

City of Missoula
Park Maintenance Division

Turf Management Plan

***Approved by City Council
on February 24, 2014***



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Executive Summary

- The purpose of this plan is to assist staff and public in understanding and implementing cultural, biological, mechanical and chemical control to improve turf health.
- Provide detailed information on how Parks and Recreation manages sports turf, general turf and common turf utilizing Best Management Practices within and for the City of Missoula, MT.
- Establish and implement BMP's and industry standards.
- Assists Operations staff and City officials in developing an effective maintenance budget that is commensurate with this plan and provides a provision for increased growth and demand.
- Recognize Integrated Pest Management (IPM) as a decision-making model used to prevent and manage weed and pest problems.
- Maintain turfgrass at acceptable levels of health through effective, economical, and environmentally-sound methods and develop and implement maintenance schedules that maximize turf vigor.
- Establish effective and environmentally-sound land stewardship.
- Contribute to personal well-being through protecting and enhancing our natural and recreational environments.

Overview

Why the need for a turf management plan?

- Establish standards for turf management
- Identify safety standards
- Identify the most cost-efficient best management practices
- Maximize labor efficiency
- Maximize sustainability, including environmental, social and economic impacts

Purpose

The City has a responsibility to develop public policies that address turfgrass use, safety and overall management within its jurisdiction. A Turfgrass Management Plan will provide overall direction to the City in the development and management of turfgrasses. The objective of this plan is to balance the responsibility of providing for parks and recreation in all park areas while responsibly managing natural resources such as vegetation, soil, and water. The Turfgrass Management Plan will provide sound direction in the development and maintenance of sports turf, parks and common turfgrass areas to ensure optimum benefits to the environment and the community.

Because turfgrass varies substantially in use, so do turf management practices. Appropriate management ensures high quality turfgrass where it is needed such as athletic fields and reasonable, attainable standards for general use/parks and common areas.

Identifying Turf Types

Areas will be divided into five different types with differing levels of maintenance:

1. Type-A/Sports Turf-Athletic Fields
2. Type-B/General Turf-Parks
3. Type-C/Common Turf-Smaller turf settings
4. Type-D/Non-irrigated, Native or Xeriscape
5. Type-E/Medians and ROW's

Level of visibility and site use dictate maintenance standards for turfgrass areas. Even within the same park, maintenance techniques can differ. From athletic and high-traffic areas as opposed to remote areas that may remain informal and natural. For that reason, turfgrass BMP's are tailored to the specific requirements of the turfgrass and site.

Chapter 1 General Management Practices/Best Management Practices

Overview

General Management Practices

The goal of any turfgrass management plan should be to produce and maintain healthy turf. A healthy turf produces the best possible sports and passive recreation conditions for all users and will also have the following benefits:

1. Turf can recover more quickly from the wear and tear of intense sports activities and repeat use, resulting in safer playing surfaces for users with fewer weeds and areas of compaction.
2. Thicker, healthier turf allows for better water retention and less exposure of the soil surface, thereby reducing water evaporation (ET) and water run-off.
3. Potential pest problems are reduced because the chances of drought, stress and subsequent susceptibility to insect and disease damage are minimized.
4. Proper grass selection and cultivar types.

Best Management Practices for Turf

This BMP guide is intended for use in the management of sports, general and common use turf. These BMPs are designed to be used in a wide range of turf management situations. Not every BMP will apply to every site. Activities and practices will vary depending on use, management objectives and site parameters. In addition, there may be a specific practice or practices appropriate for an unusual site that does not appear in this document.

Factors and objectives

When instituting a management plan based on BMPs, the turf manager must first determine the desired functional quality of the lawn and the management level and resources necessary to achieve it. Various factors will need to be considered including site parameters, level and intent of use, potential for pest infestation, pest action level, and environmental sensitivity of the site. BMPs for maintenance of lawn and landscape turf areas are most effectively implemented by an educated and experienced turf manager, but can also serve as guidelines for less experienced turf managers and others caring for lawn and landscape turf.

The BMPs detailed in this document are agronomically sound, environmentally sensible strategies and techniques designed with the following objectives:

- Enhance the environment
- Use resources in the most efficient manner possible
- Enhance human health
- Enhance the positive benefits of turf in varied landscapes and uses
- Produce a functional turf
- Enhance the values of managed assets
- Enhance economic impact

Landscape Turf: A Key Resource

Sports turf, general-use turf and common turf comprise a significant portion of the landscape in Missoula’s developed parks and sports fields. Turf can be found in many additional areas such as; private residences, business establishments, industrial developments, on public or private school grounds, and along roadsides and other utility areas. Sports, General use and Common turf areas are key resources, as they contribute to open space, provide recreation, add value to properties, and help to protect the environment. Properly maintained turf provides many functional, recreational, economic and ornamental benefits, which are summarized below:

Benefits of Turf

Functional	Recreational	Economic	Ornamental
Weed abatement	Playing surfaces	Revenue-generating	Aesthetics
Dust, mud control	Physical health	Open space preservation	Weed suppression
Heat abatement	Social space	Increases property values	
Noise abatement	Entertainment		
Minimized irrigation runoff	Safety		
Erosion control			

Chapter 2 – The Tools

- Soil Aeration
- Fertilization
- Seeding
- Mowing
- Irrigation
- Amendments/Top Dressing
- Herbicides

Soil Aeration and Compaction

Aeration is the process of replacing soil with air from the atmosphere and is important in sustaining sufficient soil oxygen for root growth and other growth related activities. A major contributor to poor aeration is soil compaction caused by vehicular and foot traffic. Soil compaction can create turf management problems caused by alterations in the physical properties of the soil including:

- **Decrease in total pore space:** associated with a decrease in macropore (large) spaces essential for internal drainage, channels for root growth, and air exchange. Micropore (small) spaces actually increase, and in turn increase water retention (although much of this water is unavailable for plant uptake).
- **Decrease in soil oxygen content:** oxygen is essential for root respiration and growth. Nutrient uptake by roots is an active process requiring oxygen and therefore nutrient uptake is limited by poor air exchange induced by compacted soils. Respiring roots also produce carbon dioxide (CO₂) which can accumulate to plant damaging levels in compacted soils because of poor gas exchange with the atmosphere.
- **Reduction in water infiltration and percolation rates,** which alters irrigation practices and scheduling.
- **Increase in soil strength and density,** which reduce rooting density and depth.
- **Increase in water retention:** compaction prolongs wet soil conditions which can delay spring green up (by delaying soil warming) and intensify compaction in trafficked areas. Conversely, dry compacted soils in summer warm up faster and promote high soil temperatures which can dramatically slow root growth.

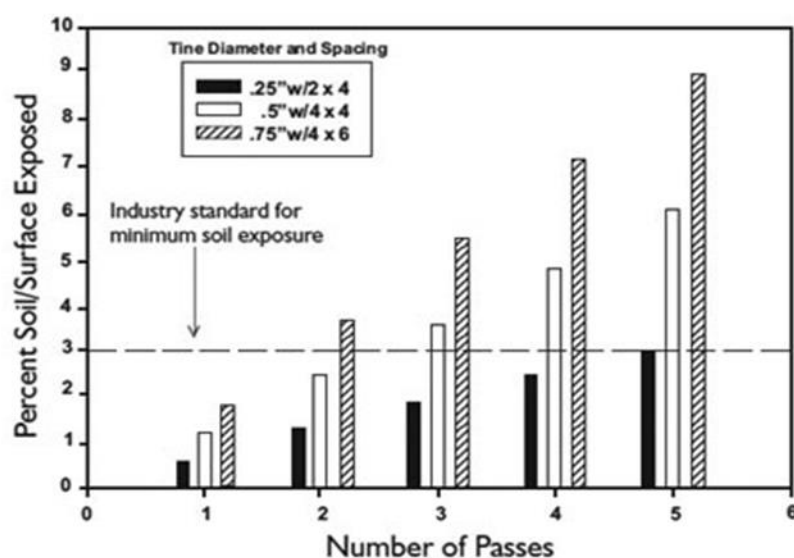
Turf Cultivation Practices and Objectives

Core Aerating

Turf cultivation practices are typically applied to the root zone with the intent to limit surface disruption as much as possible. Cultivation methods available to turfgrass managers include coring (hollow tine, solid tine or shatter coring), slicing and spiking.

Cultivation practices such as slicing and spiking, commonly used on golf courses, do not improve soil aeration to the same extent as do core cultivation practices, but are less disruptive to putting surfaces. Coring (especially hollow tine) is more disruptive to surface uniformity and requires a longer period for recovery. However, coring is the most effective method for improving aeration and alleviating compaction (Figure 1).

FIGURE 1. Percent soil and surface exposed during coring operation: effects of tine diameter (inches), spacing (inches), and number of passes.



Coring involves closed-hollow tines or open spoons that penetrate the soil and remove (and deposit) the soil core at the turf surface (see **Figure 1**). Core cultivation is the single most important management tool for controlling compaction. Other benefits of core aeration not listed in **Figure 1** include:

- Release of gases such as CO₂ (which begins immediately after coring).
- Increased soil infiltration rate which is the result of increased surface area from coring, reducing water runoff and puddling, and allowing wet soils to dry faster. For example, 1,000 square feet of turf after a single aeration event using a .75 inch diameter tine, spaced two inches on center, with a tine penetration depth of 2 inches, would be equivalent to 2180 square foot of surface area after aeration.
- Enhanced rooting that occurs within core aerifier holes (within 2 to 3 weeks after coring).
- Decreased thatch accumulation following core cultivation. This results from soil cores intermingling with the organic thatch layer and from accelerated decomposition associated with more favorable conditions (aeration) for microbial activity. Substantial amounts of thatch can be physically removed by core cultivation if thatch-containing plugs are collected and removed. The extent of thatch removal will vary with tine diameter, tine spacing, and the number of passes but can be as much as 10% or more.
- Increased fertilizer uptake and use that results from aeration. Aeration also promotes incorporation of immobile materials such as lime and phosphorus into the root zone.

Nutrient and Soil Management Information

Developing and implementing a soil and nutrient management plan is critical to the proper management of turf with environmental protection and enhancement as priorities. The term ‘nutrient management’ infers a responsibility common to all turf managers that goes beyond simple additions of fertilizer in efforts to positively influence turf growth. In the interest of environmental protection, natural resource preservation, and economic viability, modern nutrient programs necessitate custodial responsibility for the fate of applied nutrients in the environment and complementary practices designed to enhance nutrient efficiency.

Nutrient management for turf involves:

- Analysis of the existing condition and fertility of the soil that provides the growing medium for the turf and influences site characteristics such as drainage and water infiltration.
- Careful consideration of the nutritional requirements of the turf, based on several variables including soil fertility, expected quality of the turf, use of the turf, suitability of the growing environment, grass species and varieties present, and available management resources.
- Awareness of the potential for adverse impact from nutrient contamination on precious natural resources, particularly water, from off-site movement of nutrients due to factors such as misapplication, runoff, erosion and leaching.
- Informed and judicious additions of nutrients into the turf system with regard to proper timing, proper application rate, proper material selection, and proper placement, with the intention of meeting expectations for turf function and aesthetics while simultaneously minimizing the potential for adverse environmental impact.
- Reduction of fertilizer application to the lowest possible level, in addition to the use of turf cultural practices designed to maximize efficient use of nutrients by the plants in the turf system, thereby eliminating waste and minimizing nutrient loss.
- Appropriate accounting for all nutrient inputs and record-keeping of other cultural practices that influence nutrient relations in the turf system.

Application criteria

- **Formula.** Select a formulation that is best for the soil type and time of year. Cold weather slows the activity of soil microbes that make nutrients available to the grass. Turfgrass requires nitrogen, phosphorous, potassium and other nutrients to optimize growth. Fertilizer shall be a slow release compound of Nitrogen (N), Iron (Fe), and Potassium (K), the ratio dependent upon the time of year.
- **Nutrients.** Nutrient requirements differ according to grass type and the desired performance of a grass. Too much nitrogen can cause excess growth, which will be more susceptible to insect and disease damage.
- **Application Timing.** Timing application to the biological cycle of the grass is important in maintaining optimum growth. Each application should not exceed 1 lb. of N per 1000 square feet. Applications in very hot weather shall be avoided.
- **Micronutrients.** Micronutrients are also important for turfgrass health. It is best to test the soil to determine existing levels of these nutrients because an imbalance can harm plants.
- **Site-specific fertilizer restrictions** must be observed. Site-specific cautions include restricting use of fertilizer on turf areas adjacent to streams and wetlands and prohibiting phosphorus within 25 ft. of lakes and waterways.

**NOTE: Soil analysis will dictate most of the above criteria*



Managing soil types and soil moisture

Assess the soil type and condition on the site.

- Soil type affects nutrient-holding capacity and nutrient retention characteristics.
- Sandy soils low in organic matter are prone to leaching and generally have a low nutrient reserve.
- Loamy soils with organic matter (humus) and some clay content are less prone to leaching and generally have a higher nutrient reserve. Nutrients can also bind to soil particles or organic matter and become less available.

Manage soil pH appropriately.

- pH management is crucial, as pH extremes have implications for solubility (availability) of nutrients.
- pH in the slightly acidic to neutral range generally maximizes nutrient availability.
- Managing pH is often the best way to avoid micronutrient deficiencies.
- Maintaining proper pH is important for preventing build-up of unhealthy amounts of thatch.

To maximize nutrient availability, make provisions for sufficient moisture.

- Plants take up mineral nutrients in solution, therefore adequate moisture is required for nutrient release from most fertilizers and mineralization of nutrients from organic matter.
- Less moisture makes nutrients less available to plants and less mobile in soil.
- Excess moisture, however, can facilitate nutrient loss via leaching and runoff.
- Adequate moisture is especially critical at establishment, not only for seedling growth and development, but also to enhance nutrient availability.

Chapter 3 – Integrated Pest Management

The BMPs in this document are based on the scientific principles and practices of Integrated Pest Management (IPM). IPM is a systems approach that should form the foundation of any type of sound turf management plan. This holds true whether the materials being used are organic or not. The components of IPM for lawn and landscape turf are detailed below and are described in more detail in pertinent sections of the document.

What is IPM? -IPM is a systematic approach to problem solving and decision making in turf management. This approach may involve cultural, chemical or a combination of both practices.

In practicing IPM, the turf manager utilizes information about turf, pests and environmental conditions in combination with proper cultural practices. Pest or weed populations and possible impacts are monitored in accordance with a pre-determined management plan. Should monitoring indicate that action is justified, appropriate pest or weed control measures are taken to prevent or control unacceptable turf damage. A sound IPM program has the potential to reduce reliance on pesticides because applications are made only when all other options to maintain the quality and integrity of the turf have been exhausted.

The key components of an IPM system for turf can be tailored to fit most management situations. The steps in developing a complete IPM program are as follows:

1. Identify the problem
2. Determine standards or expectations
3. Assess site conditions and history
4. Determine action levels-cultural or chemical
5. Establish program
6. Establish policies related to IPM
7. Keep accurate records and evaluate program
8. Communicate with users as to purpose

An integrated approach to vegetation management

The Parks & Recreation Department manages over 4,275 acres of public lands for parks, trails, conservation lands, and landscaped right-of-ways, with new lands and facilities being added nearly every year. Through Integrated Pest Management, the department manages pests that are detrimental to the health, function or aesthetic value of parks landscapes in an effective and environmentally responsible manner, with utmost consideration to public and employee safety.

The department's IPM program includes multiple strategies to minimize health, environmental and economic risks. The range of horticultural practices used to manage parkland vegetation and pests includes design standards, appropriate selection of plants, grasses and trees, mowing and irrigation practices, fertilization and mulching, biological and organic controls, mechanical control, use restrictions and herbicides.

When it is necessary to use herbicides as part of IPM, Parks and Recreation minimizes risks by careful product selection and application. Thoughtful, timely and selective use of herbicides is just one tool of many used to maintain park lands. The department reviews herbicide use regularly and continually looks for safer alternative products and other cost-effective control measures. We also carefully consider citizen input with regard to safety of park facilities, quality of the park user's experience and service expectations.

- Parks and Recreation maximizes safety with respect to the use of herbicides through extensive training, and employee adherence to label directives and government regulations and safety procedures during use. All applicators are licensed and required to maintain annual CEU's to maintain said licenses.

Vegetation Management -The Tool Box

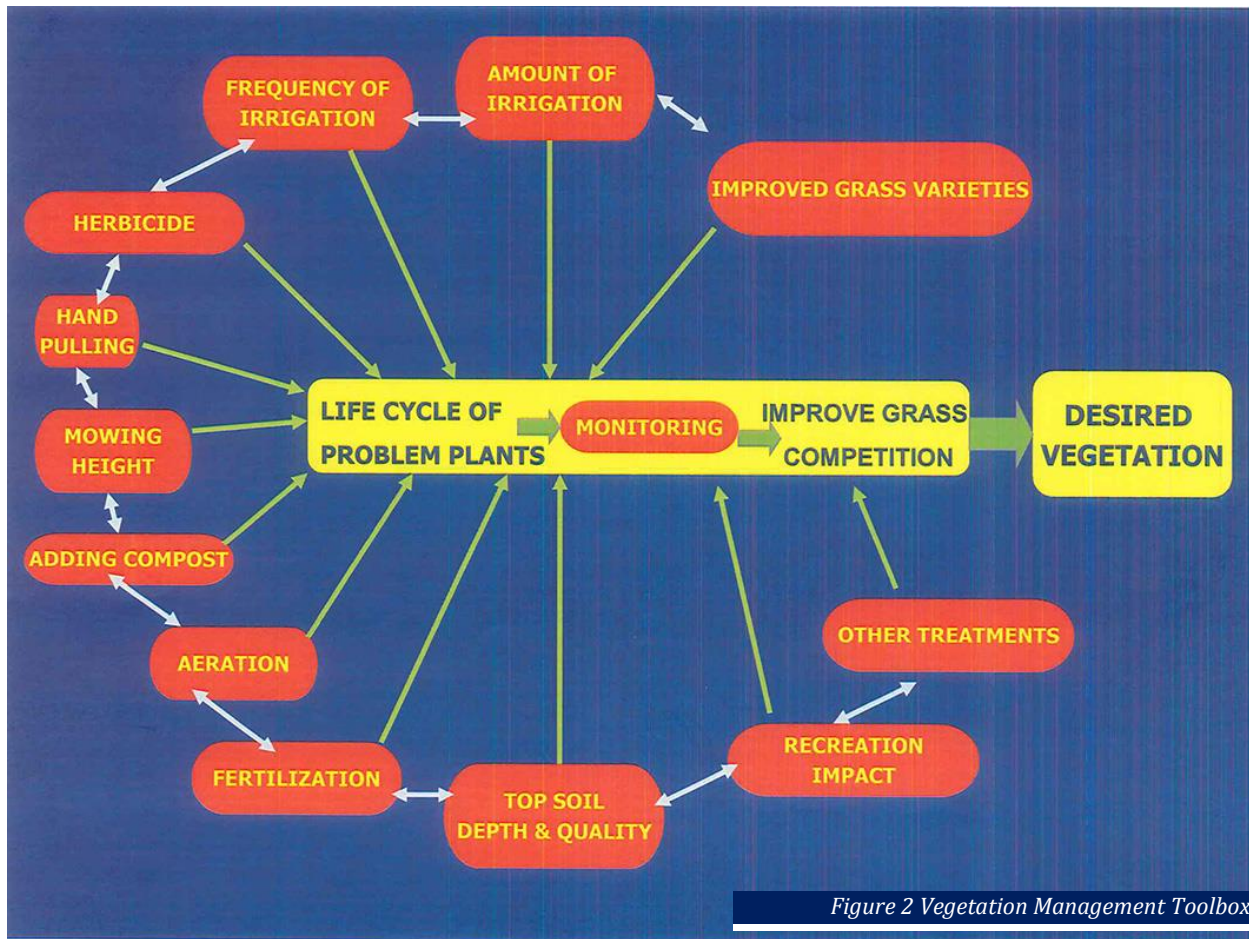


Figure 2 Vegetation Management Toolbox

Here are some of the ways we manage vegetation in City parks, ranked in order of frequency of use:

1. Mowing and irrigation practices.
2. Fertilization, aeration, top dressing, reseeding
3. Mechanical control (such as weed pulling and trimming)
4. Mulching.
5. Field rotation and use restrictions.
6. Geo-textile and barrier fabrics.
7. Herbicides.

Vegetation management methods include human activities that promote healthy desirable plants while discouraging opportunities for pests to establish. Examples include proper pruning, irrigation, fertilization, mulching, aeration, and physically removing pests (e.g. hand pulling weeds or vacuuming insects off plants). In order to implement appropriate cultural methods, staff must have current and ongoing training in horticulture. Staff should be encouraged to attend professional trainings and participate in professional organizations to facilitate continuing education in this area.

The foundation of any pest management program must be maintenance of healthy turf and other desirable plants. These healthy plants can resist more serious pest infestations and require less time and money to maintain. Some essential cultural methods that all turf managers should use include:

Irrigation scheduling

This practice seeks to apply water at the proper time and in the precise amount needed to satisfy plant needs. Even in our northern Missoula climate, lawns can use over 1.5 inches of water per week in hot weather, and can slow down to use only .5 inches per week in cool weather. Irrigation must be adjusted to these fluctuations to prevent over or under watering.

Too little water stresses turf and plants and encourages weeds, while too much can cause fungal diseases, damage to turf and plants, increase risk to user safety and is not environmentally sound. Parks staff needs to be aware of how plant water use varies with season and interacts with water holding capacity, pest populations and irrigation strategy. Finally, water should be provided infrequently via deep watering instead of frequent shallow watering. The former practice encourages deep healthy roots, while the latter encourages shallow roots that require more water. Understanding site and soil conditions serves as a major benefit in developing an efficient irrigation schedule as well.

Nutrition management

Fertilizers must be used judiciously to augment, not replace the natural nutrition of the soil. Addition of composting is often appropriate to promote plant health and balance soil composition. Soil tests and good record keeping are essential to prevent over application and to judge the success of management decisions. Slow release fertilizers are preferred-these help to increase the turf's health while reducing the number of fertilizer applications.

Proper mowing

Maintaining proper mower height is essential to good turf, and height should be adjusted when needed to overcome special weather, weed or logistical problems. Most experts recommend not cutting more than 1/3 of the plant height above ground. Cutting too short harms grass plants and encourage weeds. Taller grass competes better with weeds and helps overcome moisture stress. Maintaining sharp mowers will minimize plant injury. Parks staff should be utilizing mulching mowers as a Best Management Practice.

Aeration

Aeration or Cultivation methods available to turfgrass managers include coring (hollow tine and solid tine) or slicing and spiking. More information on this subject is discussed in the Cultivation Practices section and table-2

Mulching

Mulching is the addition of plant matter to the top of soil and it is available in many different sizes from wood waste. Mulching promotes soil water retention, soil microbial activity, and reduces weed growth.

Re-seeding and over-seeding

New species and varieties of grass continue to become available which require less water, fertilizer and mowing. These new plants are often more resistant to insect and disease damage. Turf managers should stay current with new developments and establish a budget and program to reseed when appropriate. Over-seeding of existing turf should be practiced on a regular basis on heavily used sports turf or park sites, emphasizing the best suited variety for the use.

Hand pulling

Physically disturbing or removing weeds is a Best Management Practice and while not always practical, this method is still an essential part of most park maintenance programs. Micro- climate or shady smaller beds often benefit from this practice and this method should be considered over chemical use.

Employee education

Promote education about pest management through participation in professional arenas, meetings, research, and training opportunities. Promote all related training opportunities through the Operations Safety Coordinator.

Herbicides

Where are herbicides used in developed parks, commuter trails and medians when needed?

- Athletic fields: At high densities, broadleaf weeds reduce suitability of sports fields for their intended use. A thick, resilient sports turf prevents injuries; provides quality of play for users; and optimizes the efficient use of water. In addition, fields are treated to meet sports organizations' and user groups' requirements for competitive sport field conditions. Fence lines are treated to increase user visibility and create a warning to outfielders and other players with respect to fence proximity.
- In selected park areas, to reduce infestations of broadleaf weeds and respond to citizen requests to conform to the traditional public aesthetic of mostly weed-free turf areas when other options are not available, effective or efficient. In addition, tree wells and fence lines are often treated to prevent damage to fences and trees from mowing equipment as well as damage to mowers.
- Medians: To maintain motorist visibility, comply with state weed control laws, protect planted ornamental vegetation, and respect citizen requests for City street medians and highly visible shrub beds to be attractive gateways to our community. In addition, treating medians reduces the staff exposure to hazardous traffic conditions.

Two methods of herbicide application

1. Parks staff

- Spot applications with minimal amounts of product to reduce exposure to park users, the environment and staff:
 - a. Hard-to-mow areas like fence lines, landscaped shrub beds, tree wells, sign posts; to maintain the health and quality of desirable vegetation in the most cost-effective and fuel-efficient way. Mitigating property and mower damage plays a role as well.
 - b. Some hard surfaces: parking lots, sidewalks, building foundations, paved trails to prevent damage to paving/concrete and provide a safe, even walking surface.
 - c. Number of spot treatments in 2012: 111
 - d. The product most commonly used for this type of application is Glyphosate. Glyphosate is rated a Toxicity Category III herbicide by the EPA. Toxicity Category I indicates the highest degree of acute toxicity, and Category III the lowest. Glyphosate is sprayed directly on the weed's foliage, absorbed systemically through the plant and is rendered inert when it dries or comes into contact with soil or heat/sunlight.

2. Licensed contractor

- Broadleaf applications on sports turf and high use turf:
 - a. McCormick Park softball fields
 - b. Fort Missoula baseball and sports fields
 - c. Selected parks per agreements with HOA's or other requests
 - d. Playfair baseball and sports fields
 - e. Selected traffic medians
 - f. City Hall Areas
 - g. Northside Softball Fields

Considerations before each herbicide application

1. Health and safety of citizens and staff.
2. Health of the environment.
3. Comprehensive staff training in use of herbicides
4. Compliance with all local, state and federal regulations.
5. Before applying an herbicide, the following factors are considered:
 - a. Does the density of pest plants meet or exceed the threshold for treatment?
 - b. Have non-herbicide options been considered and tried?
 - c. Are appropriate cultural methods in place to ensure that the weed is not being promoted?
 - d. Have we selected the least toxic herbicide to be effective, and are we applying at the lowest dose?

Public Notification

Several federal and state agencies regulate the use of herbicides. Parks and Recreation conforms to all applicable herbicide laws and regulations. The department exceeds legal requirements by posting areas to be treated 24 hours before application and 24 hours after application. Multiple signs are used to mark treated areas. These signs include information about the herbicides being applied as well as contacts for additional information.

Areas where herbicides are NOT used in developed parks, trails, medians

Per department standards, herbicide manufacturer's directions and EPA regulations, herbicides are not used in or on the following areas:

- ✓ Playgrounds
- ✓ Picnic Shelters
- ✓ Volleyball Courts
- ✓ Splash decks or other water features or sources

What herbicides are being used?

Parks Staff	Contractors
Glyphosate /non-selective, post emergence Herbicide	Triplet /selective broadleaf herbicide
Dimension 2EW Herbicide /selective, pre-emergence herbicide	Glyphosate /non-selective, post emergent herbicide

Individual Herbicide Information

Glyphosate

Glyphosate is a broad-spectrum systemic herbicide that controls weeds and is especially effective against perennials. Glyphosate is a non-selective, post emergent herbicide.

Triplet

Triplet Low Odor is a liquid post-emergent broadleaf herbicide that uses a unique formulation of 2,4-D. Triplet selectively controls broadleaf weeds in turfgrass, without the initial strong odor or lingering chemical smell. Triplet Low Odor effectively controls broadleaf weeds such as dandelion, clover, oxalis, henbit, and plantains and others.

Dimension 2EW Herbicide

Dimension Herbicide is a specialty herbicide formulation that is water-based. Dimension works as a pre-emergent and post-emergent on broadleaf weeds. It is a selective herbicide for use in turfgrass applications.

Noxious Weeds

Currently there are 32 plants listed on the State of Montana and the Missoula County Noxious Weed list. The County Noxious Weed Management Act, Title 7, Chapter 22, Sections 7-22-2101 through 7-23-2153, Montana Codes Annotated, requires landowners to implement a noxious weed management plan. Missoula Parks and Recreation agrees to collaborate with the Missoula County Weed District in carrying out a noxious weed management program.

Summary

Herbicides are only one tool used by Parks and Recreation for weed management. The goals of the department's IPM activities in developed parks are:

1. Safety of citizens, staff and the environment.
2. Maintain park infrastructure to extend the life span of park fixtures, paving and buildings.
3. Minimize number of treatments and amounts of herbicides needed to control noxious weeds.
4. Manage vegetation and weeds cost-effectively.



Integrated Pest Management - Herbicide Use

Alternatives

In addition the cultural practices identified in the previous section, there are other alternate treatments or applications to address weed infestations in select areas. It is important to understand the two treatments described below have very limited use as recognized tools. Additionally, there is limited data to support the effectiveness or efficiencies of these treatments. See Appendix E for additional information.

Corn Gluten

- Corn gluten meal is non-selective in action as an herbicide. That means it will effectively prevent germination or control young seedlings on a wide variety of plant species, including desired crops in the garden. It has not been proven in large, turf type applications or as a post or over-the-top application. It is difficult to prevent translocation of corn meal to undesirable vegetation.

Vinegar

- Vinegar can function as a natural weed control. It's the acetic acid in vinegar that gives it the power to control weeds. The higher the percentage of acetic acid in the vinegar, the better it will operate as a natural weed control. Vinegar is primarily used for culinary purposes and is relatively low (5%) in acetic acid, so repeated applications will be necessary when using it as a natural weed control. The long-term effects of using vinegar as a turf herbicide are unknown. It has been commonly used to treat hardscape areas like sidewalks, patio areas, etc.



Chapter 4 - Best Practices By Turf Type

Sports Fields

Mowing

- Athletic fields will be mowed twice a week during the growing season, to encourage rhizome growth and recovery. All mowing shall be done in a cross-cut or alternate mowing direction to ensure a positive cut and thatch reduction. No more than 1/3 of grass should ever be cut at one time. A minimum 2.5" and a maximum of 3.5 "cut shall be maintained in the summer months. A maximum cut of 2.5" shall be maintained in the fall. During the early spring and late fall one cutting per week may be sufficient.

Irrigation

- Irrigation will be adjusted to cover dry areas and scheduled as ET conditions indicate.
- Fields will receive sufficient water to promote a healthy turf, yet mitigate runoff, standing water or excess wear and damage.
- All controllers shall be equipped with a rain sensor device or be ET compatible.

Aeration

- Sports fields are to be aerated twice per year. Aeration should occur as early in the spring as possible and in the late fall when irrigation is still running so that irrigation heads can be located and properly marked. Timing should be carefully scheduled to prevent interference with user groups. Depending on soil type and/or results of soil tests, soil will be dressed with compost, sand, or a combination of the two. Seeding will be done in the early spring or late fall after aeration (when necessary) to fill in thin/worn areas of turf.

Fertilization

- Athletic turf area will be fertilized with a slow release fertilizer two times a year, and a high-nitrogen fertilizer as a winterizer once per year, based on soils testing recommendations and on the following schedule:
 - Early spring
 - Early fall
 - Late fall/early winter

Soil amendment

- Top dressing will be done in conjunction with aeration to amend soils and help prepare for seeding. Depending on soil type or results of soil tests, soil will be dressed with compost, sand, or a combination of the two.

Seeding

- Seeding will be done in the early spring or late fall after aeration (when necessary) to fill in thin areas of turf.

General use turf areas

Mowing

- Areas of high use will be mowed on a weekly basis at a length of 3 to 3.5 inches to help ensure vigorous turf during the growing season, and mitigate wear.

Irrigation

- Turf areas will receive sufficient water to promote a healthy turf and reduce unsafe, overly wet conditions. Irrigation will be adjusted to cover dry areas and adjusted as weather dictates.

Aeration

- Aeration of high use areas will be done twice annually

Fertilization

- Turf in general-high use areas will be fertilized a minimum of twice a year — once in the early spring and again in the fall.

Soil amendment

- Top dressing will be done in conjunction with aeration to amend soils and help prepare for seeding. Depending on soil type or results of soil tests, soil will be dressed with compost, sand, or a combination of the two.

Seeding

- Seeding will be done in the early spring or late fall after aeration (when necessary) to fill in thin or damaged areas of turf.

Common Areas

Mowing

- Common areas will be mowed on a weekly basis at a length of three inches to help ensure good turf health during growing season.

Irrigation

- Common areas will receive sufficient water to promote a healthy turf. Irrigation will be adjusted to cover dry areas and adjusted as weather dictates.

Fertilization

- Turf in common areas will be fertilized a minimum of twice a year ~ once in the early spring and again in the fall.

Aeration

- Aeration of the common areas will occur once a year in either the spring or fall.

Soil amendment

- Amending soils in common areas will be done every two to three years as needed in conjunction with aeration.

Seeding

- Seeding will be done in the early spring or late fall after aeration (when necessary) to fill in thin areas of turf.

Chapter 5 – Special Considerations of Athletic Fields and Sports Turf

Overview

Athletic fields are among the most complex turf types to manage. Subject to the wear and tear of a multitude of sports activities; athletic turf requires considerable knowledge and understanding to maintain industry standards, best practices and aesthetics. Fields with bare patches, weeds and compacted soils create uneven playing surfaces, can be difficult to play on and can potentially cause injuries to athletes. The management of athletic field turf can also have an impact on sensitive resources such as neighboring creeks and rivers, groundwater and various users of the fields. Such impacts can result from the use of fertilizers and pesticides that have the potential to move off-site, as well as sensitivity to people and animals that may come in contact through field use.

The challenge turf managers face is the scheduling of a management program around a busy athletic timetable while producing healthy, functional turf and protecting sensitive resources from any potential impacts-all this while working within budgetary limits. This Turfgrass Management Plan will assist the Parks staff and City officials in accomplishing the following three important objectives:

Objective One

Identify and implement athletic field management best practices and industry standards and develop a budget that will commensurate with the Turf Management Plan.

Objective Two

Identify risks to sensitive resources in and around athletic fields and develop an

Integrated Pest Management plan that commensurate with those resources.

Objective Three

Promote better communications and “buy-in” among local interest groups concerning the management of athletic fields and the impact from said use.

Summary

A well designed plan will allow Parks staff and City officials to evaluate existing and future impacts on athletic fields and address these impacts as part of their normal management activities and budget needs. Further, it communicates why turf management practices, such as pesticide applications, are being implemented.

Chapter 6 – Water Conservation in Turf Management

- Irrigation
- Species Selection
- Removal/alternatives to turf

The demand for potable water (drinking water) for agricultural, residential, and industrial use is expected to increase in the future while our supply of water will remain essentially unchanged. As this demand for a finite supply of water continues to increase, the cost associated with its use will inevitably increase. As a result, water conservation strategies are needed for both economic and judicious reasons. Furthermore, when rainfall is insufficient and water resources become limited, supplemental irrigation required to sustain ornamental plantings such as turf is often the first to be placed on water use restrictions. Under such restrictions professional turfgrass managers and homeowners are forced to maintain functional and high quality turf with less water. Water conservation strategies are routinely practiced in the semi-arid and arid regions, such as the desert Southwest. These strategies include:

- Proper design and installation
- Incorporating water-use-efficient plant material into the landscape
- Implementing water conserving management practices, and
- Maximizing irrigation efficiency by controlling leaching, pooling or ponding of irrigation water, and surface water runoff.

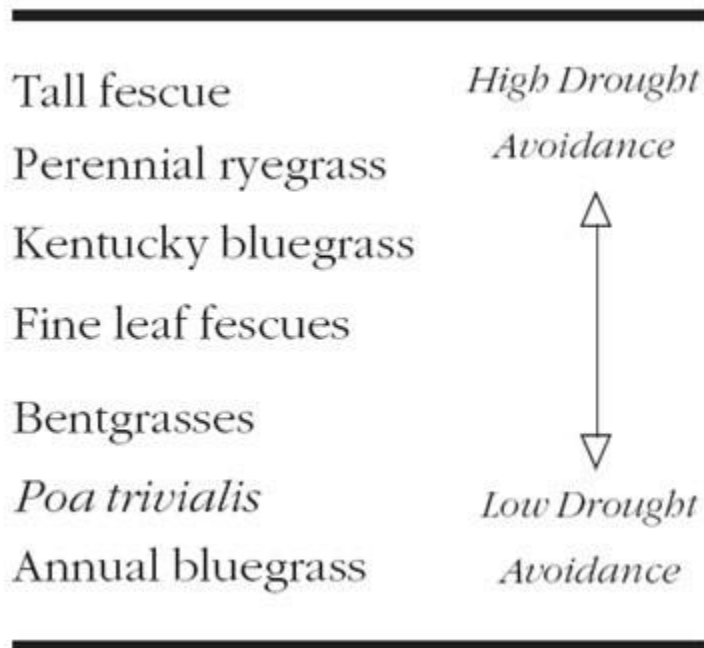
Drought Resistance and Water Use Efficient Turfgrasses

Turf managers have the ability to alter many management factors (mowing, nutrition, and irrigation) which affect drought resistance. Drought resistance mechanisms include structural and physiological adaptations, which allow plants to survive extended periods of limited water availability. By selecting turfgrass species (and varieties) having superior drought resistance adaptations, the turfgrass practitioner (professional and homeowner) can delay or postpone drought stress injury and associated decline in turf quality and function during extended periods of little or no water. Superior drought resistance can lengthen the time between before moisture input (from irrigation or rainfall) is necessary. Two major components of drought resistance include:

- Drought avoidance
- Drought tolerance

During periods of drought both avoidance and tolerance mechanisms are operating to ensure turfgrass survival. Drought avoidance adaptations, however, are most important to turfgrass managers because these allow for turfgrass survival (without dormancy) and provide for sustained growth and function (although at reduced levels) during drought stress periods. Avoidance mechanisms are short-term adaptations that allow plants to ‘avoid’ tissue injury during drought by postponing tissue dehydration through development of deep and extensive root systems and shoot characteristics that reduce evapotranspiration (ET) rates. Evapotranspiration is the sum total of water lost to the atmosphere due to evaporation from the soil surface plus transpirational water loss associated with leaf surfaces. In high quality turf where 95% of the soil surface may be shaded by leafy vegetation, the major contributor to ET is transpiration. Cultural practices that promote extensive root development are important for enhancing drought avoidance.

The more extensive the root system, the larger the soil moisture reservoir available for plant use. Therefore both shoots and roots are important aspects affecting turfgrass survival during drought.



Grass Selection

It is important when establishing new turf to choose a grass that is suitable for the particular site. Conditions such as soil characteristics, light, intensity of use, and desired maintenance level should be considered when selecting the grass type. This is because grasses vary in their tolerances to environmental stresses, in their resistances to pests, and in their abilities to withstand wear and tear.

Many of the athletic turfgrasses are “seeded mixtures” which contain two or more species of turfgrass. Cool-season grass mixtures are recommended because they are characterized by maximum growth in the cool spring and fall seasons and become semi-dormant in hot or dry summer seasons. The principal species of cool season grasses for athletic field use are Kentucky Bluegrass, Perennial Ryegrass, Fine Fescues and Tall Fescues. Mixtures are used to get the most effective and long-lasting seasonal coverage. Because different species vary in their pest tolerances and wear resistances, the potential for damage due to wear and pest is reduced with the correct seed mixture. Mixture is largely dependent on purpose, site condition and specific location or micro-climate.

Turfgrass resistance to drought can vary. It is important to recognize that within species, cultivars (varieties) vary significantly in rooting characteristics and ET rates, which contribute to a wide range of differences in drought avoidance. Superior drought avoidance can result from deep rooting potential or low consumptive water use, but preferably both. Drought resistance is an integration of both shoot and root components.

- Bluegrass: While slow to establish, is a common choice for most turf applications. Abbey and Victa are good cultivars for Missoula. For more drought tolerant cultivars Bitterroot Turf farm uses the varieties bariris, barister, fullmoon, and R impalla in their turf mix.
- Fine Fescue: Varieties such as Reliant, are shade, drought, and insect tolerant. They do well in sandy, acidic, fertile and/or infertile soils. They blend well with Kentucky Bluegrass and ryegrass, both which requires more irrigation than any of the fescues. They germinate rapidly (5 to 12 days), and are winter hardy.

Soils and Irrigation

The size of the plant-available soil moisture pool (reservoir) is determined by rooting depth and soil texture. Soil moisture-holding capacity is largely determined by soil texture. Soil textures vary by site and profile may even change depending on past site history. Excavation and construction will have huge impacts on contaminating existing conditions through imported materials like rock, clay and other materials.

Inches of Plant-Available Water per Foot of Soil at Field Capacity

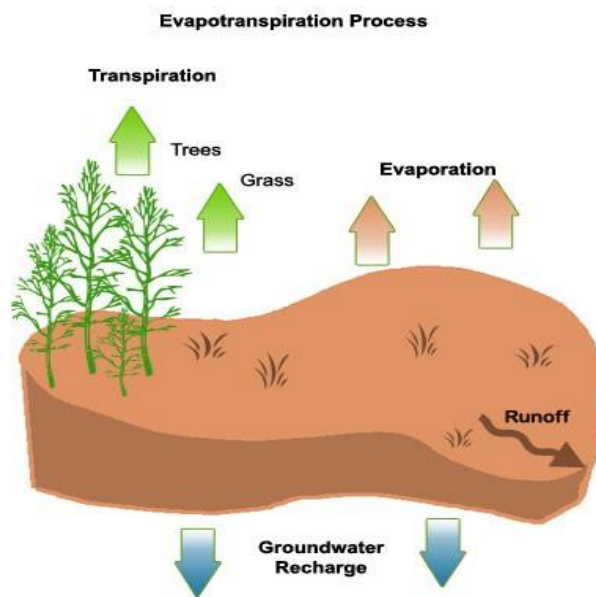
Soil Texture	Available water inches (storage	Days of use before recharge
Sand	0.4-1.0	2-5
Sandy Loam	0.9-1.3	4-5
Loam	1.3-2.0	6-10
Silt Loam	2.0-2.1	10
Clay Loam	1.8-2.1	9-10
Clay	1.8-1.9	9-10

Based on an ET rate of 0.2 inches (5mm) per day and a 12-inch rooting depth. Fine textured soils (loam, silt loam, clay loam, and clay) hold more water in storage than coarse soils (sand, sandy loam) and require less frequent irrigation. Shallower root zones would need to be recharged to field capacity on a more frequent basis. For example, the days of use before recharging a rootzone to a 6-inch rooting depth would be cut by half (i.e.; a loam has 6 to 10 days of water per 12 inches, and 3 to 5 days of available water per 6 inches based on normal water use rate of 0.2 inches per day).

Turfgrass Water Use (ET) Rates

The driving force for water loss (ET) from an irrigated turfgrass maintained under non-limiting soil moisture conditions is the evaporative demand properties of the atmosphere. This integrates solar radiation, temperature, and relative humidity (air water vapor content relative to saturation). Evaporative demand (and ET) increases with increasing solar radiation, high temperatures, and decreasing relative humidity.

Reducing irrigation requirements by reducing turfgrass ET can be accomplished by selecting species or varieties having low water use rates. However, a variety's relative water use rate is not necessarily predictable (consistent) in all possible environments and significant shifts can be expected. For example, the water use pattern of a cultivar (variety) evaluated in one location (the humid Northeast) can be different in its response when evaluated in another location with distinctly different evaporative conditions (for example the humid Southeast or arid Southwest.)



Chapter 7 – Turfgrass Alternatives

Turf isn't always practical

Lawns located on steep slopes or narrow strips, in the shade, or in areas that receive heavy foot traffic are not practical. The following are alternatives to the above or similar situations:

- Terraced flower beds on slopes
- Ground-cover plants in narrow strips
- Perennials or shrubs for shady or microclimate areas
- Flagstone path or sidewalk for heavily traveled areas.
- Ornamental grasses:
 - Native grasses
 - Bunch grasses-fescues
- Xeriscaping:
 - Reduces the need for irrigation with low-water plants and shrubs, usually planted in a bed of mulch or rocks to fight weeds. Plants are selected for their water needs and are often grouped in zones with similar plants.



Turfgrass Removal-considerations

There are potential locations within a sports turf or general use turf location where turfgrass removal may be cost effective and practical. The following are examples of such removals and are only examples as every site and situation may not be the same. Consideration to intended use, frequency of use, site location or other issues should be considered before removing any portion of a sports turf, general use or common use turf area.

Turf removal considerations:

- Sports Turf
 - Warning tracks *Replacement cost-\$130.00 sf
 - Walk-on paths *Replacement cost-\$130.00 sf
 - Warm-up circles or areas
 - Bullpens or batting cages
- General Use Turf
 - Picnic shelters
 - Walkways
 - Vehicle access points
 - Restrooms
 - Storage bldgs.
 - Volleyball courts
 - Basketball courts
- Common Use Turf
 - Problematic high traffic areas-walkways, ADA access points, etc.
 - Planter/mulch beds
 - Pavers or patios

Appendix A – Cultural Practices

The Tool Box

Implementation Guidelines

Cultural Practice	Turf Type-A <i>Sports Turf</i>			Turf Type-B <i>General Turf</i>		Turf Type-C <i>Common Turf</i>		Turf Type-D <i>Native/Non-irrigated</i>		Turf Type-E <i>Landscaped Medians</i>	
Practice	Spring	Fall	Winter	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Aeration	✓	✓		✓	✓	✓					
Fertilization	✓	✓	✓	✓	✓	✓	✓			✓	
Top Dress	✓										
Seeding		✓									
Mowing	2x Week	Weekly	As-Needed	Irrigation Schedule		Daily	3x week	As-needed			
Turf Type-A	✓			Turf Type-A		35-45 min					
Turf Type-B		✓		Turf Type-B			35-45 min. 1x				
Turf Type-C		✓		Turf Type-C			15-25 min. 1x				
Turf Type-D			✓								
Turf Type-E		✓									

❖ As of 2013

- Total Turf Acreage: 492.7
- Total Type-A Turf: 37.7
- % Type-A: 7.65%

Appendix B – IPM Herbicide Use Site and Treatment Schedule

Site and Treatment Schedule

Turf Type-A	Spot	Contract	Turf Type-B	Spot	Contract	Turf Type-C	Spot	Contract
Fence Lines	✓		Fence Lines	✓		Fence Lines	✓	
Tree Wells	✓		Tree Wells	✓		Tree Wells	✓	
Outfields		✓	Green Space		✓	Green Space		✓
Infields		✓						
Green Space								
Turf Type-A	Spot	Contract	Turf Type-B	Spot	Contract	Turf Type-C	Spot	Contract
Spring	✓	✓		✓	✓			✓
Summer	✓	✓		✓	✓			
Fall	✓			✓				

- ❖ Turf Type-A Sports Turf
- ❖ Turf Type-B General Turf
- ❖ Turf Type-C Common Turf

Appendix C - FAQs

Frequently asked questions about herbicide purpose, application and safety

Q-Why should we control weeds?

A-Weeds may be unwanted for a number of reasons: they might be unsightly, or crowd out or restrict light to more desirable plants or use limited nutrients from the soil. They can be home to and spread pests and diseases that can degrade the quality of crop or horticultural plants. Some weeds are a nuisance because they have thorns or prickles, some have chemicals that cause skin irritation and allergies or are hazardous if eaten, or have parts that come off and attach to fur or clothes. Some weeds can severely damage paths and walkways which could become hazardous to those walking on them and if left unchecked are very expensive to repair.

Q-What is a weed?

A-Generally, a weed is a plant in an undesired place. More specifically, the term is often used to describe native or non-native plants that grow and reproduce aggressively- particularly in settings such as gardens, lawns or agricultural areas, but also in parks, woods and other natural areas.

Q-What is contact weed control?

A-Contact weed controls are those that damage the parts of the weed that are treated- usually the treated leaf area. This can give fast visual effects; but this type of weed control are not effective on the roots, so in many cases there is regrowth.

Q-What does 'systemic' mean?

A-Systemic Weed controls are those that are absorbed through the leaf and into the weeds sap stream to be transported to all growing points including the roots. The weed control will then stop the weed from growing and it will eventually die. This process can take between 7 days and several weeks, depending on the climatic conditions and the type and size of the weed.

Q-What is the Purpose of Herbicides?

A-Herbicides control existing weeds or prevent the growth of weeds. This is important because weeds steal nutrients, water, sunlight and carbon dioxide from desirable plants and grasses. Moreover, some weeds contain chemicals that can poison pets and livestock.

Finally, weeds germinate very easily and are adaptive to different microclimate conditions and a variety of soil types and dry or overly wet conditions. Because most weed types are aggressive in nature, they make it difficult for turf, groundcovers and other vegetation to compete once weeds are established.

Q-What are the Types of Herbicides?

A-Herbicides are classified as non-selective or selective, pre-emergent and post-emergent, and contact or systemic. Non-selective herbicides control everything they touch, whereas selective herbicides target a specific weed. Pre-emergent herbicides control weeds before they emerge from the soil, whereas post-emergent herbicides control weeds once they emerge. Contact herbicides cause injury where they come in contact with the weeds, whereas systemic herbicides move within the plant, causing injury at various points. Systemic herbicides are most effective on older weeds.

Q-What Is 2, 4-D Weed Control?

A-Widely used to control broad-leaved weeds, some grass and woody plants, 2, 4-D (2, 4-Dichlorophenoxyacetic acid) acts as a hormone plant growth regulator. The herbicide comes mixed with other herbicides or singularly as esters, salts or acidic forms for application through spraying and broadcast methods.

Q-Why weed control in soccer and baseball fields?

A-Maintaining a weed-free turf stand on an athletic field can be nearly impossible. Even with a good fertilization program and reseeding schedule, weeds seem to find a way into the desirable turf species. Weeds are excellent competitors of turfgrasses in baseball fields. Some produce vast amounts of seed to gain a foothold. Since wind, equipment, and player movement can distribute summer annual, winter annual, or perennial weed seeds across the entire field, weeds are a constant threat. All weeds need is a chance to get established, so any break in the competition from the turf caused by player divots, turf stress, or mismanagement of water or fertility can lead to increased weed development.

Q-What does the term “Translocate” mean?

A-Herbicides must be absorbed into plants in order to be effective. Herbicide absorption can occur through leaves, roots or both. The process by which herbicides control weeds, called mode of action, requires herbicide absorption and may also require herbicide movement or translocation within the plant. Translocation means that the herbicide moves from the site of absorption to some other plant part. Foliar applied herbicides that have the necessary characteristics to move in the phloem will translocate to areas of the plant that are actively growing; however, not all foliar-applied herbicides move from the leaves that intercepted the spray solution. Herbicides that are absorbed but not translocated are called *contact herbicides*, while herbicides that translocate to shoot or root meristems are called *systemic herbicides*.

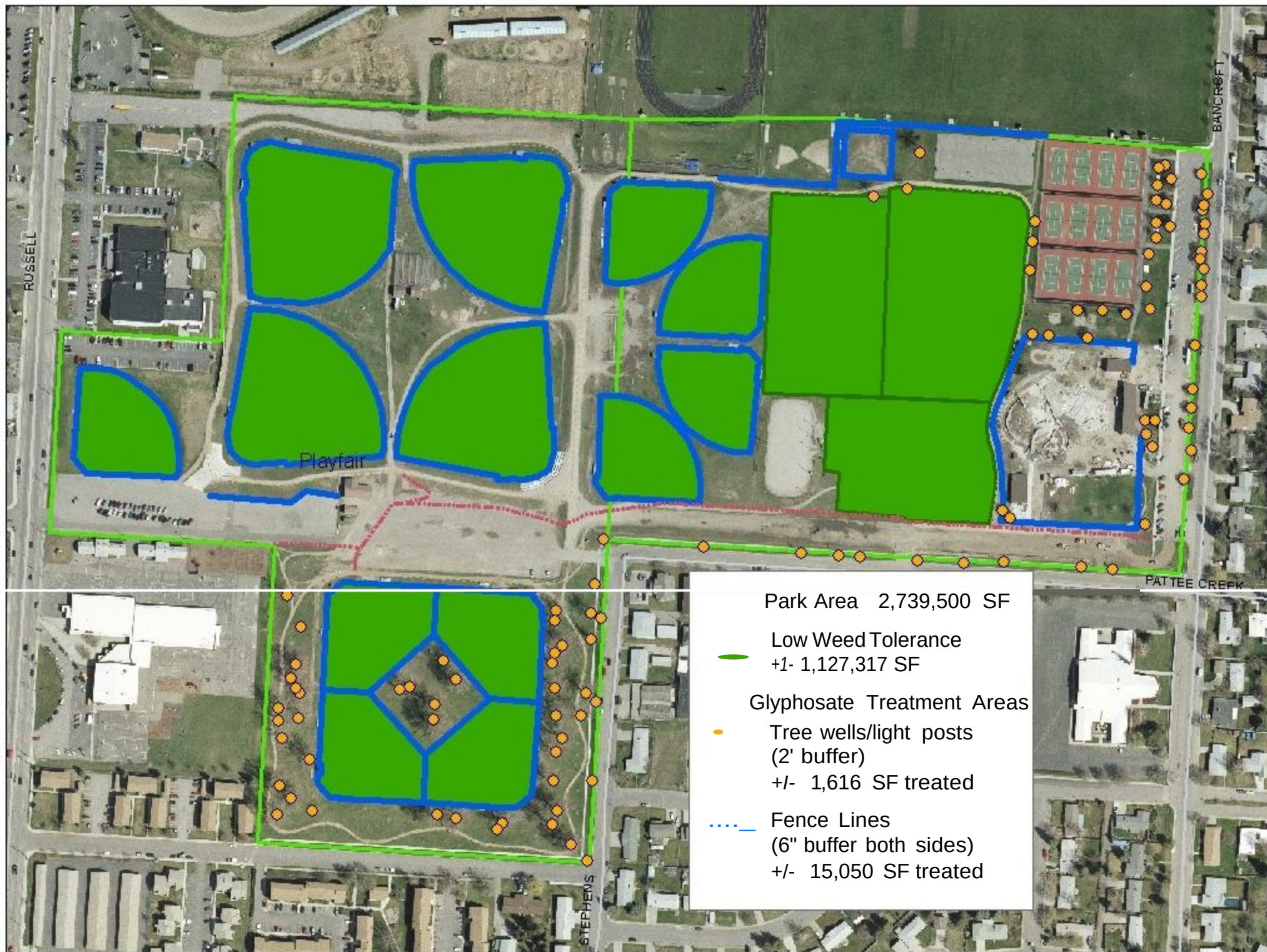
Q-What are signal words and what do they mean?

A Signal Word is the word listed on a pesticide label that indicates a product's toxicity to humans. It must be listed in large print and positioned clearly on the front of all pesticide labels.

Definitions of Signal Words

- **Caution-** This is a word that signals the product is slightly toxic or relatively non-toxic. It has only slight potential to cause acute illness if swallowed, inhaled or exposed to the skin. The skin or eye irritation it would cause would be less than those with other signal words.
- **Warning-** This is a word that signals the pesticide or product is moderately likely to cause acute illness if swallowed, inhaled or exposed to the skin. It is also likely to cause moderate eye irritation.
- **Danger-** This is a signal word that means the pesticide or product is very toxic. These products should not be swallowed, inhaled or exposed to skin. It may indicate that it will cause serious eye irritation. Some pesticides have a time period following an application before children and pets are allowed back in the house or yard. If allowed back in before the safety period ends and comes in contact with the pesticide, it could result in exposure. Carefully follow safety guidelines.

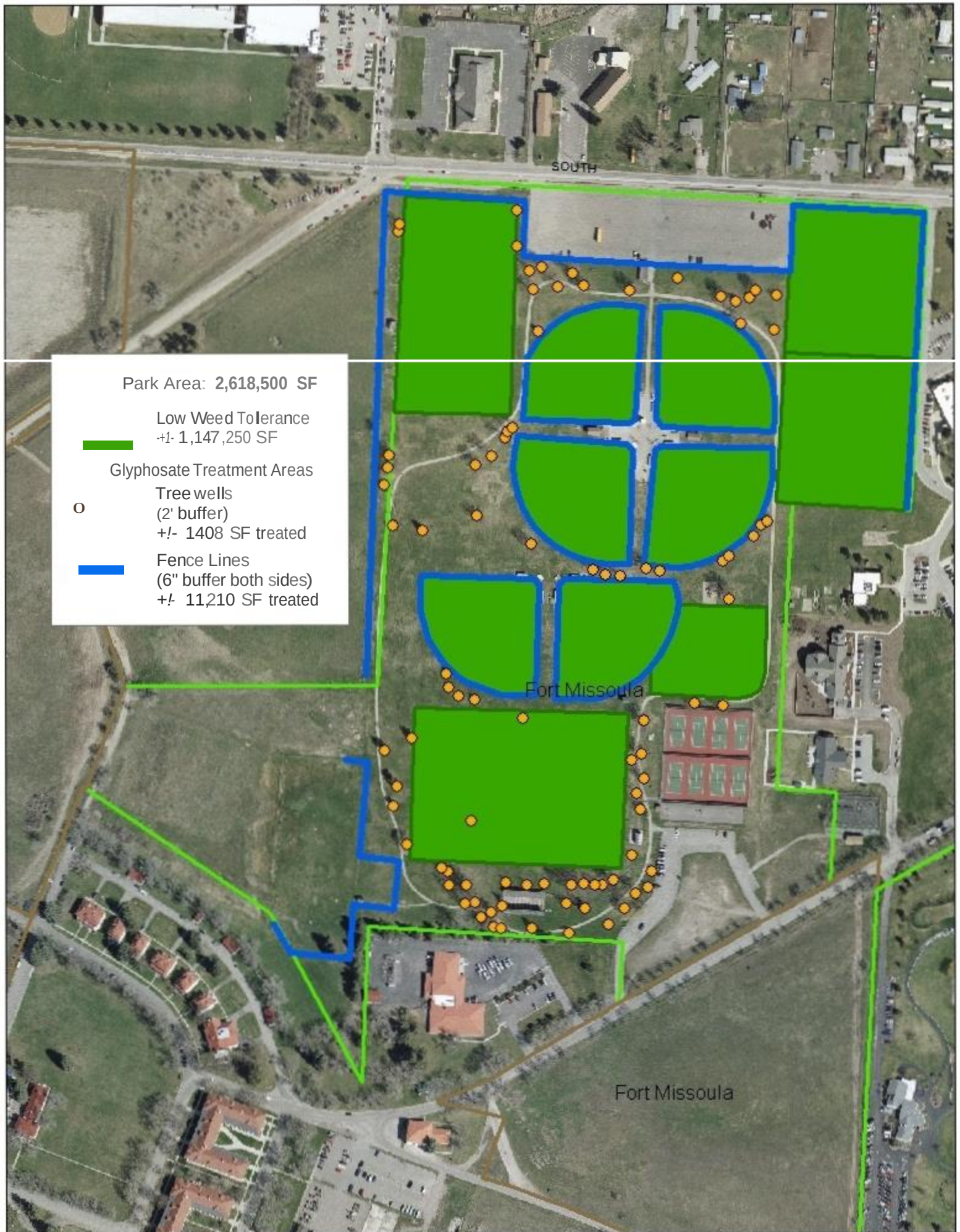
Appendix D/1 Playfair Park



Appendix D/2 McCormick Park



Appendix D/3 Fort Missoula



APPENDIX E – Herbicide Alternatives

As stated in Chapter 3, there is limited data to support the efficacy of corn gluten or vinegar as alternatives to pesticides. Some of the research findings are summarized below.

CORN GLUTEN ALTERNATIVE

Corn gluten meal is a byproduct of the corn milling process. It's about 60% corn protein and 9% nitrogen, and is used in livestock foods and in commercial pet food products.

In 1991, Iowa State University researchers were granted a patent for the use of corn gluten meal as a pre-emergence herbicide. It's thought that the dipeptides inhibited root formation of susceptible annual plant species. Greenhouse studies found various degrees of effectiveness on annual grasses and on broad leaf weeds. Field studies have found corn gluten meal ineffective. Studies at Oregon State University, Washington State University and Purdue University all found corn gluten meal not to be an effective herbicide.

Corn gluten meal may be more effective as a mulch. Because of the nitrogen, turfgrasses become more competitive with other plants.

Considerations for corn gluten meal are:

- 1) Very limited effectiveness as an herbicide;
- 2) Can be expensive depending on the rate of application;
- 3) A high protein livestock feed, it can be an attractant to raccoons, bears and deer;
- 4) It has a very disagreeable odor as it breaks down.

VINEGAR ALTERNATIVE (ACETIC ACID)

The use of vinegar is promoted as an herbicide to control weeds. Grocery store vinegar is 5% acetic acid; herbicide vinegar is 10% to 25% acetic acid.

The higher concentration of acetic acid causes dissolution of cell membranes and desiccation of plant tissue. It acts as a non-selective herbicide impacting both grasses and broad leaf plants.

Depending on growing conditions, perennial plants will grow back in three to five weeks.

Vinegar does not translocate well to the roots but does have the potential for controlling annual plants.

The concentration of acetic acid can be toxic, causing skin burns and damage to the eyes.

Overall, the use of vinegar as an herbicide is limited.