PDFs/NevadaUtah.pdf
- Relocate beehives in proximity to play areas



PLANT TRAITS AND THE POLLINATORS THEY ATTRACT

WHICH FLOWERS DO THE POLLINATORS PREFER?

NOT ALL POLLINATORS ARE found in each North American province, and some are more important in different parts of the United States. Use this page as a resource to understand the plants and pollinators where you live.

Plants can be grouped together based on the similar characteristics of their flowers. These floral characteristics can be useful to predict the type of pollination method or animal that is most effective for that group of plants. This association between floral characteristics and pollination method is called a pollination syndrome.

The interactions of animal pollinators and plants have influenced the evolution of both groups of organisms. A mutualistic relationship between the pollinator and the plant species helps the pollinator find necessary pollen and nectar sources and helps the plant reproduce by ensuring that pollen is carried from one flower to another.

Plant Trait	Pollinator							
	Bats	Bees	Beetles	Birds	Butterflies	Flies	Moths	Wind
Color	Dull white, green or purple	Bright white, yellow, blue, or UV	Dull white or green	Scarlet, orange, red or white	Bright, including red and purple	Pale and dull to dark brown or purple; flecked with translucent patches	Pale and dull red, purple, pink or white	Dull green, brown, or colorless; petals absent or reduced
Nectar guides	Absent	Present	Absent	Absent	Present	Absent	Absent	Absent
Odor	Strong musty; emitted at night	Fresh, mild, pleasant	None to strongly fruity or fetid	None	Faint but fresh	Putrid	Strong sweet; emitted at night	None
Nectar	Abundant; somewhat hidden	Usually present	Sometimes present; not hidden	Ample; deeply hidden	Ample; deeply hidden	Usually absent	Ample; deeply hidden	None
Pollen	Ample	Limited; often sticky and scented	Ample	Modest	Limited	Modest in amount	Limited	Abundant; small, smooth, and not sticky
Flower Shape	Regular; bowl shaped – closed during day	Shallow; have landing platform; tubular	Large bowl-like, Magnolia	Large funnel like; cups, strong perch support	Narrow tube with spur; wide landing pad	Shallow; funnel like or complex and trap-like	Regular; tubular without a lip	Regular; small and stigmas exerted

NAPPC and the Pollinator Protection Partnership, Selecting Plants for Pollinators.

Best Management Practices

Required | Recommended | Exceeds

- ☐ Pollinator-protection language is a label requirement found on pesticide labels; follow the label, it is the law.
- ☐ NAC 555.470 requires any pest control licensee who intends to apply any pesticide known to be harmful to bees give 24 hours advance notice to any apiarist having bees on the land or adjacent land by telephone or in person.
- ☐ Proper records of pesticide applications should be kept according to local, state, or federal requirements.
- ☐ Those applying pesticides should understand effects of pesticides on bees.
- ☐ Pesticide applicators must be aware of honey bee toxicity groups and able to understand precautionary statements.
- ☐ Those applying pesticides should understand routes of exposure (outside/inside hive).
- ☐ Mow flowering plants (weeds) before insecticide application.
- ☐ Develop new pollinator habitat and/or enhance existing utilizing native species when possible.
- ☐ Use insecticides that have a lower impact on pollinators.

Pollinator-protection language is a label requirement found on pesticide labels; follow the label, it is the law.
https://www.epa.gov/pollinator-protection/new-labeling-neonicotinoid-pesticides

Nevada Department of Agriculture Nevada Managed Pollinator Protection Plan (MP3). More info at
http://agri.nv.gov/uploadedFiles/agrinvgov/Content/Plant/Entomology/nevada_pollinator_protection_plan_final.pdf

Pollinator Protection Checklist

1. **Read and follow the pesticide label and use products wisely.**
2. **Determine if the pesticide may be harmful to insect pollinators.**
3. **Understand insect pollinator visitation habits.**
4. **Use Integrated Pest Management (IPM).**
5. **Follow pesticide product stewardship practices.**
6. **Cooperate and communicate in a timely manner with stakeholders in the area of pesticide application.**
7. **Understand the signs of pesticide exposure to bees and other disorders that may cause similar effects.**
8. **Check state and local ordinances pertaining to insect pollinators**

References:

Bayer Insect Pollinators and Pesticide Product Stewardship – Protecting Insect Pollinators on Farms and in Urban Landscapes.

California Golf Course Superintendents Association BMP Guide, Section 9 – Pollinator Protection and Enhancement.

United States Golf Association, Making Room for Native Pollinators. Available at https://www.xerces.org/wp-content/uploads/2008/10/making_room_for_pollinators_usga1.pdf

Pollinator Partnership, Honey Bee Health. Available at http://pollinator.org/learning-center/bee-issues#hblife

Pollinator Partnership and NAPPC, Selecting Plants for Pollinators. Available at https://www.pollinator.org/PDFs/Guides/NevadaUtahrx1FINAL.pdf.

Nevada Department of Agriculture, Nevada Managed Pollinator Protection Plan. Available at http://agri.nv.gov/uploadedFiles/agrinvgov/Content/Plant/Entomology/nevada_pollinator_protection_plan_final.pdf

United States Environmental Protection Agency. New Labeling for Neonicotinoid Pesticides. Available at https://www.epa.gov/pollinator-protection/new-labeling-neonicotinoid-pesticides

United States Environmental Protection Agency. Pollinator Risk Assessment Guide. Available at https://www.epa.gov/pollinator-protection/pollinator-risk-assessment-guidance

9.0 Maintenance Operations

> Working with all stakeholders to design and construct a safe and efficient maintenance facility can minimize environmental impact.

Equipment maintenance, fueling, and chemical storage can have an impact on water quality on-site and off-site both during construction and during the maintenance of existing golf courses.

Regulatory Considerations

Local and state regulations may be in place in your location. Early engagement among developers, designers, local community groups and permitting agencies is essential to designing and constructing a golf maintenance and storage facility that minimizes environmental impact and meets the needs for the approval process.

NDEP requires notification of spills (releases) to the environment, e.g. line-breaks of reclaimed water, pesticides, fertilizer solution, etc.

Storage and Handling of Chemicals

Principles

- Proper handling and storage of pesticides and petroleum-based products is important to reduce risk of serious injury or death of an operator or bystander. Fires or environmental contamination may result in large fines, cleanup costs, and civil lawsuits if these chemicals are not managed properly.
- Check federal, state, and local regulations for specific requirements related to storage of pesticides.

Best Management Practices

- Storage buildings should have appropriate warning signs and placards.
- Follow all personal protective equipment (PPE) statements on pesticide labels.
- Store PPE away from pesticide storage areas in an area that is easily accessible.
- Develop an emergency response plan and educate all golf course personnel regarding emergency procedures on a regular basis.
- Individuals conducting emergency chemical cleanups should be properly trained under requirements of federal Occupational Safety and Health Administration (OSHA).
- Store pesticides in a lockable concrete or metal building.
- Locate pesticide storage away from other buildings, especially fertilizer storage facilities.
- Floors of chemical storage buildings should be impervious and sealed with chemical-resistant paint.
- 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. Metal shelving should be painted to avoid corrosion. Wood shelving should never be used because of its ability to absorb spilled pesticides.
- Automatic exhaust fans and an emergency wash area should be provided
- Explosion-proof lighting may be required. Locate fan and light switches outside the entrance to the building to facilitate ventilation of building before entrance of staff.
- Maintain detailed records of current pesticide inventory in the storage facility. Safety Data Sheets (SDS) for the chemicals stored on-site should be stored separate from the storage room, but readily accessible on-site.
- Do not store large quantities of pesticides or chemicals for long periods of time. Follow a “first in, first out” principle to rotate products into use to ensure products do not expire.
- Store chemicals in original containers. Never store them in containers that might be mistaken as packaging for food or drink.
- Arrange containers so the 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 those that are nonflammable.
- Store liquid materials below dry materials to prevent leaks from contaminating dry products.
- Ensure that oil containers and small fuel containers (service containers) are properly labeled and stored within the facility

Equipment Storage and Maintenance

Principle

Storing and maintaining equipment properly will extend useful life and reduce repairs.

Best Management Practices

- Store and maintain equipment in a covered area complete with a sealed impervious surface to limit risk of fluid leaks contaminating the environment and to facilitate the early detection of small leaks that may require repair before causing significant damage to the turf or the environment.
- 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. Rain can wash pesticide and fertilizer residues from the exterior of the equipment and possibly contaminate 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 those materials on-site but in a different location where they will be easily accessible in case of an emergency.
- Keep basins of solvent baths covered to reduce emissions of volatile organic compounds (VOC).
- 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; schedule collection by a commercial service.
- Blow off all equipment with compressed air to reduce damage to hydraulic seals.

Sprinkler Maintenance

Principles

- Good system management starts with good preventive maintenance (PM) procedures and record keeping. 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.
- 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 expensive repairs are needed. It also provides a basis for evaluating renovation or replacement options.
- Be proactive; if the system requires frequent repairs, it is necessary to determine why these failures are occurring.
    - Pipe failures may be caused not only by material failure, but also by problems with the pump station.
    - Wiring problems could be caused by corrosion, rodent damage, or frequent lightning or power surges.
    - Control tubing problems could result from poor filtration.

Best Management Practices

- ☐ System checks and routine maintenance on pumps, valves, programs, fittings, and sprinklers should follow the manufacturer's recommendations.
- ☐ 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.
- ☐ Flush irrigation lines 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 the lateral lines before shutting down the irrigation system.
- ☐ Clean and maintain filtration equipment.
- ☐ Systems must be observed in operation at least weekly. This process detects controller or communication failures, stuck or misaligned heads, and clogged or broken nozzles.
- ☐ 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.
- ☐ Ensure that all lubrication, overhauls, and other preventive maintenance are completed according to the manufacturer's schedule.
- ☐ Keep records of filter changes, as this could be an early sign of system corrosion, well problems, or declining irrigation water quality.
- ☐ Application/distribution efficiencies 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.
- ☐ Document equipment run-time hours.
- ☐ Monitor pump 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.
- ☐ Monitor and record the amount of water being applied, including system usage and rainfall. By tracking this information, you can identify areas where minor adjustments can improve performance. Not only is this information essential in identifying places that would benefit from a renovation, but it is also needed to compute current operating costs and compare possible future costs after a renovation.
- ☐ Document and periodically review the condition of infrastructure (such as pipes, wires, and fittings).

Waste Handling

Principles

- Proper disposal of waste materials is critical for protection of water and natural resources. State or local laws and regulations related to disposal of hazardous waste products may vary. Familiarize yourself with state and local laws related to disposal/recycling of waste materials.
- Identify and implement waste-reduction practices.
- Look for ways to increase recycling efforts and programs.
- Purchase environmentally preferred products in bulk packaging when possible.

Best Management Practices

- Pesticides that have been mixed for application must be disposed of as waste and may be classified as hazardous waste depending on the materials involved. Contact local authorities for guidance regarding proper disposal.
- 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.
- Lead-acid batteries are classified as hazardous waste unless they are properly recycled.
- Store old batteries on impervious surface, protect from rainfall; recycle as soon as possible.
- Recycle used tires.
- Recycle or dispose of fluorescent tubes and other lights according to state requirements.

Equipment Washing

Principle

Wash water generated from equipment-washing facilities can be a source of both surface-water and groundwater pollution. Steps should be taken to prevent pollution.

Best Management Practices

- Equipment washing areas should drain to oil/water separator before draining to a sanitary sewer or holding tank.
- Consider the use of a closed-loop wash-water recycling system.
- Grass-covered equipment should be brushed/blown off with compressed air before washed.
- 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.
- Spring-operated shut-off nozzles should be used.
- Do not allow any wastewater to flow directly into surface waters or storm drains.

Fueling Facilities

Principle

Safe storage of fuel, including use of above-ground tanks and containment facilities, is critical to the protection of the environment. State or local laws and regulations related to storage of fuel may vary.

Best Management Practices

- Locate fueling facilities on roofed areas with a concrete (not asphalt) pavement. Areas should be equipped with spill-containment and recovery facilities.
- Use of above ground fuel tanks is preferred.

Pollution Prevention

Principles

- Plan appropriately to minimize the possibility of an elicit discharge and need for disposal. Monitor the water to be discharged for contamination; never discharge to the environment any contaminated water. If the water is not contaminated, it can be reused or discharged to a permitted stormwater treatment system.
- 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 water bodies.
- Wash water from pesticide application equipment must be managed properly, since it contains pesticide residues. This applies to wash water from both the inside and the outside of the application equipment. Material should be collected and used as a pesticide in accordance with the label instructions for that pesticide.
- An equipment-washing facility can be a source of both surface water and groundwater pollution, if the wash water generated is not properly handled. All equipment used in the maintenance of golf courses and associated developments should be designed, used, maintained, and stored in a way that eliminates or minimizes the potential for pollution.
- One of the key principles of pollution prevention is to reduce the unnecessary use of potential pollutants. Over time, the routine discharge of even small amounts of solvents can result in serious environmental and liability consequences, because of the accumulation of contaminants in soil or groundwater.
- The proper handling and storage of pesticides is important. Failure to do so correctly may lead to the serious injury or death of an operator or bystander, fires, environmental contamination that may result in large fines and cleanup costs, civil lawsuits, the destruction of the turf you are trying to protect and wasted pesticide product.
- Generating as little as 25 gallons per month of used solvents for disposal can qualify you as a "small-quantity generator" of hazardous waste, triggering EPA and state reporting requirements.
- Pesticides that have been mixed so they cannot be legally applied to a site in accordance with the label must be disposed of as a waste. Depending on the materials involved, they may be classified as hazardous waste.
- Provide adequate protection from the weather. Rain can wash pesticide and fertilizer residues from the exterior of the equipment, and these residues can contaminate soil or water.
- Never allow solvents to drain onto pavement or soil, or discharge into water bodies, wetlands, storm drains, sewers, or septic systems, even in small amounts.
- Office paper, recyclable plastics, glass, and aluminum should be recycled. Place containers for recycling aluminum cans and glass or plastic soft drink bottles at convenient locations on the course.
- Pesticides should be stored in a lockable concrete or metal building.
- Pesticide storage and mixing facility floors should be impervious and sealed with a chemical-resistant paint. Floors should have a continuous sill to retain spilled materials and no drains, although a sump may be included.
- For valuable 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.

- Use a chemical mixing center (CMC) as a place for performing all operations where pesticides are likely to be spilled in concentrated form—or where even dilute formulations may be repeatedly spilled in the same area—over an impermeable surface. (A CMC is a concrete pad treated with a sealant and sloped to a liquid-tight sump where all of the spilled liquids can be recovered.)
- Flush wash pad with clean water after the equipment is washed. Captured wash water can be used as a dilute pesticide per labeled site, or it may be pumped into a rinsate storage tank for use in the next application.
- FIFRA, Section 2(ee), allows the applicator to apply a pesticide at less than the labeled rate.
- The sump should be cleaned of any sediment before another type of pesticide is handled.

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.

- Discharge to a treatment system that is permitted under industrial wastewater rules.
- Never discharge to a sanitary sewer system without written permission from the utility.
- Never discharge to a septic tank.
- Use a closed-loop wash-water recycling system and follow appropriate BMP.
- Use non-containment wash water for field irrigation.
- Do not discharge non-contaminated wastewater during or immediately after a rainstorm, since the added flow may cause the permitted storage volume of the stormwater system to be exceeded.
- Whenever practical, replace solvent baths with recirculating aqueous washing units (which resemble heavy-duty dishwashers).
- Use soap and water or other aqueous cleaners; these are often as effective as solvent-based ones.
- Blowing off equipment with compressed air instead of washing with water is often easier on hydraulic seals and can lead to fewer oil leaks.
- Grass-covered equipment should be brushed or blown with compressed air before being washed. Dry material is much easier to handle and store or dispose of than wet clippings.
- It is best to wash equipment with a bucket of water and a rag, using only a minimal amount of water to rinse the machine.
- Clean up spills as soon as possible.
- Keep spill cleanup equipment available when handling pesticides or their containers.
- If a spill occurs of a pesticide covered by certain state and federal laws, you may need to report any accidental release if spill quantity exceeds “reportable quantity” of active ingredient specified by law.
- Large spills or uncontained spills involving hazardous materials may best be remediated by hazardous material cleanup professionals.
- Do not allow any wash water to flow directly into surface waters or storm drains.
- Avoid washing equipment in the vicinity of wells or surface water bodies.
- Wash equipment over a concrete or asphalt pad that allows the water to be collected. After the residue dries on the pad, collect, compost, or spread in the field.
- If applicable, allow runoff onto a grassed area to soak into the ground, but never into a surface water body or canal.

- Use compressed air to blow off equipment. This is less harmful to the equipment's hydraulic seals, eliminates wastewater, and produces dry material that is easier to handle.
- Handle clippings and dust separately. After the residue dries on the pad, it can be collected and composted or spread in the field.
- Minimize the use of detergents. Use only biodegradable non-phosphate detergents.
- Minimize the amount of water used to clean equipment. This can be done by using spray nozzles that generate high-pressure streams of water at low volumes.
- Do not discharge wash water to surface water or groundwater either directly or indirectly through ditches, storm drains, or canals.
- Do not conduct equipment wash operations on a pesticide mixing and loading pad. (This keeps grass clippings and other debris from becoming contaminated with pesticide).
- Solvents and degreasers should be used over a collection basin or pad that collects all used material.
- Oil/water separators can be used but must be managed properly to avoid problems. Do not wash equipment used to apply pesticides on pads with oil/water separators
- Collect used solvents and degreasers, place them into containers marked with the contents and the date, and then have them picked up by a service that properly recycles or disposes of them. Never mix used oil or other liquid material with the used solvents.
- Collect used oil, oil filters, and antifreeze in separate marked containers and recycle them. Arrange pickup of used oil, or deliver to a hazardous waste collection site.
- Do not mix used oil with used antifreeze or sludge from used solvents. Antifreeze must be recycled or disposed of as a hazardous waste.
- Store batteries on an impervious surface and preferably under cover. Remember, spent lead-acid batteries must be recycled if they are to be exempt from strict hazardous waste regulations.
- Lead-acid storage batteries are classified as hazardous wastes unless they are recycled. All lead-acid battery retailers in Florida are required by law to accept returned batteries for recycling.
- Spent lead-acid batteries must be recycled to be exempt from strict hazardous waste regulations.
- Equipment used to apply pesticides and fertilizers should be stored in areas protected from rainfall.
- Pesticide application equipment can be stored in the chemical mixing center (CMC), but fertilizer application equipment should be stored separately.
- Blow or wash loose debris off equipment to prevent dirt from getting on the CMC pad, where it could become contaminated with pesticides.
- Ensure that all containers are sealed, secured, and properly labeled. Use only regulatory agency-approved, licensed contractors for disposal.
- Rinse pesticide containers as soon as they are empty. Pressure rinse or triple-rinse containers and add the rinse water to the sprayer.
- Shake or tap non-rinseable containers, such as bags or boxes, so that all dust and material fall into the application equipment.
- After cleaning them, puncture the pesticide containers to prevent reuse (except glass and refillable mini-bulk containers).
- Keep the rinsed containers in a clean area, out of the weather, for disposal or recycling.
- Storing the containers in large plastic bags/tubs to protect the containers from collecting rainwater.
- Recycle rinsed containers in counties where an applicable program is available or take them to a landfill for disposal. Check with your local landfill before taking containers for disposal, as not all landfills will accept them.

10.0 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.

An environmental landscape design approach addresses environmentally safe and energy-saving practices; therefore, environmentally sound landscape management is also economically important. Non-play areas require a mix of sun and shade, optimal soil conditions and adequate canopy air movement to sustain growth and function.

Species Selection and Size Considerations

Principles

- The fundamental principle for the environmentally sound management of landscapes is "right plant, right place." The ideal plant from an environmental standpoint is the one that 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.
- Know the ultimate sizes and growth rates of trees, shrubs, and ground covers. This reduces the need for pruning and debris removal and lowers maintenance costs.
- The addition of proper soil amendments can improve soil's physical and chemical properties, increase its water-holding capacity, and reduce the leaching of fertilizers. Amendments may be organic or inorganic; however, soil microorganisms rapidly decompose organic amendments such as peat or compost.
- The goal of species-selection BMP is to maintain as close to a natural ecosystem as practical, while meeting the needs of a golf course.
- 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 playability may be removed and replanted with native plant material that requires little to no maintenance after establishment.
- Additionally, 50% to 70% of the non-play areas should remain in natural cover. As much natural vegetation as possible should be retained and enhanced through the supplemental planting of native trees, shrubs, and herbaceous vegetation to provide wildlife habitat in non-play areas, along water sources to support fish and other water-dependent species. By leaving dead trees (snags) where they do not pose a hazard, a well-developed understory (brush and young trees), and native grasses, the amount of work needed to prepare a course is reduced while habitat for wildlife survival is maintained.

Best Management Practices

- ☐ Base plant selection as close to a natural ecosystem as practical, while meeting the needs of the golf course. It has adapted specifically to soil, microclimate, rainfall, light patterns, insects and other pests, and endemic nutrient levels over many years.
- ☐ Select trees, plants, grass species to attract birds seeking fruits, herbs, seeds, and insects.
- ☐ Know the ultimate sizes and growth rates of trees, shrubs, and ground covers.
- ☐ Use plants adapted for the site based on the United States Department of Agriculture (USDA) cold-hardiness map. In the desert southwest consider heat tolerance based on the American Horticultural Society Plant Heat Zone Map. Reference the Southern Nevada Regional Planning Coalition's Regional Plant List. https://www.snrpc.org/policies-plans-reports.
- ☐ Select stress-tolerant species or cultivars to manage periodic dry/wet conditions.
- ☐ Choose the most stress-tolerant species or cultivar for an area.
- ☐ Consider a "blended zone" or transition from imported plants to native plants.
- ☐ Natural pavements or mulches should be used to hold soils, promote water infiltration and deep rooting of trees and shrubs.

Design and Function

Principles

- Aesthetic gardens, window boxes, and container gardens should include a variety of plants of different heights that provide nectar for hummingbirds and butterflies. Again, "right plant, right place" is the key to success.
- When integrating turf areas into the landscape around the clubhouse, entries, and other areas, design them for ease of maintenance and keep in mind that turf grasses grow best in sunny areas. Consider the effect that tree canopy and other design features may have on the health and function of the turf. Conversely, trees grown in turf have shallow root systems, and pose maintenance and safety issues at maturity.
- Garden plants, shrubbery, ground covers, or native plants may provide a pleasing view and provide useful food, cover, or other environmental benefits to wildlife; they may also require reduced maintenance.
- Trees and shrubs along streams provide temperature moderation through shade, which lowers water temperature in summer and increases it in winter.

Best Management Practices

- ☐ Well-designed forested buffers should contain a mixture of fast- and slow-growing native trees, shrubs, and grasses to provide a diverse habitat for wildlife.
- ☐ Use forested buffers to trap and remove upland sources of sediments, nutrients, and chemicals.
- ☐ Use forested buffers to protect fish and wildlife by supplying food, cover, and shade.
- ☐ Use forested buffers to maintain a healthy riparian ecosystem and stable stream channel.
- ☐ Leave dead tree snags whenever possible for nesting and food source to wildlife. However, make sure that these snags are a safe distance away from playing surfaces should they get blown over.
- ☐ Use of turf should be limited to functional applications (ex: in play surfaces).

Additional Resources:
http://www.cityofhenderson.com/docs/default-source/community-development-docs/snrpc_regional_plant_list_final_06-30-11.pdf?sfvrsn=4
https://www.snwa.com/landscapes/plants/index.cfml
http://www.unce.unr.edu/publications/files/nr/2007/eb0701.pdf
https://planthardiness.ars.usda.gov/PHZMWeb/
http://ahsgardening.org/gardening-resources/gardening-maps/heat-zone-map
https://www.snrpc.org/policies-plans-reports

Planting Methods

Principles

- The ideal plant from an environmental standpoint is the one that nature and evolution placed there. It has adapted specifically to the soil, microclimate, rainfall, light patterns, insects, and other pests, and endemic nutrient levels over hundreds or thousands of generations. Where these factors have changed, the challenge is finding other suitable plants. A BMP goal is to maintain as close to a natural ecosystem as practical, while meeting the needs of the golf course.
- The use of organic mulches in gardens and aesthetic areas increases the moisture-holding capacity of plantings and prevents weed growth when applied in sufficient depth. Organic amendments are decomposed by soil microorganisms and add to soil tilth.
- 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 encourage overwatering. Compaction or excessive mulch buildup should be avoided, especially when annual re-mulching is performed.
- Rock mulches (decomposed granite) should be considered in larger landscape areas, on slopes, and drainage channels.

Best Management Practices

- ☐ The plant palette and irrigation system should be appropriate for site conditions, considering that, in some cases, soil improvement can enhance water-use efficiency. Overhead irrigation should be limited to turf areas; landscape areas should be irrigated with more efficient methods (ex, drip irrigation).
- ☐ Tree and shrub irrigation should consider the plant size and canopy at maturity to promote deep rooting.
- ☐ Plants should be grouped together based on irrigation demand.
- ☐ Pruning and fertilizing will also benefit landscape plants while they are becoming established.
- ☐ Avoid excessive pruning in landscape areas ("topiary like"), to ensure healthy growth and longevity.
- ☐ Add proper soil amendments in garden areas to improve the soil's physical and chemical properties, increase its water-holding capacity, and reduce the leaching of fertilizers.
- ☐ The percentage of landscaped area in irrigated high-water-use hydro zones should be minimized. Local government ordinances should address the percentage of irrigated landscaped area that may be included in high-water-use hydro zones. These high water-use limits should not apply to landscaped areas requiring large amounts of turf for their primary functions (for example, ball fields and playgrounds).
- ☐ In most instances, established, drought-tolerant landscape plants have a root system substantial enough to keep them alive with little or no supplemental irrigation.
- ☐ Blending native and landscape plants offer a smooth transition to native landscape areas.

11.0 Energy

> Golf facility managers must take steps toward identifying options for conservation, efficiency, and cost savings.

According to the GCSAA Golf Course Environmental Profile, Vol. IV (GCSAA 2012), six major energy sources were identified for golf course use: electricity, gasoline, diesel, natural gas, propane and heating oil. In addition, operational uses were segmented to meet irrigation, turf maintenance, buildings, clubhouse operations, swimming pools and various amenity needs.

To address current needs and future energy reduction opportunities, managers should evaluate current energy conservation performance practices based on the following categories:

- General energy conservation position statements on policy and planning
- Buildings and amenities statements –buildings, infrastructure and facility amenities such as the clubhouse, swimming pool, restaurant, parking lot, kitchen, offices, maintenance building(s), tennis courts, etc.
- Golf course statements – the golf course and surrounding landscapes, pump station, irrigation system and related agronomic operations (playing surfaces, equipment, turfgrass maintenance etc.)

Energy Conservation

Principles

- Determine goals and establish an energy policy that is part of the facility's overall environmental plan. All senior management should be involved in the formation of a facility plan/policy.
- Establish an energy management plan for the facility based on current energy use baselines to optimize efficiency.
- Communicate policy to all staff regarding use patterns and management practices to effect change.
- Relate the policy to the entire facility, including the services the facility provides to its customers and community.
- Incorporate quality management elements for continual improvement (assess, measure baseline, plan, do, check, act, and monitor) to reduce environmental and economic impacts.

Understand that the irrigation pump is the largest user of energy. A well-engineered pump station is critical to reducing energy consumption, incorporating variable frequency drives (VFDs) wherever possible can minimize energy use. A pump station can account for up to 50 percent of a golf facilities energy use.

Photo Courtesy of Jim Key

Best Management Practices

- Conduct an energy audit. A professional audit can reduce energy costs by 5% to 30%. NV Energy's commercial energy services offers incentivized ASHRAE Level 2 and 3 audits to take advantage of energy efficiency opportunities. More information on audits is available at (https://www.nvenergy.com/save-with-powershift/business-energy-services/ashrae-audit).
- Conduct a lighting audit. Conduct a carbon footprint analysis. Explore ways to decrease output and increase sequestration.
- Add insulation where needed.
- Use non-demand electrical hour rates: charge golf carts, and use pumps to acquire water, charge maintenance equipment, and other items later in the day or early in the morning.
- Limit high-consumption activities during periods when demand is high.
- Use alternative energy from natural sources, such as solar, geothermal and wind energy generation. Explore onsite options for energy creation. Land and natural resources on golf courses lend themselves to energy generation as technology evolves and cost decreases.
- Upgrade or install National Electrical Manufacturers Association's (NEMA) premium efficiency-rated pump motors (www.nema.org).
- Seek output reduction by watering less area, apply target golf goals. Work with a golf course architect to determine out of play areas where turf can be removed and replaced with drought tolerant landscapes. Turf removal rebate programs are available through the Southern Nevada Water Authority at (https://www.snwa.com/rebates/wsl/index.html). Rebates are currently not available in Northern Nevada.
- Install LED lighting and/or retrofit devices, motion sensors for lights where appropriate, programmable thermostat, air compressor timer, solar/Geothermal pumps for pool/spa.

Evaluation

Principles

- Continually track and measure energy use at the facility based on energy assessment units, for example, kilowatt hour.
- Benchmark practices to evaluate existing facility consumption with other local golf facilities of similar size.

Best Management Practices

- Monitor energy use: track data, evaluate billing meters. You can't manage what you don't measure.
- Install adequate meters, gauges, etc.
- Develop an equipment inventory incorporating individual equipment's energy use, use / traffic patterns, etc. (maintenance records, operation hours, etc.).
- Establish a baseline for performance parameters to optimize irrigation pumps.

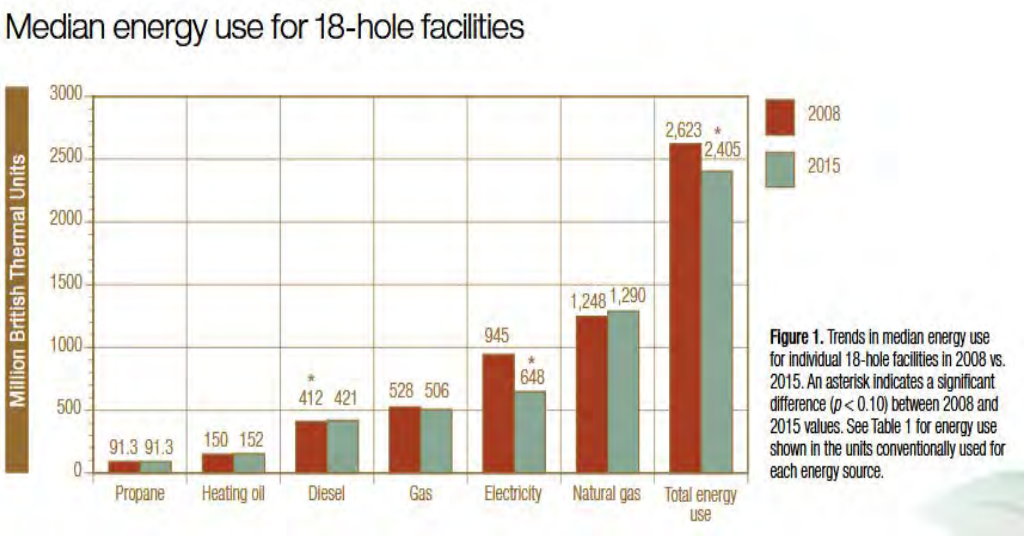


Figure 1. Trends in median energy use for individual 18-hole facilities in 2008 vs. 2015. An asterisk indicates a significant difference ($p < 0.10$) between 2008 and 2015 values. See Table 1 for energy use shown in the units conventionally used for each energy source.

GCSAA Energy Use and Environmental Practices on U.S. Golf Courses, Phase II Volume V.

Efficiency

Principles

- Evaluate energy efficiency performance and cost-effectiveness.
- Evaluate electric equipment/operations and ensure proper selection, operation, charging, and maintenance.

Best Management Practices

- Evaluate all energy providers (electricity, natural gas and liquid petroleum fuels) for costs, efficiency/assistance programs, and incentives.
- Identify and categorize operations for energy efficiency opportunity and conservation analysis.
- Perform assessments of all the facility's infrastructure and operations and review the facilities last 12 months of energy bills.
- Perform appropriate audits throughout the facility depending on operation, infrastructure, and planning stage.
- Identify efficiency and conservation elements of infrastructure/hard items and behavioral/process-oriented items.
- Consider alternative equipment, products, and practices.

Design and Renovation

Principles

- Incorporate an analysis of the assessments, audits, and data.
- Incorporate first cost consideration (initial investment and long-term gain).
- Redesign – evaluate future projects with a priority for energy conservation.
- According to system and compliance standards, communicate with utility provider, insurance company, and any state or local regulatory officials.

Best Management Practices

- Identify buildings, amenities, and operations including existing, new construction, or renovation activities where energy efficiency enhancements are needed.
- Identify the golf course, course infrastructure, and related agronomic operations including existing and future developments or renovations that would benefit from energy efficiency improvements.
- Incorporate natural landscape for shading and site selection (shade from trees, minimize/maximize solar positioning)

Implementation Plan

Principles

- Set goals for buildings/amenities and the golf course operation; develop an implementation plan. Communicate the plan with management, employees, members and guests.
- Set energy-use goals according to efficiency/conservation of the building, infrastructure and equipment efficiency. Goals could adjust or change, but they always should be at the forefront during decision-making processes.

Best Management Practices

- Evaluate effectiveness of upgrades according to efficiency/conservation goals for energy use.
- Continue to identify future energy needs and maintain good record keeping.
- Prioritize energy consumption as part of purchase/decision-making process for HVAC, food service, laundry, swimming pools, etc.
- Consider other devices as part of the plan; do research on building, pumps, and power generation.

Infrastructure

Principles

- Ensure efficient building/facility/amenities and related infrastructure.
- Consider the materials: used insulation and color selection.
- Ensure efficient lighting in both interior and exterior areas.

Best Management Practices

- Maximize use of space.
- Inspect and repair leaks/maintenance.
- Monitor temperature/environmental settings (heat loss, etc.).
- Evaluate building automation systems, monitoring systems, etc.
- Incorporate technology and up-to-date equipment (lights, controls, switches, etc.).
- Implement schedules/controlled use.
- Evaluate off-grid pole lighting and similar technology.

Alternative products, operations, and practices

Principles

- Educate and motivate employees, guests, etc.
- Educate, train, and motivate employees on energy efficiency practices pertaining to golf course operations.
- Identify incentives and programs from energy providers. A list of energy incentive programs, credits and tax incentives for the State of Nevada and additional Federal programs are available at (http://programs.dsireusa.org/system/program?fromSir=0&state=NV).
- Consider U.S. Green Building Council's LEED program. https://www.usgbc.org/LEED/
- Consider EPA's EnergyStar, Portfolio Manager, etc. https://www.energystar.gov/
- Consider energy management software, services, etc. Applications provide utility tracking, real-time metering and demand response among numerous other features.
- Consider national and local programs and programs like the EPA's WaterSense program as it relates to buildings (see Water Conservation BMP). www.epa.gov/watersense

Best Management Practices

- Evaluate alternative transportation.
- Evaluate cleaning practices (dry vs. wet).
- Consider local vs. distant purchases, product selection, etc. Buying local is less energy intensive.
- Evaluate energy acquisition and energy coming into the facility.
- Evaluate golf car equipment/operations and ensure proper selection, operation, charging, and maintenance.
- Incorporate training for employees.
- Incorporate the use of incentives.

Photo Courtesy of Toro

Principles

- Set energy-use goals for efficiency/conservation including infrastructure, equipment, behavior and agronomic practices.
- Ensure proper selection (type, size, etc.), operation, and equipment maintenance.
- Ensure efficient design, selection, operation, and maintenance of irrigation pumps, irrigation controls and other irrigation components.

Implement energy source selection, management, and efficiency/conservation practices.

Conduct a golf facility energy audit!

Nevada Energy offers audits and incentives. More at https://www.nvenergy.com/save-with-powershift/commercial-energy-services/ashrae-audit

Consider a turf removal project. Rebate information available at https://wwww.snwa.com/rebates/wsl/index.html

Best Management Practices

- Work with energy providers and evaluate existing programs, resources, etc. www.nvenergy.com
- Consider long-term costs in addition to acquisitions.
- Schedule reviews to evaluate future technology and fuel types.
- Evaluate upgrades.
- Evaluate use of alternative energy/fuels. These include geothermal heating and cooling systems and small-scale wind, solar and photovoltaic installations.
- Identify future energy needs.
- Prioritize energy consumption as part of selection.
- Optimize equipment use data including hours operated, use patterns, etc.
- Incorporate new technology and upgrades when feasible.
- Consider alternative equipment (propane/electric), products, and practices.

Irrigation

Principles

- Ensure efficient design, selection, operation, and maintenance of irrigation pumps, irrigation controls, and other irrigation components.
- Assess irrigation pump efficiency; consider alternative equipment, products, and practices; use energy efficiently to maximize the output of the pump station.

Best Management Practices

- Audit irrigation system (see Water Conservation BMP).
- Schedule and operate pumps and irrigation in an efficient manner.
- Identify and implement infrastructure and behavioral changes.
- Evaluate technology and upgrades; implement when feasible.
- Where practicable, incorporate GPS-monitored irrigation controls to minimize mechanical failures and energy use
- Install timers on recirculating pumps (i.e. for water features or lake aeration)

Best Management Practices

- ☐ Establish an energy management plan for the facility and communicate the plan.
- ☐ Track and measure energy use at facility for efficiency and effectiveness.
- ☐ Educate, train, and motivate employees on energy efficiency practices pertaining to golf course operations.
- ☐ Conduct and energy audit for the property.
- ☐ Identify incentives and programs from energy providers.
- ☐ Use non-demand electrical hour rates in early morning or later in the day.
- ☐ Evaluate implementing use of alternative energy/fuels.
- ☐ Consider alternative equipment (propane/electric), products, and practices.
- ☐ Work with energy providers and evaluate existing programs.

References

Golf Course Superintendents Association of America, Energy Use and Environmental Practices on U.S. Golf Courses, Phase II, Volume V. Available at (https://www.gcsaa.org/docs/default-source/Environment/phase-2-energy-survey-full-report.pdf?sfvrsn=9cedeb3e_2).

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(Database of State Incentives for Renewables and Energy. Available at http://programs.dsireusa.org/system/program?fromSir=0&state=NV)

(United States Green Building Council. Available at https://www.usgbc.org/LEED/)

(United States Environmental Protection Agency, Energy Star. Available at https://www.energystar.gov/)

(United States Environmental Protection Agency, WaterSense. Available at www.epa.gov/watersense)

(Nevada Energy. Available at www.nevadaenergy.com)

12.0 Air Quality

> Golf courses can help impact air quality through effective use of BMPs during construction and operations. Golf courses provide valuable green spaces in urban environments which can help with air quality control.

Golf courses impact air quality in several ways. In Nevada, the largest single impact falls in the dust control category. Other areas of air quality impacted are exhaust emissions, smoke (wood stoves), and carbon emissions. It is the responsibility of each golf course representative to ensure they are complying with all federal, state, and local, laws and ordinances.

Regulatory

Dust Control Standard

In Clark County Nevada a Dust Control permit is required for a soil disturbing project greater than or equal to .25 acres, for the demolition of any structure greater than 1000 square feet or for trenching greater than or equal to 100'. A full detail can be found in the Clark County Air Quality Construction Activities Dust Control Handbook
http://www.clarkcountynv.gov/airquality/compliance/Pages/Compliance_DustForms.aspx

Tier 4 Standards

On May 11, 2004, EPA signed the final rule introducing Tier 4 emission standards, which are phased-in over the period of 2008-2015 [2786]. The Tier 4 standards require that emissions of PM and NOx be further reduced by 90%. Such emission reductions can be achieved by using control technologies—including advanced exhaust gas aftertreatment—similar to those required by the 2007-2010 standards for highway engines https://www.epa.gov/regulations-emissions-vehicles-and-engines/regulations-emissions-heavy-equipment-compression.

Carbon Sequestration

Carbon dioxide is the most commonly produced greenhouse gas. Carbon sequestration is the process of capturing and storing atmospheric carbon dioxide. It is one method of reducing the amount of carbon dioxide in the atmosphere with the goal of reducing global climate change. Turfgrass green space from a golf course can help sequester carbon dioxide. The USGS is conducting assessments on two major types of carbon sequestration: geologic and biologic https://www.usgs.gov/faqs/what-carbon-sequestration?qt-news_science_products=0#qt-news_science_products

Dust Control

Principles

Insuring you are complying with dust control regulatory requirements will greatly improve the quality of the air around your course. Air borne particulate matter can be harmful to humans, plants, and animals.

Best Management Practices

Best Management Practices are site-specific dust control measures that are based on each project soil type, specific activities, phases and stages. Every golf course should have a Dust Mitigation Plan established to meet the goal of reducing particulate emissions from the golf course. The Clark County Department of Air Quality has authored a comprehensive Dust Control Handbook that addresses many of the tasks performed on a golf course. A flow chart of Particulate Emission Potential (PEP) can be found on page 19 of the handbook. Tasks performed on a golf course that may produce dust are listed below along with their corresponding BMP.

Construction

1. BACKFILLING – BMP 01
    1.1. Definition: Filling an area previously excavated or trenched
2. CLEARING AND GRUBBING – BMP 04
    2.1. Definition: Clearing and Grubbing for site preparation and vacant land cleanup
3. DISTURBED SOIL – BMP 10
    3.1. Definition: Disturbing soil throughout project including between structures
4. MATERIAL HANDLING – BMP 13
    4.1. Definition: Importing or exporting of soil, aggregate, decorative rock, debris, Type II and other bulk material.
5. LANDSCAPING – BMP 14
    5.1. Definition: Installation of sod, decorative rock, desert or other landscape material.
6. SCREENING – BMP 17
    6.1. Definition: Screening of rock, soil, or construction debris
7. STAGING AREAS – BMP 18
    7.1. Definition: Staging areas, equipment storage and material storage areas.
8. STOCK PILING – BMP 19
    8.1. Definition: Stockpiling of materials, such as Type II, rock or debris, for future use or export.
9. TRAFFIC, UNPAVED ROUTES & PARKING AREAS – BMP 21
    9.1. Definition: Construction related traffic on unpaved interior and/or access roads and unpaved employee/worker parking areas.
10. TRENCHING – BMP 22
    10.1. Definition: Trenching with track or wheel mounted excavator, shovel, backhoe or trencher.
11. TRUCK LOADING – BMP 23
    11.1. Definition: Loading trucks with materials including construction and demolition debris, rock and soil.
12. OVERSEEDING
    12.1. Avoid scalping on windy days
    12.2. Don't over-dry the area prior to scalping
    12.3. Apply water to the area to moisten prior to scalping
    12.4. Reduce the area to be over-seeded and the depth of scalping
    12.5. Keep dust collection screens and filters in good working order
    12.6. Sweep loose debris from paved areas instead of using leaf blowers
    12.7. Do not blow or handle scalp material while it is windy
    12.8. Reduce or eliminate the use of blowers
    12.9. Consider chemically treating turf for overseed preparation (Diquat) instead of scalping and verticutting (https://cdn.cybergolf.com/images/1177/2015-MAQD-Overseeding-Flyer.pdf)

Tier IV Emissions

Principles

Purchasing Tier IV compliant equipment will help reduce the particulate matter (PM) and NOx levels surrounding your golf course, helping to improve the quality of the air in your community.

Best Management Practices

- As your non-road compression ignition (diesel) equipment needs to be replaced, replace it with Tier IV compliant equipment.
- Ensure your equipment technicians understand the operational principles of the Tier IV compliant equipment.
- Ensure your equipment operators understand the operational principle of Tier IV equipment. Tier IV equipment may enter a 'regeneration mode' requiring the operator to pause operation until the regeneration is complete.

Carbon Sequestration

Principles

Atmospheric carbon dioxide comes from two primary sources—natural and human activities. Natural sources of carbon dioxide include most animals, which exhale carbon dioxide as a waste product. Human activities that lead to carbon dioxide emissions come primarily from energy production, including burning coal, oil, or natural gas.

Best Management Practices

- Minimizing traffic routes from combustion equipment thereby reducing the amount of fuel consumed and carbon dioxide produced.
- Consider purchasing electric equipment or equipment with improved fuel economy.
- Turf and trees help to naturally sequester carbon and provide a cooling effect in urban areas.
- Consider LEED certification https://new.usgbc.org/leed for your buildings.

13.0 Community Engagement

> Community engagement includes collaboration, communications, and involvement with surrounding community, city, state, and golf course stakeholders.

Principles

Real community engagement goes beyond one-way communication or a public relations campaign. Community engagement is more than providing updates to members, guests, neighbors, city or state officials from your owners or course officials. “Community engagement-done effectively-provides your course with the opportunity to build local networks, enhanced relationships, identify underlying concerns and values, leverage assets and resources, increase participation, improve decision-making, get out ahead or avoid conflict, and perhaps most importantly increase trust in your organization” https://extension.psu.edu/understanding-community-engagement

Best Management Practices

- Establish Engagement Targets, Goals, and Desired Outcomes
- Understand the Importance of Building Trust
- Plan Engagement Efforts and Strategies

Increasing Impact on Decision-Making and Implementation

INFORMING	CONSULTING	INVOLVING	COLLABORATING	EMPOWERING
Providing balanced and objective information about new programs or services, and about the reasons for choosing them	Inviting feedback on alternatives, analyses, and decisions related to new programs or services	Working with community members to ensure that their aspirations and concerns are considered at every stage of planning and decision-making. We also engage their assets as partners to implement solutions.	Enabling community members to participate in every aspect of planning and decision-making for new programs or services. Community members actively produce outcomes.	Giving community members sole decision-making authority over new programs or services, and lead work to implement solutions. Professionals only serve in consultative and supportive roles
We will keep you informed	We will keep you informed, listen to your input and feedback, and let you know your ideas and concerns have influenced decisions	We will ensure your input and feedback is directly reflected in alternatives, and let you know how your involvement influenced decisions. We will engage you as partners to implement solutions.	We will co-create and co-produce solutions with you. You will be true partners in making and implementing decisions for the community, your advice and recommendations will be incorporated as much as possible.	We will support your decisions and work to implement solutions.
Fact sheets, newsletters, websites, open houses	Surveys, focus groups, community meetings and forums	Community organizing, leadership development, workshops	Advisory boards, seats on governing boards, engaging and funding as partners	Support full governance, leadership, and partnership

Source: https://www.collectiveimpactforum.org/sites/default/files/Community%20Engagement%20Toolkit.pdf

Strategies for community engagement:

1. **Informing**
2. **Consulting**
3. **Involving**
4. **Collaborating**
5. **Empowering**

Regardless of level of engagement, it is important to engage consistently.

Informing

- Social Media
- Newsletters
- Articles/Press Release/Blogs
- Podcasts
- Speaking events/conferences
- Open House
- Monthly/annual board and member meetings
- Hosting Member/Community workshops or attending programs
- Sharing presentation with community organizations & schools
- Signage
- Corporate Social Responsibility (CSR) Report
- Case Study
- Website
- Email updates
- Social Media
- Newsletters
- Flyers, collateral, infographics
- Talking Points
  - Local Economic Impact
  - Green Space
  - Wildlife Corridors

Consulting

- Surveys
  - Short
  - Mode
- Programs

Involving

- Eco-tours (farm-to-table onsite garden/meal/demo, bee tours/honey cocktails/demo, bird watching, tree walks, etc.)
- First Tee
  - https://southernnevadajuniorgolf.com/
  - http://www.nnjga.org/
- Audubon International
  - Bird Counts
  - Local wildlife organizations
  - Programs
- School Programs
  - The First Green http://www.thefirstgreen.org/
  - USGA STEM http://www.usga.org/content/usga/home-page/stem-resource-center.html

Collaborating

- Course Renovations
- Advisory Boards
  - Partial Redevelopment

Southern Nevada Golf Course Superintendents Association
https://www.sngcsa.org/

Sierra Nevada Golf Course Superintendents Association
https://sierranevadagcsa.com/

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