Integrated Pest Management Plan
University of Montana

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University of Montana, Missoula Campus

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1.0 Introduction and overview

1.1 Background, Purpose, and Program

This plan identifies the University of Montana's management goals, philosophy of pest management, and specific management activities to be used by UM staff to maintain an attractive, healthy and sustainably landscaped campus. A written plan is useful to guide staff decisions and to solicit public input to pest management on campus.

Pests are populations of living organisms (i.e., insects, rodents, bacteria and weeds) that interfere with the human purposes for an area. Strategies for managing pest populations will be guided by the species of pest and the threat they pose to people, property, and the environment.
To reduce the impact of these pests, UM relies on an Integrated Pest Management (IPM) program, a combination of cultural, mechanical, chemical and biological methods to keep pests below a threshold level that will enhance or maintain the desired health and allow UM to attain a high level of aesthetic on campus.

Integrated Pest Management (IPM) is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment. IPM involves a series of pest management evaluations, decisions and controls. IPM is a decision-making process that emphasizes prevention, knowledge of pest biology, and the use of least-disruptive control tactics, with pesticides saved as a last resort.

Purpose
Structural and landscape pests can pose hazards to people, property, and the environment. Pesticides which may be required to treat individual pests are, by design, either toxic to, or a deterrent for the pest to be controlled. Application of these products may pose an inherent risk to the applicator, individuals present during application, and individuals entering the treated areas during the post-application restricted re-entry interval. This Integrated Pest Management Program is designed to minimize prospective hazards related to pest management while creating and enabling world–class research, learning and recreation environments.

Program
The goal of the University of Montana's Integrated Pest Management plan is to incorporate IPM procedures to control structural and landscape pests in a safe, efficient and effective manner within the buildings and on the grounds of the University of Montana.

Set Action Thresholds - Before taking any pest control action, IPM first sets an action threshold, a point at which pest populations or environmental conditions indicate that pest control action must be taken. Sighting a single pest does not always mean control is needed. The level at which pests will become an economic or environmental threat is critical to guide future pest control decisions.

Monitor and Identify Pests - Not all insects, weeds, and other living organisms require control. Many organisms are innocuous, and some are even beneficial. IPM programs work to monitor for pests and identify them accurately so that appropriate control decisions can be made in conjunction with action thresholds. Pest monitoring and accurate identification removes the possibility that pesticides will be used when they are not necessary and insures that the appropriate control method is used for the pest of concern.

Prevention - As a first line of pest control, IPM programs work to manage the crop, lawn, tree and shrub population, or indoor space to prevent pests from becoming a threat. In lawn maintenance for example, selecting pest-resistant types of sod and grass seed will reduce future pest densities, thereby reducing the future need for pest control. Implementation of preventative measures can be very effective and cost- efficient, while minimizing risk to persons and the environment.

Control - Once the action threshold has been reached while the landscape is being monitored and pest identification is accurate, pest control is required. When the decision to control a pest has been made, IPM programs evaluate and implement the least harmful, yet still effective, control program. Minimally invasive pest control methods are preferred, which may include: pest specific, spot spray applications, pheromone treatments to disrupt pest mating, or mechanical controls, such as trapping or weeding. If these minimally invasive control efforts are determined to be ineffective or significantly inefficient, then additional pest control methods would be employed. For example, if spot treatment is deemed inadequate, pest specific, broadcast applications within the problem areas may be required. Broadcast spraying of non-selective pesticides is used when all other programs have been deemed ineffective in achieving the desired level of control.

1.2 Project areas and their management goals

This plan addresses control of insect, disease and plant pests at the University of Montana campus in Missoula. This grouping of geographic parcels includes: UM Mountain campus (excluding the beds surrounding the University Center), the Missoula College River campus, University Villages, Lewis and Clark Housing, and the UM Golf Course
UM's natural areas, including land on Mount Sentinel and at Fort Missoula, are covered under a different management plan titled *Vegetation Management Plan for UM Natural Areas*.
The most logical way to discuss UM campus landscape components is by type, not by location. For that reason, this plan starts with a discussion of multi-purpose turf areas, golf course turf areas, landscape beds, trees and shrubs, and edges or waste areas. Later in the plan, special consideration is given to unique situations and uses around campus that affect pest management activities or plant management goals.

1.2.1 Types of landscape areas

Multi-purpose turf: Areas of multi-purpose turf should be maintained to support foot traffic, allow for public recreation and leisure, and provide aesthetic value to campus. The goal of having all turf areas free of pests is unrealistic and would require an intense pest control program

with a high pesticide application frequency. The Association of Physical Plant Administrators (APPA) is an advisory organization that provides a set of maintenance standards for turf care (and most other forms of maintenance) within the realm of higher education. There are five levels of maintenance with 1 being the highest and 5 being effectively no maintenance. UM operates at either a level 2 or level 3 maintenance category, depending on turf location and primary turf use. This level of turf maintenance is classified as a moderate to high level of maintenance and the associated APPA standards provide guidelines for management and establishing appropriate action thresholds.

Golf course turf: Support golf games.

Landscape and Annual Flower Beds: These provide visual interest to a campus; also areas for birds and beneficial insects.

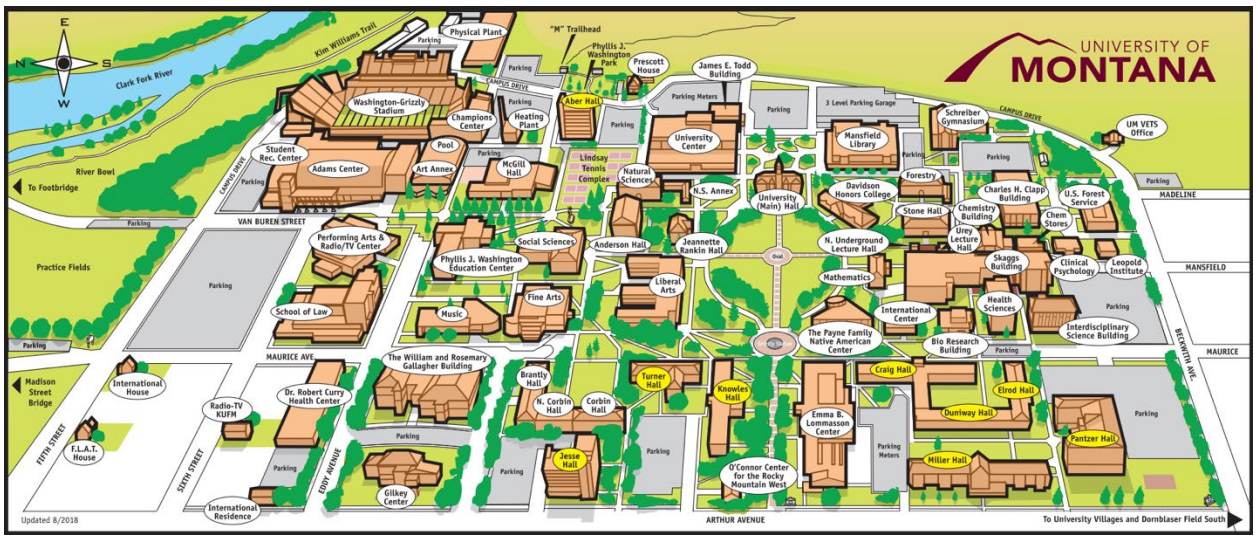
Trees and Maintained Hedges: Trees provide numerous environmental, aesthetic, social, and public health benefits when properly located in a built environment. Maintained hedges add formality to the aesthetic of UM and can help to define borders between individual landscaped areas.

Edges and waste areas: These areas are minimally maintained interface areas where a planned landscape area meets an unmaintained parcel. These areas are frequently adjacent to parking lots, City/State rights of way, and/or in transitions to riparian areas. Vegetation control is done to comply with Montana state and Missoula County noxious weed laws and is accomplished using mechanical controls (brush hog mowing, weed whipping) or, when appropriate, both selective and non-selective herbicides.

1.2.2 The individual properties

Main campus. Contact Ben Carson, Grounds Maintenance Manager
University Villages and Lewis & Clark Apartments. Contact Brad Hall, Associate Director of Maintenance and Facilities, Residence Life
UM Golf Course. Contact Tom Burt, Grounds Supervisor, University of Montana Golf Course

A complete interactive campus map can be found on the University website. Below is a labeled image of the main campus.



University of Montana, Missoula Campus

2.0 Integrated Pest Management at UM

2.1 Philosophy

The University of Montana implements Integrated Pest Management practices. Listed below are the basic tenets of this philosophy as practiced at UM:

- UM's goal is to maintain healthy vegetation with minimum inputs of water, fertilizer, pesticides, or energy.
- IPM relies on a combination of cultural, mechanical, chemical and biological control methods to keep pests below action thresholds in order to maintain and enhance desired vegetation and achieve the desired level of aesthetic.
- Action thresholds for each landscape type are determined by pest density, potential damage, history of infestations, tolerance for pests in specific areas, and the impact of the natural enemies.
- The best way to manage pests is by managing for healthy landscape plantings. Therefore, cultural practices play a crucial role in suppressing pest populations in an effort to keep them below action thresholds.
- Chemical applications cannot be solely relied on to control all of UM's pest insects, weeds, or plant diseases. However, they are an important tool to address major pest outbreaks, and situations where pests are distributed over large geographic areas.
- UM will prioritize the least toxic alternative when action thresholds are met and herbicide or pesticide application is necessary.
- Ongoing monitoring of pests by trained, qualified staff is crucial to pest management success.
- Landscape managers and staff should continually receive continuing education to insure that they remain familiar with emerging technology and best management practices (BMP). Appropriate implementation of industry standards and BMP's should be discussed at regular meetings with the UM IPM committee.
- This management plan is considered a guiding document and staff will use their discretion and experience to apply the IPM principles therein.

2.2 Definitions and Discussion

2.2.1 Cultural and Mechanical Control Methods.

Cultural control methods include human activities that promote healthy, desirable plants while also reducing the potential for pest establishment by suppressing environmental conditions that are ideal for pest establishment. Examples of cultural control methods include: proper pruning of trees and shrubs, protection of soil structure during construction, appropriate irrigation for the desired vegetation, fertilization/nutrient supplementation, appropriate species selection, mulching/increasing soil organic material, aeration, and physically removing pests (e.g. hand pulling weeds).

In order to implement appropriate cultural control methods, UM staff must have current and ongoing training in horticulture, arboriculture, turf management, and industry BMPs. 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 focused on implementing maintenance practices that promote vigor and vitality in the desired vegetation. Healthy plants can resist and often out compete pest infestations, and therefore require fewer resources to maintain. Regularly scheduled preventative maintenance tasks are forms of cultural pest control. When maintenance tasks are omitted/deferred, pest infestations can quickly become difficult to control and detrimental to the landscape.

Cultural pest control methods that are included in UM's IPM regimen include but are not limited to:

Appropriate Irrigation scheduling: This practice seeks to apply water at the proper time and in the appropriate amount needed to satisfy the need of the target plant(s). In Missoula, turf generally requires 1-2 inches of rainfall equivalent water per week through the summer months and can be reduced to .5-1 inch per week in spring and fall. Trees require similar water quantities and should continue to be watered until irrigation systems are winterized for the season, or the ground begins to freeze. Irrigation must be adjusted in coordination with changes in weather to prevent over or under watering. Insufficient water causes plant stress, which may allow for insect and plant pest infestations that would not occur during times of vigorous growth. Conversely, excessive water is wasteful, can prevent root respiration, and may create conditions ideal for fungal diseases. Grounds Maintenance staff need to be aware of how plant water use varies with season and interacts with soil water holding capacity. Soil pore space, both macropore and micropore, varies significantly from parcel to parcel. This requires that individuals responsible for irrigating these areas be familiar with the substrate present in each area and know how to adjust watering schedules accordingly. In situations where soil water holding capacity allows, water should be provided infrequently via deep waterings instead of frequent shallow waterings. The former practice encourages deep, healthy roots, while the latter encourages shallow roots that require more water.

Fertility management: Fertilizers must be used judiciously to augment, not replace, the natural fertility of the soil. Topdressing turf and/or ornamental beds with compost helps to increase soil

water holding capacity, increases beneficial soil microbial activity, and improves nutrient cycling. UM topdresses turf when funding and seasonal workload allows. Soil tests provide a good baseline for establishing a supplementary fertilization program. Insuring that accurate records of the types and amounts of synthetic fertilizer applied help managers to qualify the success of management decisions. Slow-release fertilizers (sulfur coated or polymer coated-sulfur coated) are preferred as these help to increase the turf's health while reducing the number of fertilizer applications needed per year.

Proper mowing: Seasonally adjusting to insure proper mower height is essential to having healthy turf through spring, summer and fall. Experts recommend not removing more than 1/3 of the plant height above ground. Cutting lawns too short may damage grass crowns, expose soil areas where turf is thin, increase watering frequency, and encourage weed growth. Taller grass competes better with pest plants, and it helps to cool the soil, decreasing the need for frequent watering. Maintaining sharp mower blades will insure a clean cut on individual grass blades. This clean cut, as opposed to severance with a dull blade, reduces water loss, and provides a cleaner appearance. All UM properties use mowers equipped with mulching decks. Golf courses have stricter guidelines for mowing and this is discussed later in the plan.

Aeration: The importance of aeration is often overlooked, but plant roots respire, meaning that they require oxygen be present in the soil pore spaces. Compacted and/or saturated soils reduce plant vigor, and allow for the establishment of pest plants. Soil structure and the presence of adequate soil pore space (non-compacted soil) is essential to the health of trees and woody ornamental plants. Soil compaction has significant negative impacts on tree/shrub health and when severe may cause plant death.

Mulching: Mulching is the addition of plant matter to the top of soil. Mulching includes adding attractive shredded bark to landscape beds, topdressing with compost, or leaving grass clippings in place. 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 devote part of their budget to reseeding when appropriate. Over seeding of existing turf should be practiced on a regular basis to ensure high turf density.

Hand pulling: Physically disturbing the soil and removing plant pests is the most basic form of mechanical control. This method is still an essential part of plant pest mitigation/management and may be appropriate for smaller scale applications at UM. Examples of appropriate use of hand pulling weeds would include areas where non-target plants may be adversely affected by herbicides, areas not included in product label specifications, and/or areas immediately adjacent to building air intakes. Hand pulling weeds is labor intensive and inefficient, making it an inappropriate option for most large areas.

Employee education: Promote education about effective IPM implementation and industry BMP's through participation in professional societies, meetings, research, and training opportunities.

Campus education: Notify staff, faculty, students, and the public about pest control and turf management efforts. Notice should be posted in all areas 24 hours prior to treatment with any pesticide and shall remain in place until the restricted reentry interval on the product label has been met. Signage may be effective in turf restoration efforts to keep traffic off turf when it is especially susceptible to damage.

In addition to these basic tools, many plant species have specific requirements for timing of pruning and so forth. It is beyond the scope of this plan to outline proper cultural management tools for every plant species used in landscape settings at UM. The next section discusses specific cultural control actions for each of the landscape areas included in this plan in the context of their major pests.

2.2.2 Biological control

Biological control is the deliberate introduction of living organisms that are meant to control, in some capacity, the target pest. Examples of biological control agents may include pathogens, insects, and natural predators. Biological control methods are not a "quick fix" and are generally used on a limited basis to control a specific pest in an isolated area. However, biological controls can be combined with cultural and chemical methods to increase their efficacy.

UM takes the position that it is better to encourage native insects and birds that are predators of pest insects than to release non-native organisms. Introduction of non-native predatory/parasitic organisms can create additional management issues because there is little ability to contain the introduced organism spatially and it is often difficult to quantify control successes. Encouraging native pest predators/parasites can be aided through cultural methods that promote habitat for those species.

Commonly available biological control agents are discussed for each landscape area. UM should also make itself available as an area for biological control trials as appropriate. Staff should stay in touch with the Missoula County Extension agents and remain informed of new biological control agents and research.

2.2.3 Chemical control

Chemical control includes the use of synthetic herbicides, insecticides or fungicides to control pest organisms on desired plant species. Chemical control applications are effective in a relatively short amount of time, take minimal labor effort, and provide results at a low cost. However, the use of chemical pesticides brings with it concerns for the potential effects to the health of the applicator and campus patrons. Chemical applicators also need to be diligent about responsible application of pesticides to ensure protection of the environment. UM takes the approach that pesticide use should be limited as much as possible to achieve management goals, and that cultural practices are the first line of defense against pests. Labels for all pesticides used on the UM campus are included in this report.

Any pesticide application made at UM will be done by a licensed applicator. Any needed pesticide applications on main campus, Missoula College, and at the golf course are typically made by UM staff, while the University Villages and Lewis and Clark Apartments have historically conducted applications both in-house and through the use of outside contractors. Pesticide licensing and enforcement is handled by the Montana Department of Agriculture, which is permitted to audit UM pesticide application records, equipment and practices at any time.

Pesticides are stored in a dedicated storage unit at the Physical Plant. This storage unit has a secondary containment tank floor design to contain spills should they occur and is heated throughout the year to prevent freezing and breaking of storage containers or application equipment.

Care must be exercised in handling and mixing chemicals. Equipment must be in good condition and inspected regularly. Chemicals should be mixed per label specification, and when possible, in quantities amounts that will be used the same day. Mixing and rinsing of equipment shall take place at a location with adequate rinsate collection, or rinsate should be mixed back into the tank and included in a future application.

Broadcast pesticide applications are prefaced by public notification at least 24 hours in advance with signage at the locations to be treated. All signs shall be formatted such they are in compliance with all local laws, codes, and ordinances. Signage is not generally posted when conducting spot spray applications in locations where foot traffic and/or recreation is not expected (landscape/ornamental beds). Signs shall be posted 24 hours prior to application, and left in place at least 24 hours after application, longer if specified on the product label. Specific pesticide application issues are discussed for each landscape area addressed by this plan.

Product name (active ingredient)	Link to specimen label
Herbicides	
Glystar Plus® (glyphosate)- non-selective	http://www.cdms.net/ldat/ld4KG007.pdf
SP 3WAY® (2,4-D, MCPA, Dicamba)- selective broadleaf herbicide	http://techsheets.simplot.com/Partners/SP_3WAY.pdf
Sureguard SC® (Flumioxazin) - pre-emergent	http://www.cdms.net/ldat/ldDC5002.pdf
Tree Growth Regulator	
Cambistat® (Paclobutrazol)	https://www.treecarescience.com/pdf/Growth_Regulators/Cambistat_Specimen_Label.pdf
Insecticides	
Tenguard SFR® (permethrin)	https://www.cvear.com/wp-content/uploads/2012/05/Tengard-SFR-Label.pdf
Tempo SC Ultra®	https://www.environmentalscience.bayer.us/-/media/prfunitedstates/documents/resource-library/product-labels/tempo-sc-ultra.ashx
Imidastar 2L ® (imidaclopyrid)	http://www.cdms.net/ldat/ld7HA003.pdf
Fungicides	
11-0-22 Fertilizer plus Fungicide VIII (Iprodione and thiophanate-methyl)	www.umt.edu/sentinel/fungicideviii_label.pdf
Vitavax-PCNB Flowable Fungicide (pentachlornitrobenzene)	www.umt.edu/sentinel/vitavax_pcnb_label.pdf

Table 1. Pesticides used on UM properties.

2.2.4 Monitoring

Ongoing monitoring and evaluation of pest populations is important. Adapting to changing pest and environmental conditions to ensure application efficacy is essential for program success. Landscape workers and managers monitor conditions on an ongoing basis using visual assessment. This relies on trained staff recognizing and reporting problems and emphasizes the important role that UM landscape staff have in keeping our campus healthy and attractive.

3.0 Common Pests at UM

3.1 Plant Pests

Common name	Latin name	Affected areas
Black medic	*Medicago lupulina*	T B
Broad leaved plaintain	*Plantago major*	T B
Canada thistle*	*Cirsium arvense*	B W
Cheatgrass	*Bromus tectorum*	W
Chickweed	*Stellaria media*	T B
Common tansy*	*Tanacetum vulgare*	B W
Dalmatian toadflax*	*Linaria dalmatica*	W
Dandelion	*Taraxacum officinale*	T B W
Field bindweed*	*Convulvulus arvensis*	W
Field pennycress	*Thlaspi arvense*	T B W
Hairy vetch	*Vicia villosa*	B W
Lamb's quarters	*Chenopodium album*	B W
Leafy spurge*	*Euphorbia esula*	W
Kochia	*Kochia scoparia*	W
Mustards	Brassicaceae family	W
Knotweed	*Polygonum species*	W
Quack grass	*Agropyron repens*	T W
Redroot pigweed	*Amaranthus retroflexus*	T W
Round leaved mallow	*Malva rotundifolia*	T W
Shepherd's purse	*Capsella bursa-patoris*	T B W
Smartweed	*Polygonum spp*	T B W
Spotted knapweed*	*Centaurea maculosa*	W
Sulfur cinquefoil*	*Potentilla recta*	W
Wild buckwheat	*Polygonum convolvulus*	T W

* Designated noxious weeds

T= irrigated turf, B= planting beds, W= waste areas including parking lots, edges of playing fields, etc

A pest plant or a weed is any plant that is growing where it is not wanted. For landscaped areas of campus, this includes many species as listed in Table 2. Here it is important to distinguish between noxious weeds and general pest plants. Noxious weeds are plants that have been placed in a legal category, and by state and county laws, they must be controlled. General pest plants, including shepherd's purse and dandelions, do not legally require control, instead, their control is necessitated by aesthetic expectations for landscaped areas.

3.2 Pest Insects

Nuisance insects, found in all areas: Ants, bees, and wasps sometimes form nests in areas that are too close to human activities, necessitating removal for safety or health reasons.

Trees and shrub pests: Tree and shrub pests include aphids, adelgids, tent caterpillars, bark beetles (Mountain Pine Beetle (MPB) and red turpentine beetle), leafhoppers, thrips, cinch bugs, white pine weevil, and various scale insects.

Turf insect pests: There are two categories of turf insect pests. The first category lives in the soil and eats or disturbs roots. Soil insect pests include grubs (larvae of various beetles in the Family Scarabaeidae), cutworms, nematodes and armyworms. The second category of insect pest are surface insects which generally damage foliage. These include aphids and leaf hoppers. Insects from both categories can act as vectors for plant pathogens, although the primary damage occurs from insects eating the vegetation. The severity of damage depends on the specific insect, its population size, and turf health. Healthier turf is more resistant to insect damage, and turf treatments for insect pests are generally unnecessary on multi-purpose turf at UM.

3.3 Disease Pests

Pink and gray snow molds, leaf spot and dollar spot are the most common disease pests requiring control at UM, and these control efforts are almost always confined to golf greens and tees. These diseases are tolerated on other turf areas with lower standards of quality and appearance. Fairy rings are sometimes a problem at the golf course. Tree and shrub diseases of note on UM main campus include: fire blight, pseudomonas syringae bacterial infection, western pine gall rust, and Ganoderma root rot.

4.0 Specific Areas and Management Practices

4.1 Turf

UM has over 200 acres of turf, including the golf course. Due to the finite nature of landscaping budget and staff time, these areas need to be prioritized. Not all lawns need to be maintained to the highest maintenance standard. Different thresholds for pest tolerance are applied in different areas. The threshold level is determined by pest density, potential damage, visual impact of the pest population, and effectiveness of cultural control methods.

The highest priority areas on main campus include the Oval, all adjacent turf parcels, and the sports complex fields. These must be always visually appealing, able to withstand heavy traffic, and always maintained in high quality condition. These higher priority areas are usually attended to first in the growing season and receive slightly higher rates of fertilizer, closer attention to broadleaf weeds, and an extra aeration treatment each year.

Second priority areas include the rest of Main Campus lawns, including those around dorms and apartments. These must be visually appealing and relatively weed free, although weed tolerance is higher in these areas.

Cultural.
Water appropriately- that is, infrequently and deep. One watering of ½ inch in one day (with a brief pause partway through the irrigation to allow water to soak in) is preferred to two ¼ waterings on two consecutive days. Soil water holding capacity is the primary determining factor in irrigation run times for individual turf parcels. Lawns are irrigated from April through mid-October, but the amount of water provided each week depends on daily high temperatures as well as precipitation. In cooler seasons, lawns may require ½ -1 inch per week, while in mid-summer, 1.5-2 inches may be needed.

Aerate: High priority lawns are aerated 3-4 times per year. Lower priority lawns are aerated 1-2 times per year.

Mow: Mower blades are kept sharp and grass is cut to a height of 2.5-3 inches in spring and fall, and 3.5 inches through the summer months. Lawns should be mowed frequently enough that workers are never removing more than 1/3 of the total above ground length.

Soil testing: This is done on a rotating or occasional basis or in response to a situation in which the lawn appears to be unhealthy.

Compost/mulch: Compost is applied lawns once a year and when budget and staff time allows. “Green mulch” is added every time a lawn is mowed since all UM’s mowers are mulching mowers.

Fertilizer: The primary nutrient given to lawns is nitrogen, but in fall applications balanced fertilizers containing phosphorus and potassium are applied to encourage root development. Slow release nitrogen is applied once a year (40% N), and one balanced fertilizer application is conducted in the fall. The total amount of nitrogen applied each year to multi-use turf is up to 3

pounds per 1000 square feet. (Note: this is less than most commercial lawn care companies use in western Montana, where 4-6 pounds per 1000 square foot is typical.)

Over seeding: Lawns are over seeded and/or slit seeded as needed to fill in bare or thin spots.

Pest plant control.
Primary weeds are dandelions, black medic, clovers and plantain. Cultural control methods detailed above will favor grass instead of these weeds. Herbicides will be used as needed to keep turf pest plants below action thresholds. The APPA standards for % weed growth in maintained turf areas are summarized below:
Level 1 (highest) turf maintenance: weeds represent less than 1% of turf area
Level 2 turf maintenance: weeds represent less than 5% of turf area
Level 3 turf maintenance: control measures taken when 50% of small areas or 15% of the general turf area is infested with weeds
Level 4 & 5 turf maintenance: weed control limited to legal requirements for noxious weeds

On main campus, all the lawns currently receive a general broadleaf herbicide once a year. Follow-up treatments may be needed to reduce pest populations to within desired specifications.

At Lewis and Clark Apartments, applicators conduct one application for the control of dandelions each year. UM Housing staff will contract with a commercial company to apply a broadleaf herbicide twice a year in the first year, and then once a year in subsequent years. UM Housing's goal is to eventually modify this to a general application in alternate years only, with spot spraying in between to maintain.

Insect pest control
Currently, best cultural practices have kept turf insect pests well under control. There is no general pesticide application for insects currently in practice on campus.

Disease control.
Turf diseases are currently only a problem at the golf course. Main campus, University Villages, and Lewis and Clark Apartments do not now, nor do they expect, to have any cause to treat lawn diseases. At the golf course, one of the fungicides listed in Table X may be locally applied on fungal diseases, with watering and mowing regimes altered as necessary to prevent additional disease outbreak.

4.2 Golf Course Turf

Golf course turf needs to be considered in 3 separate categories: Tees/greens, fairways and roughs. Of these, tees and greens need to be maintained at the highest standard, with fairways receiving less scrutiny, and even less needed for the roughs.

Cultural.
Cultural management strategies are the same as those in section 4.1 with the exception of different mowing requirements for the 3 different types of golf course turf. Greens are mowed to a height of 0.145 inches, tees to 0.450 inches, fairways to 0.750 inches, and roughs to about 2 inches or more.

When grass is mowed very short (as on greens and tees), it requires more water. This is why turf diseases are more common on golf courses than on the rest of UM's turf areas.

Pest plant control.
The primary pest plants at the golf course are dandelions and clovers. These are treated with Confront or Roundup, depending on their locations.

Insects.
Turf insects are currently not a big management problem at the golf course. Occasionally a grub outbreak in the greens will require a spot insecticide treatment with one of the insecticides from Table 1.

Diseases.
Occasionally snow molds, fairy rings, dry spot or dollar spot need to be treated on the tees or greens. Treatments are discussed below:

Pink snow mold, gray snow mold, and dollar spot. Staff will use a backpack blower to increase air movement, and increase sun exposure by keeping greens clear of debris daily and removing snow at various times in the winter. Water spots are squee-gied off after snow melt. Fungicides (see Table 1) can be applied in early fall and throughout the winter. Finally, affected areas are top dressed with sand late in the fall.

Localized dry spots. This condition is due to plant roots' inability to penetrate some areas, and usually it occurs in the peak of summer heat. It is addressed through aeration, application of wetting agents, and irrigation with a syringe in heat of summer.

Fairy ring. This is addressed with aeration, application of wetting agents and fungicides.

4.3 Landscape Beds

Landscape beds are decorative areas, typically adjacent to buildings, which are not turfed and contain a variety of herbaceous plants, trees, and woody perennials. The primary management goal with regard to landscape beds is to achieve a high level of aesthetic value, with a minimum inputs of water, pesticide, and labor.

Cultural approaches to healthy landscape beds.

1. Select plant material that is appropriate to the arid intermountain west. Native plant materials should be favored when suited for the location because they are adapted to low water situations and are resistant to many local insects while providing haven for beneficial insects.
2. Water only as much as necessary, using drip emitters or bubblers for irrigation. This helps to ensure that water is delivered to the desired plants, but not to the remainder of the bed.
3. Ensure 3-4' bark mulch is present to suppress weeds and retain soil moisture

4. Take caution when treating for pest plants to ensure that there is no damage to off target plant material.

Pest plants. In landscape beds, pest plants are typically any plant that was not intentionally planted there. Most often, this includes a wide variety of plants from Table 2.
High visibility beds on the main UM campus are treated in the spring with pre-emergent herbicide to reduce the need for follow up control through the growing season. In established landscape beds, applicators must take care when spot treating for weeds to protect desired vegetation. The cultural methods listed above help to reduce pest plant populations; however, spot treatments are seasonally necessary to kill pest plants to avoid them going to seed.

Insect pests. Insect pests are not typically a problem in UM landscape beds.

Disease pests. Main campus and University Villages and Lewis and Clark Apartments do not have issues with disease pests in landscape beds.

4.4 Trees and Shrubs

Trees and shrubs provide shade and beauty for campus. A mature tree canopy in an urban setting has countless qualitative and quantitative benefits. Trees significantly cool buildings, provide significant carbon sequestration, provide social and health benefits, and add millions of dollars of landscape value to the campus landscape. UM main campus is the Montana State Arboretum and therefore the approximately 2000 trees on campus are of special significance, not only to the campus itself, but to the state of Montana.

Cultural practices:
Selecting the appropriate tree species for the site, proper pruning, and species appropriate irrigation are important for woody plant health. Trees should be inspected and pruned regularly to promote good growth form, avoid conflicts with campus patrons and infrastructure, and to mitigate the inherent risk associated with trees in a public setting. Trees that are not in landscape beds should be surrounded by a wood mulch ring that is 2-4 inches deep and no less than 6 feet in diameter. Mulch rings reduce water and nutrient competition from turf, cool tree roots, increase soil fertility and nutrient cycling, and hold water in the tree's rooting area.

Insect pests:
These include aphids, mites, and tent caterpillars, bark beetles, and scale insects. Preventative treatments for pests that can cause plant mortality in a short period of time, specifically MPB, are undertaken annually on UM main campus. This treatment either comes in the form of a trunk spray with permethrin, or use of pheromone (verbenone) packets to deter pests. All other insect pest populations are monitored and treated when population densities significantly threaten plant health. When treatment is necessary, a systemic insecticide is preferred to canopy sprays due to its minimally invasive, soil drench application method.

Diseases:
Western pine gall rust: Remove affected limbs during normal pruning cycle.
Fire blight: Prune out infected limbs, sanitizing pruning tools between cuts.

Pseudomonas syringae: Prune out infected limbs, sanitizing pruning tools between cuts. If bacteria moves into the cambium of the stem the only effective treatment it plant removal.
Ganoderma root rot: Cannot be treated. Tree should be monitored for health issues, and removed if there is an increased risk of failure due to compromised roots.

4.5 Edges and Waste areas

Plant pests, especially noxious weeds are of primary concern in this land use type. Pest plants should be removed via weed whip or brush mowing. If this type of control is impractical or unsafe due to location or difficult terrain, herbicides should be used to kill the pest plants. Noxious weeds need to be controlled at specific times in the growing season to ensure that they are mowed and/or sprayed before they flower and set seeds.