

The logo features a stylized green plant with several long, narrow leaves on the left. To the right of the plant, the word "Montana" is written in a green, cursive script. Below "Montana", the words "WEED DISTRICT COORDINATOR" are written in a green, bold, sans-serif font. At the bottom, the word "HANDBOOK" is written in a larger, green, bold, sans-serif font.

Montana WEED DISTRICT COORDINATOR HANDBOOK

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Contents Detail

Introduction

SECTION 1 Weed District Organization

- 1.1 County Weed Boards
- 1.2 Weed Coordinator Job Description
- 1.3 Seasonal Employee/Applicator Job Description
- 1.4 Interview Tips
- 1.4 Tips for Interviewing and Hiring Seasonal Employees
- 1.5 Personnel Policy
- 1.6 Weed District Budgets
 - 1.6.1 Four factors determine your Weed District Budget
 - 1.6.2 An Example Budget
 - 1.6.3 Budget Basics Outline
- 1.7 Contracting Weed Management Activities
 - 1.7.1 SAMPLE: Contract for Weed Management
- 1.8 Weed Program Coordination

SECTION 2 Noxious Weed Laws & Rules

- 2.1 Montana County Noxious Weed Control Act and Rules
- 2.2 Montana Pesticide Act and Rules
- 2.3 Enforcement Procedures
 - 2.3.1 SAMPLE: Voluntary Compliance Request – 1st Notice
 - 2.3.2 SAMPLE: Notice of Compliance

SECTION 3 Public Relations

- 3.1 PR Planning and Organization
 - 3.1.1 SAMPLE: Weed Manager's Public Relations Activity Schedule
 - 3.1.2 Information Sources
- 3.2 Dispensing Information
 - 3.2.1 News Releases: Using the Media
 - 3.2.1.1 Writing Guidelines
 - 3.2.1.2 SAMPLE: News Release
 - 3.2.1.3 Newspapers
 - 3.2.1.4 Magazines
 - 3.2.1.5 Television & Radio
 - 3.2.2 Social Media
 - 3.2.3 Others Ways to Spread the Word
- 3.3 General Media Tips
- 3.4 The Do's and Don'ts of Public Relations
- 3.5 Meeting Guidelines
 - 3.5.1 Public Meetings
 - 3.5.1.1 Conducting a successful public meeting.
 - 3.5.1.2 Keeping your head (attached) during Confrontational Public Situations
 - 3.5.1.3 Checklist for Setting up a Public Meeting
 - 3.5.1.4 Meeting Preparation Form-Action Planning Worksheet for Meeting
 - 3.5.1.5 Public Meeting Agenda
 - 3.5.2 Negotiation Meetings
 - 3.5.3 Activist Encounters

SECTION 4 Weed Management Concepts

- 4.1 Ecological and Economic Impacts of Noxious Weeds
 - 4.1.1 Impact of Exotic Plant Species on the Ecosystem
 - 4.1.2 Economic Impact of Noxious Weeds
 - 4.1.3 Summary

- 4.1.4 Literature Cited
- 4.2 Integrated Weed Management Strategies
 - 4.2.1 Planning, Inventory, & Monitoring
 - 4.2.2 Prevention & Education
 - 4.2.3 Physical or Mechanical Weed Management
 - 4.2.4 Biological Weed Management
 - 4.2.5 Chemical Weed Management
 - 4.2.6 Cultural Weed Management
 - 4.2.7 Land Management
 - 4.2.8 Conclusion

SECTION 5 Weed Inventory & Monitoring Techniques

- 5.1 Weed Inventory Methods-General Guidelines
 - 5.1.1 Why Inventory Noxious Weeds?
- 5.2 Monitoring and Evaluation
 - 5.2.1 Photo Points
 - 5.2.1.1 How to Establish Photo Points
 - 5.2.1.2 SAMPLE: Photo Point Monitoring Form
- 5.3 Mapping Invasive Species in Montana: An EDDMapS West User Guide

SECTION 6 Herbicides in the Environment

- 6.1 Herbicides and Their Properties
 - 6.1.1 Herbicide Mode of Action
 - 6.1.2 Herbicide Families and Properties
- 6.2 Herbicides and the Environment
 - 6.2.1 Environmental Factors
 - 6.2.2 Atmospheric Effects
 - 6.2.3 Herbicide Loss Following Application
 - 6.2.4 Herbicide Runoff Potential
 - 6.2.5 Herbicide Movement in Soil
 - 6.2.6 Depth to Groundwater
 - 6.2.7 Geology
- 6.3 Herbicides and Human Toxicity
 - 6.3.1 Pesticide Toxicity
 - 6.3.2 Carcinogenicity and Mutagenicity

SECTION 7 Pesticide Safety and Handling

- 7.1 Emergency Phone Numbers
- 7.2 Personal Safety
- 7.3 Protective Clothing and Equipment
 - 7.3.1 Preventing Skin Exposure
 - 7.3.2 Preventing Eye Exposure
 - 7.3.3 Preventing Lung Exposure
 - 7.3.4 Preventing Oral Exposure
 - 7.3.5 Additional Personal Protective Equipment in Certain Mixing and Loading Situations
 - 7.3.5.1 Front protection
 - 7.3.5.2 Face protection
 - 7.3.5.3 Protection from dusts
 - 7.3.5.4 Protection from vapors

- 7.3.6 Additional Protection For Some Types Of Pesticide Application Tasks
 - 7.3.6.1 Hand-carried application equipment
 - 7.3.6.2 Entering the path of the released pesticide
 - 7.3.6.3 Walking into a just-treated area
 - 7.3.6.4 High-exposure applications
 - 7.3.6.5 Adjusting pesticide-coated equipment
 - 7.3.6.6 Applying in air currents
 - 7.3.6.7 Applying concentrates
 - 7.3.6.8 Immersing hands and forearms
- 7.4 Personal Cleanup
- 7.5 Health Hazards & Pesticide Poisoning
 - 7.5.1 Types of Injuries
 - 7.5.2 Blood Tests
 - 7.5.3 Pesticide Poisoning: Recognition, Basic First Aid & Prevention
 - 7.5.3.1 Symptoms of Pesticide Poisoning
 - 7.5.3.2 Basic First Aid
 - 7.5.3.3 Prevention
- 7.6 Handling Pesticides Safely
 - 7.6.1 Transportation
 - 7.6.2 Storage
 - 7.6.3 Mixing & Loading
 - 7.6.3.1 Closed Mixing and Loading Systems
 - 7.6.3.2 Pesticide Collection Pad or Tray
 - 7.6.4 Equipment Cleaning, Maintenance, and Calibration
 - 7.6.4.1 Cleaning
 - 7.6.4.2 Maintenance: Field Equipment Daily Check List
 - 7.6.4.3 Calibration
 - 7.6.5 Waste Disposal & Recycling
 - 7.6.5.1 Guidelines for Pesticide and Pesticide Container Disposal
 - 7.6.6 Spill Prevention and Management
 - 7.6.6.1 Preparation and Prevention
 - 7.6.6.2 Reporting & Assistance
 - 7.6.6.3 Handling a Spill
 - 7.6.6.4 Spill Follow-up
 - 7.6.7 Pesticide Fires
- 7.7 Applying Pesticides Safely
 - 7.7.1 Basic Safety Procedures
 - 7.7.1.1 Livestock
 - 7.7.1.2 Wildlife
 - 7.7.1.3 Groundwater
 - 7.7.2 Application Procedures
 - 7.7.3 Application Record-Keeping
 - 7.7.3.1 Necessary information
 - 7.7.3.2 Additional information
 - 7.7.3.3 Required records
 - 7.7.3.4 SAMPLE: Daily Application Record
- 7.8 Pesticide Labels

SECTION 8 Chemical Weed Management

- 8.1 Factors Affecting Herbicide Performance
 - 8.1.1 Soil-Applied Herbicides
 - 8.1.2 Foliar-Applied Herbicides
 - 8.1.3 Environmental Impacts on Foliar Herbicide Performance

- 8.1.4 Surface Active Agents (Surfactants)
- 8.1.5 Herbicide Selectivity
- 8.2 Recommendations for Noxious Weeds
 - 8.2.1 Weed Response to Pasture and Rangeland Herbicides
 - 8.2.2 Weeds Listed On Pasture and Rangeland Labels
 - 8.2.3 General precautions found on herbicide labels recommended on problem weeds and poisonous plants
 - 8.2.3 Grazing and haying restrictions for herbicides labeled for range and pasture
 - 8.2.4 Application & remarks for weeds on non-crop and rights-of-way

SECTION 9 Biological Weed Management

- 9.1 Introduction
- 9.2 Status and role of biological weed control agents
- 9.3 Handling and Monitoring Methods
 - 9.3.1 Obtaining Biocontrol Agents
 - 9.3.2 Releasing Biocontrol Agents
- 9.4 Monitoring and Managing Biocontrol Agents
 - 9.4.1 Monitoring biological control agents and impact
 - 9.4.2 Managing biocontrol agent populations
 - 9.4.3 Biocontrol as part of an integrated weed management strategy

SECTION 10 Planning

- 10.1 Introduction
- 10.2 Guidelines for Developing a Weed Management Plan
 - 10.2.1 Integrated Weed Management (IWM)
- 10.3 Funding – Montana Noxious Weed Grant Program
- 10.4 Noxious Weed Trust Fund Act and Rules

SECTION 11 Contacts

- 11.1 Montana County Weed District Coordinators: November 2018
- 11.2 Noxious Weed Advisory Council
- 11.3 Noxious Weed Seed Forage Advisory Council
- 11.4 Montana Department of Agriculture Contacts
- 11.5 State and Regional Contacts
- 11.6 Noxious Weed Task Forces (TF)
- 11.7 Sites Relating To Weed Control, Herbicide and Applicator Safety, or Information Concerning Vegetation Management

Introduction

The purpose of this handbook is to serve as a reference guide to County Weed Coordinators for management of weeds and weed district activities. District operations, monitoring and mapping guidelines, weed and pesticide laws and rules, and other reference material are included to provide uniform standards for coordinating and conducting weed management activities. Since herbicides are an integral part of a weed district program, and their use requires considerable knowledge, a large portion of the handbook is targeted toward this subject. However, THIS HANDBOOK IS NOT INTENDED AS A COMPLETE GUIDE TO HERBICIDE USE.

There are several professional organizations that support weed district activities by providing training and updates on weed research, education, and management issues. These organizations include: Coordinator's Support Group, The Montana Weed Control Association (MWCA) and the associated area councils, North American Invasive Species Management Association (NAISMA), and the Western Society of Weed Science (WSWS) which is the Western Region chapter of the Weed Science Society of America.

The authors and updaters of this handbook have assembled the most reliable information available to them at time of publication. However, due to constantly changing laws, regulations, and herbicide options there may be some information that is not current. The handbook is distributed in a 3-ring binder allowing for material to be added, removed, or updated as necessary. It is designed to be a working document and material should be updated annually. The handbook and updates are available from the Montana Weed Control Association Coordinator Support Workgroup.

SECTION 1 Weed District Organization

COUNTY WEED BOARDS WEED

COORDINATOR JOB DESCRIPTION

SEASONAL EMPLOYEE/ APPLICATOR JOB DESCRIPTION

INTERVIEWING TIPS/ QUESTIONS

PERSONNEL POLICY

WEED DISTRICT BUDGETS

CONTRACTING WEED MANAGEMENT ACTIVITIES

WEED PROGRAM COORDINATION

This section provides background information on organization, policies and procedures implemented by County Weed Districts. In addition, job duties and descriptions for descriptions for county weed coordinators, and seasonal sprayers/operators are included. Guidelines for developing weed district budgets and contracts are also provided.

1.1 County Weed Boards

The Montana County Noxious Weed Control Act of 1985 mandated that a weed management district will be established in every county in Montana. The County Commission in each county shall appoint a “District Weed Board” subject to the provisions of 7-1-201 through 7-1-204 MCA. The board may call upon the county attorney for legal advice and services as it may require. The weed board has certain powers and duties as defined by law. These include:

- Supervise a coordinator and other employees.
- Purchase equipment, herbicides, biological agents, other materials necessary, and pay other operational costs necessary to implement an effective noxious weed management program. The cost must be paid from the noxious weed fund.
- Enter into agreements with the Montana Department of Agriculture (MDA) for control and eradication of any new noxious weeds not previously found in the state.
- Determine what herbicides, biological agents, equipment, or other materials may be made available to people managing noxious weeds in the county.
- Enter into cost-share agreements for noxious weed management.
- Enter into agreements with commercial applicators, for the control of noxious weeds within the county.
- Request legal advice and services from the county attorney.
- Perform other activities relating to weed management within the county.

In addition to these activities, the weed board must:

- Administer the weed district’s noxious weed program.
- Establish management criteria for noxious weeds on all lands within the district under a County Weed Management Plan.
- Make all reasonable efforts to develop and implement a noxious weed program covering all land within the district owned or administered by state and federal agencies.
- Recognize and follow the State Weed Management Plan to the best of their abilities.

County responsibility for noxious weed management mandated by law is detailed in Section 2 of this guide.

1.2 Weed Coordinator Job Description

OBJECTIVE - To develop and implement a weed management program for the county that includes administration, public education, and weed prevention and control.

ACCOUNTABLE TO - Board of [_____] County Commissioners and the [_____] County Weed Board.

KNOWLEDGE and SKILLS -

- The ability to communicate effectively both orally and in writing
- Working knowledge of plant identification, biology, and ecology with emphasis on noxious weeds
- Knowledge of weed management methods including herbicides, biological methods, and cultural methods
- Must be able to interpret aerial photographs and topographic maps
- Working knowledge of computers, including word processing, and GIS and GPS systems
- Possess understanding of Montana Weed Laws and Pesticide Regulations
- Working knowledge of sprayer equipment operation and calibration; be able to perform light maintenance of equipment
- Must have or be able to obtain a Governmental Pesticide Applicator's License, Pesticide Dealer License, and possess a valid Montana Drivers License, and should become trained as a Noxious Weed Seed Free Forage agent/inspector.
- Experience in personnel supervision and budget process
- Possess organizational and leadership skills.
- Know how to read and interpret pesticide labels.

EDUCATION AND EXPERIENCE - The above knowledge and skills are typically acquired through a combination of education and work experience. Minimum requirements include:

- A high school or equivalent diploma
- Two years experience in weed management activities including application of integrated weed control tools (biological, cultural, and chemical methods).
- Additional classes in agriculture, plant biology, herbicide safety and handling, and related fields preferred.
- Experience in public speaking

- Experience in employee supervision

JOB DUTIES AND REQUIREMENTS -

General

- Ability to be punctual to work and for appointments, dress in a presentable manner and present self as a professional
- Responsible for developing, updating, and implementing the County Noxious Weed Management Plan
- Purchase herbicides, equipment, and other materials under the direction of the Weed Board to meet objectives of the Weed Management Plan, within the limitations of available funds
- Implement and enforce district compliance with provisions of 7-22-2131 of the County Noxious Weed Control Act
- Ensure proper equipment maintenance and conducts light repairs
- Develop special weed management areas within the county and assist interested parties in writing grant proposals to Montana Noxious Weed Trust Fund program; these Grants can be cooperative, educational or research.
- Implement weed inventory and monitoring programs to determine the effectiveness of the county weed management plan
- Coordinate weed management activities between private, county, state, and federal land managers
- Develop and ensure compliance with contracts/agreements between the County Weed District, state and federal entities, and private companies for management of noxious weeds (i.e. Montana Department of Transportation; Rail Link; State Lands, Fish, Wildlife, & Parks; Corrections; and University System)
- Notify landowners of weed infested areas on their property, and assist landowners with development, implementation, and monitoring results of weed management plans
- Develop and implement prevention programs including weed seed free hay certification; revegetation; public education on new invading weed species; inspections of county and state gravel pits and stock piles; vigilant monitoring of roadsides, railroad rights-of-way and other areas highly susceptible to newly invading weed species including subdivisions
- Keep accurate records of materials used and work performed.
- Supervise the spraying operations of contractor's and/or seasonal labor.

- Attend meetings and educational workshops.
- Interpret aerial photographs and topographic maps
- Maintain a professional image with the public.

Administrative Duties

- Perform administrative duties that include hiring and supervision of employees
- Issue work directives, prepare employee work schedules, and establish deadlines to insure completion of projects
- Hiring employees per personnel policy of the county
- Provide and/or ensure training of employees on pesticide safety, application techniques, hazards, environmental impact of pesticides, state and federal regulations, and general weed management activities
- Review daily reports from employees on work conducted and ensure completion of reports
- Prepare budget for yearly operation including personnel, equipment, and supplies
- Maintain updated files on Noxious Weed Trust Fund projects and submit reports to the Montana Department of Agriculture twice per year.
- Maintain current information on weed management including herbicide material safety data sheets (MSDS), biological, cultural control options and weed identification
- Meet with the Weed Board monthly, or as needed to efficiently manage the weed control program

Public Education

- Develop and implement public education programs on invasive plants that include but are not limited to:
 - Education of road department personnel and other county “field staff” on weed identification
 - Programs for schools and organizations on invasive plants
 - Publishing news stories in newsletters and papers
 - Holding weed tours for the general public that review special weed control projects, new invasive species, etc.
 - Conducting radio announcements as necessary to inform the public about invasive plants
 - Establishing demonstration plots to show various weed management tools
 - Conducting sprayer calibration clinics in the spring or as needed

PHYICAL DEMANDS AND WORKING CONDITIONS

- Normally required to stand, sit for long periods of time.
- Frequently required to lift and move up to 50 pounds.
- Regularly the employee works near moving or mechanical parts, with fumes or airborne particles; with chemicals in outdoor weather conditions and with vibration.
- The employee occasionally works in extremely hot outdoor conditions with risk of heat exposure.
- The noise level in the work environment is usually moderate and the employee may be exposed to hazardous fumes or products.
- The employee commonly works in rough uneven terrain.
- The employee frequently works outside in range areas where there are snakes.
- The employee is always required to wear proper personal protective equipment that may include but is not limited to boots, long pants, long sleeve shirts, gloves, safety glasses, helmets, etc.

JOB PERFORMANCE STANDARDS - This position will be evaluated by the [_____] County Weed Board based on performance of duties and requirements as outlined in the job description.

- Performs assigned duties
- Competently develops, implements, and monitors the County Weed Management Plan.
- Ensures district compliance with provisions of the County Noxious Weed Control Act and Montana Pesticides Act.
- Ensures employee training in pesticide safety, application, hazards, and environmental impact of pesticides, state and federal regulations, and weed management concepts.
- Provides public education about invasive plants
- Effectively handles public questions and concerns regarding county weed management efforts.
- Maintains current knowledge of new materials and management methods.
- Provides technical and professional consultation to the weed board.
- Maintains and submits accurate and timely records and reports

- Follows safety procedures in storage and handling of pesticides and proper disposal of empty pesticide containers.
- Follows safety procedures while working with herbicide application equipment.
- Observes work hours and demonstrates punctuality.
- Establishes and maintains effective working relationships with fellow employees, the Weed Board, other county, state and federal cooperators, and the public.
- Shows courtesy and presents self in a professional manner.

1.3 Seasonal Employee/Applicator Job Description

OBJECTIVE - To perform field tasks and technical duties in noxious weed management to meet the goals of the County Weed Management Plan.

ACCOUNTABLE TO - Weed Coordinator or Field Supervisor

KNOWLEDGE and SKILLS -

- The ability to communicate effectively both orally and in writing.
- Working knowledge of weed identification.
- Interpret aerial photographs and topographic maps.
- Knowledge of weed management methods including herbicides, biological methods, and cultural methods.
- Working knowledge of sprayer equipment operation and calibration; be able to perform light maintenance of equipment.
- Must have a valid Montana driver's license.
- Understand pesticide safety and handling.
- Ability to drive a truck with manual transmission.
- Ability to present self to the public in a courteous business-like manner.
- Know how to read and interpret pesticide labels

EDUCATION AND EXPERIENCE - The above knowledge and skills are typically acquired through a combination of education and work experience. Minimum requirements:

- A high school or equivalent diploma and be at least 18 years of age
- Additional classes in agriculture, plant biology, herbicide safety and handling, and related fields preferred.
- Attend pesticide safety and handling course (or correspondence course) sponsored by the county, state agency, Montana State University Extension, Montana Weed Control Association, etc.
- Pass (with an 80% or better score) the Basic Pesticide Exam and Weed Exam administered by the Montana Department of Agriculture or attend an area spring training program to obtain a Certified Operator's License.

JOB DUTIES AND REQUIREMENTS

General

- Work as part of a TEAM with other district employees on conducting weed management activities
- Complete tasks assigned by immediate supervisor
- Mix pesticides and herbicides from concentrated materials
- Operate application equipment, two-way radio, hand and vehicle mounted sprayers
- Treat noxious weeds within the county in accordance with the County Weed Management Plan and environmental assessment
- Maintain a professional image with the public
- Document and file daily application progress for reports
- Notify field supervisor of problems or deficiencies encountered
- Clean trucks, containers, and chemical storage areas
- Perform other related duties as required

PHYICAL DEMANDS AND WORKING CONDITIONS

- Normally required to stand, sit for long periods of time.
- Frequently required to lift and move up to 50 pounds.
- Regularly the employee works near moving or mechanical parts, with fumes or airborne particles; with chemicals in outdoor weather conditions and with vibration.
- The employee occasionally works in extremely hot outdoor conditions with risk of heat exposure.
- The noise level in the work environment is usually moderate and the employee may be exposed to hazardous fumes or products.
- The employee commonly works in rough uneven terrain.
- The employee frequently works outside in range areas where there are snakes.
- The employee is always required to wear proper personal protective equipment that may include but is not limited to boots, long pants, long sleeve shirts, gloves, safety glasses, helmets, etc.

JOB PERFORMANCE STANDARDS - This position will be evaluated by the [_____] County Weed Coordinator or Field Supervisor based on performance of duties and requirements as outlined in the job description.

- Perform assigned duties
- Ensure weed management activities are conducted safely and in accordance with county, state, and federal regulations
- Properly clean and maintain equipment
- Demonstrate sound judgment in making decisions
- Attend training sessions as required
- Prepare and submit accurate and timely reports
- Effectively handle public questions and concerns regarding county weed management efforts in a professional courteous manner
- Follow safety procedures in storage and handling of pesticides and equipment
- Observe work hours and demonstrates punctuality
- Establish and maintain effective working relationships with fellow employees, supervisors, and the public
- Keep the working area; outside and inside of headquarters clean and presentable to the public

1.4 Interview Tips

1.4.1 Tips for Interviewing and Hiring Seasonal Employees

Tip 1- Plan Ahead

Selecting and hiring the best talent is critical to having a less stressful and successful weed spraying season, but if you're like most weed coordinators, you may not have a ton of time to strategically plan for these efforts. Given the high rate of turnover and that willing help is hard to find help, it is recommended making the time for a few key considerations up front when hiring for the upcoming season.

Process – First consider what criteria is appropriate. Consider the basic qualifications (e.g. education, knowledge and experience) and critical job-relevant competencies (e.g. teamwork, accountability) that are critical for success, required on day one that employees will not be trained on. A good practice is to conduct a job analysis to learn what criteria is job relevant and legally defensible. After figuring out what criteria should be considered in the selection process, think about where each should be measured. Basic qualifications will likely fit into an application, while competencies are best measured in tests and interviews.

Volume – Once a process has been identified, you can begin thinking about how many candidates you'll need to meet your target hiring goals. Whether you're hiring one full time employee or a few seasonal employees, you can forecast how candidates will do on each stage of your selection process.

Timing – Now that you have your process and volume considerations worked out, you can begin thinking about how long it might take you to reach your hiring goals. Outline on a calendar when you will begin advertising and where, how long you will keep the application open, when you'll begin reviewing candidates, approximately when candidates may need to complete any testing, and when you'll need interviewers (and how many resources you'll need). How long will your interviews be? How many will you schedule a day? These are all things that might change a little down the road, but by planning ahead you'll save yourself many scheduling headaches and have a much smoother hiring experience for everyone.

Tip 2- Don't Forget About a Job Analysis!

For seasonal hires, make sure you review and identify the competencies/behaviors that are critical for success in the target role, just as you would for your direct hire/full-time staff. Keep in mind that although seasonal hires are temporary, it shouldn't stop you from hiring candidates that have all of the traits and behaviors that predict great performance in the target role as you would a full-time employee. After all, the seasonal hires will be performing the same or similar work and representing your county and department just the same!

Seasonal workers should meet your standards for success, too. You should not settle, just because they are seasonal. Your temporary staff may end up coming your full-time staff in the future if the opportunity arises, so ensure they have the same competencies/behaviors.

Tip 3- Start an Employee Referral Program

If your current staff is hardworking, dedicated, and provides a great repertoire with other county employees and people of the county – some of their friends and families may have these similar traits! Reach out to your staff and encourage them to refer family members and friends. Make sure to mention that they should also refer individuals that will work just as hard as them – remember their reputation is on the line and remind them of this.

Referrals are a great way to build your pipeline from a trusted source! Before the candidate walks in the door, you already have a recommendation of that person. However, after you do have a pipeline of referrals, you still want to have them go through your current recruitment process. It is a great start by having a current employee already recommend the individual but it is important to be consistent with your recruitment efforts.

Tip 4 – Streamline the Screening Process

Sorting through applications to determine what candidates meet your criteria for a seasonal position can be overwhelming; especially during a season when you just don't have time to spare. To make your screening process more efficient, you can move your application online, if your county will allow it. Online applications are easier to filter and search through than paper applications, and they take up a lot less space! Applicants without computer or internet access at home can also complete these applications at a public library, human resource office, or even onsite at your department.

To increase the utility of your online application, you may want to include “knockout” questions. These questions are designed to narrow the candidate pool so you can focus on candidates who meet your specific needs and are well suited for the work environment/tasks at hand.

Ensuring candidates meet these types of requirements at the start saves you from wasting time during a phone screen or interview. It also saves your organization from wasting costs on assessments and other selection steps, only to find out the person doesn't meet a basic requirement.

Tip 5 – Keep Your Selection Process Consistent

It may be tempting to skip certain steps in the selection process when you're hiring seasonal help in favor of a condensed hiring process. However, this may cause headaches down the road. First, consider that your goal is to hire quality individuals to perform an important function in your organization. It's likely the work duties and tasks are the same or very similar to those of your permanent employees. It makes sense then for seasonal workers to

have the same skills and qualifications as your permanent hires, which means you need to vet them through the same selection steps – from the application, to any assessments, and through structured interviews. It just doesn't make sense to hire someone without knowing if they can actually meet the needs you have, and importantly, if they'll work well your team.

Second, there may be a case where you'd like a seasonal or temporary worker to rollover to a permanent position if the opportunity is available. It's a lot easier to do this when they've already gone through your hiring process, and could just be a matter of filling out some additional paperwork. Frustration and inconsistency creep in when you have an "amazing temp" who fails a part of your process, whether that's a background check or a pre-hire assessment. We know from research that applicants have very different test motivations and response patterns, so existing employees don't always score as well on the same tests as applicants. Additionally, some seasonal workers are extremely motivated to do well on the job just to earn that permanent position; once they've got it, they loosen up a bit and their true colors shine through. These situations aren't helpful for anyone, and cause a lot more grief than necessary. It is recommended that you avoid these scenarios in the first place by vetting seasonal hires through your typical, standard, permanent hire process from the start.

Tip 6 – Training

Most people would agree that training is valuable in any job. Training seasonal employees is no exception, especially when dealing with chemicals, weeds and the spray equipment we use. Since these employees are often working full time during the spray season and often overtime, it's crucial that their training is both comprehensive and concise. You've taken the time to hire these employees, and the next step is to make sure that they have the resources they'll need to help your department during this busy season. If your seasonal employees are working in the field, it's especially important to remember that your local producers typically notice these employees out in the field and their performance and job they're doing. This is just another reason why proper training is a good idea.

Tip 7 – Orientation

Since your seasonal employees may only work with you for a short time over the summer months, it's best to offer an abbreviated orientation. Think efficiency. They obviously don't need to know all of the information that long term employees do, but organizing a short and customized orientation will make them feel like part of your team. If they have a good sense of your county's values, and policies, they're more likely to be engaged in their work – even if they're only working with you for a couple months. It's also important to remember that high potential performers may become long term employees, and you want to make sure that they have a good impression of your county/agency from the start.

Tip 8 – The Future

Your seasonal employees may never work for your organization again after the spray season is over, but that doesn't mean you won't come into contact with them again. It's

worthwhile keeping in mind that your seasonal worker is very likely to also be your future customer – and maybe even your current customer too. A seasonal employee's negative work experience could end up hurting you and your department and that negativity could rollover to their friends and families. Bad word-of-mouth travels far and fast. You should keep in mind that a seasonal worker has the ability to generate positive or negative press about your organization and to help make a positive impact on the noxious weed industry!

1.5 Personnel Policy

Personnel policies should be written for your county. Check with the County Commissioners and obtain a copy of the policy from the courthouse.

References:

1. Montana Department of Labor, Labor Safety Laws
2. County Personnel Handbook

1.6 Weed District Budgets

Under the Montana Noxious Weed Act, Section 7-22-2142; County commissioners may provide sufficient money in the noxious weed fund for the board to fulfill its duties, as specified in 7-22-2109, by: appropriating money from any source in an amount not less than \$100,000 or an amount equivalent to 1.6 mills levied upon the taxable value of all property, and subject to 15-10-420 and at any time fixed by law for levy and assessment of taxes, levying a tax of not less than 1.6 mill on the taxable value of taxable property in the county. The tax levied under this subsection must be identified on the assessment as the tax that will be used for noxious weed control.

The proceeds of the noxious weed control tax or other contribution must be used solely for the purpose of managing noxious weeds in the county and must be deposited in the noxious weed fund.

Any proceeds from work or chemical sales must revert to the noxious weed fund and must be available for reuse within that fiscal year or any subsequent year.

The commissioners may accept any private, state, or federal gifts, grants, contracts, or other funds to aid in the management of noxious weed within the district. These funds must be placed in the noxious weed fund.

Subject to 15-10-420, the commissioners may impose a tax for weed control within a special management zone as provided in 7-22-2121(4). For the purposes of imposing the tax, the special management zone boundaries must be established by the board and approved by a majority of the voters within the special management zone. Pursuant to an election held in accordance with 15-10-425, the amount of the tax must be approved by a majority of the voters within the special management zone, and approval of the zone and the tax may occur simultaneously. Revenue received from a special management zone tax must be spent on weed management projects within the boundaries of the special management zone.

1.6.1 Four factors determine your Weed District Budget

1. **Mill Levy:** The first item in order is to establish the taxable valuation of your county. This is determined by the Montana Department of Revenue prior to July 1 of each year. These figures can be obtained in your county courthouse. After obtaining the taxable valuation, divide this figure by 1000 or move your decimal point over three places to the left. You will then have what a Mill is worth for budgeting purposes.
2. **Non-Tax Revenue:** Non-tax Revenue is money taken in by a county that is not Real, Personal, Mobile Homes or Net Proceeds (oil or gas) dollars. Some examples of these dollars are; motorcycles, ATV's, penalties and interest on delinquent taxes, 0.05% tax on motor vehicles (option for counties), new interim production (pipelines), and some permit charges.

1.6.2| SECTION 1 WEED DISTRICT ORGANIZATION

3. **Cash on Hand and Tax Money on Hand:** Cash on Hand is money created by the Weed District over the previous budget year – dollars deposited for custom work, sale of chemical, sprayer rentals, inspection fees, sale of used equipment or weed identification, books etc. Weed Districts should keep a deposit receipt book of dollars received.
4. **Cash Money on Hand:** This is money you still have at the time of budgeting.
5. **Reserve:** A Weed District is authorized to carry, as cash reserve, up to one-third of the appropriation budget. The reserve allows you to operate from July to November each year until November taxes begin coming in.

1.6.2 An Example Budget

The Weed District in a County with a taxable valuation of \$24,907,000 would like to request a \$120,000 operating budget for that year. According to the Clerk and Recorder's Office, the non-tax revenue is \$53,580. Your receipts or cash on hand for the year is \$30,000 and taxes on hand (money at the time of budgeting) is \$31,000.

Step 1: Add non-tax revenue, cash on hand, and taxes on hand.

Non Tax Revenue	\$ 53,580
Cash on Hand	\$ 30,000
<u>Taxes on Hand</u>	<u>\$ 31,000</u>
TOTAL	\$114,580

Step 2: To determine the total amount needed, calculate the reserve amount and add it to your requested budget.

$\$120,000 \div 3 =$	\$ 40,000
<u>+</u>	<u>\$120,000</u>
NEED	\$160,000

{ \$160,000 minus \$114,580 = \$45,420 needed from a mill levy or general fund }

Step 3: Calculate the value of 1 Mill by dividing the taxable valuation of the County by 1,000, or moving the decimal place three digits to the left.

$$\$24,907,000 \div 1000 = \$24,907$$

If 1 Mill equals \$24,907, then 1.824 Mills would give us \$45,420. We will have to budget for \$45,420 from a Mill Levy.

$$\{ \$45,420 \div \$24,907 = 1.824 \text{ mills} \}$$

Step 4: Add the Mill Levy budget to the TOTAL to come up with an amount for the new budget year.

$$\$114,580 + \$45,420 = \$160,000$$

1.6.3 Budget Basics Outline

- 1) Weed District Enabling Legislation
 - a) Title 7, Chapter 22, Part 21
 - i) District created by law under Section 7-22-2102, MCA
 - ii) Board appointed by the County Commissioners under Section 7-22-2103, MCA
- 2) Weed Control Financing
 - a) Funding is provided for in Section 7-22-2142, MCA
 - i) Noxious Weed Fund authorized under Section 7-22-2141, MCA
 - (1) Fund #2140 in the BARS chart of accounts
 - ii) Section 7-22-2142 Source of funding
 - (1) Can be exceeded by vote of electorate
 - iii) Proceeds from contracted services and the sale of chemicals are to be deposited into this fund also and is to be available for reuse within the fiscal year received or any subsequent year.
 - b) Weed control grants from state
 - i) Department of Agriculture-no matching required (Section 80-7-814, MCA)
 - ii) Weed Grant Fund
 - (1) Fund #2840
 - (2) Separate fund is not necessary if the accounting system can account for grant separately within the Noxious Weed Fund
- 3) Basic Budgeting
 - a) Planned expenditures have to be financed by estimated revenues
 - i) Balanced budget
 - (1) If resources are not sufficient to fund planned expenditures, the plan has to be revised downward.
 - (2) If resources are more than enough to fund the planned expenditure, either the plan can be revised upward or the County Commissioners may reduce the levy
 - (a) Ultimate authority for setting the levy and adopting the budget vests with the County Commissioners.
 - ii) Expenditures are limited to the budget as finally adopted or revised by transfers and/or amendments. This is County budget law.
 - iii) Expenditures to be made by warrants drawn by the weed board and paid from the noxious weed fund.

1.7 Contracting Weed Management Activities

Always work closely with your County Attorney when developing contracts. Also, it is important to keep both parties involved from the beginning. Following is a sample contract for weed control or other management activities in your county.

1.7.1 SAMPLE: Contract for Weed Management

AGREEMENT FOR THE MANAGEMENT OF NOXIOUS WEEDS ON THE HIGHWAY RIGHT- OF- WAY

THIS AGREEMENT is made and entered into this _____ day of _____, _____, by and between _____ COUNTY WEED BOARD, hereinafter called the Board, and _____, hereinafter called the Applicator, for the purpose of controlling noxious weeds within the rights of way of the County-maintained roads and State secondary roads in _____ County.

I/We, _____, do hereby request permission to manage noxious weeds along the following described highway right-of-way during calendar year _____.

Highway Route No. _____, right side beginning _____ feet (past/before) milepost _____, and ending _____ feet (past/before) milepost _____. Left side beginning _____ feet (past/before) milepost _____, and ending _____ feet (past/before) milepost _____.

AGREEMENT

I. WHEREAS, the Board desires control of noxious weeds within the limits of their rights of way, the Applicator will base his/her performance upon, but not limited to, the following:

1. The Applicator, while performing herbicide application work under this contract shall adhere to the policies of the Board, and the spray crews shall be under the supervision of a licensed applicator at all times.
2. The Applicator agrees to submit a management plan to the Noxious Weed Management office for approval by the Weed Board outlining the management techniques to be used.
3. The Applicator must meet with the _____ County Weed Coordinator, hereinafter called the Supervisor, prior to the start of the application of herbicides with the County. The Supervisor shall determine the locations to which herbicides shall be applied.
4. The application of herbicides will be limited to noxious weeds only. Continuous spraying of the rights of way, or boom spraying, will not be permitted, except as agreed to by the Applicator and the Supervisor, hereinafter called the Supervisor, in accordance with the policy set by the Board.
5. Noxious weeds to be controlled: See County Weed List as stated in the County Noxious Weed Management Plan.
6. Herbicides will be prepared and applied according to the label on the container and in strict compliance with all State and Federal laws and regulations.
7. All emptied containers must be disposed of in a manner, which complies with current rules and regulations.
8. Only equipment in good condition, drip free, designed and calibrated for the application of herbicides shall be used.
9. The timing of herbicide application will be such that the maximum killing effect will be obtained.
10. No herbicides will be applied during any adverse weather conditions or when winds exceed twelve (12) miles per hour.
11. The maximum boom spraying pressure at which herbicides may be applied will be forty (40) psi.
12. The Applicator, by signing this agreement does hereby acknowledge receipt of and agrees to be bound under all terms and conditions of the "SPECIFICATIONS FOR ROADSIDE CHEMICAL SPRAYING CONTRACT" dated _____, with the exceptions of Paragraph 8. Said "SPECIFICATIONS" are incorporated by reference in the Agreement as if fully set forth herein. In regard to liability and contractor's responsibility, applicator has provided the Board with a certificate of insurance for liability insurance, which Board acknowledges as sufficient to cover Applicator's liability hereunder.
13. The applicator must comply with the provisions of all appropriate Federal and State laws including Title VI of the Federal Civil Rights Act of 1964, and agrees not to discriminate against any client, employee or applicant for employment or the services because of race, creed, color, national origin, sex or age.
14. The Applicator agrees to place a sign, along the right-of-way boundary, on each side of the highway at the beginning and end of the management area. The signs shall be at least 18 inches by 18 inches square with a bright yellow background and two- (2) diagonal one inch red lines extending from corner to corner to form an "X".

15. The Applicator agrees to furnish all tools, labor, equipment, chemicals, and supplies which are necessary to effectively complete the work in a workmanlike manner.
16. If equipment other than hand tools is used to manage the noxious weeds the Applicator agrees to the following:
 - a. Display two (2) amber flashers, one on each side of the equipment, and display a "Slow Moving Vehicle" emblem, as required by Montana statutes.
 - b. Obtain liability insurance with a minimum limit of liability of \$_____/ single occurrence and attach a copy of the certificate of insurance to this agreement.
 - c. Liability Insurance Company _____
 - d. Policy No._____, Amount _____
 - e. Flag person, pilot car, or both with appropriate warning signs, shall be employed if equipment is to be operated on or across the main traveled portion of the highway.
 - f. On controlled access highways, access to the work site will be permitted only at existing points of ingress of egress. Cutting fences will not be permitted.
 - g. On controlled access highways, weed management operations shall be completed on one side before crossing over and managing the weeds on the other side.
 - h. When idle, all equipment shall be parked off the right-of-way if possible. If not possible, it must be parked at least 30 feet from the edge of the pavement. All vehicles and equipment, operating in the course of this work, shall comply with 61-10-102, M.C.A. The department may require additional safety regulations for special safety problems.

II. The parties hereto expressly agree and understand the Applicator is not an employee or agent of the Montana Department of Transportation of the _____ County Noxious Weed Management District in any sense, but is solely an independent contractor.

III. Applicator agrees to indemnify and hold harmless _____ County and the County Noxious Weed Management District and Montana Department of Transportation from any and all liability that may be incurred due to the Applicator's actions under this contract.

IV. For and in consideration of the services herein described, the Board agrees to pay the Applicator upon completion if the work, in accordance with Paragraph V and Paragraph VI outlined below.

V. The Applicator shall be compensated at the rate of \$_____per hour per spraying unit for services provided in conformance with this agreement.

VI. It is mutually agreed and understood by the parties hereto that the Applicator shall perform the above services to the satisfaction of the Supervisor.

VII. If the Weed Board finds that the Applicator has failed to adhere to the agreement, the Board shall issue an order informing the Applicator that the agreement will be void and the

responsibility for the management of noxious weeds on the right-of-way will revert to the Board unless the Applicator complies with the management plan within a specified time period. (7-22-2153, M.C.A.)

VIII. The Applicator must contact and obtain the approval and signature of the Maintenance Chief of the Department of Transportation before the County Noxious Weed Management Board Chairman will approve this permit.

_____ Applicator	_____ [_____] County Weed Board
_____ Address	_____ Dept. of Transportation, Maintenance Chief
_____ Date	_____ Weed Board Chairman
_____ Telephone No.	_____ Date

1.8 Weed Program Coordination

Remember—an important part of the Coordinator’s job is to coordinate weed management activities in the county. This includes forging good working relationships between all private, state, and federal land managers within a proposed project area.

SECTION 2 Noxious Weed Laws & Rules

COUNTY NOXIOUS WEED CONTROL ACT AND

RULES MONTANA PESTICIDE ACT AND

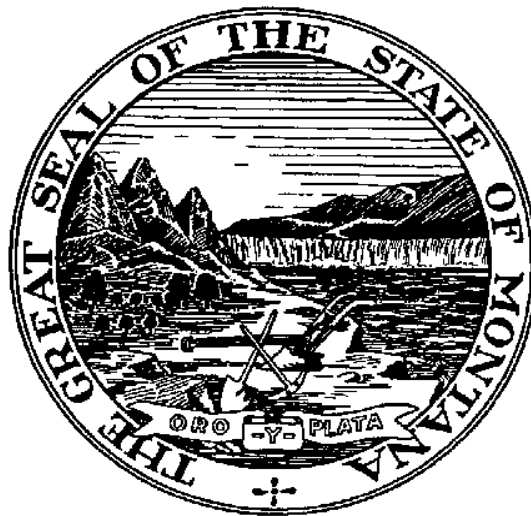
RULES EXAMPLES OF ENFORCEMENT

PROCEDURES

This section includes administrative documents describing County Noxious Weed Control Act and Rules, and Montana Pesticide Act and Rules. Examples of enforcement procedures (notice of non-compliance letters) are also provided. Updated material should be obtained annually from the County or Montana Department of Agriculture.

2.1 Montana County Noxious Weed Control Act and Rules

MONTANA COUNTY WEED CONTROL ACT AND ADMINISTRATIVE RULES



**STATE OF MONTANA
DEPARTMENT OF AGRICULTURE
PO BOX 200201
HELENA, MONTANA 59620-0201
(406) 444-5400
www.agr.mt.gov**

**MONTANA DEPARTMENT OF AGRICULTURE
AGRICULTURAL SCIENCES DIVISION
HELENA, MONTANA**

**COUNTY WEED CONTROL ACT
COUNTY BOARDS
NOXIOUS WEED DESIGNATION
MONTANA PESTICIDE ACT & ARM RULES**

**DR. MARK NECHODOM
ADMINISTRATOR**

**BEN THOMAS
DIRECTOR**

Disclaimer

This document contains a copy of the statutes relating to the subject matter. Although every attempt is made to ensure that the information placed in this document is accurate and timely, the Department of Agriculture cannot assure the accuracy of any specific provision, and you are urged to consult the official printed versions of these publications or to contact legal counsel of your choice. All critical information should be independently verified.

The Montana Code and Constitution is at: http://leg.state.mt.us/css/mtcode_const/default.asp.

CHAPTER 22
WEED AND PEST CONTROL

MCA	CONTENTS
7-22-2101	<u>DEFINITIONS</u>
7-22-2102	<u>WEED MANAGEMENT DISTRICTS ESTABLISHED</u>
7-22-2103	<u>DISTRICT WEED BOARD- APPOINTMENT- COMMISSIONER POWERS</u>
7-22-2104	REPEALED
7-22-2105	REPEALED
7-22-2106	RENUMBERED
7-22-2107	RENUMBERED
7-22-2108	RENUMBERED
7-22-2109	<u>POWERS AND DUTIES OF BOARD</u>
7-22-2110	REPEALED
7-22-2111	<u>LIABILITY RESTRICTIONS</u>
7-22-2112	<u>INFORMATION ON HERBICIDE USE</u>
7-22-2113	<u>MINUTES</u>
7-22-2114	RESERVED
7-22-2115	<u>NOXIOUS WEEDS AND SEEDS DECLARED NUISANCE</u>
7-22-2116	<u>UNLAWFUL TO PERMIT NOXIOUS WEEDS TO PROPAGATE- NOTICE REQUIRED IN SALE</u>
7-22-2117	<u>VIOLATIONS</u>
7-22-2118 through 2119	RESERVED

7-22-2120	<u>FUNDING- REPORTING REQUIREMENTS- EMERGENCY EXEMPTION</u>
7-22-2121	<u>WEED MANAGEMENT PROGRAM</u>
7-22-2122	REPEALED
7-22-2123	REPEALED
7-22-2124	REPEALED
7-22-2125	REPEALED
7-22-2126	<u>EMBARGO</u>
7-22-2127	REPEALED
7-22-2128 through 2129	RESERVED
7-22-2130	<u>WEED DISTRICT COORDINATOR TRAINING</u>
7-22-2131	<u>NONCOMPLIANCE WITH WEED CONTROL REQUIREMENTS- GENERAL NOTICE</u>
7-22-2132	<u>PROCEDURES FOR COMPLIANCE</u>
7-22-2133	<u>NONCOMPLIANCE- ACTIONS FOR LANDOWNERS</u>
7-22-2134	<u>NONCOMPLIANCE- ACTIONS BY BOARD</u>
7-22-2135 through 2140	RESERVED
7-22-2141	<u>NOXIOUS WEED FUND</u>
7-22-2142	<u>SOURCES OF MONEY FOR NOXIOUS WEED FUND</u>
7-22-2143	<u>DETERMINATION OF COST OF WEED CONTROL PROGRAM</u>
7-22-2144	<u>PAYMENT OF COST OF WEED CONTROL PROGRAM</u>

7-22-2145	<u>EXPENDITURES FROM NOXIOUS WEED FUND</u>
7-22-2146	<u>FINANCIAL ASSISTANCE TO PERSONS RESPONSIBLE FOR WEED CONTROL</u>
7-22-2147	REPEALED
7-22-2148	<u>PAYMENT OF WEED CONTROL EXPENSES- TAX LIABILITY</u>
7-22-2149	REPEALED
7-22-2150	<u>COOPERATION WITH STATE AND FEDERAL-AID PROGRAMS</u>
7-22-2151	<u>COOPERATIVE AGREEMENTS</u>
7-22-2152	<u>REVEGETATION OF RIGHTS-OF-WAY AND AREAS THAT HAVE POTENTIAL FOR NOXIOUS WEED INFESTATION</u>
7-22-2153	<u>AGREEMENTS FOR CONTROL OF NOXIOUS WEEDS ALONG ROADS- LIABILITY OF LANDOWNER WHO OBJECTS TO WEED DISTRICT CONTROL MEASURES- PENALTIES</u>
7-22-2154	<u>PUBLIC PURCHASE OR RECEIPT OF PROPERTY- WEED MANAGEMENT PLAN</u>

PART 2
BOARDS

7-1-201	<u>BOARDS</u>
7-1-202	<u>CREATION OF NEW BOARDS</u>
7-1-203	<u>COUNTY COMMISSIONERS TO ASSUME DUTIES OF ADMINISTRATIVE BOARDS, DISTRICTS, AND COMMISSIONS</u>
7-1-204	<u>BOARD MINUTES</u>

SUB-CHAPTER 2
DESIGNATION OF NOXIOUS WEEDS

ARM	CONTENT
4.5.201	<u>DESIGNATION OF NOXIOUS WEEDS</u>
4.5.202	CATEGORY 1
4.5.203	CATEGORY 2
4.5.204	CATEGORY 3
4.5.205	CATEGORY 4- WATCH LIST
4.5.206	<u>PRIORITY 1A</u>
4.5.207	<u>PRIORITY 1B</u>
4.5.208	<u>PRIORITY 2A</u>
4.5.209	<u>PRIORITY 2B</u>
4.5.210	<u>PRIORITY 3 REGULATED PLANTS (NOT MONTANA LISTED NOXIOUS WEEDS)</u>

2.1 Montana Pesticide Act and Rules

TITLE 80, CHAPTER 8
MONTANA PESTICIDE ACT

PART 1 - GENERAL ADMINISTRATION

MCA	CONTENTS
80-8-101	<u>SHORT TITLE</u>
80-8-102	<u>DEFINITIONS</u>
80-8-103	<u>PURPOSE</u>
80-8-104	<u>ADMINISTRATION</u>
80-8-105	<u>RULES</u>
80-8-106	<u>ADMINISTRATIVE PROCEDURES</u>
80-8-107	<u>NOTICE - PUBLIC INFORMATION</u>
80-8-108	<u>ADVISORY COUNCIL</u>
80-8-109	<u>EDUCATIONAL PROGRAMS</u>
80-8-110	<u>COOPERATION WITH OTHER AGENCIES</u>
80-8-111	<u>WASTE PESTICIDE AND PESTICIDE CONTAINER COLLECTION, DISPOSAL, AND RECYCLING PROGRAM</u>
80-8-112	<u>DEPOSIT OF WASTE PESTICIDE AND PESTICIDE CONTAINER COLLECTION, DISPOSAL, AND RECYCLING FEES</u>
80-8-113	THROUGH 80-8-115 RESERVED
80-8-116	<u>PESTICIDE MANAGEMENT ACCOUNT - DEPOSIT OF FEES AND PENALTIES - INVESTMENT</u>
80-8-117	<u>PESTICIDE CLEAN-UP SPECIAL REVENUE ACCOUNT</u>
80-8-118	THROUGH 8-8-119 RESERVED
80-8-120	<u>LOCAL PESTICIDE REGULATION</u>
80-8-121	<u>PENALTY</u>

PART 2
REGISTRATION AND LICENSING

80-8-201	<u>REGISTRATION</u>
80-8-202	<u>PROHIBITED ACTS</u>
80-8-203	<u>COMMERCIAL APPLICATOR</u>
80-8-204	<u>APPLICATION OF APPLICATOR'S LICENSE</u>
80-8-205	<u>COMMERCIAL OPERATOR</u>
80-8-206	<u>APPLICATOR'S AND OPERATOR'S EXAMINATION</u>
80-8-207	<u>DEALERS</u>
80-8-208	<u>DEALER'S EXAMINATION</u>
80-8-209	<u>FARM APPLICATORS</u>
80-8-210	<u>LICENSING NONRESIDENTS</u>
80-8-211	<u>REVOCATION OF LICENSES AND PERMITS</u>
80-8-212	<u>RETAIL SALE OF PESTICIDES - EDUCATION PROGRAM</u>

MCA CONTENTS

80-8-213 [GOVERNMENT AGENCIES](#)
80-8-214 [LIABILITY](#)

[PART 3](#)
[ENFORCEMENT AND PENALTIES](#)

80-8-301 [REPORT OF LOSS OR DAMAGE - EFFECT OF](#)
 [FAILURE TO REPORT](#)
80-8-302 [SAMPLING AND ANALYSIS](#)
80-8-303 [EMBARGO](#)
80-8-304 [INVESTIGATION AND ENFORCEMENT AUTHORITY](#)
80-8-305 [GENERAL VIOLATIONS - COMPLIANCE ORDERS](#)
80-8-306 [PENALTIES](#)

[PART 4](#)
[MODEL SCHOOL INTEGRATED PEST AND PESTICIDE MANAGEMENT SAFETY](#)
[PROGRAM](#)

80-8-401 [SHORT TITLE](#)
80-8-402 [STATEMENT OF POLICY](#)
80-8-403 [DEFINITIONS](#)
80-8-404 [MODEL SCHOOL INTEGRATED PEST AND PESTICIDE](#)
 [MANAGEMENT SAFETY PROGRAM](#)
80-8-405 [POLICYMAKING AUTHORITY](#)

MONTANA DEPARTMENT OF AGRICULTURE
AGRICULTURAL SCIENCES DIVISION

CHAPTER 10

SUB-CHAPTER 1
LIABILITY RULES

ARM CONTENTS

4.10.101	<u>FINANCIAL RESPONSIBILITIES</u>
4.10.102	<u>TYPES AND CONDITIONS OF FINANCIAL RESPONSIBILITY</u>
4.10.103	<u>APPROVAL, MODIFICATION, AND CANCELLATION OF FINANCIAL RESPONSIBILITY ELEMENTS</u>
4.10.104	<u>JUDGEMENT OF DAMAGES AND/OR INJURY</u>
4.10.105	<u>INCIDENT REPORTS AND RECORDS</u>
4.10.106	<u>REVOCAION OF LICENSE</u>
4.10.107	<u>PERSONAL LIABILITY FOR DAMAGES</u>
4.10.108	<u>LICENSING PERIOD</u>

SUB-CHAPTER 2
PESTICIDE APPLICATOR AND OPERATOR RULES

4.10.201	<u>PESTICIDE APPLICATOR LICENSING REQUIREMENTS</u>
4.10.202	<u>CLASSIFICATION OF PESTICIDE APPLICATORS</u>
4.10.203	<u>COMPETENCY STANDARDS FOR LICENSING AND CERTIFICATION - LICENSING OF PESTICIDE APPLICATORS</u>
4.10.204	<u>GENERAL STANDARDS OF COMPETENCY FOR ALL APPLICATORS</u>
4.10.205	<u>SPECIFIC STANDARDS OF COMPETENCY FOR EACH APPLICATOR CLASSIFICATION</u>
4.10.206	<u>INDIVIDUALS REQUIRING A PESTICIDE OPERATOR'S LICENSE</u>
4.10.207	<u>RECORDS</u>
4.10.208	<u>INCONSISTENT USE</u>
4.10.209	<u>NOTIFICATION BY LICENSED OR CERTIFIED LICENSED APPLICATORS</u>
4.10.210	<u>PESTICIDE CERTIFICATION AND TRAINING FEES</u>

SUB-CHAPTER 3
AQUATIC HERBICIDE RULES

ARM	CONTENTS
4.10.301	SALE OR USE OF AQUATIC HERBICIDES PROHIBITED- EXCEPTION (REPEALED)
4.10.302	SALE OF AQUATIC HERBICIDES (REPEALED)
4.10.303	USE OF AQUATIC HERBICIDES (REPEALED)
4.10.304	APPLICATION FOR PERMIT (REPEALED)
4.10.305	APPLICATOR RECORDS (REPEALED)
4.10.306	APPLICATOR INCIDENT REPORT (REPEALED)
4.10.307	AQUATIC PESTICIDE TRAINING CREDENTIAL (REPEALED)
4.10.308	PERSONAL LIABILITY FOR DAMAGES (REPEALED)
4.10.309	VIOLATIONS (REPEALED)
4.10.310	EXPIRATION DATE OF RULES (REPEALED)
4.10.311	<u>DESIGNATION OF RESTRICTED-USE AQUATIC HERBICIDES</u>
4.10.312	<u>SALE OF RESTRICTED-USE AQUATIC HERBICIDES.</u>
4.10.313	<u>USE OF RESTRICTED-USE AQUATIC HERBICIDES</u>
4.10.314	<u>APPLICATION OF RESTRICTED-USE AQUATIC HERBICIDES</u>
4.10.315	<u>APPLICATOR RECORDS</u>
4.10.316	<u>APPLICATOR INCIDENT REPORT</u>
4.10.317	<u>PERSONAL LIABILITY FOR DAMAGES</u>
4.10.318	VIOLATION (REPEALED)

SUB-CHAPTER 4
CERTIFICATION OF FARM APPLICATOR RULES

4.10.401	<u>FARM APPLICATOR CERTIFICATION</u>
4.10.402	EMERGENCY PEST PROBLEMS (REPEALED)
4.10.403	<u>CREDENTIALS</u>
4.10.404	<u>IMPROPER PURCHASE OR USE</u>

SUB-CHAPTER 5
PESTICIDE DEALER AND RETAILER RULES

4.10.501	<u>APPLICATION FOR LICENSE</u>
4.10.502	<u>RETAIL SALE OF PESTICIDES</u>
4.10.503	<u>PESTICIDE DEALERS REQUIREMENTS AND STANDARDS</u>
4.10.504	<u>RECORDS</u>
4.10.505	VIOLATIONS (REPEALED)

SUB-CHAPTER 6
RULES FOR ISSUANCE, REVOCATION, OR DENIAL OF
PESTICIDE LICENSES AND PERMITS

ARM	CONTENTS
4.10.601	RULES OF PRACTICE (REPEALED)
4.10.602	GRANTING, RENEWING, AND DENYING LICENSES, CERTIFICATES AND PERMITS (REPEALED)
4.10.603	REVOCATION OF LICENSES AND PERMITS (REPEALED)
4.10.604	PERMANENT INJUNCTION OR REVOCATION (REPEALED)

SUB-CHAPTER 7
RESTRICTION OF PESTICIDE RULES

4.10.701	<u>GENERAL</u>
4.10.702	<u>REGISTRATION REQUIREMENTS</u>
4.10.703	CLASSIFICATION OF PESTICIDES (REPEALED)
4.10.704	CHANGE IN CLASSIFICATION FROM GENERAL TO RESTRICTED USE (REPEALED)
4.10.705	WARNINGS AND PRECAUTIONARY STATEMENTS (REPEALED)
4.10.706	CONTENTS OF LABEL DIRECTIONS FOR USE (REPEALED)
4.10.707	STATEMENT OF USE CLASSIFICATION (REPEALED)
4.10.708	VIOLATIONS (REPEALED)
4.10.709	<u>USE OF PESTICIDES ON PEST INFESTATIONS IN ALFALFA SEED CROPS</u>
4.10.710	<u>ANNUAL PESTICIDE REGISTRATION FEE/ SPECIAL NEEDS FEE</u>

SUB-CHAPTER 8
RINSING AND DISPOSING OF PESTICIDE CONTAINERS

4.10.801	<u>DEFINITION OF TERMS</u>
4.10.802	<u>RINSING AND DISPOSAL REQUIREMENTS</u>
4.10.803	<u>RINSING EMPTY PESTICIDE CONTAINERS</u>
4.10.804	<u>USE OF RINSATES.</u>
4.10.805	<u>DISPOSAL AND RECYCLING OF METAL, GLASS OR PLASTIC PESTICIDE CONTAINERS.</u>
4.10.806	<u>DISPOSAL OF OTHER TYPES OF EMPTY PESTICIDE CONTAINERS</u>
4.10.807	<u>BURNING OR INCINERATION OF PESTICIDE CONTAINERS</u>
4.10.808	<u>HANDLING PESTICIDE CONTAINERS BEING RINSED, RECYCLED, RECONDITIONED, DISPOSED OR REFILLED</u>

SUB-CHAPTER 9
ENDRIN

ARM	CONTENTS
4.10.901	SALE AND USE OF ENDRIN FOR PALE WESTERN AND ARMY CUTWORM CONTROL (REPEALED)
4.10.902	VIOLATION (REPEALED)
4.10.903	ENDRIN (REPEALED)

SUB-CHAPTER 10
CIVIL PENALTIES

ARM	CONTENTS
4.10.1001	<u>DEFINITIONS</u>
4.10.1002	<u>ENFORCEMENT</u>
4.10.1003	<u>ABILITY TO STAY IN BUSINESS</u>
4.10.1004	<u>OTHER PENALTIES</u>
4.10.1005	<u>PENALTY DETERMINATION</u>
4.10.1006	<u>GRAVITY OF VIOLATIONS</u>
4.10.1007	<u>DEGREE OF CARE - MISUSE</u>
4.10.1008	<u>DEGREE OF CARE - VIOLATIONS OTHER THAN MISUSE</u>
4.10.1009	<u>NONCOMPLIANCE WITH PESTICIDE WORKER PROTECTION STANDARDS AND LABELING</u>
4.10.1010	<u>NONCOMPLIANCE WITH PESTICIDE GROUND WATER AND ENVIRONMENTAL PROTECTION AGENCY ENDANGERED SPECIES STANDARDS AND LABELING</u>
4.10.1011	<u>NONCOMPLIANCE WITH PESTICIDE CONTAINER DISPOSAL LABELING OR HANDLING REQUIREMENTS AND STANDARDS</u>
4.10.1012	<u>REMEDIAL ACTION IN LIEU OF CIVIL PENALTIES</u>

SUB-CHAPTER 11
PESTICIDE REPORTING, CLEANUP AND CONTAINMENT

4.10.1101	<u>DEFINITION OF TERMS</u>
4.10.1102	<u>GENERAL SPILL CLEANUP, REPORTING AND CONTAINMENT REQUIREMENTS</u>
4.10.1103	<u>GENERAL REQUIREMENTS AT PERMANENT STORAGE FACILITIES</u>
4.10.1104	<u>PRIMARY CONTAINMENT STANDARDS FOR BULK PESTICIDES</u>

ARM	CONTENTS
------------	-----------------

- | | |
|-----------|---|
| 4.10.1105 | <u>SECONDARY CONTAINMENT AT PERMANENT STORAGE FACILITIES</u> |
| 4.10.1106 | <u>OPERATIONAL ACTIVITIES FOR BULK PESTICIDES AT A PSF</u> |
| 4.10.1107 | RECOVERY, USE OR DISPOSAL OF SPILLS, DEBRIS, PRECIPITATION AND WASH WATER AT A PERMANENT STORAGE FACILITY |
| 4.10.1108 | <u>SPILL RESPONSE PLAN</u> |
| 4.10.1109 | <u>RECORDS, INSPECTION AND MAINTENANCE RECOMMENDATIONS</u> |

SUB-CHAPTER 12
1080 LIVESTOCK PROTECTION COLLARS

- | | |
|-----------|---|
| 4.10.1201 | <u>GENERAL</u> |
| 4.10.1202 | <u>REGISTRATION</u> |
| 4.10.1203 | <u>DEALER SALES</u> |
| 4.10.1204 | <u>APPLICATOR CLASSIFICATIONS AND REQUIREMENTS</u> |
| 4.10.1205 | USE RESTRICTIONS OF COMPOUND 1080 LIVESTOCK PROTECTION COLLARS (REPEALED) |
| 4.10.1206 | SUPERVISION, INSPECTION OF 1080 LIVESTOCK PROTECTION COLLARS (REPEALED) |
| 4.10.1207 | RECORDS (REPEALED) |
| 4.10.1208 | VIOLATIONS (REPEALED) |

SUB-CHAPTER 13
RESERVED

SUB-CHAPTER 14
RULES OF REGISTRATION AND USE OF M-44 SODIUM CYANIDE CAPSULES AND M-44 DEVICES

- | | |
|-----------|--|
| 4.10.1401 | <u>GENERAL</u> |
| 4.10.1402 | <u>REGISTRATION</u> |
| 4.10.1403 | <u>DEALER SALES</u> |
| 4.10.1404 | APPLICATOR CLASSIFICATIONS AND REQUIREMENTS |
| 4.10.1405 | USE OF CYANIDE CAPSULES AND M-44 EJECTOR (REPEALED) |
| 4.10.1406 | SUPERVISION, INSPECTION, AND REMOVAL OF CYANIDE CAPSULES AND M-44 DEVICES (REPEALED) |
| 4.10.1407 | RECORDS (REPEALED) |
| 4.10.1408 | VIOLATIONS (REPEALED) |

SUB-CHAPTER 15
PESTICIDE TERMINOLOGY RULE

ARM	CONTENTS
------------	-----------------

4.10.1501	<u>DEFINITION OF TERMS</u>
-----------	--

SUB-CHAPTER 16
RESERVED

SUB-CHAPTER 17
RODENTICIDE SURCHARGE AND GRANTS

4.10.1701	DEFINITIONS (REPEALED)
4.10.1702	DEALER RECORDS AND SURCHARGE ASSESSMENT (REPEALED)
4.10.1703	GRANT APPLICATION PROCEDURE (REPEALED)
4.10.1704	GRANT APPLICATION CONTENT AND FEASIBILITY (REPEALED)
4.10.1705	LEGAL REQUIREMENTS (REPEALED)
4.10.1706	PROJECT EVALUATION (REPEALED)
4.10.1707	REPORTING AND MONITORING PROCEDURES (REPEALED)
4.10.1708	APPLICABILITY DATE (REPEALED)

CHAPTER 18
PESTICIDE DISPOSAL PROGRAM

4.10.1801	<u>GENERAL</u>
4.10.1802	<u>DEFINITIONS</u>
4.10.1803	<u>STANDARDS FOR DISPOSAL PROGRAM OPERATION</u>
4.10.1804	<u>DISPOSAL PROGRAM OPERATION</u>
4.10.1805	<u>DISPOSAL PROGRAM COLLECTION PRIORITIES</u>
4.10.1806	<u>FEES</u>
4.10.1807	<u>LIABILITY</u>
4.10.1808	TERMINATION OF RULES (REPEALED)

2.3 Enforcement Procedures

2.3.1 SAMPLE: Voluntary Compliance Request – 1st Notice

NAME: _____ DATE: _____

Our weed problem in Montana is increasing at an alarming rate. Noxious weeds consume approximately 19% of the Montana lands each year at an annual cost of over 20 million dollars to the landowners. Noxious weeds are expensive when allowed to grow.

The Montana Legislature recognized the extent of the problem and passed legislation to assist in the weed management effort. The [_____] County Weed District supports the legislation and are in hopes you, as a landowner, will do the same.

A complaint has been filed with the [_____] County Weed District, alleging that noxious weeds are growing on property belonging to you.

Weed Species Present: _____

Location of Complaint: _____

Legal Description: _____ 1/4 _____ 1/4 _____ 1/4 , Sec _____ T _____ R _____

Your Options:

1. Control the noxious weeds on your property by a recommended or feasible means within ten (10) days of this notice and notify the Weed District of date and means noxious weeds were managed. (or)
2. Develop a five- (5) year noxious weed management plan for your property. The Weed District or Extension Service staff will be glad to help design a workable plan to manage your noxious weeds.

Action after ten (10) days – Due to our strong dedication to manage noxious weeds, further action will be taken if we do not hear from you within ten (10) days. Action will consist of a “certified letter” of non-compliance that will state that you **MUST** submit a noxious weed management plan within ten (10) days. Failure to comply with the notice is a misdemeanor (7-22-2216 MCA). You could be prosecuted or the district has the authority to take corrective action at your expense.

Thank you for your cooperation.

Sincerely, [_____] County Weed District

2.3.2 SAMPLE: Notice of Compliance

NAME: _____ DATE: _____

ADDRESS: _____

CITY: _____ STATE: _____ ZIP: _____

We are sending you this certified notice on no-compliance pursuant to the County Noxious Weed Control Act, Title 7, Chapter 22, Sections 7-22-2101 through 7-22-2153, MCA, because you have not responded to the initial complaint dated _____. The Weed Board has reason to believe that there are noxious weeds being allowed to grow on your property.

Weed Species Present: _____

Location: _____

Legal Description: $\frac{1}{4}$ _____ $\frac{1}{4}$ _____ $\frac{1}{4}$, Sec. _____ T: _____ R: _____

The [_____] County Weed District directs you to control your noxious weed problem. You will be in compliance by submitting a 5-year Noxious Weed Management Plan that must be approved by the [_____] County Weed Board and then you must follow this plan. The above action must be taken within 10 days. Failure to comply with this notice is a misdemeanor, which can result in fines. Control measures may be done at the landowner's expense and the landowner may be required to file a Weed Management Plan.

You have the right to request an administrative hearing within these same 10 days. (7-22-2110-MCA)

Enclosed you will find a Weed Management Plan for your use. For more information or if you have any questions, please call us at _____.

Sincerely,

[_____] County Weed District

SECTION 3 Public Relations (PR)

PR PLANNING AND ORGANIZATION

DISPENSING INFORMATION

GENERAL MEDIA TIPS

THE DO'S AND DON'TS OF PUBLIC RELATIONS

MEETING GUIDELINES

Public education and support of weed management issues is a critical part of implementing successful weed management programs. Developing good public relation skills will help weed coordinators communicate with the public in an effective and positive way. This section provides guidelines for dealing with a variety of confrontational and negotiation situations in which good PR skills are important. Guidelines for planning, preparing and presenting information to the media and the public are also provided.

How to Keep People Happy and Still Manage Weeds

Part of the payoff of developing and implementing a weed management program is a feeling of confidence and pride in what you're doing. That others also perceive you as a professional carrying out a worthy and effective program is important to its success. To accomplish this, you must be skilled at promoting and communicating information about your weed management activities to the public. Good public relations result from integration of planning and organization, making and maintaining contacts, using the media, and practicing good social, written and verbal presentation skills. The following is an outline to aid you in your public relations efforts.

3.1 PR Planning and Organization

Elements of a public relations plan include specific goals, strategies for meeting those goals, target audiences, target news media, and a timeline. **The Montana Weed Control Association has set statewide goals for public education about noxious weeds. Be sure to coordinate your county efforts with the state program as well as the Montana Noxious Weed Education Campaign.**

As the old saying goes, "If you don't know where you're going, any road will do." The same is true for the PR plan. If you don't have a plan, then each time someone comes up with a PR idea, you won't be able to assess whether or not it might help you achieve your goals, or just sidetrack you for a while. Without a good plan, PR becomes reactive, rather than pro-active. Know what you want to achieve through your public relations efforts, and then set out to achieve it by implementing a strategic public relations or communications program.

1. Define the objectives of the public relations program

A good tool to define objectives is a brainstorming session. A brainstorming session will lead to the development of public relations objectives on which everyone agrees. Draft the purpose of public relations function in writing.

2. Define the target audience(s)

Who do you wish to reach with your message? Since publicity will likely be your highest priority, and because the news media will enable you to reach the most people, it's important to have an up-to-date target media list. Identify where you would like to see stories about your program.

3. Define the message(s)

What is your message? What do you want to get across to any one of the

audiences? What messages do you want your target audiences to hear? Identify one or two key messages that you will incorporate in your public relations activities (e.g. news releases, interviews, brochures, newsletters, etc.)

4. Develop the strategy(ies)

The strategies are a key element of your plan. The strategies are used to reach your target audiences and convey your messages, as well as forming the basis of your public relations plan. An abbreviated list of strategies might include:

- Continually develop public relations materials.
- Use a broad spectrum of media to convey the message.
- Build and develop media contacts.

5. Set goals

What do you want to accomplish? These goals need to be clear, measurable objectives for the year(s) ahead. In order to determine your program's PR goals, you should meet with key decision-makers in your weed district. Interview them about their views regarding PR efforts in the past, and what they would like to accomplish this year. A good question to ask: If PR could accomplish only ONE thing this year, what would you like it to be?

Ideas may include:

- Effectively promote programs and services.
- Increase support for weed programs.
- Increase interest in weed district programs and activities.
- Enhance or improve the image of the Weed District.
- Change our image from_____to_____.
- Increase financial support.
- Increase attendance at meetings or special events (professional development).
- Increase publication distribution.

6. Prepare a written plan and timetable

Have a written plan complete with deadline dates. The best plans are yearly but implement what is most effective given your constraints. You don't want to find yourself buried under a mountain of PR activities one month, and nothing to do the next. Develop a realistic month- by-month PR timeline charting all the activities contained in the plan. Activity schedules may be the most important tool for effective public relations, as timing is the key to good communications, and the key to correct timing is a schedule.

3.1.1 SAMPLE: Weed Manager's Public Relations Activity Schedule

JANUARY

- Crop Protection Clinic exhibit
- Make contacts with public and private land managers
- Programs to schools and civic organizations on weeds

FEBRUARY

- Private applicator training—comments and exhibit
- Make contacts with local media
- Programs to schools and civic organizations on weeds

MARCH

- Letters to Adopt-A-Road (weed control on rights-of-way) sponsors
- Pesticide license recertification programs
- Spring inspections news release
- Distribute weed education posters

APRIL

- Importance of follow-up in effective weed management programs (news release)
- Managing pastures news release
- Mailing insert - weed district newsletter

MAY

- Spring general notice about weed issues
- Spring hoary cress (white top) management news release
- Hay inspection news release
- Seeding areas news release
- Public land managers weed management efforts news release
- Roadside weed control efforts news release

JUNE

- New invading weed species news release
- Leafy spurge news release

JULY

- Weed tours to IWM plots
- Spotted knapweed management (news release)
- Inspection service for noxious weed free hay and mulch certification news release

AUGUST

- County fair - exhibit
- Tours of weed demonstration areas

SEPTEMBER

- Report on spring-summer program news release
- Fall inspections news release

OCTOBER

- News release on weed spread it relates to hunting activities
- Fall leafy spurge control news release

NOVEMBER

- Hunter awareness of noxious weed issues
- Public education programs about weeds to civic organizations.

DECEMBER

- Program accomplishments news release
- Mailings to Vo Ag instructor.

CONTINUALLY

- Promote NWSFF program all year long for small acreage landowners and for fall hunting use in the backcountry.
- Promote NWTF all year long for all landowners and help from CWMAs

3.1.2 Information Sources

In order to provide information to the public, you must be informed yourself. Build your public relations reference library with the following possible categories.

- Association training meetings
- Chemical application guides
- Conferences
- Crop Watch
- Educational meetings
- Farm magazines
- Industry meetings
- Industry newsletters
- Information Kits
- Noxious Weed Newsletter
- Pesticide newsletter
- Research papers
- University publications
- Internet weed information sites
- Exhibits
- File of photographs and slides
- List of available videos
- News contacts
- News releases
- Public agency contacts
- Published articles
- Vocational Agriculture
- Weed Management Resource Library
- Weed Science Journals
-

3.2 Dispensing Information

Before you begin preparing information to dispense to the public, get to know your audience and learn how to use the media effectively. While a news release is an essential tool in public relations, it is one of many. The following section provides guidelines for preparing and presenting news releases to the media, but also provides several other methods of spreading the word about weed issues in the area.

3.2.1 News Releases: Using the Media

The news release is usually the primary way you communicate your "NEWS" and information to the outside world and will help to improve awareness and education about the county weed program. Types of news releases include activity reports, planned actions, explanation of your program, program accomplishments, success stories, upcoming meetings/tours/events, changes in department/staff, changes in law/procedures/duties, response to error/mistakes, legal notification, etc. A news release should relate some genuine news, and be brief, clear, factual, accurate, thoroughly proofread and neat.

Whether submitting a news release for print, television, or radio coverage, always use consistent written presentation. The following provides guidelines for preparing news releases and getting your story included in newspapers, magazines, newsletters, radio and television.

A well-constructed and clearly written news release is broken into two general parts: The lead and the body. The most important information belongs in the first paragraph, and additional information follows in order of importance.

- **Lead:** The first or "lead" paragraph will be short, but will contain all basic information: Who, What, Where, When, Why, and How. It is vital to have those questions answered in the lead.
- **Body:** The "body" or balance of a press release provides the full information on the news or event in descending order of importance. Be brief. If an editor or reporter wants more information, he or she will call you. Releases should be limited to two pages. If there is more to the story, other information can be added as attachments (Fact Sheets, Biographies or Brochures).

Develop a standard news release distribution list. Include appropriate local newspapers (daily and weekly), radio and television stations, cable news stations, trade publications, and business publications. Develop two mailing lists—a large, general list, and one carefully targeted to key media whom you will contact individually.

3.2.1.1 Writing Guidelines

The following guidelines should be applied to all written material submitted for publication in newspapers, newsletters, fact-sheets, bulletins, magazines, etc.

- **Get the Facts:** Gather as much information as possible. Research the topic. Interview key people to obtain quotes.
- **Decide on an Angle:** What makes this story newsworthy? What is the primary issue being conveyed to the target audience?
- **The Headline:** Many editors admit that if the headline doesn't spark immediate interest, a release won't be read. Keep it to one line. If it doesn't rate a headline, don't write it.
- **The Basics:** Be sure to include the answers to the questions: Who, what, when, where, why and how, in the first two paragraphs. Limit press releases to major events.
- **Inverted Pyramid Style:** Give information in the order of diminishing importance. With hundreds of releases to read every day, it is a rare editor who reads every word of every release. By putting the most important information first, the chances are greatly increased that the editor will read the key points.
- **Don't Editorialize:** A release should include only the facts.
- **Be Accurate:** Double-check all statistics, names, dates, etc. Don't say Tuesday, January 3, if January 3 is a Wednesday. Errors cause the media to question the accuracy of other information.
- **Be Grammatically Correct:** Poorly written material will not only present a poor image of your organization, but they will be quickly discarded. Always have one other set of eyes (if not more) thoroughly proof every written document, which will be distributed to the media.
- **Neatness Counts:** Editors often look through the stack of releases to sort out and discard the sloppy, handwritten and unprofessional looking. Avoid that trap.
- **Follow Accepted Form:** An editor should be able to quickly identify the date of the release and the name and phone number of a person to contact for more information. Number and identify each page of the release.
- **Use Your Weed District Letterhead**
- **Always Date Your Release** with the date the information becomes effective.
- **Double-Space,** provide healthy margins and, whenever possible, type your release.
- **List a Contact Person** and office and home telephone number.
- **End Your Release** with "#" or "-30-" — the typographer's symbol for "the end." If the announcement is more than one page, put "more" at the bottom of the each page in case pages get separated.

- **If You are Including a Photograph** with the release, mark it clearly on the back with the names of people in the photo, headline from the news release, contact name, and phone number.
- **Avoid Calling at Deadline Times** when you have a news item that is not urgent. Learn when news deadline times are for announcements.
- **Make Reference to a Related Story** or Item if appropriate.
- **Be Concise:** Limit your letter to one subject and avoid long, complex paragraphs. Write a draft, then go back and simplify it.
- **Be Positive and Constructive:** When possible, support your views with objective data from other sources.
- **Use Your Own Words, Not a Form Letter:** Refer to personal experiences. Legible handwriting or typed letters are acceptable.
- **Be Courteous and Reasonable:** Avoid being rude, threatening, or self-righteous. Remember, if your letter is published under Letters to the Editor, you are writing to the whole community. The impression conveyed will apply to the Weed District.
- **Don't Apologize for Writing:** ("I know you're busy but..." or "I don't mean to complain..." That undermines your argument.
- **Use Correct Spelling:** Spell the name of the person you're writing correctly. If using a computer with spell-check, make sure you didn't use a wrong word that was spelled correctly.
- **Time Your Letter:** Have it arrive while the issue is current. Don't write about something that appeared months ago.
- **Use a Fax Machine** for timely essential information.
- **Include Trivia/Fact Sheets.** Items from fact sheets get picked up in news stories every day.
- **Don't Make Exaggerated Claims:** sweeping claims usually lack credibility.

3.2.1.2 SAMPLE: News Release

****NEWS: For Immediate Release****

NEWS FROM:

Crupina County Weed District
100 Spurge Dr.
Whitetop Flats, MT 55555

CONTACT:

Wayne Weedwarrior
(406)555-2222
8-5, M-F

Trailhead Area Targeted for Improvement by County and Forest Service

The popular Dry and Dusty Trailhead areas located five miles north of Whitetop Flats was scheduled for closure this spring due to rapidly spreading noxious weeds. However, a new cooperative vegetation control effort between the county and U.S. Forest Service promises to prevent closure, according to Wayne Weedwarrior. Weedwarrior is the Crupina County weed genius who developed the program. He worked in cooperation with Susan Starthistle, National Forest range technician.

“These weeds, which destroy the native beauty of the area, were nearly impossible to manage in the past,” says Weedwarrior. “But an insect recently released by the Montana Department of Ag’s insectary should help reduce the infestation.”

“We will follow the insect release with selected herbicide applications this fall with EPA- approved products. These products pose no danger to people, wildlife, other plants, or the insects in the areas,” explains Starthistle. “This program worked successfully in three other similar areas in Montana and Idaho.”

--More on Next Page--

The remainder of the news release may include additional information on:

- The target weed and why it is a threat,
- The insects and how they manage the plant,
- Safety, notification, and application procedures to be used,
- Dates of releases and other photo opportunities,
- Names address, and phone numbers of others quoted in release if they can be contacted.

Remember, news releases should be used when you have important news to share. Use the media appropriately and effectively by knowing their needs, requirements, and maintaining good on-going relationships with them.

3.2.1.3 Newspapers

The following hints will help you see that news release make the newspaper.

- Match your release or article to the publication. A telephone call to the news desk can get you guidelines and suggestions that will indicate the types of stories the editor is willing to publish.
- Read the masthead to determine the appropriate editor to contact. An article addressed blindly to "The Editor" frequently will be thrown away.
- Read the publication. See what department or sections it has, how it is structured, how long the articles are, how they are written, and whether the publication has special or seasonal supplements that may be an outlet for your story idea.
- Call or write to the editor to see if your idea has merit. Keep your call or letter brief and to the point. If the editor expresses interest, follow-up. Deliver your manuscript, information or contact the individual the editor has suggested.
- Target your article to a local issue or trend.
- Know the deadlines. Allow time to allow the editor or writer to ask questions before the deadline rush. All publications--daily newspapers and weeklies--and electronic media have strict deadlines.
- Think of visual illustrations that can accompany your article. A photograph, chart, or illustration sometimes can help get the article published. If a photograph is supplied, provide a caption that identifies people. Provide credit lines if appropriate.
- Develop a news angle that is exciting or has local impact. Do something that is exciting and will separate your article from competing stories on the editor's desk.
- In writing your article—Think. A "fluff" story will be immediately identified. Develop factual stories. A credible authority will add authority to the story.
- Follow-up calls after the story is submitted may annoy editors and may do more

harm than good.

From initial contact to publishing, remember, the editor is a professional and knows the publishing business. Good public relations professionals will see their articles in print. Successful public relations practitioners will get their names and addresses in an editor's file for future questions.

In considering a topic for its news value, ask yourself the following questions:

- Is it timely?
- Is it local?
- Is it important or interesting to the general public?
- Does it have consequence, conflict or is it controversial?
- Is it new, novel or different?
- Are the people involved community leaders, personalities, high visibility citizens or ordinary people?
- Is it going to change the future?
- Does it have human interest? What makes it unusual?
- How will it affect the average person?
- Is it on the "cutting edge?" Is it something few people know about?
- Is it odd, unusual, the biggest, the smallest or is it outstanding in some way, shape or form.
- Does it relate to a "hot" news item? Is the media already interested in the topic?

3.2.1.4 Magazines

When writing articles for magazines, you will need to take a somewhat different approach. Because magazines are less frequent, they are not geared for news as are other media. They are looking for topical stories of interest to their readers. The type of readers will vary depending upon the focus of the publication--business, entertainment, or general interest.

3.2.1.5 Television & Radio

Television and radio broadcast require an articulate spokesperson. Develop a working relationship with television and radio stations. Keep an up-to-date contact list, and contact them about possible stories pertaining to your weed management program and activities in the county. Setting up a regular program will increase awareness, and make weeds a more "common knowledge" issue.

Many electronic media (TV, radio, cable TV) accept and air public service announcements (better known as PSA's). Analyze the coverage area you wish to reach, and the coverage

area of the station. Make a call to those electronic outlets that reach potential audiences you want to inform. Ask them about their PSA policy. What format should they take? To whom should they be sent? What kind of lead time do they require? Put that information into your file on target media. Keep it updated!

3.2.2 Social Media

Social Media platforms such as Facebook, Twitter, LinkedIn, Instagram, and Snapchat and the various blogging outlets are gaining popularity day by day due to the fact they are interactive, user friendly, have a wide reach along with lots of daily traffic, and provide a place to where you do what you want. These platforms allow one to easily write, share, upload photos, linking webpages, networking and communication. To have a successful social media platform, it pays to know the Do's and Don'ts.

THE DO'S

1. **Know your audience.** Your social media pages should be tailored to your audience base, not based on your own personal interests. To be frank, your audience don't care about YOU. They care about what you can do for THEM. Post stories that they can relate to. Follow the 80/20 rule. That is, 80 percent of your content (or more) should be relevant to THEM, while 20 percent or less can be specifically about your business, products or services.
2. **Be active but don't over-do it.** Be active on your social media, but don't post so often that you overwhelm or annoy people. This could lead to two problems: 1) Too much information can cause your followers to stop following your posts, and 2) Your posts can get lost within their newsfeeds and they won't see the content that could be really valuable to them.
3. **Keep track of time.** Time does matter. Experiment by posting at different times and pay attention to the analytics. Find out when your followers are most active on social media and post during those time frames.
4. **Maintain one voice.** Social media is great for sharing, but make sure your message is clear and consistent across all channels: website, public, social media, etc.
5. **Share.** We've been taught to share since we were kids. Some things never change. This is one of those things. Share information!
6. **Follow a checklist.** Checklists are great for many facets of life, including social media. Sure, it sounds simple: Just log onto Twitter or Facebook, type a post and hit share, right? Unfortunately, it's not quite that simple. Make a checklist to ensure that your message will be understood, check for any grammar issues, make sure the

information you're sharing can be shared and check the time you send it to ensure your readers will see it. Make sure all of your links are valid. These are just a few examples of things to pay attention to when crafting your tweets and posts.

Attention to this detail could save you time and trouble later.

7. **Be original.** Take a chance and be creative with your posts. Show your personality. Help people see what makes you different from the competition. When your main goal is to bring in customers, you have to stand out and make people remember you!
8. **Provide great customer service.** Great customer service can make or break a company or organization. Happy customers are more likely to come back and establish a loyalty to your brand. Not only will these customers be loyal to you, but they will also be your best brand ambassadors by word-of-mouth advertising. That's the best advocacy you can ask for!
9. **Have a personality.** Dull, boring posts lead to dull, boring results. You have to be excited about your company, your product and the services you can provide your customers. If you aren't excited and don't love what you stand for, neither will your audience.
10. **Understand which social media platform(s) are best for your business or organization.** Just because everyone else seems to be on Facebook doesn't mean you need to be. Social media isn't one-size-fits-all. If you want to improve your SEO, then Google+ or YouTube might be your best choice. If you want to drive traffic to your site or improve your customer engagement, then Facebook, Twitter and Pinterest might be a better fit for example.

THE DON'TS

1. **Don't like your own posts.** Of course you like your post. You posted it! But don't "like" or "favorite" your own material. Encourage your employees or members, however, to share and like the material that is posted. Your employees can be your brand's greatest ambassadors.
2. **Don't neglect your profile(s).** Use your social media! Having a Facebook page or Twitter account isn't enough. You have to maintain your accounts to make them work for you.
3. **Don't share too much.** Be careful of the things you share and don't share too much information. This one goes back to having a checklist.
4. **Don't connect with everyone.** Just because someone follows you, doesn't mean you

have to follow them back. Think of it as choosing who you surround yourself with in real life. Before you follow back, think of how it will reflect on you. Is this someone who would represent you and your business or organization in a good way if consumers saw that you were associated with them?

5. **Don't forget to network.** Just as you would in real-life, always work to make connections by networking and building quality relationships on social media.
6. **Don't forget about privacy settings.** You use them on your personal profiles, so do the same with your business or organization. Remember: Once you share something on the internet, it doesn't go away. Sure, you can delete the post, but screenshots live forever. Taking care of privacy settings also includes protecting your passwords. Choose a password that is extremely secure and only give passwords to a select few. You don't want your social accounts to fall into the wrong hands!
7. **Don't be spammy.** Just don't do it. Nobody likes spam, whether it be via email or social media. If you are constantly posting the same information over and over or inundating your followers, you risk becoming a nuisance and could lose some of the followers you've worked so hard to attract.
8. **Don't ignore comments.** It is vital to engage with your audience. With no engagement, they may feel as if you don't care about their question, comment or concern. It all comes back to customer service. Don't ignore relevant comments. Use them as an opportunity to interact with your followers and show them how you address positive and negative situations.
9. **Don't delete negative comments.** Acknowledging the problem can not only make an upset follower happy, but it can also prevent the company or organization from a PR issue later. Addressing negative comments shows that your company or organization is proactive in resolving issues and that you aim to serve your customers.
10. **Don't rely on automation.** You lose the personal touch with customers if it sounds like a computer is speaking to them. Humanize your brand to make the engagement experience for the customer more personable.

3.2.3 Others Ways to Spread the Word

There are several other methods of spreading news about weed issues in your county without using the media. Methods include informative meetings, exhibits and posters, mailings and mailer inserts, tours and demonstrations, bulletins and circulars, direct contact, and word-of mouth. The following lists provide some ideas for spreading the

3.2.3 | SECTION 3 PUBLIC RELATIONS

word in your community.

NEWSLETTERS

- Farm Service Agency
- Extension Service
- Conservation District

JOINT MEETINGS

- Extension Service
- RC&D
- Federal and State Agencies

AUTHORITY SPONSORED MEETINGS

- Schools
- Luncheon programs (Kiwanas, Lions Club, Rotary, etc)
- 4H and VoAG
- Farm organizations
- By invitation

EXHIBITS AND POSTERS

- Bank lobby
- Barber shops
- Co-ops
- County fair
- Expositions
- Extension service meetings
- Extension Service lobby
- Sale barns

MAILINGS

- Letters
- Adopt-A-Road sponsors
- Adopt-A-Trail groups
- Alfalfa Growers
- Homeowners associations

- Landowners
- Neighborhood associations
- Public land managers
- Realtors
- Christmas tree growers
- Nurseries
- Developers

MAILER INSERTS

- Utility bills
- Co-op mailings

TOURS AND DEMONSTRATIONS

- Treatment comparison plot
- Twilight tour
- Self-guided tours
- Joint tours

DIRECT CONTACT

- Visits to their house or office
- Invitations to stop by the office
- Telephone contacts

BULLETINS AND CIRCULARS

- Same locations you use exhibits
- Mailing inserts
- Office pamphlet rack

GETTING OTHERS TO TELL THE STORY; “WORD- OF- MOUTH”

- Extension service educators
- VoAg instructors
- School teachers
- Students Weed board members
- Landowners

3.3 General Media Tips

- **Use Supportive Literature:** Brochures, pamphlets, reprints of pertinent articles, fact sheets--all help support your position. Public Relations committees should continuously identify representative materials and keep a supply on hand for use in responding to media.
- **Match Your Response to the "Offense":** In taking on local media, you build credibility if your response is balanced with the significance of the issues. Don't request a meeting with the editor because the paper omitted the notice of your meeting from the calendar of events. Don't overreact or overkill; develop levels of action corresponding to the seriousness of the offense.
- **Respect Basic Lines of Authority:** Generally, try to build relationships even when confronting media staff. By respecting basic lines of authority, you may gain cooperation rather than making enemies. If a media story feeds stigma, look for the writer's byline and target your response to him/her. If the reporter is not responsive, you may want to move up to the next line of authority--the editor who supervises the reporter.
- **A Little Honey:** "You catch more flies with...etc." If you're having trouble getting cooperation from a newspaper, or radio or TV station, invite a news director/reporter/editor to speak to your group and present her/him a plaque or certificate of appreciation. Also, you can ask media persons to serve on your board. Even if they turn you down, they may feel honored. Besides, they may accept, and bring invaluable experience and knowledge to the group.
- **Who Needs to Respond:** Is this something that many participants should write a letter about, or is it something that would be better handled by an individual or a few persons meeting with a key station executive?
- **Anticipate How the Media Might Respond to Your Interests:** Avoidance ("We appreciate your comments, but we stand by our story."); or Defensive denial ("We've received several awards for the quality of our reporting and public service programming.")
- **Have a Strategy:** (e.g., Identify several participants willing to share their story in a news segment or special program.)

3.3.2 Schedule an Appointment with the News Director: Ideally, there should be the same number of persons in your group as the number of people you'll be meeting with (so neither group feels overwhelmed). Two or more people can alternate responses, one picking up on key points the other may have missed in responding to a question. Two can also alternate asking questions, with one thinking of a significant follow-up question, while the other is listening to the answer to an initial query. Also, a second person can help verify what was asked, and what was said.

- **Rehearse:** Whether for a meeting to resolve a problem, or to appear on an interview, know what your main points are, and keep the key phrases in mind.
- **Post Mortem:** After the event, discuss among yourselves how you think it went. Did we win our points? If not, why not, and how could we have done it better? We continue to learn from experiences as long as we live.

3.4 The Do's and Don'ts of Public Relations

Editors, reporters and program directors are the They determine which stories will appear in print or on the air. Therefore, it is critical to maintain a good working relationship with these media professionals.

Do's

1. Do respect reporters and editors.
2. Do invite media people to events and on tours of interesting facilities.
3. Do answer telephone calls from media promptly.
4. Do provide facts and figures when asked.
5. Do have your facts and figures clear.
6. Do get to know your media contacts.
7. Plan, plan, PLAN.
8. Do target media with an interest in weed issues and management activities.
9. Do respect deadlines.
10. Do keep an up-to-date media mailing list.

Don'ts

1. Don't ignore radio and weekly newspapers as important sources of media placement.
2. Don't talk off the record--it doesn't exist.
3. Don't talk to a reporter unprepared. If you do not have an answer, don't make one up. Offer, instead, to gather the information and call the reporter back.
4. Don't become angry with members of the media. Angry letters or calls close doors.
5. Don't attack a newspaper for a negative story or for not using your story. Do investigate other reporters who might be interested in your story.
6. Don't badger or harass busy reporters. If it is clear that a reporter is busy, cut the call short. If it is clear that a reporter isn't interested in a story, end the conversation.

7. Don't say "no comment." This phrase indicates that you're hiding something.
8. Don't give up. Developing an effective public relations campaign is not easy or quick.
9. Don't forget to thank reporters.

3.5 Meeting Guidelines

3.5.1 Public Meetings

3.5.1.1 Conducting a successful public meeting.

(Keep It Simple, to the Point, and Brief!)

1. Determine the Meeting objective

- Define the purpose of the meeting and what you hope to accomplish
- Define who should be invited.
 - Identify and invite local residents known to be interested and active in weed management
 - Personally contact the key people you want to participate. (who can challenge or block a decision?)
 - Make sure key agencies are represented (who can make decisions for the agency?)
 - Make sure the group is broad-based.
 - Keep it local (hold several meetings if necessary to accomplish this).

2. Organize the Meeting

- Type of Meeting – Presentation, feedback, problem solving, decision-making, combination.
- Define clear desired outcomes.
- Design effective agendas (see worksheet in this section).
- Determine length of the meeting (keep the meetings short).
- Identify who will serve as chairperson, meeting manager, facilitator, and recorder.
- Keep discussion centered on the agenda (form a WMA, determine the best management options, treatment priority, etc.).
- Stay on time.
- Form a Board of Directors of Steering committee to keep the project progressing. Choose a broad-based board or committee, and keep board/steering committee to less

than 10 members.

3. Anticipate and provide meeting materials

(see checklist at end of this section)

- Flip charts or overheads.
- Markers
- Maps to identify areas to be discussed.
- Coffee, refreshments (be sensitive to your audience and the time of the meeting).

4. Decision-Making Process

- Clearly define the decision making process
- How will decisions be made? Consensus, majority vote, one person?
- Who will be the final decision-maker? Manager, group, other?
- Conduct productive meetings
- Get everyone involved.
- Facilitate the discussion to keep it on track.
- Use a strategy for solving problems and responding to opportunities.
- Build high quality, consensus decisions. Consensus decisions are built on a series of agreements, and agree with desired outcomes.

5. Insure good meeting follow-up

- Evaluate the effectiveness of the meetings.
- Organize the information produced.
- Produce useful minutes.
- Plan for implementation of decisions and future meetings.

3.5.1.2 Keeping your head (attached) during confrontational public situations

- Follow preparation hints for public meetings. The more you know, the better off you'll be.
- Always consider self-protection first.
- Anticipate confrontation at various levels, then develop and rehearse a good response to each.
- Don't travel alone. Assemble elsewhere and come together.
- Park your vehicle in a well-lit, visible area.

3.5.1.3 | SECTION 3 PUBLIC RELATIONS

- Consider advanced warning to local law enforcement, and request they be on standby/ready alert, or attend meeting.
- Sit where you have good view of entire meeting room.
- Audio or video tape entire proceeding.
- Request audience “introductions” at meeting, and write down names of potential troublemakers.
- Don’t hang around after the meeting. Leave with main crowd.
- Ignore “redneck” comments made to provoke you.
- Carry a cellular phone, and have police numbers handy.

3.5.1.3 Checklist for Setting up a Public Meeting

- Reserve an appropriate room and equipment
- Decide on the seating arrangement
- Design an agenda
- Announce the meeting and an agenda to the identified target audience in advance
- Make appropriate charts and overheads (i.e.-outline purpose, decisions to be made, needed information, etc.)
- Arrange for refreshments
- Make sure key decision makers and community leader receive invitations to the meeting
- Arrive at the meeting room early to double check the room arrangements, verify any audio/visual equipment needed is in proper working condition, and display any charts or brochures, or other information.
- _____
- _____

3.5.1.4 Meeting Preparation Form-Action Planning Worksheet for Meeting

Date:_____ **Place:**_____

Why: Identify the need for the meeting and other potential ways to solve the problem:

Who: Identify key participants who have relevant expertise, are concerned, have the power to make decisions, have the power to challenge or block the decisions, or have influence on the community.

Desired Outcomes: Identify the desired outcome of the meeting.

Determine what success will look like.

Specifically, identify what will be accomplished.

Type: Identify the type of meeting to be held: presentation, feedback, problem-solving, decision making, or combination.

Length: Determine a reasonable length of time for the meeting.

Roles: Identify who will fulfill key roles in the meeting:

Moderator/Chair (open meeting, keep it moving):

Facilitator (keep the meeting participants on track making decisions and plans):

Recorder (keep accurate notes of decisions made. Write up reports as needed).

Wall recorder (may need several; record decisions on wall charts).

3.5.1.4 | SECTION 3 PUBLIC RELATIONS

Equipment facilitator (will make sure all equipment is properly working).

Decision making process: Identify how group and management decisions will be made.

3.5.1.5 Public Meeting Agenda

Group / Meeting Name: _____

Date: _____ Time: From _____ to _____

Location: _____

Purpose:

Provide a signup sheet at the meeting.

What	How	Who	Time

3.5.2 Negotiation Meetings

1. Determine who are the real and perceived stake-holders in the issue, who are the activists or spokespersons.
2. Your team should be assertive but not aggressive personalities.
3. KEY: Consider using a professional mediator to facilitate the meeting. You do not want one of your key negotiators forced into the neutral role the facilitator must play to be effective.
4. Negotiators who maintain credibility and self-control are key.
5. Don't lie, be defensive, or display condescending behavior.
6. Keep a sense of humor; it can be very disarming.
7. Presume there are some valid issues under the exaggerations.
8. If immediate resolution is desired, come prepared to negotiate: Representative should have decision-making power; have constructive alternatives ready.
9. Recognize community members' need to share in decision-making that affects their lives. Are the true stakeholders even at the table?
10. Look for solutions that require "buy-in" or specific commitment from stakeholders on the other side.
11. Consider use of a trial period concept to flush out sincerity of other party or unforeseen, real problems.
12. Publicly communicate the terms of any agreement to keep parties accountable.

3.5.3 Activist Encounters

Before:

1. Monitor – assess your vulnerability
2. Determine if purpose is legitimate
3. Research the activists
4. Select the best participant
5. Prepare for the meeting

During:

1. Follow predetermined safety plan
2. Stay focused on your objective
3. Maintain appropriate personal conduct

4. Expect press involvement
5. Be ready to handle confrontation

After:

1. Follow-up; document points in letter
2. Inform others who need to know
3. Evaluate results and effectiveness
4. Revise procedures/policies, as needed
5. Monitor – reassess your vulnerability

SECTION 4 Weed Management Concepts

ECOLOGICAL AND ECONOMIC IMPACTS OF NOXIOUS WEEDS

INTEGRATED WEED MANAGEMENT STRATEGIES

This section provides an overview of general concepts in weed management methods and issues. Impacts of exotic species on species diversity, wildlife habitat, natural resources, and economics are discussed.

Weed management strategies are outlined beginning with planning, inventory, and monitoring methods, and followed by integrated management strategies including prevention, mechanical, biological, chemical, and cultural control methods. This section only provides an introduction to these concepts. More information can be found in other sections of this handbook or separate documents and publications.

4.1 Ecological and Economic Impacts of Noxious Weeds

Celestine Duncan, Weed Management Services

Summary

Exotic Plant Impacts on Species Diversity and Native Plant Habitat

- The introduction and spread of non-native plants threaten biological diversity of native plant communities and can alter ecosystem processes such as intensity and frequency of fire, hydrologic cycles, and soil erosion rates.
- Invasion of cheat grass (downy brome) in the Intermountain West has increased the frequency of fires from once every 60 to 110 years to once every 3 to 5 years. This has changed plant diversity by reducing native shrub communities.
- Native species have been displaced by invasions of spotted knapweed and leafy spurge. As weed infestations increase, the abundance and diversity of native species decline.
- Native plant communities in Glacier National Park, Theodore Roosevelt National Park, the Bob Marshall Wilderness, and Rocky Mountain National Park are threatened by weed invasion.
- Altamont Prairie Preserve in South Dakota is no longer managed as native prairie by The Nature Conservancy because of invasion by leafy spurge. The site is now used to study the effectiveness of grazing animals (goats and sheep) for controlling leafy spurge and prairie restoration.
- Wetland vegetation is endangered by purple loosestrife invasions. The displacement of native vegetation by this weed has caused serious reductions in waterfowl and aquatic furbearer productivity as breeding habitats are degraded.
- The status of rare and threatened plants such as bulrush, dwarf spikerush, bog turtle, Sacramento thistle, sapphire rockcress, and Colorado butterfly plant are further imperiled by weed invasions.

Noxious Weed Impacts on Wildlife Habitat Quality

- The introduction of exotic plants impacts wildlife by reducing forage, modifying habitat (i.e. replacing a grass community with forbs), or changing how a species interacts within the environment.

- Bison and deer use of habitat infested with leafy spurge was 82% and 70% lower respectively than for non-infested habitat. This causes animals to use non-infested areas more heavily intensifying stress on these sites and increasing their susceptibility to invasion by non-native species.
- The use of herbicides to remove spotted knapweed from an elk winter range in Montana changed elk distribution patterns resulting in a 266% increase in elk use. This change in elk distribution reduced grazing pressure on adjoining private lands.
- Spotted knapweed invasion of bunchgrass sites in western Montana reduces available winter forage for elk by as much as 50% to 90%. Since a highly productive foothills site in western Montana can produce an average of 1,800 pounds per acre, forage (grass) loss from spotted knapweed can be as high as 1,620 pounds per acre.
- Purple loosestrife invasion of wetland sites degrades habitat for aquatic furbearing animals and waterfowl species. Degradation to these habitats from exotic species is of special concern because of the additional loss of wetland from urban, agricultural, and industrial uses.
- Displacement of native vegetation by exotic species significantly changes bird species composition and small mammal populations.

Noxious Weed Impacts on Soil and Water Resources

- Salt cedar invasion can lower water tables influencing native plant habitat, and can alter stream flow cycles.
- The displacement of native bunchgrasses by spotted knapweed substantially increases surface water run-off and sediment yield (soil loss). For example, an additional 18 tons of soil would be lost from a 500 acre spotted knapweed infested rangeland in western Montana during an average 30 minute rainfall event, compared to a similar site with native bunchgrass.

Economic Impacts of Noxious Weeds

- Noxious weeds have a substantial economic impact on state economies and may cause potential job losses. However, the economic impact of most noxious weeds is not well documented.
- Economic impacts of leafy spurge in Montana, North Dakota, South Dakota, and Wyoming total \$129.5 million annually, and represent the potential loss of 1,433 jobs.
- Economic impacts of knapweed infestations on grazing land and wildland in Montana are about \$42 million annually, which could support 518 full-time jobs.

- If knapweed infested all lands highly susceptible to invasion in Montana (34 million acres), the economic loss to the state would be \$155 million.

Introduction

Invasions by non-native plants degrade biological communities and threaten survival of native species world wide. These plants, commonly known as “weeds” or “exotic species”, use water, nutrients, and sunlight that would normally be utilized by native species, thus altering communities and ecosystems (Herbold and Moyle, 1986; Randall, 1995). Dewey and Torell (1991) defined a weed as any plant that interferes with the management objectives for a given area of land (or body of water) at a given point in time. Once a plant has been classified as a weed, it attains a “noxious” status only by legislation. Noxious weeds, as defined by Montana state law, are, “...*exotic plant species established or that may be introduced in the state which may render land unfit for agriculture, forestry, livestock, wildlife, or other beneficial uses or that may harm native plant communities and that is designated*”. More than 500 weeds are designated as noxious by either weed or seed laws in the United States and Canada (Lorenz and Dewey, 1988).

Most weeds are not native to the areas in which they are a problem. In a survey conducted on Nature Conservancy managed lands, 237 plants were listed as problem species. Of these, 197 were not native to the area in which they were troublesome (Randall, 1995). Most weeds were either introduced for their perceived value to man, or unintentionally as contaminants in feed and seed products. The invasiveness of weeds is due to their genetic make-up which enables them to exploit a resource “niche”, and the lack of natural enemies such as insects, diseases, and pathogens (Story, 1992).

The spread of noxious weeds has been considered analogous with a biological wildfire. As with wildfire management, a variety of treatments or techniques are available for management of weeds. These include prevention, early detection, timely control (biological, physical, chemical, or cultural), and site rehabilitation (Dewey et.al., 1995). The selection of respective control methods is influenced by land management objectives; effectiveness of the control technique on the target species; environmental factors; land use; economics; and the size of weed infestations (Lacey, C. 1991). An integrated weed management (IWM) approach that gives equal consideration of all management tools, including herbicides, is critical for managing extensive weed infestations.

Land managers involved with controlling weeds on public lands must be able to discuss weed management issues and concerns with the public. This includes information on the importance of managing non-native species, management techniques, and an assessment of health and environmental information associated with various methods. The purpose of this section of the guide is to review current literature on: (1) impacts of exotic plants; (2) response of plant communities to weed invasion and herbicide treatments; and (3) case histories of successful weed control programs. Although invasions of exotic plant species occur worldwide, this review is limited to problem species in the western United States.

4.1.1 Impact of Exotic Plant Species on the Ecosystem

SPECIES DIVERSITY AND NATIVE PLANT HABITATS

The introduction and spread of non-native plants threaten biological diversity of native plant communities and can alter ecosystem processes. For example, annual plants introduced into California grasslands have replaced native bunchgrasses, and downy brome (*Bromus tectorum* L.) has altered ecosystem process and changed structure and function of plant communities in the Intermountain West (Mack, 1981; Randall, 1996). Downy brome invasion has increased the frequency of fires from once every 60 to 110 years to once every 3 to 5 years on millions of acres of rangeland in the Great Basin (Whisenant, S.G. 1990). The high frequency of fire has eliminated native shrub communities (Randall, 1996).

Many weeds out-compete native species, change community structure, degrade or eliminate habitat for native animals, or provide food and cover for undesirable non-native animals (Kurz, 1995; Randall, 1996). Spotted knapweed (*Centaurea maculosa* Lam.) and diffuse knapweed (*Centaurea diffusa*) are recognized as serious invaders in the western U.S., infesting over 10 million acres in nine western states and two Canadian provinces (Lacey, C. 1989). Invasion of spotted and diffuse knapweed into undisturbed native bunchgrass communities is well documented (Myers and Berube, 1983; Tyser and Key, 1988; Bedunah and Carpenter, 1989; Lacey, et.al., 1990). As spotted knapweed increases, cover of more desirable but less competitive grasses and forbs is significantly reduced, sometimes as much as 60 to 90 percent (Harris and Cranston, 1979; Bucher, 1984). In Glacier National Park, spotted knapweed reduced species richness (Figure 1) and the frequency of six native species during a three year period. In addition, seven species classified as “rare” and “uncommon” at the beginning of the study were not present three years later. These results suggested that spotted knapweed was capable of spreading into natural fescue grasslands and altering plant community composition (Tyser and Key, 1988).

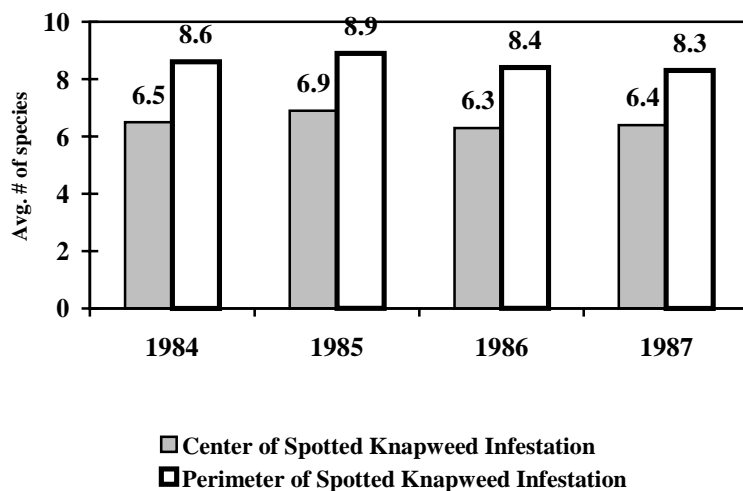


Figure 1: Average number of species, excluding spotted knapweed and *Carex* spp., per square foot within, and adjacent to, a knapweed infestation in Glacier National Park.

Cryptogamic ground crust may also be impacted by spotted knapweed. This crust, which is composed of small lichens and mosses and commonly covers undisturbed soil surfaces, is important for soil stabilization, moisture retention, and nitrogen fixation (Rychert and Skujins, 1974, Anderson et. al., 1982). Tyser (1992) compared a native fescue grassland site to one invaded by spotted knapweed in Glacier National Park. Results of the study indicated that the cryptogam ground cover within the spotted knapweed infested site was 96% less than the native fescue grassland site.

Leafy spurge (*Euphorbia esula* L.) infests about 2.7 million acres, mainly in the Northern Great Plains and prairie provinces of Canada (Lajeunesse et. al., 1995). The relationship between leafy spurge and the species composition of mixed-grass prairie was studied near Manitoba, Canada. Within a single infestation of leafy spurge, the frequency of 5 common native species decreased significantly. Most native species were absent where leafy spurge was most abundant, and species richness declined from 11 species outside the infestation to 3 species at the center. Leafy spurge poses a considerable threat to the conservation of native plant communities and to the economic use of prairie for rangeland (Lajeunesse et. al. 1995, Belcher and Wilson, 1989; Lym and Messersmith, 1985).

Other noxious weeds such as yellow starthistle (*Centaurea solstitialis*), sulfur cinquefoil (*Potentilla recta*), and Dyers woad (*Isatis tinctoria* L.) have been found to reduce establishment and growth of more desirable species (Evans and Chase, 1981; Rice et.al., 1994; Callihan et al, 1989). Yellow starthistle is especially troublesome because it aggressively colonizes a variety of sites, and is responsible for a neurological disorder called “chewing disease” in horses (Kingsbury, J.M. 1964). In California, acreage infested by the weed increased from 1.2 million acres in 1958 to 7.9 million acres in 1985 (Maddox et. al. 1986). Yellow starthistle is also a serious problem in Oregon, Washington, and Idaho where 1.2 million acres were reported infested in 1988 (Lacey C., 1989).

Noxious weeds are recognized as serious problems on lands managed for wilderness or wildland values by federal, state, and private entities. When weeds invade and expand into a wilderness environment, the “naturalness” of the area is degraded and scientific values of once biologically diverse landscapes are impaired (Asher and Harmon, 1995). Examples of weed invasion in natural areas are found in most states. The Nature Conservancy (TNC) reported weed problems on preserves in 46 states, and 13% of managers surveyed listed weeds as their number one management problem (Randall, 1995). Leafy spurge infestations occur at Pine Butte Swamp Preserve along the Rocky Mountain front in Montana, and in other preserves of the Plains of western Minnesota and eastern Dakotas. TNC’s Altamont Prairie in South Dakota is so badly infested with leafy spurge that it is no longer regarded worth managing as native prairie and cannot be sold as cropland. Instead, the site is now being used to test the efficacy of sheep and goats for leafy spurge control and prairie restoration (Randall, 1996). Leafy spurge has also successfully established and is increasing its range in rough fescue communities of Glacier National Park and has invaded the remote Danaher Creek area of the Bob Marshall Wilderness (Bedunah, 1992). Infestations of leafy spurge are also present in Theodore Roosevelt National Park in North Dakota (Andrascik, R.J. 1994) and spotted knapweed and Dalmatian toadflax (*Linaria dalmatica*) infest Yellowstone National Park. In Rocky Mountain National park, Canada thistle (*Cirsium*

arvense) has spread from horse and foot trails into native plant communities (Beck, pers. comm.).

Wetland sites are also susceptible to invasion by noxious weeds. Purple loosestrife (*Lythrum salicaria*) was introduced in northeastern North America by the early 1800's. By 1940 it was established in the Pacific Northwest and had spread into the Great Plains (Thompson et. al, 1987), and now infests all states north of the 35th parallel, except Alaska. The weed forms dense infestations which displace native species including those that provide food and cover for many waterfowl and other wildlife (Thompson et. al., 1987).

Limited information is available on the impact of weeds on rare and threatened plants and animals. Dense infestations of purple loosestrife imperil endangered species, such as bulrush (*Scirpus longii*) in Massachusetts (Coddington and Field, 1978), dwarf spikerush (*Eleocharis parvula*) in New York (Rawinski, 1982), and the bog turtle (*Desmognathus muhlbergii*) in the northeastern U.S. (Thompson, 1987). Teazel (*Dipsacus sylvestris*) is interfering with growth and germination of the Sacramento thistle (*Cirsium vinaceum*), a federally-listed threatened species endemic to the Sacramento Mountains in New Mexico (Huenneke, Laura F., 1996). Sapphire rockcress (*Arabis fecunda*) is a candidate for listing as a threatened or endangered species by the U.S. Fish and Wildlife Service, and is listed as a threatened species in Montana (Lesica and Shelly, 1991). The plant is at risk because of livestock trampling and encroachment of habitat by spotted knapweed (Lesica, 1991). Sapphire rockcress is subjected to an increased risk of extinction since spotted knapweed reduces space available for seedling establishment (Lesica, 1991). The Colorado butterfly plant (*Gaura neomexicana*) is another candidate for listing as a threatened or endangered species. As a result of competition from Canada thistle, *Gaura* populations declined 40 to 50% from the mid-1980's to 1992 (Cheater 1992). Although populations of *Gaura* are currently increasing, it is suspected that establishment and survival of seedlings of this plant may be hindered by competition for light, water, and nutrients from noxious weeds (Fertig, 1996).

IMPACT ON WILDLIFE HABITAT QUALITY

The introduction of exotic plants influences wildlife by displacing forage species, modifying habitat structure- such as changing grassland to a forb-dominated community-, or changing species interactions within the ecosystem (Belcher and Wilson, 1989; Bedunah, 1992; Trammell and Butler, 1996). Use of leafy spurge infested and non-infested habitats by deer (*Odocoileus* spp.), elk (*Cervus elaphus*), and bison (*Bos bison*) were studied in Theodore Roosevelt National Park, ND during 1992 and 1993. Fecal pellet-group densities indicated that bison use of leafy spurge infested grassland habitats averaged 83% less than for noninfested sites. Deer pellet-group densities, normally highest within creeping juniper-little bluestem habitat, were reduced 70% by infestations of leafy spurge. Use of browse in green ash and chokecherry habitat during summer and winter was reduced an average of 32% by infestations of leafy spurge. Trammell and Butler (1996) concluded that the reduction in native ungulate use of leafy spurge-infested sites may be attributed to lower forage production in infested sites as well as simple avoidance.

Spotted knapweed also influences elk and deer foraging behavior and population distribution (Hakim, 1979). In western Montana, herbicides were used to remove spotted

4.1.1 | SECTION 4 WEED MANAGEMENT CONCEPTS

knapweed from a 272 acre winter range site on Three Mile Game Range. Subsequent elk foraging behavior (trend counts and feeding craters) on spotted knapweed infested and non-infested winter range was compared for 4 years (Thompson, 1996). Elk walked indiscriminately within knapweed infested and non-infested sites, but foraged almost exclusively in the grass stand where knapweed was removed. In addition, elk use increased an average of 266% after knapweed was removed from the site. Redistribution of a portion of the area elk population to the treated site may have benefited the entire herd by reducing competition for limited resources in other areas (Thompson, 1996). Spotted knapweed invasion of bunchgrass sites in western Montana results in a 200% to 300% decline in elk winter forage (Bedunah and Carpenter, 1989). Guenther (1989) found that although knapweed was common on a mule deer (*Odocoileus hemionus*) winter range in Montana, the plant was not detected in the deer's diet.

Small birds and mammals are also impacted by noxious weeds. Purple loosestrife reduces desirable waterfowl plants such as cattails (*Typha latifolia*) that are preferred habitats for muskrats and long-billed marsh wrens (Rawinski and Malecki, 1984). Waterfowl broods are also more susceptible to predation because dense stands of purple loosestrife reduce access from water to nesting sites. Wilson and Belcher (1989) reported that the introduction of Eurasian plants not only replaced the native plant community; it also significantly changed bird species composition. Small mammal populations have been reduced as Russian knapweed (*Centaurea repens* L.) displaces native species (Kurz, 1995).

SOIL AND WATER RESOURCES

Exotic species that alter hydrologic cycles, sediment deposition, erosion, and other ecosystem processes can cause serious ecological damage (Vitousek, 1986). Salt cedars (*Tamarix chinensis* L.) which invade wetland and riparian areas in the Southwest U.S. are responsible for lowering water tables at some sites (Horton, 1977). This reduces or eliminates surface water habitats required by native plants. Salt cedar infestations also trap more sediments than stands of native vegetation, thus altering the shape, carrying capacity and flooding cycle of water courses (Blackburn, 1982).

Tap-rooted weed species can also increase erosion rates as they invade grasslands. The influence of spotted knapweed on surface runoff and sediment yield was determined under simulated rainfall conditions near Garrison, MT (Lacey et al, 1989). Surface water runoff and sediment yield (soil erosion) were measured during a 30 minute simulated rainfall event on 12 paired plots. One plot of each pair was in a bunchgrass community whereas the other was dominated by spotted knapweed. Runoff was 56% higher and sediment yield was 192% higher on spotted knapweed plots compared to bunchgrass plots during the initial 30 minute simulated rainfall period (Figure 2 and 3). The study concluded that spotted knapweed invasion onto bunchgrass rangelands of western Montana was detrimental to the protection of soil and water resources (Lacey et. al., 1989).

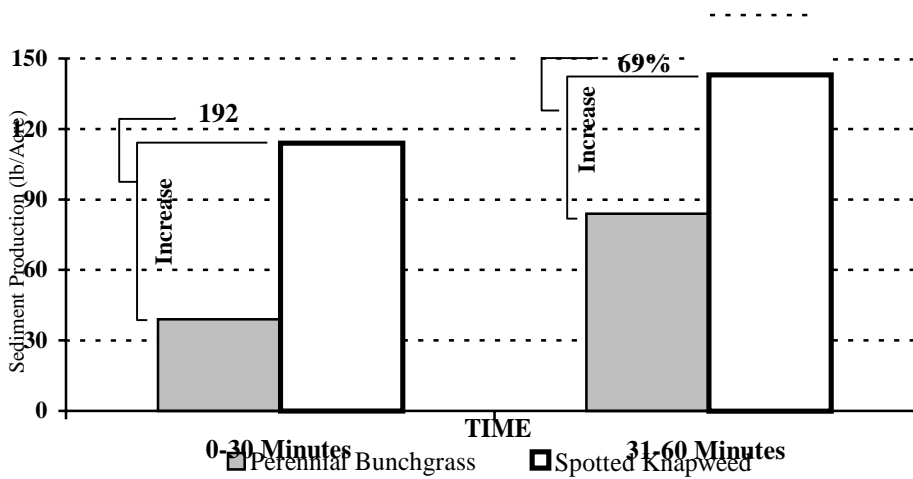


Figure 2. Sediment yield on grass-dominated and spotted knapweed dominated plots subjected to two consecutive simulated rainfall periods. The initial 30-minute period was on the unaltered site to measure the effect of vegetative cover plus soil surface characteristics. Vegetative cover was removed before the second 30-minute period to measure the effects of surface characteristics alone. (Lacey et. al. 1989)

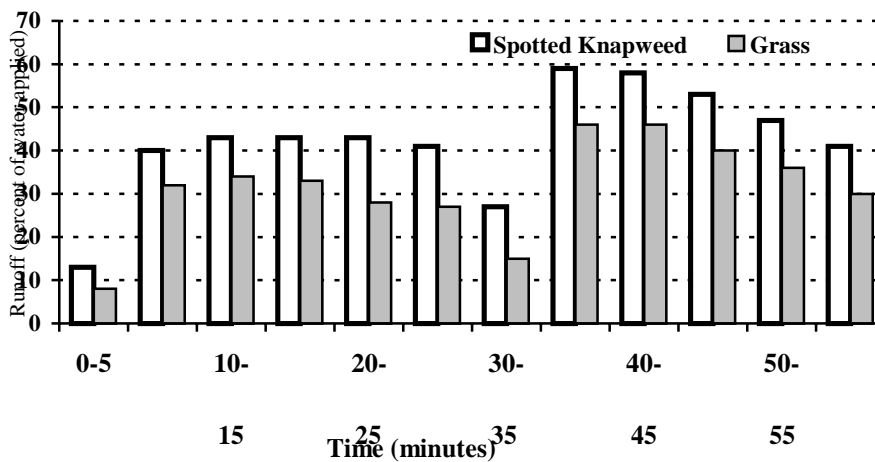


Figure 3. Surface runoff from 12 grass-dominated and 12 spotted knapweed-dominated plots at various time intervals during two consecutive 30-minute simulated rainfall periods. Vegetation was clipped and removed from the plot after the first 30-minute rainfall period.

4.1.2 Economic Impact of Noxious Weeds

There is limited information on economic impacts of noxious weeds on range, pasture, and wildland sites. The most thorough study was conducted by economists at North Dakota State University (Leitch et. al., 1994). They reviewed economic losses caused by leafy spurge in the upper Great Plains including states of Montana, North and South Dakota, and Wyoming. Economic impacts caused by leafy spurge to ranchers and landowners include reduced income from lower grazing capacity, lost livestock sales, and reduced grazing land values as a result of infestations. In 1993, grazing capacity lost to leafy spurge infestations in the four state area would have supported a herd of about 90,000 cows, which could generate about \$37.1 million in annual livestock sales. The direct loss of \$37.1 million generated about \$82.6 million in secondary impacts to the regions economy. Total direct and secondary impacts were about \$119.7 million or about \$163 per lost animal unit month (AUM). In addition to impacts to grazing lands, the study also estimated impacts of leafy spurge on wildlands from changes in wildlife habitat and soil and water conservation benefits.

4.1.2 | SECTION 4 WEED MANAGEMENT CONCEPTS

Degradation of habitat was assumed to reduce wildlife related expenditures in each state (Figure 4). Nearly \$3.4 million in direct economic impacts result from slightly less than 1% infestation level of leafy spurge. Eliminating leafy spurge on wildlands could add 174 jobs and \$9.8 million in business activity in the four state area. The study concluded that direct and secondary economic impacts of leafy spurge infestations on grazing land and wildland in the four-state area are about \$129.5 million and represent the potential loss of 1,433 jobs.

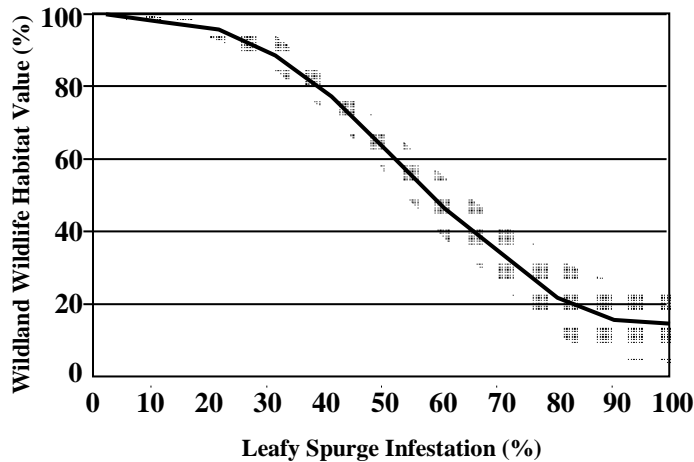


Figure 4. Estimates of reduced wildland wildlife habitat value caused by various leafy spurge infestations rates (Leitch et al., 1994). *Shading along the function indicates uncertainty associated with the relationship.*

A similar economic study was conducted on the impact of knapweed on Montana's economy (Hirsch and Leitch, 1996). Because cattle avoid grazing knapweed, the weed affects Montana's grazing industry, specifically ranchers, landowners, businesses supplying livestock products, and communities that rely on ranching as an economic base. Economic impact of the weed in Montana was estimated for an infestation level of 2 million acres for all knapweed species. Direct impact to the state's economy was calculated by adding the value of lost forage production (\$3.221 million) and reduced sales of livestock production inputs associated with herd reductions (\$7.804 million). Total direct impacts were \$11.025 million annually or \$10.73 per infested grazing land acre. The study also estimated impacts of knapweed on wildlands based on changes in wildlife habitat which would affect wildlife-associated recreation expenditures, and soil and water conservation benefits (Figure 5). Total direct impacts on Montana's economy from infested wildland are about \$3.093 million annually or \$3.95 per infested acre. The study concluded that direct and secondary economic impacts of knapweed infestations on grazing land and wildland in Montana are about \$42 million, which could support 518 full time jobs in the state's economy.

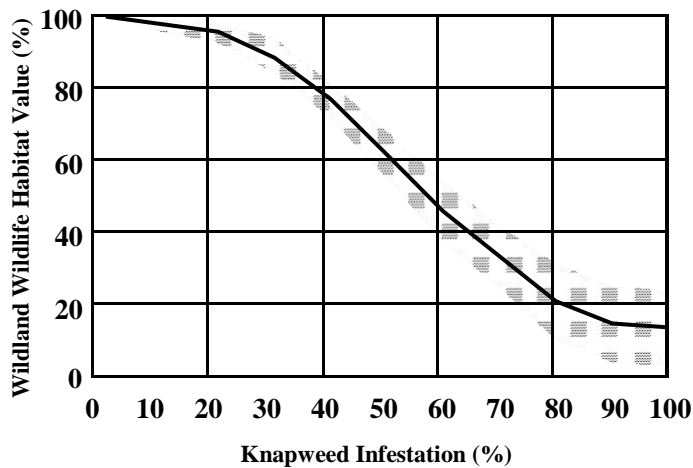


Figure 5. Estimates of reduced wildland wildlife habitat value caused by various knapweed infestations rates (Leitch et al., 1994). *Shading along the function indicates uncertainty associated with the relationship*

Another economic report in 1984 reviewed loss of range livestock income in Montana if all vulnerable lands in the state were infested with spotted knapweed. The report (Bucher, 1984) concluded that if spotted knapweed invaded 34 million acres of highly vulnerable lands (Chicoine, 1988), annual gross revenue of Montana's livestock industry would be reduced by \$155 million. Additional information and research is needed to understand the economic impact of noxious weed invasion in the western United States.

4.1.3 Summary

Noxious weeds are having a major impact on the ecology and economy of Western States. These weeds are a form of "biological pollution" because they can degrade native ecosystems by displacing native plant species, increase soil runoff and sediment yield, degrade wildlife habitat, and decrease forage for wildlife and livestock. A viable Integrated Weed Management Program is necessary to manage non-native plants, using available methods, including education, prevention, physical or mechanical practices, biological control agents, herbicides, and cultural practices for sustainable land management.

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4.1.4 | SECTION 4 WEED MANAGEMENT CONCEPTS

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4.2 Integrated Weed Management Strategies

Modified from Principles of Integrated Weed Management, by Barbara Mullin.

The goal of an effective weed management program is to replace undesirable plants that are causing loss—resource, economic, habitat, or aesthetic—with a plant or plants that are beneficial to the environment.

An integrated and coordinated approach to weed management should have two primary goals. First, development of a long-term plan that encompasses all land in a designated area, with all landowners and managers working together toward effective management. Second, implementation of the most economical and effective weed control methods for the target weed.

Integrated weed management (IWM) is a systems approach to management of undesirable plants. IWM is defined in the Federal Noxious Weed Act as “a system for the planning and implementation of a program, using an interdisciplinary approach, to select a method for containing or controlling an undesirable plant species or group of species using all available methods, including—education, prevention, physical or mechanical methods, biological control agents, herbicide methods, cultural methods, and a general land management practices.” It is a multidisciplinary, ecological approach to managing unwanted plant species—weeds.

4.2.1 Planning, Inventory, & Monitoring

Integrated weed management involves the use of the best control techniques described for the target weed species in a planned, coordinated program, to limit the impact and spread of the weed. The control methods selected should be determined by the control objectives for the land, the effectiveness of the control techniques in the target species, environmental factors, land use, economic, and the extent and nature of the weed infestation.

Factors that must be assessed prior to making a management decision include:

- Inventory and assessment to identify the target weed species and determine the size of infestation.
- Assessment of non-target vegetation in the management area.
- Determination of soil types, climatic conditions, and important water resources.
- Determination of the limitation of the control method chosen.

An accurate assessment of the target infestation will help determine the most appropriate control method or methods for the weed species. A small patch of leafy spurge could be

economically and easily controlled with a residual herbicide application and continued vigilance of the landowner. A large, dense infestation of leafy spurge may require establishment of a grazing program or biocontrol agent, combined with a herbicide containment program. All control options have some limitations. If complete eradication of a weed is necessary, biocontrol agents would not be a good choice. If soils preclude use of a herbicide, mechanical or biological may be the next choice.

In order to appraise the performance and progress of your weed management activities, systematic monitoring and evaluation should be incorporated into your weed management plan.

More detailed guidelines on planning, inventory and monitoring are provided in Section 5 (Weed Inventory Techniques), and 10 (Planning).

4.2.2 Prevention & Education

Preventing the spread of the weed by seed or vegetative propagules should be the first line of defense in developing a weed management program. There are many potential weed threats to lands and land managers need to be aware of the threat, identify unknown species and implement effective controls immediately.

Quarantines and embargoes can be effective in isolating and preventing the spread of weeds into new areas. Weed-seed-free forage programs and certification programs for agronomic crops are designed to stop movement of new species into areas where they are not currently found. A program of this type is especially well suited for protection of wilderness areas, where other control methods may be difficult to initiate if the weed becomes established.

State seed laws are enacted to insure the purity of seed for planting, thus preventing the spread of weeds. State of Montana seed laws prohibit the sale and use of purple loosestrife (purple lythrum) a commonly used ornamental that has escaped into many wetland areas.

Preventing the introduction of weed seed and plant parts into non-infested sites is an important part of any weed plan. Prevention is always recognized as the most practical and cost-effective method of weed control at tours and during other educational programs. Preventive measures include minimizing soil disturbance, restricting off-road vehicles, warning against the transport of weed-contaminated seed and feed, advising that machinery and equipment be cleaned before they are moved from weed-contaminated areas, and not allowing newly established weeds to set seed.

Early detection and treatment of weeds, and an overall effective preventive weed management program is dependent on education. Public education programs, such as tours, workshops, meetings, radio and television announcements, youth programs, etc., are useful for preventing the spread of noxious weeds. Publications and computer programs are available that give excellent information and color plates of important weed species in the West.

On going education of weed district and federal agency personnel and private landowners on weed identification, new weed management techniques and proper use of control techniques available is an important part of a weed program. This includes yearly training seminars for land managers and support of the state pesticide applicator certification programs.

Educational efforts targeting the general public emphasize what weeds are of concern and why they are a threat. These programs have included development of brochures to show hunters what spotted knapweed looks like in the fall, so they can report new infestations; a Ned an Nellie Knapweed coloring book highlights the damage knapweed can do; bumper stickers, radio announcements and tours of areas with serious weed problems all emphasize the importance of noxious weeds to the land.

4.2.3 Physical or Mechanical Weed Management

The use of physical methods to eliminate weeds can be effective on small infestations. Handpulling, hoeing, tilling, mulches, burning and mowing are all commonly used methods. Physical/mechanical methods are labor intensive for perennial, deep-rooted noxious weeds, making them expensive treatments that are often not effective.

Handpulling and hoeing are most effective in areas where there is a limited weed infestation and soil types allow for complete removal of plant material. Spotted knapweed has been effectively pulled in areas of loose soil near water, where other methods were unacceptable and the infestation was small. It is not recommended in high-density infestation where there is not native vegetation to replace the pulled plants.

Tilling is generally limited to cropland situations. Canada thistle has been effectively controlled when tilled every 21 days over several growing seasons. Some rhizomatous noxious weeds, such as leafy spurge, are not effectively controlled by tillage and in fact may be spread.

Mulches block sunlight to germinating seedlings, and can be effective against many annual weeds. However, mulches only allow better competition when the target weed is a perennial plant.

Burning has been shown to be an effective set-up treatment for herbicide applications by removing old stand vegetation that would tie-up herbicides as they are applied. Burning should be timed properly to minimize damage to non-target species.

Mowing reduces seed production in some plants. It is most effective on annual and biennial plants. Timing and frequency of mowing varies with each species. It has been shown that mowing can increase seed production in diffuse knapweed, while spotted knapweed can show a seed decrease when mowed in the flowering stage.

Although mechanical treatments are commonly used to control some weeds on cropland, success varies with the timing and frequency of the treatment, and the species of weed. It is

practically impossible to eliminate leafy spurge, or similar species that have an extensive root system and the capability of sprouting new shoots from numerous buds on lateral roots.

4.2.4 Biological Weed Management

Biological control attempts to recreate a balance of plant species with predators. Since many noxious weeds that are of the most serious concern in rangeland are exotic species, they have few established natural predators. Research focuses on introduction of natural predators from the weed's area of origin on to local plant populations. Biological control involves the use of living organisms, such as insects, mites, nematodes, pathogens or grazing animals, to control a weed infestation.

Leafy spurge currently has several insect species cleared for release in the United States. A number of other species are currently undergoing host specificity testing and additional research. Flea beetles (*Aphthona spp.*) seem to be showing the most promise at this time.

Two gallflies, a root moth, and a root weevil have established effectively on spotted knapweed in western Montana and show some stand reduction. Several additional insects are in the experimental stages and researchers expect that it will take a number of different insects, attacking various parts of the plant before stand reductions will take place.

Research on plant pathogens includes limiting the host range of a commonly found *Sclerotinia* fungus to attack close relatives to the knapweed species; determining the pathogenicity of soil borne fungi that have shown some impact on leafy spurge in the field, and screening of weeds in their native areas for potential pathogens.

Grazing animals have been used to decrease the density of leafy spurge and limit spread by reducing seed production. Grazing must be timed to have the greatest impact on the weed. Sheep and cattle have been managed under intensive grazing systems to utilize spotted knapweed. In Stillwater County, goats have been used in fishing access sites to stop seed production of leafy spurge and were effective in reducing infestations of certain biennial weeds, such as houndstongue. Predators may limit the use of grazing animals in some areas.

Section 9 (Biological Weed Management) provides more detailed information in biocontrol agents, methods for obtaining and releasing agents, and monitoring biocontrol sites.

4.2.5 Chemical Weed Management

Herbicides are important tools for controlling noxious weeds. It is important to understand the affects and limitations of those used for control of noxious weeds. Herbicides are categorized as selective or non-selective. Selective herbicides kill a specific type of plant; for example, 2,4-D kills only broadleaf plants. Herbicides are also selective based on the rate used. Spotted knapweed generally is controlled using lower rates than leafy spurge, thus causing less potential impact on non-target broadleaf species.

The most commonly used herbicides on noxious weeds are 2,4-D (various brands), picloram (Tordon), dicamba (Banvel), clopyralid (Transline, Stinger), and glyphosate (Roundup, Rodeo). With the exception of glyphosate, they are all auxin-type compounds that are selective for broadleaf plants, making them effective tools for controlling noxious weeds while maintaining valuable grass species.

Herbicides are applied several ways depending on the objectives and economic and environmental constraints. Truck or ATV-mounted spray equipment (with a boom, single broadjet, or hand-held pressure nozzles), or backpack sprayers are usually used. Aerial application is also used on large scale infestations where environmental concerns are less of a risk.

Application rates, measured in pounds of active ingredient (AI) per acre, vary for each herbicide or combination of herbicides depending on the target species, management objective, and environmental conditions. To assure proper application, all guidelines and label restrictions must be carefully followed. Use of many herbicides is restricted near surface water, areas with coarse textured soils and high water tables, under certain wind, temperature, and soil moisture conditions, and during some stages of plant growth.

Additional information regarding these herbicides is included in Section 7 (Herbicides in the Environment / Safety and Handling) and 8 (Chemical Weed Management).

4.2.6 Cultural Weed Management

Cultural methods of weed control that enhance the growth of desired vegetation may help slow invasion onto a site. The use of plant competition, smother crops, crop rotation and allelopathy are methods often most suited to cropland agriculture. When dealing with noxious weeds, it is important to maintain the native or desirable vegetation in a healthy condition to allow adequate competition once the weeds have been controlled.

In some forest sites, improving brush and tree canopy cover can reduce spotted knapweed density and slow invasion. Fertilization and reseeding with competitive, adapted species may be necessary in some areas.

4.2.7 Land Management

Follow-up management is especially important on range and pasture lands. It determines the longevity of control obtained by the methods used. Because noxious weeds have persistent growth characteristics and seeds can remain viable in the soil for years, long-term control programs must be implemented.

Long-term management includes retreatment with herbicides or continued cultural, mechanical or biological control practices to maintain low weed populations. Range improvements, such as grazing systems, cross fencing, and water development, will help retard reinvasion of many weed species. Sites with no desirable species should be reseeded to a competitive plant species as a part of the total management program.

4.2.8 Conclusion

Integrated weed management practices will work when land managers understand all of the methods available for use; evaluate the site and choices for restrictions; implement the management plan and then implement follow-up management in the area to prevent reinvasion.

A systems approach to weed management, with increased emphasis on managing the land for beneficial species and specific controls targeting unwanted vegetation, is the ultimate goal of an integrated weed management plan.

SECTION 5 Weed Inventory & Monitoring Techniques

MAPPING METHODS AND GUIDELINES

METHODs FOR MONITORING WITH LINE TRANSECTS

EDDMapS WEST USER GUIDE

This section provides methods for conducting noxious weed inventories and monitoring programs. For additional assistance on mapping procedures and requirements for the state inventory program, and EDDMapS training, contact Jasmine Reimer, Montana Department of Agriculture.

Mapping Noxious Weeds in Montana

Mapping of noxious weeds in Montana is an important task that everyone in the management of noxious weeds should be involved. Over the past couple of years the procedures for mapping weeds have changed, these changes reflect a need to find a simpler as well as a cost and time effective way to achieve this end.

5.1 Weed Inventory Methods-General Guidelines

The objectives of weed surveys are to accurately identify and delineate land with noxious weeds. Montana has a statewide weed inventory program, EDDMapS, to insure that inventory methods are standardized throughout the state. Montana State University has developed guidelines for detailed mapping of noxious weeds. This chapter of the handbook will give a complete summary of the methods that should be used. For more information contact: Jamine Reimer, Montana Department of Agriculture.

5.1.1 Why Inventory Noxious Weeds?

- Collect information on weed biology and ecology
- Location and acreage infested
- Growth requirements
- Spread patterns and rates
- Data is critical for developing management goals and options
- Establishes a historical data base
- Enables you to evaluate the progress of a weed management program
- Increases public awareness and support for the program

5.2 Monitoring and Evaluation

The primary goal of monitoring and evaluation is to appraise your weed management performance through an assessment of your progress and level of success.

To build awareness, educate, implement training, fund and justify your program, and establish a plan, you must know how you are doing. **Monitoring** means repeated systematic observation. **Evaluation** is relating information obtained from monitoring to a goal. In many ways, monitoring and evaluation are the most important parts of a weed program, but by themselves do not control or prevent weeds.

Monitoring is determining the truth about the program. It tells the conditions of the area we are managing and reports changes over time. Weed-free areas deserve as much monitoring as known infestations.

The purpose of a monitoring system is to:

- Collect baseline field data on existing weed management practices.
- Compile data on which to base weed management decisions.
- Evaluate effectiveness of treatments and programs.

The level of monitoring is dependent on financial resources and manpower available. Monitoring may entail the following activities:

5.2.1 Photo Points

A photographic collection will provide data for portraying changes on a large scale and to transfer this information to audiences of different backgrounds. The process of developing a photographic collection includes: 1) the retrieval of old images and the relocation of photo points, 2) the establishment of new photo points, 3) a systematic method of recording information about each point, and 4) methods for the storage and use of the collection. A description for establishing photo points is included at the end of this section.

5.2.1.1 How to Establish Photo Points

Establishing photo points requires a steel fence post, a 2 - 5 pound hammer, a set of metal letters and number stamps, or other permanent marking system to attach to the post, a compass, and a camera. Although a 35-mm cameral with color slide film is the best for taking photos, they are expensive and processing costs are also high. Digital cameras today are of very good quality and are convenient to use. Processing costs are eliminated making them economical.

The point number, date, and observer's initials are stamped into the spade. The post is then driven into the ground with the spade up. The top of the post can be used to locate the close-up photo center.

The long view photo should be representative of the area and have a distinctive landmark in the background (peak, rock outcrop, tree, etc) to aid in repeating the photo in the future. A compass bearing from the photo point to the center of focus (post) must be recorded for long and close-up photos.

A field form (see following form) to systematically record the location, time of year, weed species information, etc., describing information concerning each photograph needs to be developed. The description of each photo point should include: photo point number or name, name of photographer, date of photograph, date of establishment, time of day, magnetic declination, location comments, and notations on vegetation and other conditions. This information can later be transferred to a spreadsheet or simple database.

5.2.1.2 SAMPLE: Photo Point Monitoring Form

NOXIOUS WEED PHOTO POINT

Photo Point Number: _____

Photographer: _____

Photograph Date: _____

Establishment Date: _____

Time of Day: _____

Location: _____

Weed Species: _____

Notes: _____

5.3 Mapping Invasive Species In Montana: An EDDMapS West User Guide

- <https://www.eddmaps.org/west/>

SECTION 6 Herbicides in the Environment

HERBICIDES AND THEIR PROPERTIES

HERBICIDES AND THE ENVIRONMENT

HERBICIDES AND HUMAN TOXICITY

The following section provides information on herbicide properties and their fate in the environment.

The following herbicide information has been compiled to provide information on specific herbicides to readers of this handbook. The herbicides discussed in this section are those most commonly used by weed districts to control weeds on range and pasture sites, rights-of-way, and non-crop sites. For additional information regarding the physiological and biochemical activity, toxicity, and movement in and on soil, refer to *The Herbicide Handbook of the Weed Science Society of America*.

This handbook is not intended as a complete guide to herbicide use. Before mixing and applying any herbicide, read the **entire** label on the container. *Remember: herbicide labels can and do change from year to year.* Herbicides registered with the U.S. Environmental Protection Agency (EPA) require a minimum of 120 different health, safety and environmental tests which take companies 7 to 10 years to complete at a cost of \$30 to \$50 million. These tests support label recommendations and can help prevent misuse of a herbicide.

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6.1 Herbicides and Their Properties

6.1.1 Herbicide Mode of Action

To be effective, herbicides must: 1) adequately contact plants; 2) be absorbed by plants; 3) move within the plants to the site of action, without being deactivated; and 4) reach toxic levels at the site of action. The term *mode of action* refers to the sequence of events from absorption into plants until the plant dies. The mode of action of the herbicide influences how the herbicide is applied. Some herbicides, such as Paraquat, are contact herbicides that disrupt plant cells and must be applied to the foliage. There is very little translocation that occurs because cells are killed on contact. Herbicides used as soil sterilants such as Arsenal, Oust, Simazine or Hyvar are applied to the soil surface prior to seedling germination. These herbicides are absorbed by seeds, roots, and shoots. Systemic herbicides are translocated from the leaves (or site of entry) to the area in the plant where they are active. In general systemic herbicides such as Tordon, Transline, or Banvel are slow-acting with death of the plant occurring over a period of time. Understanding herbicide mode of action is useful in diagnosing herbicide injury complaints.

Herbicides are classified into families based on their mode of action. Classification begins with whether it is a contact or systemic herbicide. Families and properties for herbicides most commonly used by weed districts will be discussed below.

6.1.2 Herbicide Families and Properties

GROWTH REGULATORS

The growth regulators include the following herbicide families: phenoxy acetic acids, benzoic acids, and the pyridines. Growth regulator herbicides can act at multiple sites in a plant to disrupt hormone balance and protein synthesis. Growth regulator herbicides selectively kill broadleaf plants, but may cause injury to grasses under certain conditions. Herbicides in this group can also move in both the xylem and phloem to new plant growth. Uptake is primarily through the foliage, but root uptake is possible.

- Phenoxy Acetic Acids – 2,4-D
- Benzoic Acids – Dicamba (Banvel)
- Pyridines – picloram (Tordon 22K, Grazon P+D), clopyralid (Transline, Curtail), triclopyr (Garlon)

METABOLIC INHIBITORS

This family of herbicides includes imidazolinones, sulfonylureas, and the amino acid derivatives. These herbicides interfere with normal amino acid and/or protein synthesis. Uptake is primarily through the foliage, but root uptake is possible with Pursuit and Escort.

- Imidazolinones – Pursuit
- Sulfonylureas – metsulfuron methyl (Escort), chlorosulfuron (Telar), sulfmeturon (Oust)
- Amine Acid Derivatives – glyphosate (Roundup/Rodeo)

CONTACT HERBICIDES

This family includes bipyridiliums, diphenyl ethers, and phenols. However, the only herbicide in this group that is occasionally used by weed districts is Paraquat. This herbicide is absorbed by foliage but there is little to no translocation of the herbicide. Thus it must be applied post-emergent to annual weeds to be effective.

PHOTOSYNTHETIC INHIBITORS

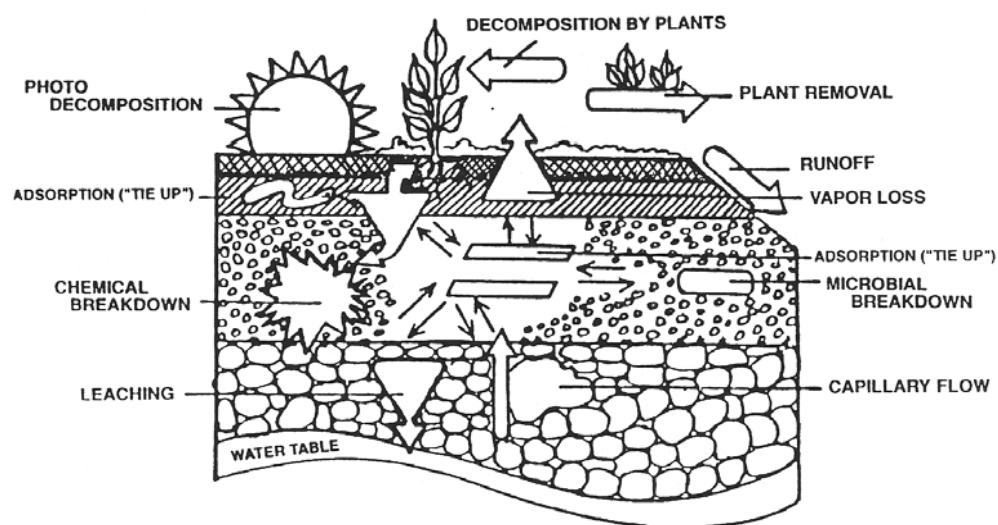
This group includes s-triazines and ureas in addition to several other families. These herbicides are readily absorbed through roots and with limited absorption in the foliage. The herbicides translocate from roots upward and accumulate in the upper leaves. Leaves turn chlorotic (yellow) between the veins. In the urea family, lower leaves are most affected and new leaves may be unaffected by chlorosis.

- S-triazines: aatrex (Atrazine) and princep (Simazine)
- Ureas: tebuthiuron (Spike)

6.2 Herbicides and the Environment

There are many different factors that determine the fate of a herbicide in the environment. These include herbicide properties and environmental conditions such as precipitation, temperature, slope, and plant growth. Figure 6-1 shows the potential fate of a herbicide following application.

Figure 6-1. Potential fate of a herbicide following application.



From Martin, A.H. et al. 1977. Herbicide Carryover. Neb. Guide. G74-180. Univ. of Nebraska, Lincoln.

There are three herbicide properties that affect how a herbicide interacts with the environment. They include solubility, adsorption, and persistence. **Solubility** is defined as the amount of a herbicide that can be dissolved in water at 25 degrees centigrade. The larger the number in parts per million (ppm) the greater the solubility. **Adsorption** is the distribution of a herbicide between soil particles and the soil solution. Adsorption coefficients are shown as a Koc factor. The higher the number, the more tightly the herbicide binds to soil particles. **Persistence** is the length of time a herbicide remains active in a soil system. Persistence will vary based on: 1) application rate; 2) temperature; 3) moisture content of the soil and soil organic matter. In general, herbicide breakdown is more rapid with low application rates under warm, moist conditions with high organic matter.

A concern when applying herbicides is the potential for the herbicide to move through soil and enter ground water or surface water. Many herbicides are water-soluble which allows them to go into solution easily. However, mobility of a herbicide in soil is determined by solubility in addition to other properties of adsorption and persistence. For example, Roundup (glyphosate) is very soluble in water, but is immobile in soil because of its ability to bind tightly to soil particles. Escort, Transline, Banvel, 2,4-D, Tordon and several other herbicides used by weed district are considered mobile herbicides.

Table 6-1: Properties for various herbicides ¹

Common Name	Trade Name	Solubility in Water (ppm)	Runoff Potential	Leaching Potential ²	Half-life in Soil (days)
Atrazine	Atrazine, AAtrex	33	Medium	Large	60
Bromacil	Hyvar X	815	Medium	Large	90
Chlorsulfuron	Telar	300 - 28,000	Small	Large	30
Clopyralid	Transline, Curtail, Confront	1000	Small	Large	21-100
Copper Sulfate	Copper Sulfate		High	Low	
Dicamba	Banvel, Clarity	6500	Small	Large	21-90
2,4-D	Several	900	Small	Medium	10
Fosamine	Krenite-S	1,790,000	Medium	None	7
Glyphosate	Roundup	15,700	Large	Small	60-90
Metsulfuron	Escort		Small	Large	60-210
Picloram	Grazon, Tordon	430	Medium	Large	28-400
Simazine	Princep, simazine	48	Small	Small	5
Sulfometuron	Oust	5300	Medium	Large	60
Tebuthiuron	Spike	2300	Small	Large	360
Triclopyr	Garlon	430	Large	Medium	46

1/ Data from 1997-1998 Weed Management Handbook, Montana State Univ, Utah State Univ., and Univ. Wyoming , and Chemical Industry Representatives.

2/Indicates herbicide adsorption to soil.

6.2.1 Environmental Factors

Environmental factors are extremely important in determining the fate of a herbicide during application and the rate at which it will degrade once it contacts soils or a plant. The sensitivity of a site for herbicide movement and the potential for contamination of groundwater resources is also determined by environmental factors. The following environmental components should be addressed prior and during application.

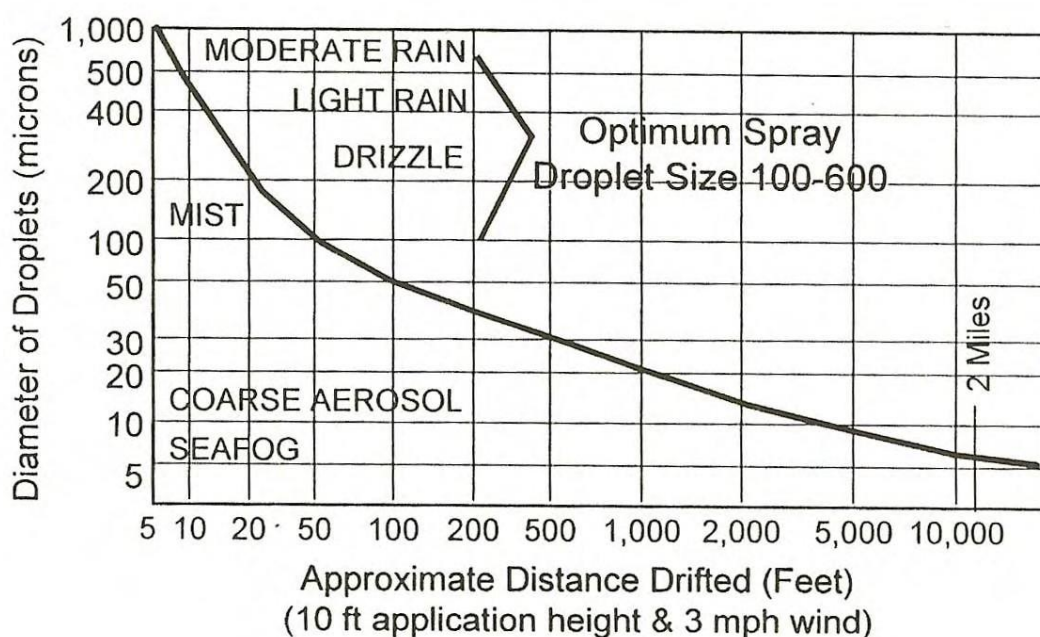
6.2.2 Atmospheric Effects

Herbicides enter the atmosphere by drift and volatilization and can affect air quality. Spray drift, the movement of airborne particles from the target area, poses the greatest air quality concern. Extent of drift depends primarily on the size of the spray droplets and wind speed.

Droplets most prone to drift are those less than 100 microns in diameter (Figure 6-2). Applicators should reduce drift by applying herbicides only when wind speeds are less than 10 miles per hour, and by monitoring application equipment and pressure so that droplet size is greater than 100 microns.

Herbicides can also move through the air in volatilized (gaseous) form. Volatilization is reported to be negligible with Roundup, Rodeo, Tordon 22K, Transline, Arsenal, and Escort. With 2,4-D, volatilization depends on the formulation; amines are less volatile than esters, which vary from high to low. The oil-soluble amines are considered the least volatile. Banvel may volatilize from soil or leaf surfaces, especially under hot temperatures. To minimize the risk of injury when using “volatile” herbicides, apply only when spray conditions are cool and the wind velocity is low and away from susceptible non-target plants or crops.

Figure 6-2: The effect of droplet size on drift.



6.2.3 Herbicide Loss Following Application

Once a herbicide contacts a plant surface it can be consumed by animals, volatilized back to the atmosphere, washed on to soil, absorbed (and degraded) by the plant, or decomposed by sunlight. Herbicides on the soil surface may be moved downward in the soil profile, or removed from the site during surface runoff. Once in the soil, herbicides can be degraded by micro-organisms or chemical decomposition. Leaching of the herbicide can occur under

certain conditions, especially with herbicides that are not tightly adsorbed to soil or organic matter.

Herbicides such as Tordon 22K are moderately susceptible to degradation by sunlight. Therefore, applications of this herbicide during hot, dry sunny conditions can reduce its effectiveness and persistence. Ester formulations of herbicides (such as 2,4-D Ester) are decomposed more rapidly by light than salt formulations.

6.2.4 Herbicide Runoff Potential

The runoff potential indicates the tendency of a herbicide to move with sediment. This is an important factor since herbicide could potentially enter surface water. Runoff is a function of herbicide characteristics, application rate, soil texture, slope, vegetation, and the length of time between application and rainfall. Tordon and 2,4-D have been reported to enter surface water through runoff. However, a study conducted by the EPA to measure runoff of Tordon concluded that, under field conditions, Tordon 22K does not present a serious threat to water quality a short distance downstream from the application site (Evans and Duseja, 1973). Runoff potential of most other herbicides commonly used by weed districts should be similar to that of Tordon 22K. The use of low-persistent herbicides on steeply sloping sites and a herbicide-free buffer near streams will reduce the risk of contaminating surface and ground water resources through runoff.

6.2.5 Herbicide Movement in Soil

The potential for a herbicide to move in soil is a function of soil texture, organic matter content and permeability, herbicide properties, and precipitation. In general, unconsolidated sand and gravel materials, and soils with rapid to moderately rapid permeability with little or no organic matter are highly susceptible to downward movement of herbicides.

Several herbicides used by weed districts are considered mobile in the soil environment (See leaching potential Table 6-1). However, on most rangeland sites in Montana, soils retain almost all available moisture within the upper 2 to 3 feet of soil. Thus, there is little opportunity for herbicide leaching to occur. Several studies conducted in Montana with Tordon 22K indicate that under dryland conditions, Tordon 22K will move to a maximum depth of about 48 inches. Clopyralid (Transline and Curtail) and 2,4-D are less persistent than Tordon 22K and moved to a maximum depth of 10 inches in a Montana study. Caution should be used along roadsides where effective precipitation is higher due to runoff from the road surface.

6.2.6 Depth to Groundwater

The depth groundwater occurs from the soil surface is one of the most important factors to consider prior to applying herbicides. Sites with coarse textured soils, low soil organic matter content, high precipitation or flooding hazard, **AND** groundwater within approximately 25 feet of the surface are most susceptible to groundwater degradation by herbicides. Weed

districts should access well log information (Department of Natural Resources and Conservation, Butte School of Mines), local groundwater reports, and soil survey information to determine depth to groundwater prior to initiating a herbicide program. Reduced rates of soil-active herbicides or application of herbicides having no soil activity (Roundup) to short soil-residual properties (2,4-D) should be applied on sites with coarse textured soils and shallow water tables.

Four major factors determine whether a pesticide is likely to reach ground water: (1) properties of the pesticide, (2) properties of the soil, (3) conditions of the site, and (4) management practices.

1. Pesticide properties that affect its potential to contaminate groundwater are:

- **Solubility:** Highly soluble herbicides have a tendency to be leached from the soil to the groundwater.
- **Adsorption:** Many herbicides do not leach because they are tightly adsorbed by soil particles.
- **Degradation:** Herbicides that break down rapidly in the soil are less likely to be leached into the ground water.

2. Properties of a soil that affect its potential to leach are:

- **Soil texture:** The coarser-textured a soil, the greater the chance of the herbicide reaching groundwater.
- **Soil permeability:** Highly permeable soils will increase the chance of a herbicide reaching groundwater.
- **Organic matter content:** Soils high in organic matter will adsorb herbicides, decreasing the chance that they will contaminate ground water.

3. The conditions of a site that affect its potential to contaminate ground water are:

- **Depth to ground water:** The shallower the depth to groundwater, the less there will be to act as a filter. If rainfall is high and soils are permeable and have a low adsorptive capacity, water carrying pesticides may take only a few days to percolate downward to ground water.
- **Geologic conditions:** The permeability of the geologic layers between the soil and groundwater is also important. Highly permeable materials, such as gravel deposits, allow water and dissolved pesticides to freely percolate downward to groundwater.
- **Climate:** Areas with rainfall or irrigation may have large amounts of water percolating through the soil. These areas are highly susceptible to leaching of pesticides, especially if the soils are highly permeable.

4. The management practices in a particular area can have an effect on the potential of pesticides to contaminate groundwater.

- **Application methods:** Injection or incorporation into the soil makes pesticides most available for leaching. Most of the pesticides that have been detected in groundwater were ones incorporated into the soil rather than being sprayed on foliage.
- **Pesticide rates and timing:** The rate and timing of a pesticide's application also are critical in determining whether it will leach to groundwater. Excessive rates (and the closer the time of application to heavy rainfall periods or irrigation) increase the possibility that pesticides will reach the groundwater.

6.2.7 Geology

Weed districts should have an adequate understanding of the type of bedrock in the county. Herbicide applications made on some sites with fractured bedrock (such as limestone) can cause migration of the herbicide through cracks and fissures in the rock and the potential for direct introduction of herbicides to groundwater.

6.3 Herbicides and Human Toxicity

Herbicides have the same mode of entry into the human body as other pesticides: through the skin (dermal), by swallowing (oral) and by breathing (inhalation). As a general rule, herbicides are not as toxic to man as insecticides, rodenticides, and nematocides, but some can accumulate in the body and be toxic when a certain concentration is reached.

Human health risks associated with herbicides used for noxious weed control have been documented in several government publications. In general, conclusions indicate that even when consideration is given to mixing errors and a variety of accident scenarios (e.g. spills, leaks, etc.) the “no observable effect levels” (NOEL) for human health are not exceeded. Health impacts to the general public are related either to direct contact with herbicides through spray drift, spills, and sprayed vegetation or to indirect contact through consumption of contaminated water, vegetables, fish, and grazing animals. The most serious human health risk is to herbicide applicators. However, worker doses are likely to be below the Acceptable Daily Intake (ADI) if reasonable safety precautions on the herbicide label are used.

There is the possibility of idiosyncratic responses such as hypersensitivity on the part of a small percentage of the population. These persons are generally aware of their sensitivities since they are typically triggered by a variety of natural and synthetic compounds. Placing signs in high public use areas during and following herbicide applications, and not allowing chemically sensitive persons to work with herbicides should limit exposure.

A definitive evaluation of health effects from pesticides is beyond the scope of this document. Discussion of health effects includes a brief discussion of toxicity, carcinogenicity (cancer) and mutagenicity (birth defects).

6.3.1 Pesticide Toxicity

Toxicity tests are used as standard reference experiments to evaluate potential harm to mammals and other organisms. Toxicity tests on mammals are segregated into acute, subchronic and chronic categories based on the length of exposure to the pesticide. Acute tests evaluate the effects of large dosages in a short time period. Observations are conducted over a span of days to weeks. The most often referred to indices for pesticide toxicity is the median lethal dose (LD50) and the medial lethal concentration (MC50). This is defined as the dose or concentration, which is lethal to 50 percent of the treated population (expressed in milligrams of compound ingested per kilogram of body weight). Values preceded by “greater than” (>) mean the LD50 is higher than the quoted. Various rating systems are used to discuss relative toxicities of pesticides. The US Environmental Protection Agency (EPA) has category guidelines for acute and subchronic toxicity, which are used on pesticide labels. Labels are required under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)

and should be on file with the County Weed District. Table 6-2 illustrates the relative toxicity of some common herbicides used by Weed Districts.

Table 6-2. Toxicity of Various Herbicides and Reference Materials.

CHEMICAL (TRADE NAME)	USE	ACUTE ORAL RAT LD50* mg/kg body wt	ORAL HUMAN LD50***
CAFFEINE	Stimulant	192	About 100 cups
ASPIRIN	Pain reliever (willow extract)	750-2000	.15 -.3 lb. (120 tablets)
2-4,D	Broadleaf herbicide	300-1000 formulation dependent	0.12 TO 0.3 PINTS
DICAMBA (BANVEL)	Broadleaf herbicide	1707	0.5 PINTS.
DIURON (KARMEX)	Bare ground trt.	3400	1.02 POUNDS
SODIUM CHLORIDE (TABLE SALT)	Condiment	4000-5000	.6 -.8 lb.
CLOPYRALID (CURTAIL, TRANSLINE)	Broadleaf herbicide	>5000	2.5 PINTS
IMAZAPYR (ARSENAL)	Bare ground trt. Industrial/row use	>5000	2 PINTS
ESCORT (METSULFURON)	Broadleaf herbicide	>5000	1.5 POUNDS
GLYPHOSATE (ROUNDUP) (RODEO)	Non-selective herbicide	>5000	2 PINTS
PICLORAM (TORDON)	Broadleaf herbicide w/ residual	8200	6 PINTS

* Lethal dose in mg/kg of body weight for 50% of the test animals (rats) - the lower the number the more toxic the substance. From WSSA Herbicide Handbook 1994; and "The Dose Makes the Poison".

*** Estimated lethal dose in POUNDS for a 180 Pound person - estimated from male rat data using a conversion factor for mg/kg to lbs/180 lbs. These numbers are not precise but provide a relative idea of lethal doses.

6.3.2 Carcinogenicity and Mutagenicity

Chronic impact studies expose a test subject to a pesticide for a majority of its life span to determine the effects of long-term, low-level exposure. The potential for mutagenicity and carcinogenicity is evaluated. These tests are very complex in relation to human biological systems and potential influences.

Current data suggest that health risks from herbicides can be significant for sensitive individuals. At the same time, it is possible to reduce herbicide risks to levels equivalent to, or well below other common risks. Proper storage, use and disposal accomplish this, and minimizing exposure including the use of protective clothing as listed on the product label.

SECTION 7 Pesticide Safety and Handling

EMERGENCY PHONE NUMBERS

PERSONAL SAFETY

PROTECTIVE CLOTHING AND EQUIPMENT

PERSONAL CLEANUP HEALTH HAZARDS & PESTICIDE

POISONING HANDLING PESTICIDES SAFELY

APPLYING PESTICIDES SAFELY

PESTICIDE LABELS

This section contains information regarding pesticide safety and handling. It is not specific to herbicides alone but references toxic materials in general. Weed Districts applying only low-toxicity herbicides can tailor health, safety, and handling guidelines to meet county needs. NOTE: Those applicators licensed in regulatory weed control are licensed to apply herbicides only. Other licenses are required to apply other pesticides.

REFERENCES

1. Mississippi State University Extension Service
<http://extension.msstate.edu/publications/>
2. Florida Agricultural Information System
<http://edis.ifas.ufl.edu/topics/agriculture/index.html>
3. Pesticide Education Resources @ University of Nebraska-Lincoln
<https://pested.unl.edu/>
4. Cornell University Cooperative Extension <http://psep.cce.cornell.edu/Tutorials>
5. Montana Department of Agriculture, Pesticide Division. <http://agr.mt.gov/Pesticides>

7.1 Emergency Phone Numbers

Poison Control Center	1-800-222-1222
Animal Poison Control.....	1-800-42-4435
National Response Center	1-800-424-8802
Chemtrec	1-800-424-9300
Montana Department of Environmental Quality	406-444-2544
Montana Department of Agriculture, Sciences Division.....	406-444-2944
Disaster Emergency Service (24 hour, spill report service).....	406-841-3911
Solid Waste Disposal	406-444-4400
Water Protection Bureau	406-444-3080
Air and Waste Management Bureau	
(handling & disposal of hazardous waste).....	406-444-3490
MHP, Motor Vehicle Inspection Bureau (placarding)	406-444-3300
Centers for Disease Control.....	1-800-232-4636
National Pesticide Information	1-800-858-7378

7.2 Personal Safety

Although most weed districts are using herbicides with relatively low toxicity, a small number of supervisors are handling pesticides other than herbicides. Therefore, this section will include safety and handling for all pesticides.

The single most important approach to pesticide safety is to read the manufacturers label before each use and follow the directions. If still in doubt after reading the label, contact extension specialists and/or chemical company representatives to help in evaluating the hazard of the chemical and its use.

All pesticides are toxic to some degree, but can be handled safely provided recommended precautions are followed. The use of protective clothing, respirators, gas masks, etc., may or may not be recommended on the label. To disregard label directions is a violation of the law. Safety should always be carefully considered until it becomes habit; it requires a purposeful, positive attitude.

TAKE THESE PRECAUTIONS

1. If you anticipate using the more toxic pesticides, maintain an antidote or at least a copy of the label with you and/or your physician for immediate action.
2. Wear protective, preferably water repellent, clothing while mixing, loading, or applying hazardous materials, because pesticides can be absorbed into the body through the skin. Change and launder clothing and bathe daily.
3. Wear a respirator when loading or mixing concentrates and whenever pesticides may be inhaled.
4. Keep your pesticide storage area locked.
5. Do not smoke, chew tobacco, or eat while spraying. Wash hands before engaging in these activities.
6. Mix pesticides according to directions and precisely apply the recommended rate.
7. Experience shows that poisoning occurs most often in hot weather. Spraying with more toxic materials should be done during cooler periods when possible. Take extra care when spraying during hot weather.
8. Forage and crops treated with some herbicides can not be harvested or grazed by livestock for a specific time period. Check the label and follow harvest and grazing guidelines.
9. When applicable, follow Worker Protection Standards when applying herbicides.

7.3 Protective Clothing and Equipment

In 1990, there were 57,248 reported accidental poisonings and 21 deaths nationwide from agricultural chemicals (fungicides, pesticides, insecticides, and herbicides). In 2012 89,000 accidental pesticide poisonings were reported to the Centers for Disease Control. The Environmental Protection Agency has developed guidelines for the use of Personal Protective Equipment. Labels on chemicals will list the specific pieces of protective gear necessary for minimum protection for the user. This clothing usually includes one or all of the following: gloves, goggles, face-mask, respirator, hard hat, waterproof boots, pants, or hat.

These special precautions are based on the assumption that each person will be appropriately dressed on all occasions when using pesticides. It is obvious that open or porous-weave clothing; bare arms, chest, or legs; and bare feet, sandals, or sneakers provide no protection at all from drift, spills, or other exposure to pesticides.

The minimum dress acceptable for personal protection and for maintenance of good discipline in handling pesticides includes: long-sleeved, closely-woven shirts, long-legged trousers, work-boots, a hat with a brim capable of protecting the back of the neck, and waterproof gloves (waterproof means chemically resistant; the gloves can be made from various synthetic materials). The importance of gloves cannot be overemphasized. Exposure studies of handlers and sprayers repeatedly show that by far the greatest risk of exposure to pesticides occurs on the hands. If a person works daily in the application of pesticides, basic safety disciplines (and basic sanitation concepts) also require that the person bathe and launder clothes daily.

Remember that these are minimum safety requirements. “Rubber” (chemically resistant) boots, apron, jacket and trousers, and goggles, face mask, or respirator should be added if one is specifically mixing and loading certain pesticides.

7.3.1 Preventing Skin Exposure

The skin is extremely sensitive to the toxic effects of pesticides. The vast majority of all accidents using chemicals are exposures to the skin. Most exposures result in a rash-type outbreak, ranging from minor irritation to painful burning, but skin exposures may also lead to more serious poisonings over time. For these reasons, take particular care to protect your skin from contact with pesticides. Regardless of the pesticide being used, 98 percent of all accidental skin exposures can be avoided by wearing extra-long, unlined nitrile or neoprene gloves.

If you are handling pesticides above your head, place the cuff of your shirt inside the cuff of the glove. If you are handling chemicals below your head, place the cuff of your shirt outside the glove. This helps prevent spills from running into your shirt sleeves and onto your arm.

(Always check for leaks in the gloves by filling them with water and squeezing to find any holes. Discard leaky gloves.) Never wear leather or lined gloves, because these types will soak up the chemicals and concentrate them on your hands. For the same reason, never wear leather or lined boots. Rubber or chemical-resistant boots or boot coverings are a must.

Also, when coveralls are called for, wear some that are loose-fitting and chemical-resistant. This may be a laminated, woven garment or a PVC garment. To stay somewhat cooler, you may elect to wear a two-piece, chemical-resistant suit--but make sure the coat is long enough to reach over the waist of your pants. This also helps protect your body from splashes and spills.

When a chemical-resistant apron is called for, wear one that covers the front of your body from chest to knees.

Finally, wear a chemical-resistant hat when you might be handling pesticides above your head. Your protective hat should be wide-brimmed to prevent any high splashes from landing on your face or neck.

7.3.2 Preventing Eye Exposure

The eyes are an extremely sensitive and fragile area of the human body. If you do not wash out your eyes immediately after an accidental chemical exposure in them, eyesight can be permanently lost within 2 minutes with certain chemicals. A little prevention can go a long way. A pair of indirectly vented goggles will provide adequate protection for your eyes. If foggy lenses are a concern, a full-face shield will protect the eyes just as well as goggles and will cover exposed areas of the face. Keep an eye-washing station set up or keep a personal eyewash bottle handy to flush out your eyes in case there is some chemical splashed into your eye.

7.3.3 Preventing Lung Exposure

Breathing in a chemical is another route for accidental poisonings, and your lungs must be protected as are other parts of your body. When the chemical label calls for a respirator, always wear a **NIOSH-approved respirator**. (Other designs may not be of top quality and may be less dependable.) Also, be sure that the chemical cartridges in the respirator are firmly in place and are the correct ones for the job. For example, the proper cartridge for pesticides is black and is marked for "organic fumes." For ammonia, the correct cartridge is green and is marked for "ammonia."

When choosing a respirator, remember that one made of silicone is more comfortable than one made of black rubber. A comfortable piece of protective equipment is more likely to be worn than one (respirator) heavy and difficult to use.

7.3.4 Preventing Oral Exposure

There are no specific pieces of safety equipment to help protect the mouth. The full-face shield or the respirator are excellent pieces for keeping chemical splashes out of the mouth. Soap and water are the best way to prevent oral exposure to a chemical. Always wash your hands with hot, soapy water before you eat, drink, or smoke, and never wipe your mouth or face while you are working with chemicals.

7.3.5 Additional Personal Protective Equipment in Certain Mixing and Loading Situations

7.3.5.1 Front protection

If you may be splashed during mixing or loading tasks, or if you will need to lean against contaminated equipment during mixing or loading, consider wearing a bib-top apron made of butyl, nitrile, or foil-laminate material. The style of apron that includes built-in gloves and sleeves is especially protective. An apron:

- keeps pesticides off the front of your clothing,
- is cooler than a chemical-resistant protective suit, and
- is easily removed at the end of the activity.

7.3.5.2 Face protection

If you will be pouring liquid pesticides or adding dry pesticides to a liquid, consider wearing a face shield to keep splashes and wafting dusts off your face and out of your nose and mouth. A face shield is easy to put on, take off, and clean at the end of the day. If you need to wear a respirator, goggles or shielded safety glasses will fit better than a face shield.

7.3.5.3 Protection from dusts

When you will be pouring dusts for long periods of time or working under conditions where dusts might swirl up into your face, consider wearing a dust/mist filtering respirator to keep from inhaling the dusts. Choose a dust/mist respirator with NIOSH/MSHA approval. Also wear eye protection, such as shielded safety glasses, goggles, or a face shield, to keep the dusts out of your eyes.

7.3.5.4 Protection from vapors

If you will be handling pesticides that produce vapors that may cause your eyes, nose, or throat to sting or that may cause you other discomfort, wear eye protection and a vapor-removing respirator with NIOSH/MSHA approval.

7.3.6 Additional Protection for Some Types Of Pesticide Application Tasks

7.3.6.1 Hand-carried application equipment

When you carry the application equipment, such as hand-held sprayers, you risk being directly exposed to the pesticide. A dripping or partially clogged nozzle, an unfastened cap, a leaky hose, or a loose connection are extremely likely to cause exposure. Consider wearing extra personal protective equipment to protect the area of your body that is in contact with the equipment.

If the application equipment is carried in front, consider wearing a sleeved apron, an apron with built-in gloves and sleeves, or an apron plus arm-covering gloves to protect your front from leaks, drift, and splashes.

If the application equipment is a type that is carried on your back, such as backpack, knapsack, or trombone-style sprayers or dusters, consider wearing a cape to protect your back and shoulders from leaking equipment.

If you carry only the nozzle, consider wearing arm-covering gloves or elbow-length gloves with the cuffs taped or otherwise sealed to the coverall sleeve.

7.3.6.2 Entering the path of the released pesticide

Many applications performed while on foot cause you to walk into the path of the pesticide you are releasing. Whenever possible, apply pesticides so that you are backing into the untreated area, away from where the pesticide is being released. However, under many conditions, it is unsafe to walk backward in an application site.

If you must walk into the path of the released pesticide, consider wearing shin-high or knee-high boots, or protective footwear with chemical-resistant pants. Spraying a thick coating of fabric starch or fabric stain protectant on the lower legs of your coveralls can provide a temporary barrier for low-toxicity pesticides and also makes the coveralls easier to clean.

When applying pesticides from a vehicle, use equipment that releases the pesticide to the rear so that you are located in front of and above the area of release and are moving away from it.

Whether you are walking or riding, if the pesticide is not directed downward or if it remains suspended in the air long enough to cause exposure to the front of your body, wear an apron or chemical-resistant suit. If the pesticide mist or dust reaches as high as your face, consider a dust/mist respirator and eye protection.

7.3.6.3 Walking into a just-treated area

Even when you apply a pesticide from a vehicle, you may need to walk into an area that was just treated. For example, you may need to repair or adjust the equipment or check

the pesticide dispersal. You probably will be climbing over a contaminated rig and walking through an area that was treated only moments before. Consider putting on additional personal protective equipment while you are out of the vehicle.

If the vegetation in the treated area is covered with pesticide spray or dust and is fairly short, consider shin-high or knee-high boots, or protective footwear with chemical-resistant pants. In this situation, as with walking into the path of the released pesticide, consider applying spray starch or fabric stain protector to pant legs. In taller vegetation consider wearing a chemical-resistant suit in addition to the footwear.

If spray is dripping or dust is falling from overhead, consider a hood or wide-brimmed hat in addition to the body protection and footwear. A dust/mist respirator and protective eyewear may be necessary, too.

7.3.6.4 High-exposure applications

Certain types of pesticide applications pose a special exposure risk because they engulf you in pesticide fallout. They include:

- mist blower or airblast applications,
- aerosol and fog applications, especially indoors,
- some applications using high-pressure sprayers and power dusters,
- applications directed upward over your head, such as to tree canopies or roof eaves, or
- aerial applications that use human flaggers to mark the swath.

Whenever you work in these situations, large amounts of pesticide fallout are likely to be deposited on your skin and clothing, often to the point of completely drenching or covering you. Unless you are in an enclosed cab, you cannot avoid this exposure, even if you perform the application during times of little or no air currents.

In these situations, you should wear more personal protective equipment than the pesticide labeling requires for other types of applications. Only a chemical-resistant suit with a hood, gloves and footwear with sealed cuffs, and a full-face respirator or half-face respirator with sealed goggles can provide enough protection for these high-exposure applications.

7.3.6.5 Adjusting pesticide-coated equipment

Be sure to wear gloves and in some cases a protective apron while doing types of equipment adjustments and repairs.

7.3.6.6 Applying in air currents

Do not apply most herbicides in wind conditions greater than 10 mph. If you will be applying herbicides into or across wind or air currents, consider wearing extra

personal protective equipment because chemical may be blown onto you. More body protection, protective eyewear, and a dust/mist filtering respirator may be appropriate.

7.3.6.7 Applying concentrates

You may be exposed to highly concentrated pesticides during some applications. Consider using extra personal protective equipment when applying concentrates, such as that required for mixing and loading of those formulations.

7.3.6.8 Immersing hands and forearms

Some application techniques, such as animal, plant, or seed dipping vats and spray-dip machines, require you to place your hands and forearms into the pesticide liquid or dust. With this exposure, consider a sleeved apron for full front and arm protection, and protective footwear. A face shield will protect against splashes or drifting dusts.

7.4 Personal Cleanup

When you finish working with pesticides or pesticide-contaminated equipment, take time for personal cleanup. Wash the outside of your gloves and boots first, before taking them off.

Then carefully peel back your personal protective equipment to avoid getting pesticides on your skin. Remove any other clothing that has pesticide on it.

If you cannot take a shower right away, use mild liquid detergent and warm water to wash your face, hands, forearms, and any other area that may have pesticide on it. As soon as you can – no later than the end of the workday – wash your whole body and hair thoroughly with a mild liquid detergent and plenty of water.

When you remove your personal protective equipment and work clothing put it in a plastic box or bag until it can be laundered. Do not allow children or pets to play with these items. Do not wash work clothing and personal protective equipment in the same wash water with the family laundry. Presoak work clothes with a little bleach or baking soda. The clothes need at least one hot water cycle, then line-dried. This helps keep the dryer from being contaminated and allows the sun to break down any remaining chemicals in the fabric. Flush out the washer by running an "empty load" through the washer's cycles.

7.5 Health Hazards & Pesticide Poisoning

Each season there are accidents, and in some years deaths, attributable to the misuse of pesticides. In case of accidents involving toxic pesticides, see your doctor at once. Your doctor may call one of the Consultation or Poison Control Centers. It will be of great help to your doctor to know exactly what pesticide was involved. The label on the container gives this information. Take along the entire pesticide container, or try at least to have the trade name of the pesticide and the EPA registration number.

7.5.1 Types of Injuries

If someone does suffer ill effects from an accidental exposure to pesticides, his or her symptoms probably will fall into three general categories: heightened sensitivity, acute illness, or chronic illness.

HEIGHTENED SENSITIVITY is an allergic reaction on an area of skin. Over time, a pesticide handler may develop an allergy to a chemical he/she has worked with for several years. A rash may develop on any area of skin that contacts the chemical. Another type of sensitivity is called photosensitivity. In this case, pesticide residues left on the skin react with sunlight to form rash-like areas. Photosensitive reactions on children whose fathers worked with pesticides have been mistaken for and reported as child abuse. (Since the reddened area burned and was in the distinct shape of an adult hand, school and health-care officials were sure the child had been beaten.)

ACUTE INJURY, appearing shortly after the exposure, is a common type of pesticide injury. Acute injuries are the immediate or near-immediate effects of accidental swallowing, skin contamination, or breathing toxic fumes. A skin contamination that is ignored or not dealt with in time may cause a skin rash in the exposed area.

Accidentally swallowing a pesticide or inhaling the fumes can cause a loss of consciousness and death. Although loss of consciousness and death are usually associated with swallowing or breathing the pesticide, they can be the result of an extreme skin contamination that was not washed or treated properly.

The less common form of injury due to pesticide poisoning is **CHRONIC (LONG- TERM) INJURY**. This type injury may require weeks, months, or even years after the initial exposure to the pesticide to develop symptoms. Chronic illnesses from pesticides may result in tumors or various cancers. However, over time, frequent minimal exposures to a pesticide can build up in the body and cause an acute reaction, e.g., an attack on the nervous system or lung failure. For these reasons, a pesticide handler must prevent exposures to a pesticide even if there are no visible signs of poisoning.

7.5.2 Blood Tests

Blood enzyme tests can determine if you have any pesticide buildup in your body. An enzyme, cholinesterase, is contained naturally in the blood at levels that vary from one person to another.

It is important to establish an enzyme "baseline" at a time of the year when pesticide handling is minimal (January or February). The baseline helps determine the level of cholinesterase normal for you. Other tests throughout the year indicate what types of danger another exposure could set off. See your doctor to set up a test for your cholinesterase determination.

7.5.3 Pesticide Poisoning: Recognition, Basic First Aid & Prevention

These general guidelines are for all pesticides.

7.5.3.1 Symptoms of Pesticide Poisoning

It is important to recognize the symptoms of chemical poisoning before irreversible damage occurs. Symptoms of pesticide poisoning are listed below. Symptoms of swallowed and inhaled pesticides are generally the same, but inhalation may hurry the effects of poisoning, which include:

<i>Headache</i>	<i>Nausea</i>	<i>Dizziness</i>
<i>Muscle twitching</i>	<i>Weakness</i>	<i>Vomiting</i>
<i>Coma</i>	<i>Convulsions</i>	<i>Pinpoint pupils</i>
<i>Blurred vision</i>	<i>Excessive tearing</i>	<i>Salivation</i>
<i>Sweating</i>	<i>Tightness in chest</i>	<i>Rapid heartbeat</i>
<i>Elevated blood pressure</i>	<i>Rashes</i>	<i>Reddening of skin</i>
<i>Abdominal cramps</i>	<i>Diarrhea</i>	<i>Tremors</i>
<i>Muscle twitching</i>	<i>Muscle weakness</i>	<i>Blisters</i>

If any of these symptoms appear, the victim must receive medical treatment. Delays after the symptoms appear cost valuable time and could mean the difference between life and death.

Should you or a fellow worker accidentally be exposed to a pesticide, it is critical you know first aid procedures to avoid additional dangers. Handling a pesticide poisoning situation wisely can lessen the effects of the exposure and possibly could save your life or that of a co-worker.

7.5.3.2 Basic First Aid

The first and most important step in first aid happens before anyone is exposed to a pesticide. That is, you must read and understand the pesticide label to know what the risks are and to be able to act accordingly. Labels provide information on preventing accidents, and the labels provide necessary steps to follow should there be an accident involving chemicals.

Take the pesticide label to the medical staff, because the label contains specific instructions for doctors to use in treating poisoning emergencies. It can be difficult to run medical tests to determine in a short time the type of chemical exposure the victim has experienced. These tests use valuable time that could be used to treat the victim.

Remember, treatment for one type of pesticide poisoning may aggravate or increase the harmful effects of a different chemical. The only way to know which treatments are helpful and which may be harmful is to read the label before a problem occurs.

If you are accidentally exposed to a chemical:

- **Eyes** -- It is most important to wash the eye out quickly but as gently as possible.
 - ✓ Hold eyelids open and wash eye with a gentle stream of clean running water.
 - ✓ Continue washing for fifteen minutes or more. It is important to use a large volume of water. If possible, at least five gallons should be used to flush the eye properly.
 - ✓ Do not use chemicals or drugs in wash water. They may increase the extent of the injury.
 - ✓ Cover the eye with a clean piece of cloth and seek medical attention immediately.
- **Clothing** -- Immediately remove any contaminated clothing.
- **Skin** -- The faster the poison is washed off the patient, the less injury that will result.
 - ✓ Drench skin and clothing with water (shower, hose, faucet, pond).
 - ✓ Remove clothing.
 - ✓ Cleanse skin and hair thoroughly with soap and water. Detergents and commercial cleansers are better than soap.
 - ✓ Dry and wrap in a blanket.
- If a chemical is swallowed, read the chemical label or MSDS for instructions concerning induced vomiting. See a doctor.
- Take the product's label to your doctor or other medical facility when you seek treatment.

SWALLOWED PESTICIDE

Swallowing a pesticide is a serious situation. The decision you must make with this accident is whether or not to induce vomiting. Again, read the label and get immediate medical attention.

But you should know this:

- **Never** induce vomiting if the victim is unconscious or is having convulsions. The victim could choke to death on the vomitus.
- **Never** induce vomiting if the victim has swallowed a corrosive poison. Find out what poison the person has ingested. A corrosive poison is strong acid or alkali. The victim will complain of severe pain and will show signs of severe mouth and throat burns. A corrosive poison will burn the throat and mouth as severely coming up as it did going down. Dilute the poison as quickly as possible. For acids or alkalis, use milk or water. For patients one to five years old, use one to two cups; for patients five years and older, use up to one quart. For acids, milk of magnesia may also be used (two tablespoons in one cup of water).
- **Never** induce vomiting if the person has swallowed petroleum products such as kerosene, gasoline, oil, or lighter fluid. Most pesticides which come in liquid formulations are dissolved in petroleum products. The words "emulsifiable concentrate" or "solution" on the pesticide label are signals NOT to induce vomiting in the poison victim if he has swallowed the concentrates. Concentrated petroleum products (like corrosive poisons) cause severe burns. They will burn as severely when vomited up. If he has swallowed a dilute form of these formulations, he should be forced to vomit immediately.

To care for the victim:

- If pesticide is still in the mouth, wash it out with plenty of water.
- Quickly but accurately read the **First Aid** section of the label again to see if the swallowed chemical should be diluted. When swallowed, some chemicals should be diluted with water or milk. Other chemicals should never be diluted; again, the label provides the information.
- Check to see if vomiting should be induced. **Do not waste a lot of time inducing vomiting. Use it only as first aid until you can get the victim to a hospital. Make sure the victim is lying face down or kneeling forward while retching or vomiting. Do not let him lie on his back, because vomitus could enter the lungs and do more damage.** Ipecac syrup can be used to induce vomiting. If it is not available, put your finger in the victim's mouth and touch the back of the victim's throat. Do not use salt water to induce vomiting or attempt to give liquids.

How to Induce Vomiting

- ✓ First give the patient large doses of milk or water. One to two cups for victims up to five years old; up to a quart for victims five years and older.
- ✓ If victim is alert and respiration is not depressed, give syrup of ipecac followed by one to two glasses of water to induce vomiting. Adults (twelve years and over): 30 ml (two tablespoons); children under twelve years: 15 ml (one tablespoon). Activity hastens the effect of the syrup of ipecac.
- ✓ Collect some of the vomitus for the doctor they may need it for chemical tests

- Do not induce vomiting if the victim is unconscious, because the victim could choke.
- First aid for some chemicals includes giving activated charcoal after vomiting. (Activated charcoal adsorbs many poisons and is available without a prescription. It is a powder mixed with water and given to the victim to drink.) Do not give activated charcoal and ipecac syrup at the same time; the charcoal adsorbs the syrup, and any good effects are wasted.
- Keep the victim calm and take him/her to the hospital. Also take the product label and any Material Safety Data Sheets you have about the swallowed pesticide.

INHALED PESTICIDE

An inhaled pesticide presents a different problem but is just as serious. Breathing a pesticide can hurry the effects of poisoning--quick action is a must.

- If victim is in an enclosed space, do not go in after him unless you are wearing an air-supplied respirator.
- Carry patient (do not let him walk) to fresh air immediately.
- Open all doors and windows.
- Loosen all tight clothing.
- Apply artificial respiration if breathing has stopped or is irregular.
- Keep victim as quiet as possible.
- If victim is convulsing, watch his breathing and protect him from falling and striking his head. Keep his chin up so his air passage will remain free for breathing.
- Prevent chilling (wrap patient in blankets but don't overheat).
- Do not give the victim alcohol in any form

CHEMICAL BURNS OF THE SKIN

The hands and forearms account for 95 percent of all skin exposures. Usually these exposures are caused by splashes or spills that occur while mixing the chemicals.

- Wash with large quantities of slow running water.
- Remove contaminated clothing.
- Immediately cover loosely with a clean, soft cloth.
- Avoid use of ointments, greases, powders, and other drugs in first aid treatment of burns.

- Recognize the signs of pesticide poisoning and know first aid treatment for it.
- Know the importance of a pesticide first aid kit and what it should contain.
- Understand the importance of poison control centers and how to get immediate information on types of poisonings and their treatment.

Whenever the pesticide application is completed or interrupted for a time, follow these same steps whether or not you were accidentally exposed. Follow the same steps before going home. Do not expose your family to the pesticides you have used during the day. (A child's skin is more sensitive to chemicals than is an adult's.)

SHOCK

Sometimes poisoning victims go into shock. If untreated or ignored, the victim can die from shock even if the poisoning injuries would not be fatal.

- The skin will be pale, moist, cold and clammy. The eyes are vacant and lackluster with dilated pupils. The breathing will be shallow and irregular. The pulse is very weak, rapid and irregular. The victim may be unconscious or in a faint.
- Unless he is vomiting, keep the victim flat on his back with his legs up
- 1-1 1/2 feet above his head.
- Keep the victim warm enough to prevent shivering. Do not overheat.
- Keep the victim quiet and reassure him often.

7.5.3.3 Prevention

A well equipped first aid kit which is always readily available can be important in a pesticide emergency. Make up your own pesticide first aid kit from a lunch pail, tool box, or a sturdy wooden box. It should have a tight fitting cover with a latch, so that it won't come open or allow pesticides to leak inside. Label it clearly with paint or a water proof marker.

Contents

- A small plastic bottle of a common Detergent. It is used to wash pesticides quickly off the skin.
- A small package or bag of Activated Charcoal . Mixed with water and swallowed, activated charcoal acts as an absorber of all pesticides.
- A Shaped Plastic Airway for mouth-to-mouth resuscitation.
- A thermos or large plastic bottle (at least one quart) of Clean Water. If there is no clean water in an emergency, use any pond or stream water that is available.
- Simple Band Aids, Bandages and Tape. All cuts and scrapes should be covered to prevent pesticides from easily entering the body.
- A Blanket is very useful. It should be kept in a place where it will not be

contaminated by pesticides.

- Suitable Coins should always be taped to the inside cover of the first -aid kit. They are for an emergency phone call.
- A small, plastic Empty Jar with a tight fitting lid is useful as a drinking glass for the victim, in order to induce vomiting or feed activated charcoal. It can also be used for collecting vomitus to take to the doctor.

All pesticides have the potential to cause bodily harm, but used properly, they pose no special hazard. **Always read the label and follow all instructions when using any chemical.**

7.6 Handling Pesticides Safely

7.6.1 Transportation

You are responsible for the safe transport of pesticides in your possession. Carelessness in transporting pesticides can result in broken containers, spills, environmental contamination, and harm to yourself and others. Accidents can occur even when transporting materials a short distance. Do all you can to prevent a mishap, but be prepared in case of emergency.

Before transporting pesticides, know what to do if a spill occurs. If any pesticide is spilled in or from the vehicle, take action right away to make sure the spill is cleaned up correctly.

The safest way to transport pesticides is in the back of a truck. Flatbed trucks should have side and tail racks. Steel or plastic-lined beds are best because they can be more easily cleaned if a spill occurs.

- **Never** carry pesticides in the passenger section of your car, van, or truck. Hazardous vapors may be released and make the driver and other passengers ill. Some pesticides may cause illness or injury if they spill on you or your passengers. It is nearly impossible to completely remove spills from the fabric of seats and floor mats. They can cause future contamination if they are not cleaned up correctly.
- **Never** allow children, other passengers, and pets to be exposed to pesticides during transportation.
- **Never** transport pesticides with food, clothing, or other things meant to be eaten by or come into contact with people or animals. The risk of contamination is too high. Even small amounts of pesticide could contaminate these highly sensitive items.
- **Never** leave your vehicle unattended when transporting pesticides in an unlocked trunk compartment or open-bed truck. You are responsible and liable if curious children or careless adults are accidentally injured by the pesticides. Whenever possible, transport pesticides in a secure compartment.
- **Consider** transporting highly volatile pesticides in separate trips from other chemicals. Spills, or even fumes from opened containers, can make the other chemicals worthless.

Transport pesticides only in containers with intact, undamaged, and readable labels. Inspect containers before loading to be sure that all caps, plugs, and other openings are tightly closed and that there are no pesticides on the outside of the containers. Handle containers carefully to avoid rips or punctures.

Anchor all containers securely to keep them from rolling or sliding. Packing or shipping containers provide extra cushioning. Protect paper and cardboard containers from

moisture, because they become soggy and split easily when wet.

Protect pesticides from extreme temperatures during transport. Extremely hot or cold temperatures can damage pesticide containers by causing them to melt or become brittle. Such temperatures also may reduce the usefulness of the pesticides.

7.6.2 Storage

Always store pesticides in a locked building away from people and animals. The shed or building should have a cement floor and be well ventilated. Always store pesticides in the original container and do not contaminate food or feed. Keep all pesticides out of the reach of children. Never use a pesticide that is in an unlabeled container.

Many weed districts use existing buildings or areas within existing buildings for pesticide storage. However, if large amounts of pesticides will be stored, build a special storage building to reduce exposure.

A correctly designed and maintained pesticide storage site is essential. A suitable storage site:

- protects people and animals from accidental exposure,
- protects the environment from accidental contamination,
- prevents damage to pesticides from temperature extremes and excess moisture,
- protects the chemicals from theft, vandalism, and unauthorized use, and
- reduces the likelihood of liability.

1. Secure the site

Keeping out unauthorized people is an important function of the storage site. Whether the storage site is as small as a cabinet or closet or as large as an entire room or building, keep it securely locked. Post signs on doors and windows to alert people that pesticides are stored there. Post "No smoking" warnings.

2. Prevent water damage

Choose a storage site where water damage is unlikely to occur. Water from burst pipes, spills, overflows, excess rain or irrigation, or flooding streams can damage containers. Water or excess moisture can cause:

- metal containers to rust,
- paper and cardboard containers to split or crumble,
- pesticide labeling to peel, smear, run, or otherwise become unreadable,
- dry pesticides to clump, degrade, or dissolve,

- slow-release products to release their pesticide, and
- pesticides to move from the storage site into other areas.

If the storage site is not protected from the weather or if it tends to be damp, consider placing metal, cardboard, and paper containers in sturdy plastic bags or cans for protection. Large metal containers, which may rust when damp, often can be placed on pallets within the storage site.

3. Control the temperature

Choose a cool, well-ventilated room or building that is insulated or temperature-controlled to prevent freezing or overheating. The pesticide labeling may tell you at what temperature the product should be stored. Freezing temperatures can cause glass, metal, and plastic containers to break. Excessive heat can cause plastic containers to melt, some glass containers to explode, and some pesticides to volatilize and drift away from the storage site.

Temperature extremes can destroy the potency of some pesticides.

4. Provide adequate lighting

The storage site should be well lighted. Weed district personnel using the facility must be able to see well enough to:

- read pesticide container labeling,
- notice whether containers are leaking, corroding, or otherwise disintegrating, and
- clean up spills or leaks completely.

5. Use nonporous materials

The floor of the storage site should be made of sealed cement, glazed ceramic tile, no-wax sheet flooring, or another easily cleaned material. Carpeting, wood, soil, and other absorbent floors are difficult or impossible to decontaminate in case of a leak or spill. For ease of cleanup, shelving and pallets should be made of nonabsorbent materials such as plastic or metal. If wood or fiberboard materials are used, they should be coated or covered with plastic, polyurethane or epoxy paint.

6. Prevent runoff

Inspect the storage site to determine the likely path of pesticides in case of spills, leaks, drainage of equipment wash water, and heavy pesticide runoff from firefighting or floods. Pesticide movement away from the storage site could contaminate sensitive areas, including surface water or ground water. If your storage site contains large amounts of pesticides, you may need to use a collection pad to contain runoff.

7. Provide clean water

Each storage site must have an immediate supply of clean water. Potable running water is ideal. If running water is not practical, use a large, sealable container with clean water. Change the water at least weekly to ensure that it remains safe for use on skin and eyes. Keep an eyewash dispenser immediately available for emergencies.

8. Prevent contamination

Store only pesticides, empty pesticide containers, application equipment, and a spill cleanup kit at the storage site. Do not keep food, drinks, tobacco, feed, medical or veterinary supplies or medication, seeds, clothing, or personal protective equipment (other than personal protective equipment necessary for emergency response) at the site. These could be contaminated by vapors, dusts, or spills and cause accidental exposure to people or animals.

9. Keep labels legible

Store pesticide containers with the label in plain sight. Costly errors can result if the wrong pesticide is chosen by mistake. Labels should always be legible. They may be damaged or destroyed by exposure to moisture, dripping pesticide, diluents, or dirt. You can use transparent tape or a coating of lacquer or polyurethane to protect the label. If the label is destroyed or damaged, request a replacement from the pesticide dealer or the pesticide formulator immediately.

10. Keep containers closed

Keep pesticide containers securely closed whenever they are being stored. Tightly closed containers help protect against:

- a spill,
- cross-contamination with other stored products,
- evaporation of liquid pesticides or the solvent,
- clumping or caking of dry pesticides in humid conditions, and
- dust, dirt, and other contaminants getting into the pesticide, causing it to be unusable.

11. Use original containers

Store pesticides in their original containers. Never put pesticides in containers that might cause children and other people to mistake them for food or drink. You are legally responsible if someone or something is injured by pesticides you have placed in unlabeled or unsuitable containers.

12. Watch for damage

Inspect containers regularly for tears, splits, breaks, leaks, rust, or corrosion. When a container is damaged, put on appropriate personal protective equipment and take immediate action. When a container is damaged:

- Use the pesticide immediately at a site and rate allowed by the label, or
- Transfer the pesticide into another pesticide container that originally held the same pesticide and has the same label still intact, or
- Transfer the contents to a sturdy container that can be tightly closed. If possible, remove the label from the damaged container and use it on the new container. Otherwise, temporarily mark the new container with the name and EPA registration

number of the pesticide, and get a copy of the label from the pesticide dealer or formulator (whose telephone number is usually on the label) as soon as possible, or

- Place the entire damaged container and its contents into a suitable larger container. Consider this option carefully, however. Many times the label on the leaking container becomes illegible. The pesticide is useless and becomes a disposal problem unless you know the name and registration number and can get a copy of the label.

13. Store volatile products separately

Volatile pesticides, such as some types of 2,4-D, should be stored apart from other types of pesticides and chemicals. A separate room is ideal. Vapors from opened containers of volatile pesticides can move into other nearby pesticides and chemicals and make them useless. The labeling of volatile pesticides usually will direct you to store them separately from seeds, fertilizers, and other types of pesticides.

14. Isolate waste products

If you have pesticide or other pesticide containers that are being held for disposal, store them in a special section of the storage site. Accidental use of pesticides meant for disposal can be costly. Clearly mark containers that have been triple rinsed or cleaned by an equivalent method because they are more easily disposed of than unrinsed containers.

15. Know your inventory

Keep an up-to-date inventory of stored pesticides. Each time a pesticide is added to or removed from the storage site, update the inventory. The list will help you track your stock and will be essential in a fire or flood emergency. The inventory list also will aid in insurance settlements and in estimating future pesticide needs.

Do not store unnecessarily large quantities of pesticides for a long time. Buy only as much as you will need for a year. Pests, pesticides, or pesticide registrations may change by the next year and make the pesticides useless. Some pesticides have a relatively short shelf life and cannot be carried over from year to year.

16. Consider shelf life

Mark each pesticide container with the date of purchase before it is stored. Use older materials first. If the product has a shelf life listed in the labeling, the purchase date will indicate whether it is still usable. Excessive clumping, poor suspension, layering, or abnormal coloration may indicate that the pesticide has broken down. However, sometimes pesticide deterioration from age or poor storage conditions becomes obvious only after application. Poor pest control or damage to the treated surface can occur. If you have doubts about the shelf life of any pesticide, call the dealer or manufacturer for advice.

7.6.3 Mixing & Loading

Mixing and loading are among the most hazardous aspects of an applicators job. Handlers who mix and load concentrated pesticides with high acute toxicity have an especially high risk of accidental poisoning. By observing some simple precautions, you can reduce the risks involved in this part of your job.

1. Select an Appropriate Area.

Choose the pesticide mixing and loading area carefully. It should be outdoors or in a well-ventilated area away from unprotected people, animals, food, other pesticides, and other items that might be contaminated. Choose a place with good lighting. Be particularly careful not to mix or load pesticides indoors unless lighting and ventilation are adequate.

2. Protect Your Water Source.

Protect your water source by keeping the water pipe or hose well above the level of the pesticide mixture. This prevents contamination of the hose and keeps pesticides from back-siphoning into the water source. If you are pumping water directly from the source into a mix tank, use a check valve, anti-siphoning device, or backflow preventer to prevent back-siphoning if the pump fails.

Avoid mixing or loading pesticides in areas where a spill, leak, or overflow could allow pesticides to get into water systems. When mixing situations require you to use water from a faucet, well, stream, pond, or other water system, take special precautions. Place your mixing equipment where spills, leaks, and overflows will not flow toward a drain or into the water supply. If necessary, install dikes or other barriers, or grade the soil to divert the flow. If you will be mixing or loading at the site often, consider installing a collection pad or tray.

3. Opening Containers.

Do not tear paper or cardboard containers to open them. Use a sharp knife. Clean the knife afterward and do not use it for other purposes. Open pesticide containers only when they are sitting on a flat, stable surface. If they are tipped on an angle or are in an unstable position, they can easily spill over or leak out when the seal is broken.

4. Transferring Pesticides.

When pouring any pesticide from its container, keep the container and pesticide below face level. This will avoid a splash, spill, or dust from getting on your face or into your eyes and mouth. If there is a wind outdoors or a strong air current indoors, stand so the pesticide cannot blow back on you.

If you are siphoning the pesticide from the container to the tank, never use your mouth to get the siphon started. You could easily get a mouthful of pesticide.

5. Spills.

To prevent spills, close containers after each use. Even if you plan to mix more pesticide soon, close the container tightly each time. Never leave a tank unattended while it is being filled. It may overflow and contaminate the area.

If you splash or spill a concentrated pesticide on yourself while mixing or loading, stop right away and remove your contaminated clothing. Wash thoroughly with a mild liquid detergent (or soap) and water as quickly as possible. Put on clean personal protective equipment. Then clean up the spill.

6. Empty Pesticide Containers.

Even after it appears that all pesticide product has been removed from a container, it usually is not truly empty. The pesticide that clings to the inside of the container can pose a hazard to you, other people, and the environment. Take care of empty containers at once.

If containers are rinsable, triple-rinse or pressure-rinse them as soon as they are empty. The liquid you use for rinsing should be the diluent (water or another liquid) listed on the pesticide labeling for diluting the pesticide for application. After rinsing, add the rinsate to your pesticide mixture. Return rinsed pesticide containers to the pesticide storage area or the container holding area. Do not leave them unattended at the mixing, loading, or application site. Never give pesticide containers to other people for use (such as buckets).

If you have empty pesticide containers that cannot be refilled, reconditioned, recycled, or returned to the manufacturer, crush, break, or puncture them. This will make the containers unusable and may also save storage space. Dispose of containers in accordance with label directions and with federal, state, tribal, and local laws and regulations. *See guidelines for recycling containers in Montana.*

Pressure rinsing is an alternative to triple rinsing. Some pesticide equipment, including some closed system mixing and loading equipment, is equipped with a mechanism to pressure rinse pesticide containers when they are emptied. The system usually operates by:

- inserting a high-pressure nozzle and hose into the container,
- rotating the nozzle and rinsing for at least 30 seconds, and
- draining the container thoroughly into the mix tank.

Some systems puncture the base or side of the container to insert the nozzle. Other systems insert the nozzle into the container's regular opening.

7. Combining Pesticides

Weed districts often like to combine two or more pesticides and apply them at the same time. Such mixtures can save time, labor, and fuel. Manufacturers sometimes combine pesticides for sale as a pre-mix. Sometimes pesticide handlers combine pesticides at application.

Under federal law, combining pesticides is legal **unless the pesticide labeling of any of the pesticides involved instructs you not to combine them**. However, not all pesticides work well when mixed together. They must be compatible -- that is, mixing them together must not reduce their safety or effectiveness. The more pesticides you mix together, the greater the chance of undesirable effects.

Some pesticide mixtures that are physically incompatible make the mixture difficult or impossible to apply and may clog equipment, pumps, and tanks. These reactions sometimes cause the pesticide to form lumps or gels, to become solids that fall to the bottom of the mix tank, or to separate into layers that cannot be remixed.

Sometimes the combined pesticides create a chemical reaction that cannot be seen by looking at the mixture. However, the chemical change can result in:

- loss of effectiveness against the target pests,
- increased toxicity to the pesticide handler, and
- injury to the treated surface.

Some pesticide labeling lists pesticides (and other chemicals) known to be compatible with that formulation. Compatibility charts are available in some pest management recommendations, pesticide trade publications, and Cooperative Extension or industry recommendations. If you cannot find a chart that lists the compatibility of the two pesticides (or the pesticide and other chemical) that you wish to mix, test a small amount of the mixture before you mix large quantities.

8. Compatibility testing

First, put on personal protective equipment. Wear at least the equipment required by the labeling of any of the pesticides to be combined; protective eyewear; and chemical-resistant gloves and apron, both preferably made of foil laminate. Get a large, clean, clear glass container, such as a quart jar. Use the same water (or other diluent) that you will use when making up the larger mixture. Add the water and each of the products in the same proportions as you will mix them. Unless the pesticide labeling states otherwise, add pesticides to the diluent (usually water) using the "W-A-L-E" plan:

1. Add some of the diluent first.
2. Add **Wettable** and other powders and Water-dispersible granules.
3. **Agitate** thoroughly and add the remaining diluent.
4. Add the **Liquid** products, such as solutions, surfactants, and flowables.
5. Add **Emulsifiable** concentrates last.

Shake the jar vigorously. Feel the sides of the jar to determine if the mixture is giving off heat. If so, the mixture may be undergoing a chemical reaction and the pesticides should not be combined. Let the mixture stand for about 15 minutes and feel again for unusual heat.

If scum forms on the surface, if the mixture clumps, or if any solids settle to the bottom (except for wettable powders), the mixture probably is not compatible. Finally, if no signs of incompatibility appear, test the mixture on a small area of the surface where it is to be applied.

7.6.3.1 Closed Mixing and Loading Systems

A *closed mixing and loading system* is a system designed to prevent pesticide from coming in contact with handlers or other persons during mixing and loading. The labeling of some pesticides requires you to use a closed mixing and loading system when handling the product. This requirement usually appears on products that have a high risk of causing acute effects or that may cause delayed effects.

There are two primary types of closed mixing and loading systems. One type uses mechanical devices to deliver the pesticide from the container to the equipment; the other type uses soluble packaging.

1. Mechanical systems

Mechanical systems are often a series of interconnected equipment that allows you to remove a pesticide from its original container, rinse the empty container, and transfer the pesticide and rinse solution to the application equipment without being exposed to the pesticide. The most common mechanical closed systems are used only with liquid formulations.

Closed mixing and loading systems are often custom-made, using components from several commercial sources. Because pesticide container openings, shapes, and sizes vary, no single closed system can be used with all containers. The mechanical systems now available remove the pesticide concentrate from the original container by gravity or by suction.

2. Gravity Systems

Gravity systems are sometimes called "punch and drain" systems. The unopened pesticide container is inserted into a chamber, which is then sealed. A punch cuts a large opening in the container, allowing all the material to drain into the mixing tank. A water nozzle attached to the punch sprays the inside of the container to rinse it thoroughly. The rinse water also drains into the mixing tank. The rinsed container is then removed for disposal.

A limitation of this system is that only full container quantities can be used. It is not possible to use part of the pesticide in a container and store the rest.

Gravity systems are available for use with both liquid and dry concentrates.

3. Suction Systems

Suction systems use a pump to remove the pesticide through a probe inserted into the container. Some containers are equipped with built-in probes. The pesticide is transferred

to the mixing tank by hose and pipe. When the container is empty, it and the transfer system are rinsed with water. The rinse water is added to the mixing tank.

To allow the use of only part of the pesticide in the container, the system must have a way to measure the amount of pesticide suctioned into the mixing tank and must allow the probe to remain in the container until all the pesticide is used and the container and probe can be rinsed. Some probes have a breakaway head that allows the head to stay and the probe to be withdrawn and reused.

Some suction systems do not permit the resealing of partially emptied containers. Another disadvantage of suction systems is that highly viscous pesticides (those that pour like molasses) are difficult to move by suction.

4. Soluble packaging

Soluble bags or containers are a much less complex type of closed-system mixing and loading. The pesticide package is designed to be placed, unopened, into the mixing tank. The container dissolves in the solvent (usually water) in the tank.

Disadvantages of soluble packaging include the risk of accidentally releasing the concentrate if the packaging is exposed to water or other solvents during shipping or storage, and the high risk of splashing as containers are added to the tank.

7.6.3.2 Pesticide Collection Pad or Tray

If you often mix and load pesticides in one place, or if you often clean equipment at one location, you may find a *pesticide collection pad or tray* a good investment. These pads and trays are designed to catch spills, leaks, overflows, and wash water and allow them to be recovered for reuse or disposal. Larger pads may be permanently installed, but smaller pads and trays can be portable.

These systems can save you time and money. They make spill cleanup easier, and they reduce pesticide waste by allowing you to reuse the rinse water and spill cleanup water. They also help prevent the harm that spills and runoff can cause to the environment or to people.

7.6.4 Equipment Cleaning, Maintenance, and Calibration

7.6.4.1 Cleaning

Always clean mixing, loading, and application equipment as soon as you finish using it -- do not leave equipment with pesticides on it or in it at the mixing and loading site or at the application site. When the job is completed and the tank or hopper is empty, return the equipment to the designated equipment cleanup area. Avoid washing equipment repeatedly in the same location unless you use a containment pad or tray. Over time, the

flooring or soil in a frequently used area can become contaminated with large amounts of pesticides. This contamination increases the likelihood of harmful effects to people and animals and increases the likelihood of runoff or leaching into water systems. Also avoid keeping pesticide-contaminated equipment in one location all the time. Pesticides may move off the outside of the equipment and onto the floor or soil.

Do not assign a worker to clean pesticide-contaminated equipment unless that person has been instructed in the basic rules of pesticide safety. Remember that equipment cleaning presents as great a risk of exposure to pesticides as do many other pesticide handling tasks and that all parts of the equipment are likely to have pesticides or pesticide residues on them. When you clean pesticide-contaminated equipment, wear the personal protective equipment that the labeling requires for handling jobs, plus a chemical-resistant apron.

BENEFITS OF CORRECT CLEANING

Sloppy cleanup practices are one of the main causes of equipment failure or malfunction. Never keep excess pesticides in your equipment for more than a short time. Even small amounts can damage equipment. Liquid pesticides left in the equipment may quickly corrode the equipment and clog or corrode the nozzle openings. They may cause the equipment to leak or cause the nozzles to release too little or too much pesticide when the equipment is operated. Some liquid pesticides change if they are stored after being diluted and will not be suitable for application later. Some will settle out and form a solid clump at the bottom of the tank that even mechanical agitation cannot remix. Others will separate into two or more liquids that cannot be remixed easily. Liquid pesticides that are allowed to stay in the equipment until they are totally dry may be impossible to remove completely.

Dry pesticides that become wet through humidity, rain, dew, or other moisture tend to clump and stick to the sides and hopper openings. They cannot be applied later, and cannot be easily removed from the equipment.

CLEANING PROCEDURES

(1) After the equipment is empty, clean both the inside and outside thoroughly, including nozzles or hopper openings. Sometimes you may need to use the diluent used in the pesticide mixture (kerosene or high-grade oil), special cleaning agents, or water under pressure. In other cases, ordinary water may be enough. (2) Collect the rinsate -- the liquid that results from the washing process. If you do not have a way to reuse or dispose of the rinsate, limit the amount of material you use, so you will create less waste. (3) Carefully wash any vehicles, such as vans and trucks, that may be used for transporting unprotected workers or for family use.

RINSATES

Remember that the rinsates you create when you clean your equipment contain pesticides and can harm people and the environment. Do not allow rinsates to flow into water systems, including sink or floor drains, rainwater culverts, wells, streams, lakes, and

rivers. Do not create puddles that children, other unprotected persons, or animals could get into. You may use equipment rinsate as a diluent for future pesticide mixtures, if:

- the pesticide in the rinsate is labeled for use on the target site where the new mixture is to be applied,
- the amount of pesticide in the rinsate plus the amount of pesticide product in the mixture does not exceed the labeling rate for the target site,
- the rinsate is used to dilute a mixture containing the same pesticide or a compatible pesticide,
- you comply with other application instructions specified on the labeling, including any specific labeling instructions for application as an excess pesticide.

The rinsate cannot be added to a pesticide mixture if:

- the pesticide labeling does not list the rinsate as an acceptable diluent; for example, if the rinsate contains a strongly acidic or alkaline neutralizing agent,
- the rinsate contains strong cleaning agents, such as bleach or ammonia, that might harm the plant, animal, or surface to which the pesticide will be applied,
- the rinsate would alter the pesticide mixture and make it unusable; for example, if the pesticides are physically or chemically incompatible.

If you have any rinsates that you **cannot** use, dispose of them as you would excess pesticides.

7.6.4.2 Maintenance**FIELD EQUIPMENT DAILY CHECK LIST**

Truck/ Equipment #		Mileage Start	
Operator		Mileage Finish	

√ = GOOD

+ = ADD

X= CHANGE

Daily Check

DATE	Oil	Coolant	Clean Glass	Tires	Brakes	Pump Oil	Mount Bolts	Hose	Gas

Weekly Check

Date	Grease	Tire PSI	Lights	Clean & Wash	Pump Oil Change	Other

Monthly Check

Date	Service	Oil Change	Oil Filter	Air Filter	Fuel Filter	Brake/ Clutch Fluids	Sprayer Screen

7.6.4.3 Calibration**BACKPACK SPRAYER CALIBRATION—NO MATH VERSION**

C. Duncan, revision 8/97

Step 1. Establish a calibration plot that is exactly

18.5 FEET WIDE X 18.5 FEET LONG

Step 2. Spray the calibration plot uniformly with water, noting the number of seconds required.TIME REQUIRED = ____
SECONDS**Step 3.** Spray into a bucket for the same number of seconds.**Step 4.** Measure the number of ounces of water in the bucket.

VOLUME SPRAYED = ____ OUNCES

Step 5. The number of ounces collected from the bucket is equal to the number of gallons per acre the sprayer is delivering.

GALLONS PER ACRE (GPA) = ____

ADD CORRECT AMOUNT OF HERBICIDE TO TANK FOR LIQUID HERBICIDE FORMULATIONS

Step 1: Record sprayer output in gallons/acre (calculated from Step 5 –calibration sheet)

OUTPUT (VOLUME) = _____ GPA

Step 2: Determine volume of a full spray tank

TANK VOLUME = _____ GALLONS

Step 3: From the herbicide label determine amount of herbicide concentrate to apply per acre

(PINTS OR QUARTS)

Step 4: Determine the amount of herbicide to add per gallon based on the following:

VOLUME GAL/ ACRE	AMOUNT OF HERBICIDE TO ADD TO EACH GALLON				
	RECOMMENDED HERBICIDE RATE/ ACRE				
	1 PINT	1 QUART	2 QUARTS	3 QUARTS	4 QUARTS
15	6 tsp	2 fl oz	4 fl oz	6 ¼ fl oz	8 ½ fl oz
20	5 tsp	10 tsp	3 ¼ fl oz	4 ¾ fl oz	6 1/3 fl oz
30	3 tsp	6 tsp	2 fl oz	3 ¼ fl oz	4 ¼ fl oz
40	2 1/3 tsp	4 ¾ tsp	1 2/3 fl oz	2 1/3 fl oz	3 ¼ fl oz
50	2 tsp	3 ¾ tsp	1 ¼ fl oz	2 fl oz	2 ½ fl oz
60	1 2/3 tsp	3 ¼ tsp	6 1/3 tsp	1 2/3 tsp	2 fl oz
70	1 1/3 tsp	2 ¾ tsp	5 ½ tsp	1 1/3 tsp	1 ¾ fl oz
80	1 ¼ tsp	2 1/3 tsp	4 ¾ tsp	7 ¼ tsp	9 ½ tsp
90	1 tsp	2 tsp	4 ¼ tsp	6 1/3 tsp	8 ½ tsp
100	1 tsp	2 tsp	3 ¾ tsp	5 ¾ tsp	7 2/3 tsp
120	¾ tsp	1 ½ tsp	3 tsp	4 ¾ tsp	6 tsp

Step 5: Calculate the amount of herbicide to add to each tank.

$$\text{___ AMOUNT OF HERBICIDE/ GALLON} \times \text{___ NUMBER OF GALLONS IN A TANK} =$$

___ TOTAL AMOUNT OF HERBICIDE TO ADD TO A TANK.

Example: You calibrate your sprayer and the output is 30 GPA, and your sprayer holds 3 gallons. You are spraying spotted knapweed and want a **herbicide application rate** of 1 pint/acre. Go to the chart and read across from 30 Gal/A - the amount of herbicide to add per gallon is 3 tsp. Since your sprayer holds 3 gallons of total solution you would add 9 tsp (3 TBS) of herbicide in addition to the water to each tank.

SECTION II – SPRAYER CALIBRATION

Proper sprayer calibration is an extremely important step in the application of herbicides. Often, sprayers are not calibrated properly, which results in poor weed control from under application, or crop damage from over- application. To know how much chemical to add to the sprayer tank, you need to know the capacity of the spray tank whether it is one gallon or 500 gallons. With this information you will know how many acres the pesticide mix in your tank will spray. You also need to be familiar with nozzles, boom width, pressure setting, pumping arrangement, and operating speed. These are all part of proper sprayer calibration.

There are several methods of sprayer calibration: the refill or field trial methods are probably the best known. However, the 1/128th method is probably one of the simplest. Numerous other methods not discussed here may be just as accurate or easy. However, it is important to pick a method you understand and use it for your sprayer calibration.

PRE-CALIBRATION PREPARATION

Before you go to the field, service the entire sprayer and determine exactly how much liquid the sprayer tank holds. Clean all lines and strainers, and make sure all strainers are the correct size and properly placed. Check pressure gauges against one known to be accurate. Check nozzles to be sure they are the same. Flat fan nozzles should be used for broadcast applications and even fan nozzles should be used for band applications. Check the flow from each nozzle. To check nozzle flow, collect the flow from each nozzle for 30 seconds into a calibrated container such as a measuring cup marked in ounces. Or use a tip tester; it quickly helps identify worn spray tips. Tip testers are

available from Spraying Systems Company or other agricultural outlets that carry pesticide application equipment. Clean or replace nozzles when the flow varies ± 5 percent from the flow from a new nozzle. Nozzles should only be cleaned with a soft-bristled brush such as a toothbrush, never with a metal object. Even a toothpick can damage plastic nozzles.

DETERMINING SPEED FOR CALIBRATION

Step 1: Determine the sprayer speed in miles per hour over a 200 foot distance. Maintain the desired speed and measure in “seconds” the time it takes the sprayer to travel the 200 foot distance (do this several times to get an average in your speed and to get used to a certain speed) write down this time down in seconds to travel.

This equals _____ seconds to travel 200 feet.

Step 2: Determine miles per hour by taking 200 feet \times 0.682 = _____ and divide by the seconds to travel the 200 feet into that number (0.682 is a constant used in the equations for speed in 200 feet).

This equals _____ miles per hour traveling.

REFILL METHOD

The refill method of calibration is simple and easy to understand. This should always be done in the field on terrain similar to where you plan to make the chemical application. Field surface conditions can seriously affect sprayer speed, which in turn affects spray rate. The basic steps for the refill method are as follows:

1. Fill the spray tank with water.
2. Adjust for pressure within the recommended range for nozzles used.
3. Select an easily maintained speed that fits field conditions.
4. Spray a measured area.
5. Return to the filling point.
6. Measure the amount of water required to refill the tank.
7. Calculate the spray rate.

CALIBRATION OF A BOOM/BOOMLESS SPRAYER METHOD #1

Calibration of a boom sprayer by the refill method follows the steps outlined above.

1. Park the sprayer on level ground, then fill the spray tank with water to an easily determined point. It may be a mark on the spray tank, the top of the tank fill hole, or some other point.
2. Adjust the pressure to the recommended level. Most nozzles used on field sprayers work best between 20 and 40 pounds per square inch pressure (psi). When spraying below 20 psi the spray pattern may be distorted, while pressures above 40 psi tend to increase spray drift. The manufacturer's handbook gives recommended pressures for each nozzle tip.

Slight increases or decreases in spray rate can be made by changing the pressure within the recommended range. Nozzle discharge varies with the square root of pressure. For example, doubling the pressure will only increase the nozzle delivery by 1.4 times, not twice. Large delivery rate changes should be made by changing the nozzles or adjusting the speed, not by increasing or decreasing the pressure outside recommended limits.

3. Select an easily maintained speed that fits field conditions. Field conditions can have a considerable effect on speed and may seriously affect spray delivery. A sprayer calibrated at 4 mph but driven at only 3 mph will over-spray by **33 percent**, enough of an error to cause **significant crop injury**.
4. Spray a measured area. First you must determine the area to be sprayed. This can be done by measuring the swath width. This is the width of the spray pattern on the ground. Use a long tape measure or multiply the nozzle spacing on the boom by the number of nozzles (divide by 12 to get the answer in feet if nozzle spacing was measured in inches). For example, if your boom has 18 nozzles spaced 20 inches apart, the swath width is: 20 inches x 18 nozzles ÷ 12 inches per foot = 30 feet. To determine the area to be sprayed for calibration, divide 43,560 square feet (the number of square feet in one acre) by the swath width. This will equal the number of feet that must be traveled in the field in order to spray one acre. If the distance is too long for convenience, any known distance can be used and the spray rate calculated. For example, 43,560 square feet = 30 feet by 1,452 feet. In other words, 1,452 feet must be traveled by a spray rig, with a 30-foot swath width, to spray one acre. If you travel 145.2 feet, you spray 0.1 acre.
5. Return to the filling point. Return to the same point that you filled the sprayer.
6. Measure the amount of water required to refill the tank. Use a calibrated pail to measure the amount of water required to refill the spray tank to the original level. The measured area should be sprayed two or three times to check the consistency of the sprayer output.

7. Calculate the spray rate. The final step is to determine the spray rate; in this case it will be in gallons per acre (gpa). Use one of the following formulas:

$$\text{gpa} = \frac{\text{gallons sprayed} \times 43,560 \text{ sq. ft/acre}}{\text{swath width (ft)} \times \text{swath length (ft)}}$$

or,

$$\text{acres sprayed} = \frac{\text{swath width (ft)} \times \text{swath length (ft)}}{43,560 \text{ ft/acre}}$$

therefore,

$$\text{gpa} = \frac{\text{gallons sprayed}}{\text{acres sprayed}}$$

These formulas can be used to calibrate any type of spray or granular application equipment, including aerial, where the amount of material applied on the calibration course is measured.

EXAMPLE: A field sprayer with a 30-foot swath width is operated for a distance of 1/4 mile (1,320 feet). Twenty (20) gallons of water are needed to refill the tank. What is the spray rate in gal/A? Answer: 22 gpa.

$$\text{gpa} = \frac{20 \times 43,560}{30 \times 1,320}$$

$$\text{gpa} = 22$$

Boom Height

Boom height is dependent on the type of nozzle you are using. For proper boom height the spray catalog should be consulted. However, if you are using flat fan spray nozzles with an 80-degree spray angle, the minimum boom height should be whatever the nozzle spacing is. For example, if your nozzles are set at 20-inch spacing, your nozzle tips should be set at a minimum of 20 inches apart above your target. The target is whatever you are spraying. It may be the bare ground or the top of the weed canopy. For example, when spraying weeds set your nozzle tips 20 inches above the top of the tallest weeds to ensure adequate coverage. If the tallest weeds are 18 inches high, then set the nozzle tips 38 inches above the ground (18 + 20 = 38 inches).

Band Applications

Unless otherwise stated, label rates are for broadcast application. For band application, specified rates will be applied only to a portion of the area that would be covered in a broadcast application. For example, if you have a boom with 6 nozzles spaced 40 inches apart, with each nozzle spraying a 10- inch band, the area sprayed = 6 nozzles x 10 inches, or 60 inches.

Band spraying can be performed the same as broadcast. However, remember that only a portion of the area is treated. The desired band width can be attained by adjusting the height

of the nozzles above the target. It is important to distribute the spray evenly across the band. This can be achieved by using “even” fan spray nozzles.

The following formula can be used to calculate the spray rate for band

$$\text{application: gpa} = \frac{\text{gallons sprayed} \times 43,560 \text{ sq ft/A}}{\text{total treated band width (ft)} \times \text{length (ft)}}$$

EXAMPLE: A six-row planter is equipped to spray 10-inch bands centered over 40-inch rows. The planter is run 1,320 feet through a field and uses 5 gallons of water. What is the application rate? Answer: 33 gpa on the bands.

There are 6 rows x 10-inch bands = 60 inches, divided by 12 inches per foot = 5 feet of total treated band width. The gallons sprayed = 5. The length = 1,320 feet. Entering these values into the formula gives:

$$33 \text{ gpa} = \frac{5 \text{ gal sprayed} \times 43,560 \text{ sq ft/A}}{5 \text{ ft total treated band width} \times 1,320 \text{ ft}}$$

Therefore, you need to add enough chemical to spray an acre to each 33 gallons of water in the tank. A 150-gallon tank can treat 4.6 acres of bands ($150 \div 33 = 4.55$). Note that the total field acreage covered by the planter in this example would be $4.6 \times 4 = 18.4$ acres. The rows are on 40-inch spacing. However, only 1/4 of the area is being treated ($10 \text{ inches} \div 40 \text{ inches} = 1/4$). Therefore, the actual area covered is four times the area treated, or 18.4 acres.

CALIBRATION OF A BOOM/BOOMLESS SPRAYER METHOD #2

Step 1: Fill sprayer with CLEAN water

Step 2: Run sprayer at your selected operating pressure “with booms or handgun turned on” (most should be run at 20 to psi)

Step 3: Make sure all nozzle are spraying uniformly and measure the swath in “inches of sprayed area” and write that down.

This equals _____ feet width of sprayed area

Step 4: Determine the gallons per acre applying by doing the following:

$$\text{GPA (gallon per acre)} = \frac{\text{GPM (gallons per minute)} \times 5940 \text{ (constant used)}}{\text{MPH (miles per hour)} \times \text{SW (swath width in inches)}}$$

$$\text{GPA} = \text{Gallon per minute caught} \times 5940$$

$$\text{Equals _____ (divide this number by)}$$

$$\text{MPH (miles per hour)} \times \text{SW (swath width in inches)}$$

$$\text{Equals _____}$$

$$\text{This equals _____ gallons per acre applying}$$

Step 5: Collect the spray volume from each nozzle(s) and measure the “exact amount collected in one minute”, record the amount caught in gallons per minute (GPM).

This equals _____ gallons caught in one minute (if you wrote the amount down in ounces caught, divide by 128 to get gallons).

1/128 METHOD OF CALIBRATION

Calibrating Hand Sprayers and High Pressure Hand Guns

This is an easy method of calibration that involves very little math or formulas. It is based on the following principle:

Because a gallon = 128 ounces and the test area to be sprayed is 1/128th of an acre, ounces collected = gallons per acre.

STEP 1. Measure out an area equal to 1/128th of an acre. Approximately 340 ft² or an area 18.5 ft by 18.5 ft.

STEP 2. Measure the time it takes to spray the measured area. Repeat several times and take the average time.

STEP 3. Spray into a container for the same amount of time it took to spray the measured area. Measure the water collected in ounces. The amount collected in ounces equals gallons per acre.

EXAMPLE: Hand sprayer

STEP 1. Measure area. 18.5 by 18.5 ft = 340 ft²

STEP 2. Time to spray area = 51 seconds

STEP 3. Amount collected = 40 ounces. Therefore; 40 ounces = **40 gallons per acre**

DETERMINING HOW MUCH PESTICIDE TO ADD TO THE SPRAY MIXTURE

Recommendation is to apply 1 quart of 2,4-D per acre.

The sprayer is applying 40 gallons per acre. Therefore, you will need to add **1 quart of 2,4-D to each 40 gallons of water (this does not mean 40 gallons of water plus 1 qt of 2,4-D, it means each 40 gallons of water will contain 1 qt of 2,4-D).**

Your sprayer only holds 1 gallon of spray mixture. So how much pesticide will you need to add to the gallon of water?

1 quart (32 ounces) divided by 40 gallons = 0.8 ounces

1 fluid ounce = 2 tablespoons. Therefore; you will need approximately 2 tablespoon of 2,4-D per gallon of water.

1 fluid ounce also = 29.57 milliliters (ml). Therefore, if measuring in ml; you would need 0.8 ounces times 29.57 ml per ounce = **24 ml per gallon of water.**

How much area will 1 gallon spray? There are 43,560 ft² per acre. If 40 gallons will spray 1 acre then 1 gallon will spray an area 1/40 that size or 43,560 ft² divided by 40 = **1089 ft².**

1/128 METHOD OF CALIBRATION

Calibrating Multiple Nozzle Boom-Type Sprayers

This method is for calibrating sprayers with booms that have many nozzles. However, it is still based on the same principles as the 1/128 method for hand held sprayers listed above.

Because a gallon = 128 ounces and the test area to be sprayed is 1/128th of an acre, ounces collected = gallons per acre.

This method of sprayer calibration gives sprayer output in gallons per acre when nozzle discharge is measured in ounces over a course length (D) determined from Table 1.

STEP 1. Adjust the sprayer pressure (30-40 psi for most sprayers) and check for uniformity.

Operate sprayer for 1 minute and measure spray from each nozzle. Clean or replace any nozzle tip that delivers 5 percent more or less than the output required for a new nozzle in good working condition.

STEP 2. Measure the spray band width or nozzle spacing (W) in inches on the boom to determine the course length (D) in feet as shown in column 2 of Table 1. The area to be sprayed must equal 1/128th of an acre. An acre = 43,560 ft². Therefore, 1/128th of an acre would equal 43,560 divided by 128 = 340 ft². If the nozzle spacing = 20 inches then the distance to travel to equal 1/128th of an acre would be 204 ft. This can be determined by the following formula:

4084 divided by W (nozzle spacing in inches) = D (distance in feet)

or

4084 divided by 20 inches = 204 feet

Or from Table 1. W = 20 inches and D = 204 feet.

STEP 3. Catch the spray from one nozzle while operating the sprayer under field conditions or for the time required to travel the needed distance at a desired speed. Time required to travel distance (D) at selected speeds is shown in Table 1. Time required for other speeds may be calculated with the following formula:

time (seconds) = 0.682 x distance (feet) divided by speed (miles per hour)

Table 1. Distance (D) to travel and seconds required for selected speeds when nozzle coverage is (W) inches so that discharge from one nozzle measured in ounces equals gallons per acre.

		Seconds to travel (D) feet at a speed of:			
W (in)	D (ft)	2 mph	3 mph	4 mph	5 mph
5	817	279	186	139	111
6	681	232	155	116	93
7	583	199	133	99	80
8	510	174	116	87	70
9	454	155	103	77	62
10	408	139	93	70	56
11	371	127	84	63	51
12	340	116	77	58	46
14	292	100	66	50	40
16	255	87	58	43	35
18	227	77	52	39	31
20	204	70	46	35	28
22	186	63	42	32	25
24	170	58	39	29	23
26	157	54	36	27	21
28	146	50	33	25	20
30	136	46	31	23	19
32	128	44	29	22	17
34	120	41	27	20	16
36	113	39	26	19	15
38	107	36	24	18	15
40	102	35	23	17	14

STEP 4. Measure the spray collected in **ounces**. The number of ounces collected is the same as the number of gallons per acre.

EXAMPLE:

You have a sprayer that has 15 nozzles on 30 inch spacing. How would you calibrate it using the 1/128th method?

Using the formula from **STEP 2** above:

4084 divided by 30 inches = 136 feet

Or from Table 1. W = 30 inches and D = 136 feet.

Therefore, you would need to time how long it takes for your sprayer to travel 136 feet. Travel this distance several times in the field and get an average time. Perhaps it takes an average of 31 seconds to cover 136 feet.

You would then collect the spray from one nozzle in a container for 31 seconds. Measure the water collected in ounces. The amount collected in ounces equals gallons per acre. If in 31 seconds you collected 20 ounces your sprayer output would be **20 gallons per acre**.

DETERMINING HOW MUCH PESTICIDE TO ADD TO THE SPRAY MIXTURE

The recommendation from the label is to apply 1 quart of 2,4-D per acre.

The sprayer is applying 20 gallons per acre. Therefore, you will need to add 1 quart of 2,4-D to each 20 gallons of water.

Your sprayer holds 200 gallons. So how much pesticide will you need to add to the 200 gallon spray tank?

200 gallons divided by 20 gallons = **10 quarts of 2,4-D**

How large an area can be sprayed by your 200 gallon tank?

200 gallons divided by 20 gallons per acre = **10 acres**

COMPUTING CHEMICAL MIXES

The active ingredient statement on a pesticide label lists the amount of active ingredient (ai) or acid equivalent (ae) contained in the formulation. The actual amount is stated in terms of percentage of active ingredient by weight or pounds of active ingredient per gallon. Herbicide rate recommendations are usually in terms of "volume of formulation per acre." For example, the recommendation may read, "apply as a broadcast spray on hard-to-control weeds at a rate of 2 quarts per acre."

To determine the amount of chemical to add to a spray tank, you need to know (1) the spray tank capacity, (2) the sprayer application rate, and (3) the recommended herbicide rate. The spray tank capacity can easily be determined by filling the spray tank with a measured amount of water. Calibration of sprayers determines the sprayer application rate, and the label will give the recommended herbicide rate. Once these variables are known it is a simple matter to determine the amount of chemical to add to the spray tank by following these steps.

1. First determine the number of acres a full tank will spray using the following formula:

Number of acres a full tank will spray = sprayer tank capacity (gallons) / sprayer application rate (gal/A)

2. Then figure the amount of herbicide required to add to the spray tank with the following formula:

Herbicide required per spray tank = acres sprayed by a full spray tank x recommended herbicide rate on the label

If the recommendation is in lb ai/A rather than volume per acre, use this formula:

Herbicide required per spray tank = acres sprayed by a full spray tank x rate (lb ai/A) divided by chemical concentration (lb, % ai/unit)

EXAMPLE A:

A sprayer has a 100 gallon tank and is calibrated to apply 20 gallons per acre. How much 2,4-D concentrate containing 4 lb ai/gallon should be added to each tank if the recommended rate is 2 quarts per acre?

Answer: 2.5 gallons of concentrate per tank.

100 gal tank divided by 20 gal/A = 5 acres can be sprayed per tank

therefore,

5 acres per tank x 2 quarts per acre = 10 quarts (2.5 gal) of spray concentrate per tank

EXAMPLE B:

A sprayer has a 100-gallon tank and is calibrated to apply 20 gallons per acre. How much 2,4-D concentrate containing 4 lb ai/gallon should be added to each tank, if the recommended rate is 1 lb ai/A?

Answer: 1.25 gallons of concentrate per tank.

100-gal tank divided by 20 gal/A = 5 acres can be sprayed per tank

therefore,

5 acres per tank x 1 lb ai/A divided by 4 lb ai/gallon = 1.25 gal of spray concentrate per tank

EXAMPLE C:

You are using the same sprayer but the recommended rate is 2 lb ai/A of an 80 percent wettable powder. How much concentrate should be added to the spray tank?

Answer: 12.5 lb of 80 percent concentrate per tank.

$$\frac{5\text{A/tank} \times 2\text{ lb ai/A}}{0.80\text{ ai/lb concentrate}} = 12.5\text{ lb of 80\% spray concentrate per tank}$$

Read the label so that you know what the recommended rate is. As you spray your field, you should also recheck the calibration after the herbicide has been added to the tank. It may be slightly different than it was with plain water. This is especially true when mixing pesticides with liquid fertilizers. If the calibration varies from original figures, a slight adjustment in sprayer speed or pressure may be needed to apply the proper amount of chemical.

If the acreage you plan to treat requires less than a full tank of spray material, add only enough water and chemical to treat the required acreage to reduce the amount of unused chemical mixture. Dispose of any unused chemical mix in a way that will not harm the environment, such as spraying non-cropland areas at recommended field application rates.

MEASUREMENTS FOR PESTICIDE APPLICATION

The following is a compilation of equivalent, conversion and other data that will help in the mixing and application of pesticides in small amounts. Always follow the label directions and precautions of the material being used.

TABLE 1 – EQUIVALENTS

1 teaspoon	1/3 tablespoon
3 teaspoons	1 tablespoon
1 tablespoon	3 teaspoons
2 tablespoons	1 fluid ounce
4 tablespoons	1/4 cup or 2 fluid ounces
6 tablespoons	1 dry ounce
8 tablespoons	1/2 cup or 4 fluid ounces
16 tablespoons	1 cup or 8 fluid ounces
96 tablespoons	1 dry pound or 16 dry ounces
1/4 cup	4 tablespoons
1 cup	1/2 pint, 8 fluid ounces, 16 tablespoons
2 cups	1 pint or 16 fluid ounces
1 pint, liquid	2 cups, 16 fluid ounces
1 quart, liquid	2 pints, 4 cups, 32 fl oz
1 gallon, liquid	4 quarts, 8 pints, 16 cups, 128 fl oz

TABLE II – When recommendations are made on a per volume basis:

LIQUID PESTICIDES		WETTABLE POWDERS	
Rate/ 100 Gals Water	Per Gal	Rate/ 100 Gals Water	Per Gal
1 pint	1 teaspoons	1 pound	1 tablespoon
1 quart	2 teaspoons	2 pounds	2 tablespoons
1 gallon	1 ½ fluid ounce 8 teaspoons	3 pounds	3 tablespoons
10 gallons	12 ½ fluid ounces 4/5 pint	4 pounds	4 tablespoons

TABLE III – When recommendations are made on a per area basis:

LIQUID PESTICIDES		WETTABLE POWDERS	
Rate/ Acre	Per 1000 sq ft	Rate/ Acre	Per 1000 sq ft
1 pint	¾ tablespoon	1 pound	5 teaspoons
1 quart	1 ½ tablespoons	2 pounds	3 tablespoons
2 quarts	3 tablespoons	3 pounds	5 tablespoons
1 gallon	6 tablespoons	10 pounds	1 cup

OTHER

Dry Measure:	Wettable powders	1 ounce = 6 level tablespoons
	Complete fertilizer, pelletized limestone	1 ounce = 2.25 tablespoons
	Limestone	1 cup = approximately 1 lb.

Miscellaneous Measurements

1 acre = 43,560 sq ft
1 foot = 12 inches
1 mile = 5280 ft
340 sq ft = 1/128th of an acre

7.6.5 Waste Disposal & Recycling

Read the label. There are no designated landfills or incinerators in Montana for disposing of pesticide containers or unwanted pesticides. Some containers may be designed to be returned to the pesticide dealer or manufacturer for disposal.

DISPOSAL OF PESTICIDES AND THEIR CONTAINERS

Proper disposal of pesticide containers and surplus pesticide is an essential operation for all applicators and dealers. Improper disposal may create serious health hazards or cause environmental contamination. Responsibility as an applicator or dealer continues until all excess pesticides and containers are disposed of correctly. Disposal includes, but is not limited to: *recycling, encapsulation, returning to manufacturer*, and other approved methods.

From the standpoint of public health, an "empty container" does not exist. Containers always retain residual amounts of pesticide. In the case of highly toxic pesticides, remaining residues may present a hazard to humans, especially children, pets, and livestock. All plastic or metal pesticide containers **must** be triple or power rinsed, prior to disposal and should be kept in a separate locked building, room, or enclosure used exclusively for storage of pesticides. To reduce the chance of container re-use and to allow for complete drainage it is a good practice to puncture pesticide containers after triple rinsing.

Most pesticide containers composed of plastic can be recycled through programs sponsored by pesticide dealers and distributors. The containers must be triple rinsed, drained dry, and have no visible residue. Labels and caps must also be removed. Pesticide containers, plastic and metal, that have been triple rinsed are considered solid waste and can be disposed in most sanitary landfills. Be sure to check with landfill operators to determine local policies for accepting pesticide containers.

Some pesticide labels have different requirements than the regulations of Montana for disposing of empty pesticide containers. The more restrictive requirement must be followed. The following is a summary of ARM 4.10.803 Rinsing Empty Pesticide Containers:

ALL EMPTY PESTICIDE CONTAINERS MUST BE TRIPLE OR POWER RINSED EXCEPT FOR:

- aerosol containers,
- fiber drums with liners,
- paper, fiber, and plastic bags,

- containers designated by label for refilling,
- water soluble containers,
- compressed gas cylinders, and
- containers from retail pesticides labeled only for home, yard, and garden uses.

RINSING MUST OCCUR WITHING 48 HOURS OF THE TIME THAT CONTAINER IS RENDERED EMPTY.

USE RINSATE AS DILUENT IN PESTICIDE APPLICATIONS. DO NOT REUSE PESTICIDE CONTAINERS.

TRIPLE RINSE METHOD

- The minimum amount of rinse material for each rinse will be based upon the container size as specified below:

Container Size	Solution Required
less than 5 gallons	1/4 of the container's
volume 5 gallons or more	1/5 of the container's
volume	

Examples:

1 gallon container	add 1 quart rinse
solution 5 gallon container	add 1 gallon rinse
solution	
30 gallon container	add 6 gallons rinse
solution 50 gallon container	add 10 gallons rinse
solution	

- Secure lid on container and agitate to ensure all inside surfaces are rinsed.
- Pour the rinsate from the container into a spray tank and allow it to drain for 30 seconds.
- Rinse two more times or more, until no visible residues are present.

POWER RINSE METHOD

- The minimum amount of rinse material must be $\frac{1}{2}$ the volume of the container.
- The minimum pressure of the rinse material needs to be 15 pounds per square inch.
- The nozzle must be capable of rinsing all inner surfaces of the pesticide container.

- Rinsing needs to continue until no visible residues are present and allow the container to drain for 30 seconds.

OTHER DISPOSAL TIPS FOR PESTICIDE CONTAINERS:

- To obtain maximum drainage of the pesticide material into a tank, puncture the head of the metal or plastic container.
- After rinsing has been completed, dispose of containers in a sanitary landfill, recycle or recondition.
- Burning or incineration of pesticide containers is prohibited except when approved by DEQ.

DISPOSAL OF LARGE VOLUMES OF PESTICIDES

Applicators or dealers desiring to dispose of larger volumes of improperly labeled, old or unusable pesticides should contact the Montana Department of Agriculture (MDA) - Pesticide Disposal Program at 406/444-5400 or DEQ, Air and Waste Management Bureau at 406/444-3490. The DEQ will give technical assistance and recommendations for proper disposal to prevent environmental and public health accidents.

7.6.5.1 Guidelines for Pesticide and Pesticide Container Disposal

- Follow label storage instructions.
- Purchase only the amount of pesticide needed for the job.
- Pressure rinse or triple rinse containers immediately after emptying. Delay in rinsing pesticide containers may result in a residue that, upon drying, is highly resistant to rinsing. Use rinsate as dilution make-up water and apply evenly over a labeled site.
- Completely empty pesticide containers before disposing of them. Empty paper bags, plastic bags and other types of containers can be disposed of at sanitary landfills.
- Do not burn any pesticide container in an open fire, such as in the field, in trash barrels or burn piles.
- Do not reuse pesticide containers unless they are dedicated or have been cleaned according to the pesticide manufacturer's protocol and are intended to be refilled with pesticides.
- Dispose of unusable or unwanted pesticides according to local, state and federal regulations.

7.6.6 Spill Prevention and Management

If you work with agricultural chemicals for any length of time, you are likely to experience a spill or leak. Even the most careful handler can have occasional problems. Since accidents are going to happen, you need to be as prepared as possible to deal with a spill or leak when it happens.

Spills inside a storage room are generally easy to clean up, but they do pose an inhalation hazard. Spills outdoors can be more serious because they can involve damage to crops, livestock, or water sources. Whether indoors or out, the immediate concern is the safety of persons in close environs and those people cleaning up the chemical.

Federal law requires you to report hazardous-material spills contacting land, water, or air. The Comprehensive Environmental Response Compensation and Liability Act (CERCLA) requires the reporting of many pesticide spills if the reportable quantity (RQ) of that pesticide is spilled. These spills must be immediately reported to the National Response Center (1-800-424-8802). Some pesticide RQ's may be as small as 1 pound of active ingredient. Others may be 10 pounds, 100 pounds, or even higher quantities of active ingredient.

Pesticide spills and cleanup require immediate action based on foresight and preparation. All reasonable precautions should be taken to avoid spilling pesticides, but accidents will occur. Accidents are most likely to happen when pesticides are being transported or in a storage area. A spill kit carried in vehicles and kept in pesticide storage areas will allow quick and effective response to spills.

7.6.6.1 Preparation and Prevention

Stringent guidelines should be exercised by Weed Districts to prevent spillage of pesticides during storage, transportation, mixing, application or any other handling of pesticides.

- Several commercial equipment suppliers assemble spill-response kits that are designed for response to small chemical spills. If you do not have a commercial kit, you can assemble your own spill-response kit. First, have enough personal protective equipment (PPE) available for anyone designated to help clean up. Be sure to include at least the equipment necessary for handling activities listed on the label of the pesticide you are currently using. Cleanup personnel should put on their PPE before trying to contend with the spill or leak. Equipment may consist of:
- Goggles.
- Chemical-resistant coveralls or apron
- NIOSH/MSHA-approved respirator with the proper cartridges.
- Wide-brimmed, chemical-resistant hat.

- Chemical-resistant boots.
- Telephone numbers for emergency assistance,
- Containment "snakes" to confine the leak or spill to a small area,
- Absorbent materials, such as spill pillows, absorbent clay, sawdust, pet litter, activated charcoal, vermiculite, hydrated lime, or paper to soak up liquid spills,
- Sweeping compound to keep dry spills from drifting or wafting during cleanup,
- A shovel, broom, and dustpan (foldable brooms and shovels are handy, because they can be carried easily),
- Heavy-duty detergent,
- A fire extinguisher rated for all types of fires,
- Any other spill cleanup items specified on the labeling of any products you use regularly, and
- A sturdy plastic container that will hold the quantity of pesticide from the largest pesticide container being handled and that can be tightly closed.
- Highway flares

Next, you will need a solution to help decontaminate the area. Refer to the label to make the decontamination solution. Finally, you need to have on **hand shovels and plastic, sealable barrels** to collect the spill and contaminated adsorbent.

All of these items can be stored in the plastic container and kept clean, in working order, and immediately available for use. Whenever any of the above items are used, they shall be cleaned and/or replaced.

7.6.6.2 Reporting & Assistance

A Weed District should develop specific guidelines for handling potential spills in the county. The following reference material can provide some guidelines.

Contact CHEMTREC, the Chemical Transportation Emergency Center, at its toll free number: 1-800-44-9300. Chemtrec is a public service of the Chemical Manufacturing Association. Located in Washington, DC, Chemtrec is staffed 24 hours a day by trained personnel who can advise you how to manage chemical emergencies.

When you request help from Chemtrec or any other source, have the product label on hand. Many pesticide labels list an emergency telephone number that gives you direct access to the manufacturer and people who know how to manage emergencies for that product.

If the spill occurs on a highway, call the highway patrol or highway department right away. If the spill occurs on a county road or city street, call the county sheriff, city police, or fire department. These authorities are trained for such emergencies and will be able to assist you in your cleanup. Many local and state authorities require that you notify them of a pesticide spill.

If the spill may expose the public to pesticides or pesticide residues, contact public health officials. If anyone is poisoned by contacting the spill or if you suspect that an exposure may lead to poisoning call the hospital emergency room and provide them with the brand name, active ingredients, and any other labeling information about human health hazards, signs and symptoms of poisoning, and antidotes.

A spill is any accidental release of a pesticide. As careful as people try to be, pesticide spills can and do occur. The spill may be minor, involving only a dribble from a container, or it may be major, involving large amounts of pesticide or pesticide-containing materials such as wash water, soil, and absorbents.

7.6.6.3 Handling a Spill

The faster you can contain, absorb, and dispose of a spill, the less chance there is that it will cause harm. Clean up most spills immediately. Even minor dribbles or spills should be cleaned up before the end of the work day to keep unprotected persons or animals from being exposed.

When a spill emergency occurs, remember the "three C's: Control, Contain, and Clean up.

1. Control the Spill Situation

- **Protect yourself:** Put on appropriate personal protective equipment before contacting the spill. If you do not know how toxic the pesticide is or what type of personal protective equipment to wear, don't take a chance! Wear barrier-laminate apron, footwear, and gloves; eye protection; and a respirator.
- **Stop the source:** If a small container is leaking, place it into a larger chemical-resistant container, such as a plastic drum or bag. If a spray tank is overflowing, stop the inflow and try to cap off the tank. If a tank, hopper, or container has burst or has tipped over and is too heavy to be righted, you will not be able to stop the source.
- **Protect others:** Isolate the spill site by keeping unprotected people, and animals well back. Rope off the site if necessary.
- **Stay at the site:** Do not leave the spill site until another knowledgeable and correctly protected person arrives. Someone should be at the spill site at all times until the spill is cleaned up.

2. Contain the Spill

- **Confine the spill:** As soon as the source of the leak is under control, move quickly to keep the spill in as small an area as possible. Do everything you can to keep it from spreading or getting worse. For small spills, use containment snakes to surround the spill and keep it confined. For larger spills, use a shovel, a rake, or other tool or equipment to make a dike of soil, sod, or absorbent material.
- **Protect water sources:** Keep the spill out of any body of water or any pathway that will lead to water, such as a ditch, floor drain, well, or sinkhole. If the spilled pesticide is flowing toward such an area, block it or redirect it.
- **Absorb liquids:** Liquid pesticide spills can be further contained by covering the entire spill site with absorbent materials, such as spill pillows, fine sand, vermiculite, sawdust, clay, kitty litter, shredded newspaper, or absorbent pads.
- **Cover dry materials:** Prevent dry, dusty pesticide spills, such as dusts, powders, or granules, from becoming airborne by covering them with a sweeping compound or a plastic covering or by very lightly misting the material with water. Do not mist too much, because water may release the pesticidal action or may cause the pesticide to form clumps and be unusable.
- **Warning:** Pesticides that are oxidizers, such as calcium hypochlorite (a common sanitizer) and some pesticides and desiccants that contain chlorites, should not be contained with sawdust, shredded paper, or sweeping compounds. These absorbent compounds combine with the oxidizer to create a fire hazard and could burst into flame.

3. Clean Up

- **Clean up the spill:** For spilled liquid pesticides, sweep up the absorbent material containing the pesticide and place it into a heavy-duty plastic drum or bag. Keep adding the absorbent material until the spilled liquid is soaked up and removed.

Spills of dry pesticides should be swept up for reuse if possible. Avoid contaminating the spilled materials with soil or other debris, so it can be used in the usual application equipment and will not clog the nozzles or hopper openings. However, if the dry spill has become wet or full of debris, it must be swept up and placed in a heavy-duty plastic drum or bag for disposal.

- **Decontaminate the spill site:** Once you have collected as much of the spilled material as possible, decontaminate the spill site as well as you can. **Do not hose down the site with water**, unless the spill is on a containment tray or pad. (**Note:** Inform your local fire department of this procedure.)

Several materials may be used to decontaminate pesticides. Many pesticides, especially the organophosphates, decompose when treated with lye or lime. Fewer pesticides are decomposed by bleach. Other pesticides cannot be effectively

decontaminated and should only be treated with detergent and water to assist in removal. The following table is a guide for decontaminating certain pesticides:

Use Lye or Lime for:	Use Chlorine Bleach for:	Do not use any decontamination chemicals for these pesticides:
acephate	calcium cyanide	alachlor
Atrazine	chlorpyrifos	chloramben
Captan	fonophos	chlorinated hydrocarbons
Carbaryl		diuron
Dalapon		methoxychlor
Diazinon		pentachlorophenol
dichlorvos		picloram (Tordon 22K)
dimethoate		2,4-D
malathion		bromacil
Naled		glyphosate (Roundup)
Propoxur		Simazine

If the surface on which the pesticide has spilled is nonporous, such as sealed concrete, glazed ceramic tile, or no-wax sheet flooring, use water (or the chemical listed on the label to dilute the pesticide) and a strong detergent to remove the residues of the spill from the surface. Do not allow any of the wash solution to run off the site being cleaned. Place fresh absorbent material over the wash solution until it is all soaked up. Then sweep up the absorbent material and place it in a plastic drum or bag for disposal as an excess pesticide.

If the surface upon which the pesticide has spilled is porous, such as soil, unsealed wood, or carpet, you may have to remove the contaminated surface and dispose of it as an excess pesticide. Depending on the size of the spill and the toxicity of the pesticide, however, sometimes the site can be successfully neutralized.

4. Neutralize the spill site

The labeling of a few pesticides will instruct you to neutralize a spill of that pesticide. Sometimes an authority, such as the pesticide manufacturer or Chemtrec, also will instruct you to neutralize the spill site. Follow instructions carefully.

Fresh absorbent material is spread over the spill site to soak up the neutralizing liquid. This material is swept up and placed in a plastic drum or bag for disposal. You may be instructed to repeat the process several times to make sure that the site is thoroughly neutralized.

Soil is sometimes neutralized by removing and disposing of the top 2 to 3 inches and then neutralizing the remaining soil. You may be instructed to mix activated charcoal into the soil or to cover the spill site with 2 or more inches of lime and cover the lime with fresh topsoil.

Sometimes you may be instructed to cover minor spills with activated charcoal. The activated charcoal can adsorb or tie up enough pesticide to avoid adverse effects to plants and animals that contact the soil in the future. However, activated charcoal is not effective for large spills.

5. Decontaminate equipment

Clean any vehicles, equipment, and personal protective equipment that were contaminated by the spill or during the containment and cleanup process. Use a strong mixture of chlorine bleach, dishwasher detergent, and water to clean the vehicles and equipment. Wash personal protective equipment thoroughly, following manufacturers' instructions and the guidelines in the personal protective equipment unit of this manual. Remember particularly that porous materials, such as brooms, leather shoes, and clothing, cannot be cleaned effectively if they are thoroughly saturated with pesticide. They should be discarded.

6. Decontaminate yourself

When you are finished with the spill and equipment cleanup, wash yourself thoroughly with detergent and water. Wash any part of your skin that might have been exposed, and

always wash your face, neck, hands, and forearms.

7.6.6.4 Spill Follow-up

For all large spills, and any spills that take place off your property, consider keeping records of your containment and cleanup activities and your conversations with authorities and the public about the spill. Photographs help to document any damage as well as the cleanup process. Report the spill to the appropriate agency, when necessary.

7.6.7 Pesticide Fires

Some pesticides are highly flammable; others do not catch fire easily. The labeling of pesticides that require extra precautions often will contain a warning statement in either the Physical/Chemical Hazards section or the Storage and Disposal section. Pesticides that contain oils or petroleum-based solvents are most likely to contain these warning statements. Some dry products also present fire and explosion hazards.

Store combustible pesticides away from open flames and other heat sources, such as steam lines, heating systems, kerosene heaters or other space heaters, gas-powered equipment, or incinerators. Do not store glass containers in sunlight where they can focus the heat rays and possibly explode or ignite. Install fire detection systems in large storage sites, and equip each storage site with a working fire extinguisher approved for all types of fires, including chemical fires.

If you store highly toxic pesticides or large amounts of any pesticide, inform your local fire department, hospital, public health officials, and police of the location of your pesticide storage building before a fire emergency occurs. Tell fire department officials what types of pesticides are regularly stored at the site, give them a floor plan, and work with them to develop an emergency response plan.

Aside from the normal fire hazards, pesticide fires can be especially dangerous because of toxic fumes. Fighting a pesticide fire is not advisable. Most fire departments allow a pesticide-storage building to burn instead of contending with fumes or explosions and possibly contaminating the groundwater with runoff. Prevention is always the best means of dealing with disaster; so keep the pesticide storage area clear of any source of fire or sparks. Also, to prevent any further loss in case of a fire, do not keep other equipment in the chemical-storage area.

7.7 Applying Pesticides Safely

Pesticides should only be used when necessary, at recommended rates and times of application, and only for those crops and uses listed on the label. Correct use is essential to ensure that chemical residues on crops do not exceed the limits set by law.

Recommended pesticides will not generally cause injury to people, livestock, wildlife, crops, or the environment if used according to label directions. Any pesticide is potentially dangerous if improperly handled or used.

7.7.1 Basic Safety Procedures

Following these basic safety procedures will help you protect yourself and others from pesticide injury:

- Make sure that you are familiar with current federal and state pesticide laws and regulations.
- Make sure that you have the proper pesticide applicator license, if required (contact your local county Extension office for more information about licenses).
- Avoid pesticide drift that may endanger other crops or animals. Cover feed pans, troughs, and watering tanks in livestock areas. Protect sites where biological control agents are released or beehives when using insecticides.
- Follow all safety precautions on the label. Know and observe the general rules for safe pesticide use.
- Record the date, time, location, amount of each pesticide used, and weather data for each spray operation.
- Wear protective clothing and use protective equipment as instructed on the label.
- Never eat, drink, or smoke while applying pesticides.
- Immediately wash off all pesticide spills on clothing or skin with detergent (which cleans better than soap) and water. A supply of clean water should be on hand when handling pesticides.
- Bathe after pesticide application and launder clothing separate from other laundry.
- Lock pesticides in original containers in a properly marked cabinet or storeroom separate from food, feed, or fertilizer.
- Store pesticides separate from other pesticides to avoid contamination.
- Triple-rinse all empty containers and use the rinse water as part of the spray solution. Empty containers should not be used for any other purpose. Dispose of empty containers in a proper manner.

- Be familiar with basic first-aid procedure involving pesticides. Have a first-aid kit nearby at all times.

If you suspect pesticide poisoning, contact the nearest Poison Control Center, hospital emergency room, or physician. Be sure to take the pesticide label with you and give it to the attending physician.

7.7.1.1 Livestock

Pesticides sprayed on plants are not generally toxic to livestock; however, animals may be poisoned by eating unused pesticides left in open containers or by drinking water contaminated with pesticides.

Certain unpalatable or poisonous plants treated with certain pesticides may become palatable to livestock. Be certain that livestock are kept out of areas where poisonous plants have been sprayed until the plants have dried up.

The nitrate content of several kinds of plants may increase after they have been sprayed with 2,4-D, Banvel, or similar pesticides. Cattle browsing on these treated plants may be poisoned.

Pay attention to grazing restrictions outlined on the label. The restrictions will prevent illegal residues that could prevent the meat from being marketed.

7.7.1.2 Wildlife

Controlled spraying may benefit wildlife by maintaining desirable cover. Pesticides recommended for control of aquatic weeds usually have beneficial results for fish populations. Be sure to use these pesticides properly. Don't drain or rinse equipment where chemicals may wash into waterways.

7.7.1.3 Groundwater

Groundwater is the source of water for wells and springs. Approximately half the population in the United States relies on groundwater for drinking water, and more than 90 percent of rural residents obtain their water from groundwater through wells and springs.

Use the following guidelines to help prevent groundwater contamination:

- Are pesticides really necessary or is there another way to control the pest?
- Identify the vulnerability of the soil. Is the soil subject to leaching, i.e., a well-drained sandy soil low in organic matter?
- Consider the location of the pesticide application in relation to ground and surface water.
- Become familiar with pesticides that leach.
- Follow the directions on the pesticide label. Don't use more than the recommended rate.

- Apply the pesticide at the proper time. Fewer applications may be required if weeds are sprayed when small.
- Calibrate and maintain equipment.
- Avoid spills and back-siphoning into wells or water supplies.
- Direct the application to the target site.
- Dispose of the pesticide properly.
- Store pesticides safely. Keep away from pumps, wells, and other water sources.
- Keep accurate records of pesticide use.
- Where possible, delay irrigation after pesticide application. Delaying irrigation for one or more days after applying a pesticide can minimize the chances of the pesticide reaching groundwater.
- Avoid irrigation runoff.
- Use particular care when practicing chemigation. Devices must be used to prevent possible back-siphoning of the pesticide into the water supply.
- Properly seal new wells and inspect old wells to ensure that the seal is adequate.

7.7.2 Application Procedures

Every time you apply a pesticide, follow these basic procedures to make sure that you are using the pesticide safely and effectively:

1. Deliver the pesticide to the target

Take the time to be sure that the pesticide is reaching the surface or space to which you are directing it. Pesticide deposited elsewhere is a waste of time and money and may harm nontarget areas.

2. Check the delivery rate

Check to be sure that you are applying the pesticide evenly and in approximately the right amounts. No puddles of liquid pesticide or mounds of dry pesticide should be deposited in the application area. Be especially careful in areas where you turn or pause. Many types of application equipment continue to release pesticide even when not in motion.

When you have applied the pesticide to the first part of the area or space that is to be treated, check to be sure that approximately the correct proportion of pesticide has been used. If too little is being released, check the equipment openings for clogging or obstructions. If too much is being released, check for worn or stuck openings.

3. Check for appearance

As you apply, notice whether the pesticide you are releasing looks the way it should.

Applications of wettable powders usually have a whitish color. If the liquid is clear, check to be sure that you are agitating the mixture enough to keep the wettable powder mixed with the water. Granules and dusts should appear dry and should not form clumps. Emulsifiable concentrates usually look milky. If the pesticide does not look right, be sure you have the right mixture and that it is blended evenly.

Check the appearance of the target area where you have just released the pesticide. If the surface is changing colors or is stained unexpectedly, stop and check whether you are harming the surface.

4. Avoid nontarget organisms

Before you apply a pesticide, clear all unprotected people from the area. It is illegal to allow them to be exposed to a pesticide application -- either directly or through drift. Also remove any pets or livestock not being treated with the pesticide. Even when the pesticide application is narrowly directed such as a crack and crevice treatment, keep people and animals out of the immediate area during application.

Check the pesticide labeling to find out when people and nontarget animals can re-enter the treated area. The labeling of some pesticides may restrict entry into treated areas for periods ranging from several hours to several days. In general, if the pesticide labeling has no such instructions, it may be best to restrict the entry of unauthorized people into the treated areas at least until any dusts or mists have settled or sprays have dried. If necessary, provide ventilation to disperse vapors.

5. Avoid nontarget surfaces

When possible, clean the application site of any items that should not be contaminated. Cover or protect any items that cannot be removed from the area and that are not involved in the handling activity, including such things as food and food utensils; bedding; toys; seed; pet or livestock feed, water, or supplies; and other items that could transfer pesticides to people, pets, or livestock.

6. Operate equipment safely

Turn off equipment whenever you pause or need to make any adjustments or repairs. When you stop application to take a break, to move to another site, or for repairs, depressurize any pressurized tanks. Turn off the main pressure valve on the tank and release any pressure remaining at the nozzles.

When applying pesticides at a distance from your equipment -- at the end of a long hose, for example -- be sure that unprotected people and pets stay away from the equipment. You may need to post a helper near it.

Check hoses, valves, nozzles, hoppers, and other equipment parts occasionally while you are applying. If you notice a problem, stop immediately and fix it. Do not use bare hands or your mouth to clear nozzles, hoses, or hopper openings. Carry a small nylon brush for such jobs. Be sure that any tool used for this kind of job is never used for any other purpose.

Read the label. Misuse of a pesticide can be expensive or can endanger someone's health. It may also result in you losing your certification to apply certain products. Leave sufficient distance between the area to be treated and a susceptible crop or area. Keep your boom high enough to get good coverage but low enough to prevent drift. You may have to use nozzles that have a wide angle to get your boom low. Do not use a higher pressure than necessary. You may want to use a foam or another spray additive in certain situations. Use low volatile formulations and apply most pesticides when there is just a slight breeze blowing away from a susceptible crop in a nontarget area.

Make sure you are applying the correct rate. Calibrate often and check each nozzle separately for amount of liquid delivered per minute. Calibrate a granular applicator each time you change from one granular formulation to another, for example, from a 10G to a 20G. Keep your equipment in good condition and avoid leaks. Worn hoses can burst and cause injury.

If you apply pesticides to sloping ground, especially right before rain, run-off can occur. Persistent pesticides, such as soil sterilants applied to right-of-ways, for example, can wash into streams and ponds and cause problems in irrigation water by killing or stunting crops or turf. These materials can also leach into ground water. Some pesticides are highly toxic to fish.

If a product has a re-entry interval, do not allow anyone to enter the treated area until the re-entry interval (REI) listed on the label has expired. If entry into the treated area is necessary, clothing and equipment as specified on the label must be worn. Do not apply pesticides near the drip line of non-target, susceptible trees and shrubs if the pesticide can be absorbed and translocated or can volatilize and stunt or kill the non-target plants.

7.7.3 Application Record-Keeping

Weed Districts should have procedures developed by the county and state for keeping records of pesticide applications. See section 4.10.207 "Records" in the Montana Pesticide Act and Administrative Rules (Section II. of this handbook). Some general guidelines and sample Daily Application Record forms follow:

Keeping records of pesticide use and application is a good idea. Records can establish proof of proper use. If an error has been made, records are helpful in finding the cause. They also can provide you with information to use in response to claims of excess residues or damages.

Records can help you reduce pesticide mistakes or misuse. If a pest is not controlled, if damage has occurred in the target area, or if a pesticide has moved off the target area and caused problems, you may be able to determine what went wrong. Records may help you to determine that a particular pesticide, a particular formulation, a type of application equipment, or some condition in the treatment area caused the problem. Then you can take steps to avoid such a situation in future pesticide applications.

Good records can help you better determine the exact amount of pesticide you'll need. Some pesticides do not store well for long periods of time, and disposal of excess pesticide can be expensive.

7.7.3.1 Necessary information

The more information you record, the more useful the records will be. Devise a standard form to be sure you write down all the necessary facts each time. Keep the forms handy so you will fill them out promptly.

Record:

- names of any handlers involved in the activity;
- time of day and date of application;
- location and description of treated area, including climatic conditions at the site;
- equipment used;
- pesticide used -- brand name, common name, formulation type, percentage of active ingredient, and EPA registration number;
- amount of formulation used (and amount of diluent or other adjuvants added, if any);
- total amount of pesticide applied and the rate of application (pounds per acre, ounces per 100 square feet, etc.), if applicable; and
- size of treated area (total square feet, acres, or linear feet; room or structure size; number of animals, etc.).
- treated surface (plant, animal, soil, water, structure, or other surface at which the pesticide was directed);
- target pest;

7.7.3.2 Additional information

Every record form should have a space for additional comments. Use this space to jot down information for your own personal use or to record anything that was unique about the treatment. Record information about scouting or monitoring that may have been done. Write down what other pest management methods are being used and how successful the overall pest management strategy is. You can use this information to improve your pest management operations, either through better customer or worker relations or by saving money.

It is also important to write in the comment section,

- If you see someone else making an application in the area,.
- If you observe any effects to vegetation from previous treatment that was not done by you or your crews. This may protect you in the future if there is a complaint in the area.

PLEASE consider Daily Application Records as a “good thing”, not a “daily pain”.

7.7.3.3 Required records

Many states, tribes, and local authorities require you to keep records of pesticide applications. Be sure you know what records you must keep and how long you must keep them. Many enforcement inspections look closely at record keeping because records indicate how an operation is being managed. Keep your records in a safe place where you can find them when you need them.

Equipment / Application Information					
Operator	Sprayer	Speed	GPA	Acres/ Tanks	# Tanks

[illegible]

7.8 Pesticide Labels

SECTION 8 Chemical Weed Management

FACTORS AFFECTING HERBICIDE PERFORMANCE

RECOMMENDATIONS FOR NOXIOUS WEEDS

Information on the use of herbicides for managing noxious weeds is included in this Section. General herbicide recommendations and use of surfactants are discussed.

REFERENCES

1. Weed Management Handbook. 1997-1998. Montana State University, Utah State University, and University of Wyoming.
2. Hansen, Oliver, Otto. 1984. Herbicide Manual. USDI, BOR. US Government Printing Office
3. Herbicide Handbook. 1994. Western Society of Weed Science. Seventh Edition.
4. Herbicide Handbook. 1998. Supplement to Seventh Edition. Western Society of Weed Science

8.1 Factors Affecting Herbicide Performance

Herbicide performance is determined by the amount of herbicide that is absorbed into and reaches the site within the plant where it can cause damage. Herbicides can enter a plant through roots, shoots, stems, foliage, or buds. The primary site of entry is specific for each herbicide, and may be influenced by the method of application. Some herbicides can enter a plant through more than one site (i.e. Tordon 22K can enter a plant through either the leaves or roots).

8.1.1 Soil-Applied Herbicides

Plants come in contact with herbicides in soil by a variety of mechanisms. Roots and shoots intercept chemical as they grow and expand through the soil. The movement of water to the plant created as the plant uses water is largely responsible for transporting herbicide to plant roots.

Soil-applied herbicides can be absorbed by seeds, roots, and shoots. Foliar absorption may also occur from volatilization or from soil splash-up on plant leaves caused by the impact of raindrops. Herbicides must be transported from the site of entry to the site where they are active in the plant. To translocate upward from roots, the herbicide must first reach the xylem. The shoots of grass seedlings serve as an important site of absorption of certain soil-applied herbicides. In broadleaved plants, the importance of shoot absorption is generally less than that of their roots.

8.1.2 Foliar-Applied Herbicides

Leaves are the primary site of entry for most foliar-applied herbicides. To enter the leaf, herbicides must penetrate the waxy cuticle, the cell wall, the plasma cell membrane and finally be released into the cytoplasm (the fluid inside the cell) (Figure 8-1). Not all leaf parts absorb herbicide, guard cells around stomates, cells surrounding hairs, and cells overlying veins are primarily responsible for herbicide absorption.

Once inside the leaves, herbicides can translocate within the plant by several mechanisms. Short distance translocation can be accomplished in passages and spaces between cell walls or from cell to cell by cytoplasmic streaming. Long distance transport of herbicides is accomplished by the xylem and phloem, which are also responsible for moving water and nutrients within the plant. The xylem consists of dead, hollow, thick-walled conduits that move water and solutes from roots to all plant parts. The phloem is comprised of living cells that are responsible for transporting sugars made in the leaf throughout the plant.

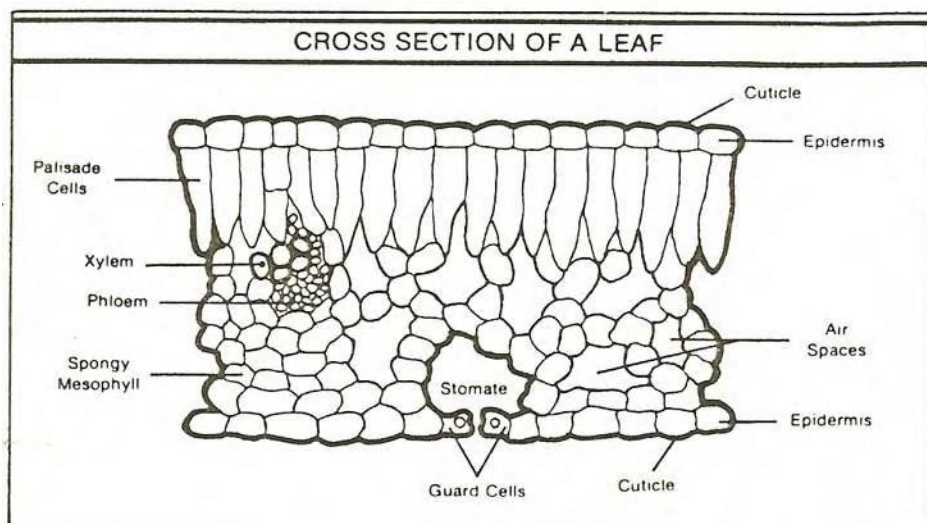


Figure 8-1: Cross Section of a leaf

8.1.3 Environmental Impacts on Foliar Herbicide Performance

Herbicides kill a plant by upsetting plant growth or metabolism. A weed or plant must be actively growing when a herbicide is applied to allow the chemical to upset or stop certain processes. A weed not actively growing is difficult to kill with any foliar herbicide.

TEMPERATURE, MOISTURE, HUMIDITY

Prolonged exposure to low moisture and humidity, and high temperatures reduces the penetration of herbicides by increasing the thickness of the cuticle, and closing stomates. Moisture stress pulls the waxy units of the cuticle closer together to conserve moisture, which decreases herbicide absorption. Older weeds are also more resistant to herbicide penetration since mature leaves tend to have thicker cuticles. Addition of a surfactant may aid penetration of plant cuticles and stomates especially under stress conditions.

Both high and low temperature extremes slow plant metabolism and can reduce the effectiveness of herbicides. Temperatures ideal for applying most post-emergence herbicides are between 65° and 85° F. Below 60° F weeds are killed very slowly or not at all. High temperatures, low humidity, and wind can dry spray droplets rapidly, before the chemical is absorbed. The herbicide then may vaporize, or crystallize on the leaf surface where it is removed by wind, rain, or sunlight.

SUNLIGHT

Both contact and systemic foliar herbicides are usually more effective on sunny days, because photosynthesis activated by sunlight enhances foliar absorption. Sunlight also increases plant metabolism, which increases both translocation and action of herbicides. There is no significant difference in the success of morning versus evening herbicide

applications, unless daytime moisture or heat stress reduces absorption of the chemical. Some herbicides may photo-decompose in sunlight if they remain on the leaf surface for extended periods.

RAIN FOLLOWING APPLICATION

Rain following application of herbicides that are absorbed rapidly have little effect on performance. Research indicates that rainfall 15 minutes after 2,4-D Ester is applied does not affect results. However, some postemergence herbicides require 8 hours free of rain following application for best performance, so rain too soon after application can cause variable results. Be sure to read the herbicide label to determine the “rain-free” period.

Table 8-2: The approximate time between application and rainfall needed for maximum weed control from several herbicides.

Herbicide	Rainfast (hours)
Escort	4
Banvel	4
Curtail	8
Transline	8
Tordon 22K	2
Pursuit	1
Roundup	6
2,4-D Amine	4
2,4-D Ester	1

FOLIAR CANOPY FACTORS

Foliage area determines the amount of herbicide intercepted by a plant. Weeds with reduced leaf area, like rush skeletonweed, may intercept an inadequate amount of herbicide to obtain control. The hairiness of leaves also influences absorption. Plants with hairy leaves, such as common mullein, do not absorb foliar herbicides readily because hair holds spray droplets from the leaf surface. An excessive amount of old growth from the previous growing season may also intercept herbicides and not allow them to contact new growth.

8.1.4 Surface Active Agents (Surfactants)

Surfactants are chemicals that produce physical changes at the surface of liquids, because the changes they produce occur at surfaces, they are also known as “surface active agents.”

They include wetting agents, emulsifiers, detergents, spreaders, sticking agents (stickers) dispersing agents, and other surface-modifying agents. They are commonly used in herbicide formulations to increase the effectiveness of the spray solution and herbicide formulation.

Surfactants may increase or decrease the phytotoxicity of a herbicide, therefore, an applicator should not add any surfactant to an herbicide formulation unless recommended by the manufacturer.

Water is not compatible with many of the chemicals used as herbicides. It will not mix with oil or oil-like substances. By adding a surfactant (emulsifying agent) to the oil, the herbicide can be mixed with water to form an oil-in-water emulsion and can then be easily sprayed.

Water is also repelled by the wax-like cuticle of plants. By adding a surfactant (wetting agent) to the herbicide, the surface tension of the herbicide-water mixture is reduced. This allows more surface area of the herbicide solution to come into contact with the plant surface, thus increasing its effectiveness.

When considering surfactants, there are four surface relationships that must be taken into account.

1. **Liquid to liquid.** An example would be oil dispersed in water by agitation to form an emulsion or an ester formulation of 2,4-D suspended in water.
2. **Solid to liquid.** An example would be clay suspended in water, or a wettable powder herbicide suspended in water.
3. **Solid to air.** Carbon in the air to form smoke or a pesticide dust particle suspended in the air would be examples.
4. **Liquid to air.** An example would be fog, which is tiny water droplets suspended in air, or herbicide spray droplets in the air.

Water has a tendency to be repelled by other liquids in a suspension or emulsion, or by the solid forming the suspension. For the materials to stay in suspension, a substance is needed that has an affinity for both the water and other material so that the two materials will be bound. A surfactant will modify the surface interfaces of the above relationships by orienting itself between the two surfaces so they are bonded in a more intimate contact, thus enabling the material to remain in suspension.

A substance will generally have surfactant activity if it contains a strongly polar group that is attracted to water (hydrophilic) and a non-polar group that is attracted to oils, fats, and

waxes (lipophilic).

TYPES OF SURFACTANTS

Surfactants are classified into three categories, depending on their ionization or dissociation in water. This is the ability of the substance to become positively (cationic) or negatively (anionic) charged.

1. **Anionic surfactants.** In these surfactants, the anion (-) part of the molecule exerts the predominant influence. They are often used in herbicide formulations alone or in combination with nonionic surfactants. A disadvantage is that they may react with other charged particles (ions), including the herbicide itself, in the formulation or spray solution, thus reducing its effectiveness. Anionic surfactants make excellent wetting agents and are also good detergents.
2. **Cationic surfactants.** In these surfactants, the cation (+) part of the molecule exerts the predominant influence. They are derived from ammonia and are not usually used in herbicide formulations. They are often phytotoxic and are very effective bactericides. A major disadvantage is that they precipitate readily in hard water and are poor detergents.
3. **Nonionic surfactants.** These surfactants do not ionize or become charged in water solutions. Therefore, they are unaffected by hard water. In other words, they do not form insoluble salts with calcium, magnesium, or iron ions that occur in hard water. They can also be used in acid solutions. These are a relatively new group of surfactants being developed mostly in the 1960's. They now make up a large portion of the surfactant market. An outstanding property of nonionic surfactants is that they make excellent emulsifiers, forming stable emulsions. As a result, these surfactants are often used as emulsifiers in emulsifiable concentrate herbicide formulations. They also make good dispersing agents, excellent detergents, and foam less than anionic surfactants. They are more soluble in cold water than hot water. They are usually blended with anionic surfactants to improve the wetting properties of EC-type formulations.

SURFACTANT EFFECTS ON PLANTS

The usual action of a surfactant is to increase the activity of a foliar applied herbicide, however, in some cases, the selectivity of the herbicide is lost.

They also favor uniform spreading of the spray solution, resulting in uniform wetting of the plant, resulting in less bounce-off. Droplets do not become suspended on hairs, scales or other projections on the leaf surface, thus allowing the herbicide solution to make intimate contact with the plant surface. As a result, substances such as the waxy cuticle or the fatty portion of the cell wall may be altered so the plant readily absorbs the herbicide.

The following table lists some of the more common nonionic surfactants that are available. Follow the label to see if a surfactant is required.

Table 8-2: Nonionic Surfactants
Suggested use rate of 2 pints/100 gallons unless noted*

Product	Supplier	Product	Supplier
Activate Plus	Riverside	Maxisurf90	T-Tech
Activator90	Loveland Industries	Motion	Loveland Industries
Active80	Walker Distributing	Neptune	Loveland Industries
Ad-Here XL	Simplot	Pen-A-Tratell	Precision Labs
Ad-Wet90	Simplot	Penetrate II	Fannland
Adspray80	Helena	Pelletrex	Midsouth Chemical Co.
Advance90	Countrymark Cooperatives, Inc.	PI IT Spray-Ad 90	Simplot
Alliance90	Countrymark Cooperatives, Inc.	Premier90	VanDiestSupplyCo.
American Spreader	VPG	Premium80	Big Rivers
APSA80	Amway	Purity 100	Rosen's Inc.
Aquagene90	Universal Cooperatives	R-11	Wilbur-Ellis/Wilfarm
Baron	Estes, Inc.	RP 80/20 Surfactant	Red Panther
Bio-88	Kalo, Inc.	S-80/20	T-Tech
Bio Surf	Loveland Industries	Saturall 60	Conklin
Boost	Precision Labs	Saturall85	Conklin
Century	Precision Labs	Saturate	Walker Distribution
ChemSurf	United Suppliers	Silkin	Riverside
ChemSurf80	Chemorse	SilwetL-77	Loveland Industries
ChemSurf90	Chemorse	Spray Activator 85	VanDiest Supply Co.
ChemSurf90	United Suppliers	Spray Fuse 90	CombeltChemical Co.
Chemwett Plus	Coastal Chemical Corp.	Spreader 80	Loveland Industries
CLASS Preference	Cenex/Land O'Lakes Agronomy	Spreader-Sticker	Lesco
CLASS Spray booster S	Cenex/Land O'Lakes Agronomy	Spret	Helena
Cohort DC ¹	Helena	SuperSurf90	Cleveland Chemical Co.
Co-op Spreader-Sticker	Farmland	Surf-Ac820	Drexel
Escort 100	Walker Distributing	Surf-Aid	Riverside
Freeway	Loveland Industries	Surf-King Plus	Estes, Inc.
Galactic	Custom Chemicides	Surfactant 80	Estes, Inc.
Herbraid Plus	Walker Distributing	Sylgard309	Wilbur-Ellis/Wilfarm
Impact	Chemorse	Tradition 93	Rosen's Inc.
Induce	Helena	Tronic-98	Kato
Inspray90	BrandtConsolidated	Unifihn707	Custom Chemicides
Kinetic ²	Helena	Widespread	Loveland Industries
Kinetic HY	Helena	X-77	Loveland Industries
Latron Ag-98	Rohm and Haas	X-90	CombeltChemical Co.
Low Foam Surfactant	Cleveland Chemical Co.	80-20 Surfactant	Universal Cooperatives
M-90	The McGregor Company	80-20 Surfactant	Johnston-LOCKE Co.
Maxi-Surf	T-Tech	80-20 Surfactant	Cannon

Always follow the specific herbicide's label for surfactant use. ¹ Use at 28 oz./100 gal. ² Use at 1 pt./100 gal.

8.1.5 Herbicide Selectivity

The use of herbicides in agriculture is based on the ability to kill some kinds of plants and not others. The degree to which a plant reacts to a herbicide is a measure of the susceptibility of that plant under the conditions in which the herbicide was applied. Tolerance is the degree to which the plants fail to respond. Plants differ in the susceptibility to a herbicide for the following reasons:

1. Metabolic differences that influence whether a herbicide is detoxified within a plant.
2. Physiological differences that influence herbicide absorption and translocation.
3. Stage of growth when treated: For example, applying herbicides when non-target plants are dormant.
4. Herbicide placement: For example, using granular herbicides rather than liquid herbicides to protect certain plants.
5. Chemical protectants: Usually used in cropland situations as seed or soil treatments.

8.2 Recommendations for Noxious Weeds

*From the Montana, Utah, Wyoming Cooperative Extension Services
2006-2007 Weed Management Handbook*

8.2.1 Weed Response to Pasture and Rangeland Herbicides

WEED RESPONSE TO PASTURE AND RANGELAND HERBICIDES

	2,4-D	Amber	Banvel	Cimarron	Cimarron Max	Clarity	Curtail	Escort	Gramoxone Max	Grazon P&D	Journey	MCPA	Milestone	Overdrive	Plateau	Redeem	Remedy	Roundup	Spike	Telar	Tordon	Transline
Grasses																						
downy brome (cheatgrass)	-	F	-	-	-	-	-	-	E	-	E	-	-	-	E	-	-	E	-	-	-	-
quackgrass	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	G	-	-	-	-
foxtail barley	-	-	-	-	-	-	-	-	F	-	-	-	-	-	G	-	-	G	-	-	-	-
bulbous bluegrass	-	-	-	-	-	-	-	-	P	-	-	-	-	-	F	-	-	G	-	-	-	-
medusahead	-	-	-	-	-	-	-	-	G	-	E	-	-	-	E	-	-	E	-	-	-	-
Broadleaf annuals																						
bedstraw	P	-	G	-	-	G	-	-	-	-	G	P	-	G	-	-	-	-	-	-	-	G
kochia	G	G	G	-	G	G	G	-	G	-	-	F	-	E	G	-	-	E	-	-	P	-
Russian thistle	G	G	G	-	G	G	G	-	G	-	-	P	-	E	-	-	-	E	-	P	F	-
yellow thistle	P	-	F	P	F	F	E	P	-	E	-	-	E	F	P	G	-	P	-	G	E	E
prickly lettuce	G	G	G	G	G	G	E	-	G	E	-	G	G	G	-	G	-	G	-	P	E	G
annual mustards	G	E	F	G	G	F	G	G	G	F	E	F	-	G	E	-	-	G	-	E	P	-
Biennials																						
burdock	F	-	-	-	G	-	F	-	-	-	-	-	E	G	-	G	G	-	-	-	-	G
houndstongue	F	G	G	E	G	G	P	E	-	-	G	-	-	-	-	-	-	-	-	-	G	-
mullein	F	-	-	E	G	-	-	E	-	G	-	-	-	-	-	-	-	G	-	F	F	-
musk thistle	F	G	F	E	G	F	G	E	-	E	G	F	E	-	G	G	-	-	-	G	E	G
plumeless thistle	G	-	E	G	G	E	E	G	-	E	-	F	E	-	-	G	-	-	-	-	E	E
scotch thistle	F	-	F	E	G	F	G	E	-	E	-	F	E	-	-	G	-	-	-	G	E	-
Perennials																						
field bindweed	F	-	F	F	P	F	P	F	P	G	F	P	-	F	-	-	-	F	-	-	G	-
sulfur cinquefoil	G	-	P	-	-	P	P	-	-	E	-	-	G	-	-	-	G	-	-	-	E	-
common crupina	G	-	G	E	F	G	F	E	-	E	-	-	-	-	-	-	G	-	-	-	E	-
dandelion	F	-	G	E	G	G	G	E	P	G	F	F	E	G	-	G	G	G	-	-	G	G
dyer's woad	G	-	F	E	G	F	-	E	-	-	F	-	-	-	-	-	-	-	-	G	P	-
curlycup gumweed	G	-	G	G	G	G	E	G	-	E	-	P	G	-	-	-	-	-	-	-	E	-
orange hawkweed	-	-	G	P	-	G	G	P	-	E	-	-	E	-	-	G	-	-	-	-	E	G
yellow hawkweed	F	-	P	P	-	P	G	P	-	E	-	-	E	-	-	G	-	-	-	-	E	G
horsetail	-	-	-	P	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
diffuse knapweed	F	-	F	P	-	F	G	P	-	E	-	-	E	F	-	G	-	F	-	-	E	G
Russian knapweed	P	-	F	-	P	F	G	F	-	E	F	-	E	-	G	F	-	P	-	F	E	P
spotted knapweed	G	-	G	P	G	G	E	P	-	E	-	-	E	-	-	G	-	F	-	-	E	F
larkspurs	F	-	P	-	-	P	-	E	-	E	-	-	-	-	-	-	-	G	-	-	E	-
locoweeds	G	-	E	E	G	E	E	E	-	E	-	-	-	-	-	-	-	-	-	-	E	G
purple loosestrife	G	-	-	G	F	-	-	G	-	-	-	-	-	-	-	-	G	G	-	-	-	-
lupines	G	-	P	-	-	P	P	-	-	F	-	-	-	G	-	-	-	-	-	-	P	-
plantains	G	-	F	G	G	F	-	G	-	-	G	F	-	G	-	-	-	-	-	-	G	-
pricklypear cactus	P	-	-	P	-	-	-	P	-	E	-	-	-	-	-	-	-	-	-	-	E	-
rush skeletonweed	F	-	F	P	P	F	G	P	-	E	-	-	-	F	-	G	-	P	-	-	E	-
common tansy	P	-	F	E	G	F	F	E	-	G	-	-	-	-	-	-	-	-	-	G	G	-
Canada thistle	F	F	F	F	F	F	E	F	-	E	-	F	E	P	-	G	F	G	-	G	E	F
dalmatian toadflax	P	-	P	-	-	P	-	F	-	G	F	-	-	-	G	-	-	-	-	G	G	-
yellow toadflax	P	-	-	-	-	-	P	F	-	G	F	-	-	-	F	-	-	F	-	-	G	-

Control: E = excellent, G = good, F = fair, P = poor or no control, - = not tested or recommended

WEED RESPONSE TO PASTURE AND RANGELAND HERBICIDES

	2,4-D	Amber	Banvel	Cimarron	Cimarron Max	Clarity	Curtail	Escort	Gramoxone Max	Grazon P&D	Journey	MCPA	Milestone	Overdrive	Plateau	Redeem	Remedy	Roundup	Spike	Telar	Tordon	Transline	
Perennials (continued)																							
leafy spurge	F	-	F	P	F	F	P	P	-	G	F	-	-	-	G	-	-	G	-	-	G	-	F
hoary cress (whitetop)	F	-	-	E	G	-	-	E	-	-	G	F	-	-	G	-	-	F	-	E	P	-	-
Trees and Shrubs																							
saltcedar ¹	-	-	P	-	-	P	-	-	-	-	-	-	-	-	-	-	-	F	F	-	P	-	-
juniper ¹	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-	*	-	-
poison oak	E	-	-	-	-	-	-	-	-	-	-	-	-	F	-	G	G	E	-	-	-	-	G
shrub oak	-	-	-	-	-	-	-	G	-	-	-	-	-	-	-	-	-	-	G	-	-	-	-
grey rabbitbrush ²	G	-	P	-	-	P	-	-	-	G	-	-	-	-	-	G	G	-	-	-	-	-	-
prickly rose	-	-	-	G	G	-	-	G	-	-	-	-	-	-	-	-	-	G	-	-	-	-	-
big sagebrush	G	-	F	-	-	F	P	-	-	-	-	-	-	-	-	F	F	P	E	-	P	P	-
broom snakeweed	G	-	F	E	E	F	F	E	-	E	-	-	-	-	-	-	-	-	F	-	E	F	-
pinus	-	-	-	-	-	-	-	-	G	F	-	-	-	-	-	-	-	-	-	-	-	-	-

Control: E = excellent, G = good, F = fair, P = poor or no control, - = not tested or recommended

¹ Individual plant treatments only.

² Need to be applied in early spring with retreatment one year later.

8.2.2 Application and Remarks for Pasture and Rangeland Weeds

PASTURE AND RANGELAND

Herbicide	Application and Remarks	
2,4-D Several trade names Formulations include 4 EC and 6 EC products	Rate:	Rates vary among labels
	Time:	For annual weeds, apply to seedlings and rosettes. For perennials apply at the timing recommended on the label.
	Remarks:	Primarily for control and suppression of many annual, biennial, and perennial broadleaf weeds in range and pasture. Multiple applications are typically required for most deeply-rooted perennials.
	Caution:	Do not apply where spray drift may contact nearby crops or desirable plants or contaminate water for irrigation purposes or domestic use. Do not apply to pastures containing alfalfa, clovers, or other legumes or on newly seeded pasture.
Amber <i>triasulfuron</i>	Rate:	0.28-0.56 oz product/A
	Time:	Apply to actively growing weeds. For seedling grasses, do not apply until at least 60 days after emergence.
	Remarks:	Approved for use on smooth brome, timothy, certain wheatgrasses, and some other perennial grass species. Suppresses wild garlic, Canada thistle, curly dock, goldenrod, and musk thistle. Partial control of downy brome with preemergence applications.
	Caution:	Any clovers or alfalfa in treated areas will be severely injured or killed. Orchardgrass, red fescue, and ryegrasses may also be injured.
Cimarron Max <i>metsulfuron + dicamba</i> + 2,4-D	Rate:	Cimarron Max is a two part product always used in a ratio of 5 oz Part A (metsulfuron) to 2.5 gallons Part B (dicamba + 2,4-D) which will treat 5, 10, or 20 acres as a broadcast application.
	Time:	Apply to annuals when they are small (<4 inches) and actively growing.
	Remarks:	Pasture grasses may vary in sensitivity to this product. Always use a Petroleum Crop Oil Concentrate (COC) or nonionic surfactant.
	Caution:	This herbicide will injure or kill most desirable broadleaf plants including legumes.
Clarity, Banvel <i>dicamba</i>	Rate:	8-64 oz product/A
	Time:	Treat annuals when small and actively growing. See label for proper timing and rates on perennials.
	Remarks:	Rates above 32 oz/A are for spot treatment only. Controls many annual, biennial, and perennial broadleaf weeds and many woody brush and vine species. Rate depends on weed species and growth stage at time of treatment. Can be applied using water, oil—water emulsions, or sprayable fluid fertilizer as the carrier. May also be applied as a cut-surface treatment to control unwanted trees or to prevent sprouts on cut trees.

PASTURE AND RANGELAND - continued

Herbicide	Application and Remarks	
Curtail <i>clopyralid + 2,4-D</i>	Caution:	Rates above 1 pt/A may injure newly seeded grasses. Will cause injury or death to forage legumes and other desirable broadleaf species.
	Rate:	2-4 qt product/A
	Time:	Apply when weeds are actively growing. For Canada thistle, spotted, and diffuse knapweed, apply at the late rosette to bolting stages, but before the bud stage. Applications made from bud to flowering may result in inconsistent control.
	Remarks:	Effective on many thistles and knapweeds. Use 2 qt/A for light infestations of Canada thistle, spotted, and diffuse knapweed and 3 qt/A for heavy infestations or when growing conditions are poor. For Russian knapweed, use 3-4 qt/A from the bud to full bloom stage.
Escort, Cimarron <i>metsulfuron</i>	Caution:	Do not apply to newly seeded grasses until they are well established. Do not apply to pastures containing susceptible desirable broadleaf forage plants (especially legumes) unless injury or death is acceptable. See Pasture and Rangeland Grazing and Haying Restrictions section for critical information for this herbicide. Do not use hay or straw from treated areas or manure from animals grazing treated areas as compost or mulch on susceptible broadleaf crops.
	Rate:	0.33-2.0 oz/A Escort 0.1-1.0 oz/A Cimarron
	Time:	Apply postemergence to actively growing weeds.
	Remarks:	Always use a Petroleum Crop Oil Concentrate (COC) or nonionic surfactant with Cimarron. Always use a nonionic surfactant with Escort. Use herbicide spray within 24 hours of mixing, or product degradation will occur.
Gramoxone Max <i>paraquat</i>	Caution:	Spray equipment used to apply Escort can not be used for crop applications. Use Cimarron or Ally instead.
	Rate:	1.5-2.5 pt product/A
	Time:	Apply prior to or at time of grass seeding. Weeds must be less than 6 inches tall for optimal control.
	Remarks:	For control or suppression of emerged grass and broadleaf weeds for pasture reseeding. Always apply with a nonionic surfactant at 0.5-2.0 pt/100 gallons spray volume. Do not use in areas with heavy sod or dense weed growth.
Grazon P & D <i>picloram + 2,4-D</i>	Caution:	RESTRICTED USE PESTICIDE. Paraquat is a nonselective contact herbicide that will injure or kill any foliage it comes in contact with.
	Rate:	2-4 pt/A
	Time:	Apply to actively growing weeds in the spring and early summer before full bloom or in the fall.

PASTURE AND RANGELAND - continued

Herbicide	Application and Remarks	
Journey <i>imazapic + glyphosate</i>	Remarks:	For selective control of many broadleaf weeds, prickly pear cactus, and woody plants.
	Caution:	RESTRICTED USE PESTICIDE. Will cause injury or death to forage legumes and other desirable broadleaf species. Do not use on sub-irrigated land.
	Rate:	10.7-32 oz/A
	Timing:	For winter annuals, apply in fall preemergence or early postemergence. For other weeds, consult label for timing.
	Remarks:	Effective for site preparation weed control prior to revegetation. Very effective on cheatgrass and mustards.
MCPA (several trade names) <i>MCPA</i>	Caution:	See label for species specific plantback restrictions.
	Rate:	1-3 pt product/A
	Timing:	Apply to annual broadleaf weeds when they are small and actively growing. Apply to perennials in the bud to full bloom stages and to fall regrowth.
	Remarks:	For control or suppression of certain broadleaf annual weeds in range and pasture.
	Caution:	Do not apply where spray drift may contact nearby crops or desirable plants or contaminate water for irrigation purposes or domestic use. Do not apply to pastures containing alfalfa, clovers, or other legumes or on newly seeded pasture. Spray equipment used to apply MCPA amine should not be used for other purposes on susceptible crops.
Milestone <i>aminopyralid</i>	Rate:	3-7 oz product/A
	Timing:	Make spring and early summer applications to actively growing weeds. Fall applications to newly emerged shoots or fall dormant applications for Russian knapweed are also effective.
	Remarks:	Effective treatment for many weeds in the sunflower family (especially thistles and knapweeds) and a few other families.
	Caution:	Will injure or kill many desirable pasture legumes.
	Rate:	4-8 oz product/A
Overdrive <i>diflufenzopyr + dicamba</i>	Time:	Apply to young, actively growing weeds.
	Remarks:	Always include a surfactant (either NIS at 0.25% v/v or MSO at 1.5-2 pt/A). Consult the label for tank mix options for additional weed control.
	Caution:	Do not apply to small grains grown for pasture or to newly seeded grasses. This product will injure or kill desirable forage legumes.
	Rate:	4-8 oz product/A
	Time:	Apply to young, actively growing weeds.

PASTURE AND RANGELAND - continued

Herbicide	Application and Remarks	
Plateau <i>imazapic</i>	Rate:	2-12 oz/A
	Time:	Annual weeds are best controlled preemergence up to small, actively growing plants. Best results for perennial weeds typically occur when applied in late summer or fall after fruit forms. Leafy spurge can be sprayed before the latex stops flowing in fall (test by breaking open a stem to see whether latex will ooze from the wound). Russian knapweed and Dalmatian toadflax can be controlled in late fall.
	Remarks:	Cheatgrass (<i>Bromus tectorum</i>) control is best with applications in the late summer to early fall before it has emerged. Apply with MSO at 1 qt/A, if cheat grass has emerged.
	Caution:	Cool season grass tolerance is variable among species. Consult the label for tolerance of specific species.
Redeem R&P <i>triclopyr + clopyralid</i>	Rate:	1.5-4.0 pt product/A
	Time:	Apply to actively growing weeds. Consult the label for application information specific to certain weeds.
	Remarks:	A nonionic surfactant is recommended for all uses.
	Caution:	Do not apply to smooth brome grass grown for seed. Do not disturb treated site for 14 days following application prior to seedbed preparation and grass seeding. The same susceptible broadleaf cautions apply to this product as for all clopyralid containing products (See Caution section for Transline herbicide). See Pasture and Rangeland Grazing and Haying Restrictions section for important information for this herbicide.
Remedy <i>triclopyr</i>	Rate:	1-2 qt/A for broadcast applications
	Time:	Apply after rapid spring growth when leaves are fully expanded and terminal growth has slowed.
	Remarks:	For woody plant and some herbaceous broadleaf weed control. May be applied as a broadcast, basal bark, cut stump, or dormant stem treatment. Consult label for specific application methods and tank mix options.
	Caution:	See Pasture and Rangeland Grazing and Haying Restrictions section for important information for this herbicide.
Roundup Pro <i>glyphosate</i>	Rate:	0.25-5.0 qt product/A
	Time:	Annual weeds are best controlled when they are small (<6 inches) and actively growing. Downy brome and medusahead can be selectively controlled with the lower rates in range and pasture if the proper conditions are met. Perennial weeds are best controlled when applications are made after the bud stage until fall if foliage is still green. Fall applications must be made before a killing frost.

PASTURE AND RANGELAND - continued

Herbicide	Application and Remarks	
	Remarks:	Glyphosate can be used for total weed control prior to range and pasture renovation. It may also be used as a spot treatment or by wiper application.
	Caution:	Glyphosate is a nonselective herbicide that will injure or kill most desirable plants that are contacted. There are several glyphosate products of differing formulations which will affect the recommended product rate applied.
Spike <i>tebuthiuron</i>	Rate:	0.5-2.5 lb product/A to thin big sagebrush 2.5-3.75 lb product/A for total control
	Time:	May be applied any time during spring, summer, or fall.
	Remarks:	Controls certain woody species including big sagebrush. Treatments only become effective after sufficient rainfall has occurred to move the chemical into the root zone where it is absorbed by the roots. Plants will go through repeated several cycles of greenup and defoliation before death. A single treatment is normally effective for several years.
	Caution:	May cause some injury to desirable grasses, which is usually temporary. This can be minimized by applying when desirable grasses are dormant in the late fall. Do not apply when the ground is frozen.
Telar <i>chlorsulfuron</i>	Rate:	0.25-1.33 oz product/A, up to 3 oz product/A on noncrop sites
	Time:	Apply when weeds are actively growing.
	Remarks:	Always use with a surfactant as specified on the label.
	Caution:	Perennial grass tolerance varies by species. Consult the label for specific pasture and range grass tolerances.
Tordon <i>picloram</i>	Rate:	0.5 pt-2 qt/A
	Time:	Apply to actively growing weeds in the spring and early summer before full bloom or in the fall.
	Remarks:	Controls many troublesome woody and herbaceous weeds including knapweeds, thistles, leafy spurge, field bindweed, and poison oak. Spot treatments may be applied at an equivalent broadcast rate of up to 2 qt/A per annual growing season, but not more than 50% of an acre may be treated.
	Caution:	RESTRICTED USE PESTICIDE. Do not apply in the vicinity of susceptible crops or desirable plants. Do not apply to water or to where surface water from treated areas can run off to adjacent cropland. Do not spray pastures if a forage legume component is desired. Do not move treated soil. Do not apply to inner bank or bottom of irrigation ditches. Do not transfer livestock that have been grazing treated areas for at least 7 days onto crop areas.

PASTURE AND RANGELAND HERBICIDES

Herbicide	Application and Remarks	
Transline <i>clopyralid</i>	Rate:	0.33 to 1.33 pt/A
	Time:	Apply to young, actively growing weeds.
	Remarks:	Effective on many thistles, yellow starthistle, and knapweeds.
	Caution:	Do not spray pastures if forage legume component is desired. See label restrictions on planting crops into treated areas. Do not use hay or straw from treated areas or manure from animals grazing treated areas as compost or mulch on susceptible broadleaf crops. Before moving livestock from treated site into sensitive crop areas, allow 7 days of grazing on an untreated pasture.
Weedmaster <i>dicamba + 2,4-D</i>	Rate:	0.5-6.0 pt/A
	Time:	Apply when weeds are actively growing.
	Remarks:	Rates above 4 pt/A are for spot treatment only.
	Caution:	Rates above 2 pt/A may injure newly seeded grasses.

8.2.3 General precautions found on herbicide labels recommended in Problem Weeds and Poisonous Plants of Range and Pasture

General precautions found on herbicide labels recommended in Problem Weeds and Poisonous Plants of Range and Pasture Section

	2,4-D	Amber	Banvel	Cimarron	Cimarron Max	Clarity	Curtail	Escort ¹	Gramoxone Max	Grazon P&D	Journey	MCPA	Milestone	Overdriv	e Plateau	Redeem	Remedy	Roundup	Spike	Telar	Tordon	Transline
RESTRICTED USE PESTICIDE									X	X										X		
Do not apply to pastures containing desirable forbs (especially legumes) unless injury can be tolerated	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
Nonselective herbicide									X		X						X					
Avoid spray drift to sensitive broadleaf crops	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X
Do not apply near desirable trees			X	X	X	X		X	X	X				X					X	X	X	X
Do not contaminate water	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
Do not apply directly to water		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
Do not apply to highly permeable soils overlying shallow water tables		X	X			X	X			X	X			X	X	X			X		X	X
Do not contaminate irrigation ditches			X	X	X	X	X	X		X			X		X	X	X		X	X	X	X
Surfactant required		X		X	X			X	X		X ²		X	X	X ²	X			X			
Use within 24 hr of mixing		X ³		X	X			X											X			
Do not apply to powdery, dry, and light, sandy soils if no precipitation is expected				X	X			X			X				X				X			
Do not apply when conditions favor movement from the treated site				X	X			X		X									X	X	X	
Do not apply when temperatures are above 85° F			X		X	X																
Time until product is rainfast in hours		4	4	4	4	4	6	N ⁴	5	N	1	N ⁴	4	4	1	2	2	1	N	N ⁴	N	2
																						4

¹ Application equipment used for Escort may not be used for application to crops.

² Surfactant required for post emergent applications.

³ Amber may be stable for up to 36 hours, however, it is recommended to mix only what will be immediately used.

⁴ No rainfast time is specified on the label, however, rainfall immediately following application may reduce activity.

8.2.4 Grazing and Haying Restrictions for Herbicides Labeled for Range and Pasture

Grazing and Haying Restrictions for Herbicides Labeled for Range and Pasture

Herbicide	Lactating dairy animals		Beef and non-lactating dairy animals			
	Rate grazing	Days before hay harvest	Days before grazing	Days before hay harvest	Days before before slaughter	Days removal
2,4-D LV4	1.5-3 qt/A	7	30	0	30	3
2,4-D amine4	2-4 pt/A	7	30	0	30	3
Amber	0.28-0.54 oz/A	0	30	0	30	0
Cimarron	0.1-1.0 oz/A	0	0	0	0	0
Cimarron Max	All labeled rates	7	37	0	0	30
Clarity Banvel	Up to 1 pt/A	7	37	0	0	30
Clarity Banvel	Up to 2 pt/A	21	51	0	0	30
Clarity Banvel	Up to 4 pt/A	40	70	0	0	30
Curtail	2-4 qt/A	14	30	0	30	7
Escort	Up to 1.66 oz/A	0	0	0	0	0
Gramoxone Max						
Grazon P&D	2-4 pt/A	7	30	0	30	3
Journey	Up to 32 oz/A	0	7	0	7	0
Milestone	3-7 oz/A	0	0	0	0	0
Overdrive	4-8 oz/A	0	0	0	0	0
Plateau	2-12 oz/A	0	7	0	7	0
Redeem R&P	1.5-4 pt/A	14 green hay, next growing season for dried hay	14 days for	0 green hay, 7 days for for dried hay	0 days for	3
Remedy	2 qt/A or less green hay, next growing season for dried hay	14 days for green hay	14 days for	0	0	3
Remedy	2-6 qtr/A season for any hay	Next growing season	Next growing green forage	14 days for green forage or dried hay ¹	14 days for	3
Spike		0	1 year	0	1 year	0
Telar	Up to 1.33 oz/A	0	0	0	0	0
Tordon	>1 qt/A	14	14	0	14	3
Transline	All use rates	0	0	0	0	0
Weedmaster	0.5-4.0 pt/A	7	37	0	37	30

¹ When application rate is greater than 4 qts/A, do not harvest dried hay until next growing season.

8.2.5 Application and Remarks for Weeds on Non-crop and Rights-of Way

NONCROP SITES/RIGHTS-OF-WAY

INTRODUCTION

Weed control on noncrop sites and rights-of-way often means total vegetation control with soil-residual herbicides, a process where herbicides render the soil unfit for plant growth without killing soil animals or microbiological organisms.

Several considerations when using soil-residual herbicides are:

1. Know which weeds you want to control so you can determine exactly which herbicide(s) to use.
2. Study the area where the herbicides will be used. Carefully note the location and proximity of adjacent non-target vegetation and surface water. The slope of the terrain to be treated, soil texture, and depth to the water table can also be very important.
3. Follow an integrated control program, including elements of weed prevention, cultural and physical control methods, as well as herbicides. Where appropriate, biological controls should be included. Remember, no single herbicide or other weed control practice will solve all weed problems.

Precautions to be followed when using soil-residual herbicides:

1. Do not move soil from treated area until herbicide is completely gone.
2. Avoid spray drift during application.
3. Do not apply residual herbicides where wind or water might move treated soils.
4. Some herbicides vaporize or volatilize easily. Reduce this hazard by applying herbicides at lower temperatures and use low-volatile herbicide formulations.
5. Do not apply where the roots of desired woody species may extend into the treated area.
6. If allowed on the label, apply soil-residual herbicides during late fall to allow winter precipitation to move the herbicide into the soil. Apply such soil-residual herbicides 4 to 6 weeks before soils are frozen in the fall.

Herbicides are categorized according to their mode of action, which is the method by which they interfere with vital processes of the plant. Repeated use of herbicides having the same mode of action can result in the development of herbicide resistance in some weeds. To avoid this problem rotate between herbicides of different modes of action.

The information provided in this section is intended to serve only as a preliminary guide to herbicide use. Before applying any herbicide product, you must thoroughly read the entire label and follow all label directions. Complete labels and MSDS information for most of the products listed in this section can be viewed on the web at: <http://www.greenbook.net>

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NONCROP SITES/RIGHTS-OF-WAY

Herbicide	Application and Remarks	
Acclaim Extra (0.57 EC) <i>fenoxaprop</i>	Rate:	16 to 39 oz/A (0.57 EC)
	Time:	Postemergence to young actively growing weeds.
	Remarks:	For postemergence control of annual grass weeds and suppression of some perennial grass weeds in certain established turfgrass, ornamental, and wildflower species in rights-of-way. Does not control broadleaf weeds or sedges. Allow mowed areas to regrow for at least 14 days before applying.
	Caution:	Rainfall within 1 hour following application may cause a reduction in grass control. Mixing with herbicides containing 2,4-D will reduce the effectiveness of Acclaim.
Arsenal (2 L) Habitat (2 L) <i>imazapyr</i>	Rate:	1 to 3 qts/A (2 L)
	Time:	Arsenal may be applied either before or after weeds emerge. Postemergence application is the method of choice in most situations, particularly for control of perennials.
	Remarks:	Arsenal controls many annual and perennial grasses and broadleaf species on noncrop areas. Weeds should be growing actively at the time of postemergence applications. Many brush and other woody species can be controlled by foliar applications of Arsenal; or by cut-stump, tree injection, basal bark, or frill-cut treatments of the formulation marketed as Habitat.
	Caution:	Do not use near desirable trees or plants, or in areas where their roots may extend. Do not use on driveways, tennis courts, or similar areas. Do not apply where drift or runoff may result in movement onto agricultural lands.
Assure II (0.88 EC) <i>quizalofop</i>	Rate:	12 to 16 oz/A (0.88 EC)
	Time:	Apply to young actively growing grasses according to the label rate chart.
	Remarks:	For postemergence control of certain weedy grasses on noncrop sites such as fence rows, roadsides, equipment storage areas, and other similar areas. Includes use to aid in the establishment of wildflowers. Use of either a crop oil concentrate or a nonionic surfactant is required.
	Caution:	Do not apply directly to water, or to areas where surface water is present.
Asulox (3.34 SC) <i>asulam</i>	Rate:	7 to 8 pts/A (3.34 SC)
	Time:	Apply to emerged grasses in the growth stages specified on the label.
	Remarks:	For postemergence treatment of annual and perennial grass weeds on noncrop areas such as fence rows, highway and roadside rights-of-way, lumber yards, pipeline rights-of-way, railroad rights-of-way and yards, storage areas, industrial plant sites, utility rights-of-way and

NONCROP SITES/RIGHTS-OF-WAY - continued

Herbicide	Application and Remarks
Campaign (3 SC) glyphosate + 2,4-D	yards, and warehouse lots. A nonionic surfactant should be added to the spray solution at 0.25 % by volume.
	Caution: Make only one application per season. Aerial application is prohibited.
	Rate: 1.5 to 4 pts/A (3 SC)
	Time: Apply postemergence to actively growing weeds according to label growth stage recommendations.
	Remarks: For control or suppression of grass and broadleaf weeds growing in areas such as airports, ditchbanks, dry canals, dry ditches, highway rights-of-way, industrial plant sites, parking areas, roadsides, schools, storage areas, and other public areas and similar industrial or noncrop sites. Additional surfactant is not necessary for this product.
Casoron (4 G) <i>dichlobenil</i>	Caution: Do not apply in the vicinity of 2,4-D sensitive crops such as grapes, tomatoes, or potatoes.
	Rate: 100 to 250 lbs/A (4 G)
	Time: Apply as a soil surface treatment in the late fall or early spring before weeds emerge, or after cultivation has removed the growing weeds.
	Remarks: For control of annual and perennial grass and broadleaf weeds around buildings and structures, around fences, industrial areas, recreational areas, and under asphalt. Distribute granules uniformly over the soil surface and thoroughly incorporate granules into the surface through watering.
	Caution: Do not plant or transplant into treated soil. To avoid ground water contamination do not use where soils are permeable, particularly where the water table is shallow. Use on or near desirable plants not listed on the label may result in damage.
Clarity (4 L) <i>dicamba</i>	Rate: 1 pt to 8 qts/A (4 L)
	Time: Apply to actively growing vegetation.
	Remarks: Controls many annual and perennial broadleaf weed species as well as brush. Other herbicides are frequently combined with dicamba and sold under a variety of trade names. Consult label for rates, times of application, restrictions, and precautions for each of these proprietary mixtures. Dicamba can be used as a spot treatment for weed control in some situations.
	Caution: Do not use in areas where roots of desirable vegetation may extend.
	Additional formulations of dicamba are labeled for noncrop uses, including Banvel, Diablo, Vanquish, and Veteran. Application rates and other label instructions for these products may differ from those stated above.

Herbicide	Application and Remarks	
Classic (25 DG) <i>chlorimuron</i>	Rate:	0.5 to 0.75 oz/A (25 DG)
	Time:	Apply postemergence before weeds exceed heights listed on label.
	Remarks:	For control of certain annual broadleaf weeds on noncrop sites such as fence rows, roadsides, equipment storage areas, and other similar areas. Add a nonionic surfactant at 1 qt per 100 gal of spray solution.
	Caution:	Do not apply by air. Do not graze treated fields or harvest for forage or hay. Do not contaminate any body of water. Do not mix/load within 50 feet of any well.
Crossbow <i>triclopyr + 2,4-D (3 EC)</i>	Rate:	1 to 4 qts/A (3 EC)
	Time:	Apply when weeds are actively growing.
	Remarks:	For control of most kinds of unwanted trees and brush, as well as annual and perennial broadleaf weeds on noncrop areas and industrial sites. May be applied by air (helicopter only), broadcast ground equipment, or handgun.
	Caution:	May not be applied to forage that is to be cut and sold for commercial purposes. Except for lactating dairy animals, there are no grazing restrictions following application of this product. Apply no more than 8 gal per acre per year.
Dimension (1 EC) <i>dithiopyr</i>	Rate:	2 qts/A (1 EC)
	Time:	Apply prior to germination of target weeds or to bare ground.
	Remarks:	For control of listed annual grasses and broadleaf weeds in terrestrial noncrop areas including farm yards, fence rows, highway, utility and railroad rights-of-way, airports, recreation areas, campgrounds, and industrial sites (lumber yards, tank farms, and storage areas). Does not control established weeds. Sequential applications may be made at 3 to 4 month intervals for extended preemergence weed control. Also approved for weed control in turf and around certain ornamentalsgrowing in noncrop areas.
	Caution:	This product may injure the foliage of non-target plants. Do not apply more than 6 qts per acre per season in sequential treatments. Do not graze livestock or feed treated forage.
Drive (75 DF) <i>quinclorac</i>	Rate:	1 lb/A (75 DF)
	Time:	Apply postemergence according to weed and turf growth stages specified on label.
	Remarks:	For control of many broadleaf and grass weeds in turfgrass on such sites as roadsides, airports, and commercial establishments. Tolerant turfgrass species include Kentucky bluegrass, tall fescue, and perennial ryegrass. See label for when to add methylated seed oil to spray mixture.

NONCROP SITES/RIGHTS-OF-WAY - continued

Herbicide	Application and Remarks
Endurance (65 DF) <i>prodiamine</i>	Caution: Do not apply more than 2 lbs/A in one year. Do not apply to exposed feeder roots of trees or ornamentals. Do not apply to any ornamental bed. Do not apply where desirable clovers are present.
	Rate: 1 to 2.3 lbs/A (65 DF)
	Time: Apply preemergence in fall and/or spring.
	Remarks: For selective control of many grass and broadleaf weeds in noncrop areas or surrounding municipal grounds and governmental installations, managed rights-of-way for transportation systems and utilities (including roadways, roadsides, railways and equipment yards), substations, tank farms, pumping stations, parking and storage areas and ungrazed fence rows. Also approved for landscape ornamentals and established perennial and wildflower plantings. Most effective if activated by at least 0.5 inches of rainfall or irrigation, or shallow incorporation prior to weed seed germination and within 14 days after application. Sequential treatments may be made so long as the total amount applied per year does not exceed 2.3 lbs/A.
Escort XP (60 DF) Patriot (60 DF) <i>metsulfuron</i>	Caution: Do not apply aerially. Do not graze or feed livestock forage cut from treated areas.
	Rate: 0.33 to 2 oz/A (60 DF)
	Time: Apply postemergence when ground is not frozen. To control brush and woody species, apply after brush has reached the full leaf stage, up until the beginning of fall leaf coloration.
	Remarks: For general weed control on private, public, and military lands. Approved noncrop sites include airports, highways, railroad and utility rights-of-way, sewage disposal areas, farm yards, fuel storage areas, fence rows, soil bank land, barrier strips, lumber yards, pipelines, and tank farms. A foliar herbicide (with soil residual properties) for control of many annual, biennial, and perennial broadleaf weeds. Also controls many undesirable woody brush and vine species. Addition of a nonionic surfactant required. Low rates are selective, leaving certain well-established grasses as ground cover.
Finale (1 SC) <i>glufosinate-ammonium</i>	Caution: Do not apply during periods of intense rainfall, or to soils saturated with water.
	Rate: 3 to 6 qts/A or 1.5 to 4 fl oz/gal (1 SC)
	Time: Actively growing weeds. Rate varies by species.
	Remarks: For nonselective weed control of emerged weeds in noncrop sites such as shelter belts, along fences, around farmstead building foundations, airports, commercial plants, storage and lumber yards, educational facilities, ditch banks, schools, parking lots, tank farms, pumping stations, parks, and other public areas. Also for trimming and edging landscape areas, recreational areas, around nursery stock, and driveways. No soil residual activity on plants. May be tank mixed with soil residual herbicides. Requires good coverage.

NONCROP SITES/RIGHTS-OF-WAY - continued

Herbicide	Application and Remarks
Fuego (75 DF + 4 SC) <i>triasulfuron + dicamba</i>	Caution: Do not allow to contact green tissue or thin bark of desirable vegetation. Do not allow grazing of treated vegetation.
	Rate: 0.39 to 0.59 oz/A (75 DF) + 8.3 to 12.5 oz/A (4 SC)
	Time: Apply postemergence at weed growth stages specified on label.
	Remarks: For broadleaf weed control in either established grass areas or bare ground sites on roadsides, railroads, industrial plant sites, lumber yards, natural areas, rights-of-way (including pipeline, power, telephone, and utility), dry drainage ditches and ditch banks, and similar industrial noncrop sites. A nonionic surfactant should be included in the spray mixture.
Fusilade II (2 EC) <i>fluazifop</i>	Caution: Do not apply within 4 hours of expected rainfall. Do not apply to stressed or dormant weeds.
	Rate: 16 to 24 oz/A (2 EC)
	Time: Apply postemergence to actively growing grasses before they exceed the recommended growth stages shown on the label.
	Remarks: For control of annual and perennial grass weeds on noncrop areas such as airports, cemeteries, electric transformer stations and substations, pipeline pumping stations, around buildings, storage yards, fence lines, parkways, roadsides, and rights-of-way. Does not control broadleaf weeds or sedges. Always add a high quality nonionic surfactant at 0.25 to 0.5% v/v of the finished spray volume. Timely cultivation 2 to 3 weeks before or after spraying may assist weed control.
Fusion (2.56 EC) <i>fluazifop + fenoxaprop</i>	Caution: For best results do not flood type spray nozzle tips. Disturbance (such as mowing or hand weeding) of treated areas is not recommended within 7 days prior to or within 7 days after application. Do not graze animals in treated areas.
	Rate: 7 to 9 oz/A (2.56 EC)
	Time: Apply postemergence when weeds are in the growth stage specified on the label.
	Remarks: For control of annual and perennial grass weeds on highway rights-of-way. Desirable roadside grasses tolerant of this product include perennial ryegrass, smooth brome, and tall fescue. The addition of a nonionic surfactant or crop oil is recommended at a rate of 32 oz/100 gal of spray mixture.
	Caution: Reduced control may result under drought stress conditions. Tank mixtures with herbicides containing 2,4-D or separate applications of 2,4D made less than 5 days before or after application of Fusion may cause a reduction in grass control.

NONCROP SITES/RIGHTS-OF-WAY - continued

Herbicide	Application and Remarks
Gallery (75 DF) <i>isoxaben</i>	<p>Rate: 0.66 to 1.33 lbs/A (75 DF)</p> <p>Time: Apply preemergence in late summer to early fall, in early spring, or anytime prior to germination of target weeds, or immediately after cultivation.</p> <p>Remarks: For control of certain broadleaf weeds in noncrop areas including industrial sites, utility substations, parking lots, driveways, walking paths, highway guard rails, sign posts and delineators where maintenance of turfgrass or bare ground is desired. Rainfall totaling at least 0.5 inches within 21 days of application is required to activate this product. In non-turf areas, if weed emerge due to lack of adequate rainfall, shallow cultivation to a depth of 1 to 2 inches will adequately incorporate the herbicide and destroy existing weeds.</p> <p>Caution: Do not apply where surface water is present. Drift may result in reduced germination or emergence of non-target plants adjacent to treated areas.</p>
Garlon 4 (4 EC) Garlon 3A (3 L) <i>triclopyr</i>	<p>Rate: 1 to 8 qts/A (4 EC)</p> <p>Time: Postemergence. Dependent on target species and application method.</p> <p>Remarks: For control of unwanted woody plants and annual and perennial broadleaf weeds on noncrop areas including industrial manufacturing and storage sites, rights-of-way such as electrical power lines, communications lines, pipelines, roadsides and railroads, fence rows, nonirrigation ditch banks, and around farm buildings. Use may include application to grazed areas (see restrictions) as well as establishment and maintenance of wildlife openings. Rates depend on weed species, stage of maturity, and environmental conditions. If lower rates are used on hard-to-control species, resprouting may occur the year following treatment. Several application method options are listed on the label.</p> <p>Caution: Do not contaminate irrigation ditches or water used for irrigation or domestic purposes. Do not allow spray or drift to contact crops.</p> <p>Additional formulations of triclopyr are labeled for noncrop uses, including Pathfinder II, Remedy, and Tahoe. Application rates and other label instructions for these products may differ from those stated above.</p>
Goal 2XL (2 EC) Galigan (2 EC) <i>oxyfluorfen</i>	<p>Rate: 2 to 8 pts/A (2 EC)</p> <p>Time: Preemergence or postemergence (depending on species and size).</p> <p>Remarks: For control of broadleaf weeds on non-agricultural areas such as highway and utility rights-of-way, industrial sites, tank farms, storage areas, airports, fence rows, and farmsteads.</p> <p>Caution: Do not feed or allow animals to graze on any treated areas.</p>

NONCROP SITES/RIGHTS-OF-WAY - continued

Herbicide	Application and Remarks
	Galigan is another formulation of oxyfluorfen labeled for noncrop uses. Application rates and other label instructions for this product may differ from those stated above.
Gramoxone Max (3 L) Gramoxone Super Tres <i>paraquat</i>	<p>Rate: 1.7 to 2.7 pts/A (3 L)</p> <p>Time: Apply when weeds are young and succulent.</p> <p>Remarks: For use in noncrop areas such as public airports, electric transformer stations, pipeline pumping stations, around commercial buildings, storage yards and other installations, fence lines, or similar noncrop areas. Paraquat is a contact herbicide that controls only the foliage of emerged weeds. Repeated treatments are necessary for continued suppression of perennials. Use 1 to 2 pints of a nonionic surfactant per 100 gallons of water. Use enough water to obtain thorough coverage of weeds.</p> <p>Caution: ARESTRICTED HERBICIDE. Avoid contact with the foliage of ornamentals or desired plants. Do not use around homes or other areas contacted by children or pets. Do not breathe spray mist. Do not let spray come in contact with skin or clothing.</p>
Hyvar XL (2 SC) <i>bromacil</i>	<p>Rate: 3 qts to 6 gal/A (2 SC)</p> <p>Time: Apply preemergence or early postemergence when weeds are actively germinating or growing, or prior to this period.</p> <p>Remarks: For control of annual and perennial weeds and brush in noncrop areas such as railroads, highway and pipeline rights-of-way, petroleum tank farms, lumber yards, storage areas and industrial plant sites. Also approved for use under pond liners and under asphalt and concrete. Rainfall following application is required for activation.</p> <p>Caution: Do not apply more than 6 gal/A per year. Do not apply to frozen soil. Do not use in residential areas. Injury or death of desirable plants may occur if their roots extend into treated areas.</p>
Journey (2.25 SC) <i>imazapic + glyphosate</i>	<p>Rate: 4 to 32 oz/A (2.25 SC)</p> <p>Time: Apply either preemergence or postemergence in the dormant or growing season. However, postemergence is the recommended method of choice.</p> <p>Remarks: For control of annual and perennial grasses and broadleaf weeds and vines on noncrop areas such as railroad, utility, pipeline and highway rights-of-way, railroad crossings, utility plant sites, petroleum tank farms, pumping installations, non-agricultural fence rows, storage areas, nonirrigation ditchbanks, airports, and wildlife management areas. Supplemental label allows use on noncrop areas that may be grazed or cut for hay. Always add an adjuvant for postemergence applications.</p>

NONCROP SITES/RIGHTS-OF-WAY - continued

Herbicide	Application and Remarks
Karmex DF (80 DF) <i>diuron</i>	Caution: Do not cut treated area for hay within 7 days after treatment. Do not exceed 32 oz/A per year.
	Rate: 5 to 15 lbs/A (80 DF)
	Time: May be used as a preemergence treatment at any time of the year except when ground is frozen, provided adequate rainfall or irrigation is supplied to activate the herbicide.
	Remarks: For control of grass and broadleaf weeds on noncrop sites such as utility, highway, pipeline and railroad rights-of-way, petroleum tank farms, lumber yards, storage areas, industrial plant sites, around farm buildings and similar areas. Use higher rates for perennial weed control, lower rates for annual weed control. Maintenance applications on areas previously treated should be made at the rate of 5 to 10 lbs/A. Control or suppression of established weeds may be obtained by the addition of a nonionic surfactant.
Krenite S (4 L) <i>fosamine</i>	Caution: Constant agitation of spray mixture is required. Do not apply to snow-covered or frozen ground. Do not apply where roots of trees or other desirable plants may extend into treated areas. Do not use on home plantings of trees, shrubs, or herbaceous plants or lawns, walks, driveways, tennis courts or similar areas. Do not contaminate any body of water.
	Additional formulations of diuron are labeled for noncrop uses, including Diuron, and Direx. Application rates and other label instructions for these products may differ from those stated above.
	Rate: 1.5 to 6 gal/A (4 L)
	Time: Apply in late summer or early fall.
Krovar I (80 DF) <i>bromacil + diuron</i>	Remarks: For control and/or suppression of many woody species. Approved for noncrop sites such as airports, highway, railroad and utility rights-of-way, sewage disposal areas, farm yards, fuel storage areas, fence rows, lumber yards, pipeline and tank farms. Also approved on intermittently flooded low-lying sites, seasonally dry flood plains and drainage areas. It is also permissible to treat marshes, swamps, and bogs after water has receded. Apply as a foliar spray to brush. Can be applied by either air or ground equipment. Susceptible treated plants fail to re-foliate the following spring.
	Caution: Do not use on lawns, walks, driveways, tennis courts or similar areas. Do not allow to contact desirable trees, shrubs, or other non-target plants.
Krovar I (80 DF) <i>bromacil + diuron</i>	Rate: 6 to 30 lbs/A (80 DF)
	Time: Apply as a preemergence spray in the fall several weeks prior to freezing or shortly after spring thaw.

NONCROP SITES/RIGHTS-OF-WAY - continued

Herbicide	Application and Remarks
	<p>Remarks: For control of undesirable vegetation in noncrop areas such as railroads, highways, pipeline and utility rights-of-way, petroleum tank farms, lumber yards, storage areas and industrial plant sites. Rainfall is necessary following application for effective weed control. Use higher rate where deep-rooted, hard-to-kill perennial weeds are dominant. Reduced rates may be used for re-treatment as needed. Also approved as a weed control barrier under asphalt and concrete pavement.</p> <p>Caution: This material has a long soil residual. Do not use in areas where the roots of desirable vegetation may extend. Do not treat frozen or saturated soils, or soils that are non-receptive to percolation. Do not use in recreational areas or around homes.</p> <p>Additional formulations of diuron + bromacil are labeled for noncrop uses, including DiBro. Application rates and other label instructions for these products may differ from those stated above.</p>
<p>Landmark (75 DF) <i>sulfometuron + chlorsulfuron</i></p>	<p>Rate: 4.5 to 9 oz/A (75 DF)</p> <p>Time: Both preemergence and postemergence activity. For best results apply at or before the early stages of weed growth, before weeds develop an established root system</p> <p>Remarks: For general weed control in terrestrial noncrop sites and for selective weed control in certain types of unimproved turf grasses on these same sites. Moisture is required to move product into the root zone of weeds for preemergence control. May be applied on noncrop sites that contain areas of temporary surface water caused by management activities. It is permissible to treat marshes, swamps and seasonally dry flood deltas after water has receded. Also approved for use under asphalt and concrete pavement.</p> <p>Caution: Do not apply more than 6 oz ai/A of sulfometuron or 2.25 oz ai/A of chlorsulfuron per year. Do not apply when soil is frozen. Do not use on irrigation ditches or canals.</p>
<p>Lorox (50 DF) <i>linuron</i></p>	<p>Rate: 2 to 6 lbs/A (50 DF)</p> <p>Time: Apply shortly before weed growth begins or at early seedling stage of growth. For best results apply when daily temperatures exceed 70° F and before weed growth exceeds 8 inches in height.</p> <p>Remarks: For short-term nonselective control of annual weeds on noncrop areas such as roadsides and fence rows. Does not control perennial weeds. Add 2 qts of surfactant per 100 gallons of spray mixture for control of established annual weeds.</p> <p>Caution: Do not exceed 6 lbs/A per year.</p>

NONCROP SITES/RIGHTS-OF-WAY - continued

NONCROP SITES/RIGHTS-OF-WAY - continued

Herbicide	Application and Remarks	
MCPA (4 L, 4 EC, 6 L) (numerous brands)	Rate:	3 qts/A (4 EC)
	Time:	Apply when annual weeds are young and growing vigorously. Apply when perennial weeds are growing rapidly (generally near the bud stage). Repeated applications may be necessary.
	Remarks:	For selective weeds in noncrop areas such as roadsides, fence rows, rights-of-way, and similar sites. Controls many annual, biennial, and perennial broadleaf weeds.
	Caution:	Do not apply when weather conditions favor drift from treated areas. Do not contaminate water used for irrigation or domestic purposes.
	Other formulations of MCPA are labeled for use on noncrop sites including Dagger, Rhomene, Rhonox, and Wildcard. Application rates, timing, and other label instructions for these and other labeled products may differ from those stated above.	
Milestone (2 L) <i>aminopyralid</i>	Rate:	3 to 7 oz/A (2 L)
	Time:	Postemergence. Most weeds should be treated when actively growing and under conditions favorable for growth. Also provides preemergence control of germinating seeds and seedlings emerging following application.
	Remarks:	For control of susceptible broadleaf weeds, including invasive and noxious weeds, on noncropland areas (such as roadsides), nonirrigation ditch banks, natural areas (such as wildlife habitats, recreation areas, wildlife openings, wildlife habitats, recreation areas, campgrounds, trailheads and trails), and grazed areas in and around these sites. May be applied as an aerial or ground broadcast treatment or as a spot application. The addition of a high-quality nonionic surfactant at 0.25 to 0.5% volume per volume (1 to 2 quarts per 100 gallons of spray solution) is recommended to enhance herbicide activity under adverse environmental conditions (such as high temperature, low relative humidity, drought, dusty plant surfaces) or when weeds are heavily pubescent or more mature.
	Caution:	Avoid mowing, burning, or soil disturbance in treated areas for at least 7 days following application. Do not aerially apply within 50 feet of a downwind border of any field containing any broadleaf crop. Do not use this product on areas where loss of broadleaf plants, including legumes, cannot be tolerated. Do not contaminate water intended for irrigation or domestic purposes. Do not treat inside banks or bottoms of dry irrigation ditches or other channels used for irrigation or domestic purposes.
Oust XP (75 DF) Spyder (75 DF) <i>sulfometuron</i>	Rate:	1.33 to 8 oz/A (75 DF)
	Time:	Apply preemergence or early postemergence to weeds.
	Remarks:	For general weed control on private, public, and military lands. Ap-

NONCROP SITES/RIGHTS-OF-WAY - continued

proved noncrop sites include airports, highways, railroad and utility

rights-of-way, sewage disposal areas, farm yards, fuel storage areas, fence rows, soil bank land, barrier strips, lumber yards, pipelines, and

Herbicide

Application and Remarks

tank farms. Controls many annual broadleaf weeds, some grasses, and certain perennial broadleaves. Rates depend on weed species and the duration of intended weed control. A low rate (1 oz ai/A), without surfactant, may be used to selectively control downy brome and foxtail while releasing crested wheatgrass or smooth brome. Approved for use under asphalt and concrete pavement.

Caution:

Not approved for use on recreation areas or for direct application to paved areas (surface). Do not apply during periods of intense rainfall or to soils saturated with water. Spray preparations may degrade in acid spray solutions (less than 7.0 pH) if not used within 48 hours.

Oust Extra, a combination of sulfometuron plus metsulfuron, is also labeled for noncrop sites.

Outrider (75 WDG)
sulfosulfuron

Rate:

0.75 to 2 oz/A (75 WDG)

Time:

Apply preemergence or postemergence. Best results are obtained when weeds are actively growing and are not disturbed by mowing or other factors for 14 days prior to or 14 days after application.

Remarks:

For control of certain annual and perennial grasses and broadleaf weeds in noncrop sites including roadsides, utility rights-of-way, airports, ditch banks, fence rows, industrial sites, lumber yards, manufacturing sites, petroleum tank farms and pumping installations, railroads, storage areas, utility substations, and warehouse areas. Also approved for over-the-top application to some unimproved turfgrass and native grass areas. Addition of a nonionic surfactant is required for postemergence applications.

Caution:

Do not apply to areas where surface water is present. The combined total of all applications of this product must not exceed 2.66 oz/A per year. Tank mixes with other broadleaf herbicides formulated as amines will decrease the effectiveness of this product. Do not allow this product to contact roots or foliage of desirable plants.

Overdrive (70 DF)
diflufenzoypyr + dicamba

Rate:

4 to 8 oz/A (70 DF)

Time:

Apply to actively growing weeds.

Remarks:

For selective postemergence control of broadleaf weeds in noncropland sites, including railroad, utility, pipeline, and highway rights-of-way; railroad crossings; utility plant sites; petroleum tank farms; pumping installations; nonagricultural fencerows; and airports. Symptoms will typically appear within hours, and control should take place in 3 to 7 days. Use 1 qt. of nonionic surfactant or 1.5 to 2 pt. of methylated seed oil in each 100 gal. of spray solution. Overdrive is normally rainfast 4 hours after application. Grass treated with Overdrive may be grazed or harvested for livestock feed immediately after application.

NONCROP SITES/RIGHTS-OF-WAY - continued

Herbicide	Application and Remarks
Paramount (75 DF) <i>quinclorac</i>	Caution: Do not apply aerially. Do not apply more than 10 oz/A per year. Do not apply under conditions which favor runoff. Do not mix or apply within 50 feet of wells. Overdrive may injure bentgrass, buffalograss, St. Augustine, and velvetgrass; and will severely injure legumes.
	<hr/> Distint is a similar product labeled for use on agricultural fencelines.
	Rate: 5.3 to 16 oz/A (75 DF)
	Time: Postemergence. Apply to most annual broadleaf weeds when small. See label for additional timing instructions.
Payload (51 WDG) SureGuard <i>flumioxazin</i>	Remarks: For control or suppression of certain annual grasses as well as annual and perennial broadleaf weeds in noncrop sites such as fence lines, roadsides, highway medians, utilities, railroad and pipeline rights-of-way. Paramount is taken up by the foliage and plant root system. Adequate moisture or light rain is needed for activation. Visual symptoms may take 3 weeks to appear while control takes 3-6 months after application. The use of a spray additive is required.
	Caution: Avoid spray drift to sensitive crops. Do not apply more than 16 oz/A per calendar year. Do not apply to irrigation ditches or to areas where surface water is present. Do not allow livestock to graze treated areas.
	Rate: 8 to 12 oz/A (51 WDG)
	Time: Make preemergence applications to soil prior to weed emergence, or apply postemergence to weeds that are less than 2 inches in height. Postemergence applications are most effective under sunny conditions at temperatures above 65° F.
Pendulum (3.3 EC) <i>pendimethalin</i>	Remarks: A nonselective herbicide to maintain bare-ground noncrop areas such as guard rails, pipelines, railroad beds, parking and storage areas, plant sites, substations, pumping stations, tank farms, airports, industrial plant sites, lumber yards, military installations, around farm buildings, fence rows, road surfaces, and gravel shoulders. Moisture is necessary for activation of preemergence applications. Always add 0.25 % v/v of nonionic surfactant or 1 qt/A of crop oil concentrate for postemergence applications.
	Caution: Do not graze treated areas or feed treated forage or hay to livestock. Do not apply more than 24 oz/A per year. Do not mechanically incorporate into soil after application.
	Rate: 2.4 to 4.8 pts/A (3.3 EC)
	Time: Prior to emergence of weeds.
	Remarks: For control of most annual grasses and certain broadleaf weeds in noncrop sites such as railroad, utility, highway, and pipeline rights-

NONCROP SITES/RIGHTS-OF-WAY - continued

Herbicide	Application and Remarks	
	<p>of-way, fence rows, shelterbelts, and paved or gravel surfaces. It is also approved for use under asphalt or concrete pavement. Performance is improved if application is followed within 30 days by at least 0.5 inches of rainfall or sprinkler irrigation.</p> <p>Caution: Avoid contact with driveways, stone, wood, or other porous surfaces to prevent staining.</p> <p>At least three additional formulations of Pendulum are labeled for noncrop uses. Application rates and other label instructions for these products may differ from those stated above.</p>	
Pennant (7.62 EC) <i>metolachlor</i>	<p>Rate: 1.3 to 2.6 pts/A (7.62 EC)</p> <p>Time: Apply before weeds emerge or after existing weeds have been removed.</p> <p>Remarks: For control of many annual grasses and certain annual broadleaf weeds on noncrop sites such as airports and roadsides. A second application may be needed to provide longer weed control.</p> <p>Caution: Do not apply to impervious substrates such as paved or highly compacted surfaces. Do not exceed a total of 4.2 pts/A per year.</p>	
Plateau (2 SC) <i>imazapic</i>	<p>Rate: 4 to 12 oz/A (2 SC)</p> <p>Time: May be applied either preemergence or postemergence to weeds. However, postemergence is the method of choice in most situations, particularly for perennial species. Weeds should be growing vigorously at the time of postemergence application.</p> <p>Remarks: For control of annual and perennial grasses and broadleaf weeds and vine species on noncrop sites such as railroad, utility, pipeline and highway rights-of-way, railroad crossings, utility plant sites, petroleum tank farms, pumping installations, non-agricultural fence rows, storage areas nonirrigation ditchbanks, airports, and other similar areas. Include a spray adjuvant with all postemergence applications. Also approved for foliar and seedhead suppression of certain cool-season grasses, including crested and intermediate wheatgrass.</p> <p>Caution: Do not cut treated area for hay within 7 days after treatment.</p>	
Poast (1 EC) Vantage (1 EC) <i>sethoxydim</i>	<p>Rate: 1 to 2.5 pts/A (1 EC)</p> <p>Time: Apply postemergence when grasses are at growth stage listed on label.</p> <p>Remarks: For use in noncrop areas including rights-of-way, roadsides and other paved areas, along fences and hedgerows, public buildings, recreation areas, industrial sites, storage yards, airports, electric transformer stations, pipeline pumping stations, and sewage disposal areas to control or suppress annual and some perennial grasses. Does not control sedges or broadleaf weeds. Always add methylated seed oil or crop oil concentrate.</p>	

NONCROP SITES/RIGHTS-OF-WAY - continued

Herbicide	Application and Remarks	
Pramitol 25E (2 L) <i>prometon</i>	Caution:	Do not use when conditions favor drift or when wind speed is greater than 10 mph. Treated vegetation may not be grazed or used as feed for livestock.
	Rate:	5 to 10 gal/A
	Time:	Apply at weed emergence or within 2 to 3 months after spring growth begins.
	Remarks:	For total vegetation control on industrial sites, noncrop areas around-the-farm, and for use in and under asphalt. Prometon has both foliar and root action. This material is an effective broad-spectrum herbicide, even on organic and alkaline soils.
	Caution:	Do not use any herbicide containing prometon within residential areas or where roots of desirable plants might extend into treated soil.
Predict (80 DF) Solicam (80 DF) <i>norflurazon</i>	Rate:	2.5 to 5 lbs/A (80 DF)
	Time:	Apply to soil surface before weeds germinate.
	Remarks:	For nonselective preemergence control of non-woody vegetation on industrial sites, rights-of-way, wasteland, and other noncrop sites. Controls most annual grasses and broadleaf weeds, and provides control or suppresssion of many perennials. Higher rates within the range should be used for finer-textures soils and where longer residual is desired. Existing weeds should be mechanically removed or controlled with a suitable postemergence herbicide before applying norflurazon. Chemical must be incorporated by precipitation or sprinkler irrigation within 4 weeks after application for best control. Tank mix combinations may be desired for broader spectrum weed control.
	Caution:	Do not apply to erodible soils that may wash into the root zone of sensitive plants.
	Solicam is another formulation of norflurazon labeled for use in noncrop areas, but is limited to farmstead sites such as ungrazed fence lines, equipment lots, ditchbanks above the high water line, driveways, on-farm roads, and other on-farm noncrop areas.	
QuickSilver (1.9 EC) <i>carfentrazone</i>	Rate:	0.25 to 2 oz/A (1.9 EC)
	Time:	Apply to actively growing weeds.
	Remarks:	For control of many annual, biennial, and perennial broadleaf weeds on rights-of-way, utility and industrial areas, and fence rows. Specific sites include roadways, rest areas, utility, railroad, highway, pipeline, and rights-of-way that run through pasture and rangeland, utility facilities such as substations, pipelines, tank farms, pumping stations, parking and storage areas, railroads, highway medians, and bridge abutments. Use a nonionic surfactant or a crop oil concentrate as a spray adjuvant.
	Caution: Do not apply more than 10 oz/A per season in rights-of-way.	

NONCROP SITES/RIGHTS-OF-WAY - continued

Herbicide	Application and Remarks	
Reward L&A (2 L) <i>diquat</i>	Rate:	1 to 2 pts/A (2 L)
	Time:	Apply when weeds are young and succulent.
	Remarks:	For fast burndown or control of weeds in industrial sites such as rights-of-way, railroad beds/yards, highways, roads, dividers and medians, parking lots, pipelines, pumping stations, public utility lines, transformer stations and substations, electric utilities, storage yards, and other similar noncrop areas. Diquat is a contact herbicide that controls only the foliage of emerged weeds. Repeated treatments are necessary for continued suppression of perennials. Use 1 to 2 pints of a nonionic surfactant per 100 gallons of water. Use enough water to obtain thorough coverage of weeds.
	Caution:	Avoid contact with the foliage of ornamentals or desired plants. Do not graze livestock on treated forage.
Ronstar (50 WSP) <i>oxadiazon</i>	Rate:	4 to 8 water-soluble packets per acre. (One water-soluble packet contains 1 pound of product.)
	Time:	Apply prior to weed germination.
	Remarks:	For selective preemergence control of annual grasses and broadleaf weeds in landscape plantings on roadsides and other commercial and industrial noncrop sites.
	Caution:	The entire content of the water-soluble bag must be used. Do not allow domestic animals to graze treated areas. Avoid contamination of water intended for irrigation or domestic purposes.
Roundup Pro (4 SC) <i>glyphosate</i>	Rate:	1 to 5 qts/A (4 SC)
	Time:	Apply to foliage of actively growing weeds and grasses at the label-recommended growth stage.
	Remarks:	For broad-spectrum postemergence control of weed in industrial sites. Use low rates for annual weed control, high rates for perennial weeds. Use enough water to achieve complete coverage but not to the point of runoff. Established perennials may require re-treatment; glyphosate is highly translocated and has little or no soil activity. Can be used in wick-wiper application equipment.
	Caution:	Do not use glyphosate in galvanized or mild steel tanks. Avoid treatment if rainfall is expected within 6 hours.
Other formulations of Roundup, as well as numerous other brands of glyphosate are labeled for use in noncrop sites. Examples include Accord, Aquamaster, Aqua Neat, Credit, Foresters, Forza, Glyfos, Glyphosate, Glypro, Honcho, Ranger, Rattler, Razor, Recoil, Rodeo, and Touchdown. Application rates and other label instructions for these products may differ from those stated above. QuikPRO is a formulation of glyphosate + diquat labeled for noncrop use.		

NONCROP SITES/RIGHTS-OF-WAY - continued

Herbicide	Application and Remarks	
Sahara DG (70 DF) <i>diuron + imazapyr</i>	Rate:	7 to 19 lbs/A (70 DF)
	Time:	May be applied preemergence or postemergence. Postemergence is preferred, particularly for perennials.
	Remarks:	For general weed control in noncrop sites such as railroads, utility, pipeline and highway rights-of-way, utility plant sites, petroleum tank farms, pumping installations, fence rows, farmyards and around farm buildings, storage areas, non-irrigation ditchbanks, and other similar area where bare ground is desired. May also be used under paved surfaces. Provides residual control of most annual and perennial grasses and broadleaf weed in addition to many brush and vine species. Sahara DG is to be mixed with water (and a spray adjuvant for postemergence applications).
	Caution:	Injury or death of desirable plants may result if this product is applied where roots are present, or where they may extend into the treated area.
Scythe (4.2 EC) <i>pelargoric acid</i> and related fatty acid	Rate:	3 to 10 percent by volume (3 to 10 gallons of Scythe per 100 gallons of total spray solution)
	Time:	Apply to emerged weeds at least 72 hours prior to reflooding of dry aquatic sites.
	Remarks:	For nonselective control of annual weeds and suppression of perennial herbaceous weeds in noncrop areas. Apply in water as a broadcast spray in 70 to 200 gallons of spray solution per acre. Continuous agitation is required. A defoaming agent may be added to prevent excessive foaming. Thorough spray coverage is required for best results. Repeated applications may be required for control of perennial weeds.
	Caution:	Do not allow spray to come in contact with the foliage of desirable plants. Do not apply through any type of irrigation system. Do not apply by aircraft.
Select (2 EC) <i>clethodim</i>	Rate:	6 to 16 oz/A (2 EC)
	Time:	Apply postemergence to actively growing grasses at recommended weed heights.
	Remarks:	For control of annual and perennial grasses on rights-of-way including railroads, highways, roads, dividers, medians, pipelines, public utility lines, pumping stations, transformer stations and substations, around airports, electric utilities, commercial buildings, manufacturing plants, storage yards, rail yards, fence lines, and parkways. Always use a crop oil concentrate at 1 % v/v or 1 qt of nonionic surfactant per 100 gal in the finished spray volume.
	Caution:	Most effective if applied when average nighttime temperatures are consistently greater than or equal to 47° F. Do not mow area for 2 weeks after application. Do not use flood nozzles. Do not graze treated areas or feed treated forage to livestock.

NONCROP SITES/RIGHTS-OF-WAY - continued

Herbicide	Application and Remarks
Snapshot TG (2.5 G) <i>trifluralin + isoxaben</i>	Additional formulations of clethodim are labeled for noncrop uses, including Arrow and Prism. Application rates and other label instructions for these products may differ from those stated above.
	Rate: 100 to 200 lbs/A (2.5 G)
	Time: Apply prior to germination of target weeds in late summer to early fall or in early spring. Areas to be treated should be free of established weeds or existing weeds should be controlled by postemergence herbicides.
	Remarks: A preemergence herbicide for control of certain broadleaf weeds and annual grasses in noncrop areas such as industrial sites, utility substations, highway guardrails, sign posts, and delineators. Does not control established weeds or woody species. Activate with 0.5 inch of water or shallow cultivation within 3 days after application, but before weeds begin to emerge.
Spike (80 W) Spike (20 P) <i>tebuthiuron</i>	Caution: This product is toxic to fish. Do not apply directly to water or wetlands. Drift or runoff from treated areas may be hazardous to neighboring aquatic sites. Do not apply more than 600 lbs of product per acre within a 12 month period.
	Rate: 1 to 5 lbs/A (80 W)
	Time: Apply prior to or just after emergence of weeds. In areas of low rainfall (less than 15 inches per year) apply prior to the time of year when the predominant portion of that rainfall occurs.
	Remarks: For control of grass and broadleaf weeds and woody plant species in noncrop areas such as utility, railroads, and pipeline rights-of-way, fence rows, airport runways, utility substations, road shoulders where no vegetation is desired, and under asphalt and concrete pavement. For control of wood species apply broadcast or to individual plants, or as a series of parallel bands to the soil surface. Spacing between bands should range between 4 and 10 feet, depending on the woody species to be controlled.
Telar (75 DF) <i>chlorsulfuron</i>	Caution: Do not use in any areas where desirable species are in the vicinity of the plants to be controlled. Spike will kill trees, shrubs, and other forms of desirable vegetation when roots extend into the treated area. Do not apply where surface water is present. Do not use where water table is predominately shallow (5 feet or less). Do not apply when ground is frozen or saturated with moisture. Do not use under asphalt or concrete pavement where future landscaping is planned.
	Rate: 0.25 to 3 oz/A (75 DF)
	Time: Apply preemergence or early postemergence to weeds when ground is not frozen. For best results, apply postemergence to young, actively growing weeds.

NONCROP SITES/RIGHTS-OF-WAY - continued

Herbicide	Application and Remarks
	<p>Remarks: For control of many annual, biennial, and perennial broadleaf weeds on noncrop industrial sites such as airports, military installations, fence rows, roadsides and associated rights-of-way, pumping installations, railroads, storage areas, and other similar areas including governmental and private lands. Also approved for unimproved industrial turf on roadsides and other noncrop sites. For postemergence applications, a nonionic surfactant should be added at the rate of 1 quart per 100 gal of spray to improve activity. Degree of control and duration of effect will vary with the amount of chemical applied, soil texture, soil pH, soil organic matter, weed size, rainfall, and other conditions.</p> <p>Caution: Do not use on lawns, driveways, or similar areas. Do not apply in or on irrigation ditches or canals, including their outer banks.</p>
Tordon 22K (2 L) <i>picloram</i>	<p>Rate: 1 pt to 2 qts/A (2 L)</p> <p>Time: Apply to foliage of actively growing weeds and brush.</p> <p>Remarks: For control of susceptible broadleaf weeds and woody plants on noncrop areas such as roadsides or other rights-of-way, fence rows, and around farm buildings. Approved for application rates up to 4 qts/A for control of juniper. Picloram has soil-residual activity.</p> <p>Caution: RESTRICTED-USE. Follow all restrictions and precautions as given on the label. Apply only as a spot treatment for rates exceeding 2 qts/A.</p>
	<p>Tordon K is another herbicide formulation containing picloram as the single active ingredient. Pathway, Tordon 101 and Tordon RTU are formulations containing picloram plus 2,4-D. Application rates and other label instructions for these or other products containing picloram can be expected to differ from those stated above.</p>
Transline (3 EC) <i>clopyralid</i>	<p>Rate: 0.25 to 1.33 pts/A (3 EC)</p> <p>Time: Apply low rate when weeds are 1 to 3 inches tall and actively growing. Apply intermediate or high rates when weeds are 3 to 6 inches tall, or under dry conditions.</p> <p>Remarks: For selective postemergence control of broadleaf weeds in noncrop areas including equipment pathways, industrial manufacturing and storage sites, road, electrical and railroad rights-of-way, fence rows, around farm buildings, and equipment pathways. May be applied to grazed areas and wildlife openings. To improve spectrum of activity or to increase activity against taller weeds, tank mix with 2,4-D.</p> <p>Caution: Do not contaminate irrigation ditches or water used for irrigation or domestic purposes. Unsatisfactory control may result if application is made when brush or weeds are under severe drought stress or other adverse conditions that inhibit plant growth.</p>

NONCROP SITES/RIGHTS-OF-WAY - continued

Herbicide	Application and Remarks
Triamine (2.5 SC) 2,4-D + MCPP + 2,4-DP	<p>Rate: 0.33 to 1.5 gal/A (2.5 SC)</p> <p>Time: Apply anytime between the time when plants come into full leaf (spring) to when the plants begin to go dormant. Best results are obtained when weeds are young and actively growing.</p> <p>Remarks: For control of broadleaf weeds and unwanted woody plants on roadsides (including aprons and guardrails) and other similar noncrop areas. Do not cut weeds until herbicide has translocated throughout the plant and caused root death. All leaves, stems, and suckers must be completely wet to the ground line for effective control of woody plants.</p> <p>Caution: Do not apply to areas where surface water is present.</p> <p>Several other herbicide formulations containing 2-way, 3-way, or 4-way mixtures of the phenoxy or growth-regulator type active ingredients 2,4-D, 2,4-DP, MCPP, MCPA, dicamba, and/or triclopyr are labeled for use on noncrop sites. Examples include Cool Power, Patron 170, Triplet, Tri-Power. Application rates, timing, and other label instructions for these and other labeled products may differ from those stated above.</p>
2,4-D (4 L, 4 EC, 6 EC) (numerous brands)	<p>Rate: 1 pt to 15 qts/A (4 EC)</p> <p>Time: Apply when annual weeds are young and growing vigorously. Apply when perennial weeds are growing rapidly (generally near the bud stage). Repeated applications may be necessary.</p> <p>Remarks: For selective weeds in noncrop areas such as airfields, roadsides, vacant lots, fence rows, industrial sites, rights-of-way, and similar areas. Controls many annual, biennial, and perennial broadleaf weeds and woody species.</p> <p>Caution: Do not apply when weather conditions favor drift from treated areas. Do not contaminate water used for irrigation or domestic purposes.</p> <p>Numerous formulations of 2,4-D are labeled for use on noncrop sites including Barrage HF, DMA 4, Esteron 99, Formula 40, Hardball, Opti-Amine, Turret, Weedar, and Weedone. Application rates, timing, and other label instructions for these and other labeled products may differ from those stated above.</p>
Velpar L (2 SC) hexazinone	<p>Rate: 1 to 4 gal/A (2 SC)</p> <p>Time: Apply as a preemergence or postemergence spray when weeds are actively germinating or growing.</p> <p>Remarks: For control of many annual, biennial, and perennial weeds in noncrop sites such as railroads, highways, utility and pipeline rights-of-way, petroleum tank farms, storage areas, industrial plant sites, and other similar areas. Also approved for control of some woody species by stem injection or by directing a thin stream of undiluted product to the soil within 3 inches of the root collar.</p>

NONCROP SITES/RIGHTS-OF-WAY - continued

Herbicide	Application and Remarks
Vista (1.5 EC) Starane <i>fluroxypyr</i>	Caution: Injury or death of desirable trees and other plants may result if applied on areas where their roots may extend. Do not apply to frozen soil.
	Oustar is a combination of hexazinone and sulfometuron labeled for certain noncrop uses.
	Rate: 0.67 to 2.67 pts/A (1.5EC)
	Time: Apply when weeds are small and actively growing, but before weeds are 8 inchestall.
	Remarks: Vista is labeled for postemergence control of annual and perennial broadleaf weeds and woody brush in noncrop areas including industrial sites, non-irrigation ditch banks, and rights-of-way such as for electrical power lines, communication lines and pipelines, roadsides and railroads including grazed areas within these sites. Starane is labeled for control of broadleaf weeds in on-farm noncrop areas such as fence rows, building perimeters, around irrigation equipment and on-farm private roadways. Reduced activity will occur when temperatures are below 45 or above 85° F.
	Caution: Do not harvest treated forage for hay within 7 days after application. Do not apply more than 2.67 pts/A of Vista per year.
	Several other herbicides containing fluroxypyr are labeled for noncrop weed control, including Escalade (2,4-D + dicamba + fluroxypyr), PastureGard (triclopyr + fluroxypyr), Starane + Esteron, Starane + MCPA, Starane + Salvo, and Starane + Sword. Application rates and other label instructions for these or other products containing fluroxypyr will be different from those stated above.
Weedmaster (4 SC) <i>dicamba + 2,4-D</i>	Rate: 0.5 to 6 pts/A (4 SC)
	Time: Apply postemergence to actively growing weeds at growth stages specified on the label.
	Remarks: For general noncrop farmstead weed control (including fence rows) and state-recognized noncrop noxious weed areas. Controls many annual, biennial, and perennial herbaceous weeds as well as undesirable brush species. Also approved for frill-cut, girdle, and stump treatments. May be applied using water or diesel oil and water emulsions for control of woody species.
	Caution: Rates above 4 pts/A are for spot treatments only. Do not exceed a total of 8 pts/A per year.
Westar (75 DG) <i>hexazinone + sulfometuron</i>	Rate: 2 to 4 lbs/A (75 DG)
	Time: Apply preemergence or early postemergence to herbaceous weeds.
	Remarks: For control or suppression of many annual and perennial weeds in noncrop sites such as airport, highway, railroad and utility rights-of-way, farm yards, fuel storage areas, fence rows, industrial sites, lumberyards, pipelines, and tank farms.

NONCROP SITES/RIGHTS-OF-WAY - continued

Herbicide	Application and Remarks
XL(2G) <i>oryzalin + benefin</i>	Caution: Not labeled for use on recreation areas or for direct application to paved surfaces. Do not mix with Hyvar XL herbicide. Do not apply in or on irrigation ditches
	Rate: 200 to 600 lbs/A (2 G)
	Time: Apply prior to germination of target weeds, or immediately after cultivation.
	Remarks: For selective preemergence control of certain annual grasses and broadleaf weeds in unimproved or landscaped noncrop sites including industrial sites, utility substations, highway guardrails, sign posts, and delineators. Areas to be treated should be free of established weeds, or existing weeds should be controlled with postemergence herbicides. Activation by at least 1/2 inch of rainfall within 21 days after application is required for best results.
	Caution: Do not apply more than 1200 lbs/A per year.

SECTION 9 Biological Weed Management

INTRODUCTION STATUS AND ROLE OF BIOLOGICAL WEED CONTROL AGENTS

OBTAINING AND RELEASING BIOCONTROL AGENTS

MONITORING AND MANAGING BIOCONTROL AGENTS

Information on the status of biocontrol agents in Montana, in addition to methods for obtaining and releasing agents, and monitoring biocontrol sites are discussed in this Section. Additional information can be obtained from the Montana Biological Weed Control Coordination Project, Melissa Maggio-Kassner, Project Coordinator, 406-258-4223.

9.1 Introduction

Biological control, or biocontrol, is the intentional use of living organisms to reduce the population of a pest. It may include the use of insects, nematodes, mites, plant pathogens, and vertebrates. Often more than one biocontrol agent is introduced on a weed. Each enemy detrimentally affects the weed to some degree. This effect may be obvious, such as when the plant is defoliated, or it may be subtle, such as when slight damage caused by the biocontrol agent allows secondary organisms (such as pathogens) to inflict greater damage.

Because the majority of the noxious weeds in the United States are introduced without their natural enemies, and many of these weeds are minor members of the plant communities in their native lands, insights about weed management may be found by studying these plants in their native homelands. Studies reveal which organisms are associated with the target plant, which of these damages the weed, and which damages other plants. From these results, potential biocontrol agents are selected and tested to determine their host range. Those that have a very limited host range under starvation feeding trials are approved for release into the United States.

The eventual impacts of a biological control agent on its target plant will be the result of: 1) the density of weeds compared to the density of the agent; 2) the effect of the local biotic and abiotic conditions on the agent and on the weed; 3) the plant's reproductive ability (seeds only or seeds and vegetative reproduction); 4) the agent's ability to stress the plant each year and the plant's ability to maintain and replace root reserves; 5) the plant's ability to recover from the effects of the biocontrol agent; and 6) the interactions of multiple biocontrol agents attacking a single weed species.

Both advantages and disadvantages are associated with the use of biocontrol agents. One advantage is that once a biological control agent becomes established it usually will reproduce, increase its numbers, and continue to attack the target organism, generally without additional costs to the land manager. Second, biocontrol agents move to host plants anywhere within their climatic range, readily crossing ownership boundaries and some geographical barriers. Third, approved biocontrol agents are selective. Host weeds are attacked without damage to the surrounding vegetation. Finally, properly tested biological agents are not a source of environmental contamination.

A disadvantage of biocontrol is that it often takes many years for the populations of the introduced agents to increase to levels that permanently decrease the pest plant population. A limited number of eggs are laid by insects and initial population build-up appears slow. However, insect numbers increase exponentially. As biocontrol agent population gradually increase, the weed population will gradually decrease and may be unnoticed by the land manager. Photopoints can help document the seriousness of the original weed problem and the change in the weed population over time. A second disadvantage is that some biocontrol agents may be subject to predators. Third, environmental conditions (shade versus sun, low

versus high rainfall, sandy versus clay soils) often exclude some biocontrol agents from certain locations. Finally, biological control agents usually do not eradicate weed populations or stop the spread of weeds. Use of multiple control and containment methods is important when implementing any management system.

Using biological control agents to help manage weed problems is more effective when the land managers understand the target weed biology, the biological control agents available and how they impact the weed and the environmental and management restrictions in the area.

Rees, N.E., P.C. Quimby, Jr., and B.H. Mullin Biological Control of Weeds in the West. Western Society of Weed Science, USDA Agricultural Research Service, Montana Department of Agriculture, Montana State University. 1996

9.2 Status and Role of Biological Weed Control Agents

Biological Control Agents of Weeds – Agents Released or Approved for Release in Montana: April 2018

From the Montana Biological Weed Control Coordination Project

Agent*	Order: Family	Type	Established	Comments
FIELD BINDWEED				
<i>Aceria malherbae</i>	Acari: Eriophyidae	gall mite	Y	Well established in eastern and parts of western Montana; patchy in distribution, with limited impact
<i>Tyta luctuosa</i>	Lepidoptera: Noctuidae	defoliating moth	?	Not recovered
HAWKWEED				
<i>Aulacidea subterminalis</i>	Hymenoptera: Cynipidae	stolon galling wasp	?	Released on orange hawkweed; not recovered
KNAPWEED - DIFFUSE & SPOTTED				
<i>Agapeta zoegana</i>	Lepidoptera: Cochylidae	root boring moth	Y	Widespread with impact at some sites
<i>Bangasternus fausti</i>	Coleoptera: Curculionidae	flowerhead weevil	Y	Established at low levels in MT; more common in ID and WA
<i>Chaetorellia acrolophi</i>	Diptera: Tephritidae	flowerhead weevil	Y	Established and widespread
<i>Cyphocleonus achates</i>	Coleoptera: Curculionidae	root boring moth	Y	Well established and increasing in number and distribution; significant impact at numerous sites
<i>Larinus minutus</i>	Coleoptera: Curculionidae	flowerhead weevil	Y	Well established, widespread; heavy damage to rosettes & stems due to adult feeding, particularly on diffuse knapweed which is nearly eliminated on many sites
<i>Larinus obtusus</i>	Coleoptera: Curculionidae	flowerhead weevil	Y	Established but difficult to differentiate from <i>L. minutus</i>
<i>Metzneria paucipunctella</i>	Lepidoptera: Gelechiidae	flowerhead moth	Y	Well established but populations limited due to cold temperature causing winter mortality
<i>Pelochrista medullana</i>	Lepidoptera: Tortricidae	root boring moth	Y	Recovered but unknown establishment

9.2 | SECTION 9 BIOLOGICAL WEED MANAGEMENT

<i>Pterolonche inspersa</i>	Lepidoptera: Pterolonchidae	root boring moth	Y	Limited establishment on spotted knapweed
<i>Sphenoptera jugoslavica</i>	Coleoptera: Buprestidae	root boring beetle	Y	Limited establishment; does well on diffuse but will also infest spotted knapweed
<i>Terellia virens</i>	Diptera: Tephritidae	flowerhead fly	Y	Established at some locations
<i>Urophora affinis</i>	Diptera: Tephritidae	flowerhead fly	Y	Well established and widespread
<i>Urophora quadrifasciata</i>	Diptera: Tephritidae	flowerhead fly	Y	Well established and widespread
KNAPWEED - RUSSIAN				
<i>Aulacidea acroptilonica</i>	Hymenoptera: Cynipidae	stem galling wasp	Y	Established with increasing populations
<i>Jaapiella ivannikovi</i>	Diptera: Cecidomyiidae	tip gall midge	Y	Established with increasing populations
<i>Mesoanguina picridis</i> (formerly <i>Subanguina picridis</i>)	Nematoda - Anguinidae	stem gall nematode	Y	Established but not recently found; may be damaging in wet years but does poorly overall
LEAFY SPURGE				
<i>Aphthona abdominalis</i>	Coleoptera: Chrysomelidae	root- feeding flea beetle	N	No reported establishment
<i>A. cyparissiae</i>	Coleoptera: Chrysomelidae	root- feeding flea beetle	Y	Established at some locations
<i>A. czwalinae</i>	Coleoptera: Chrysomelidae	root- feeding flea beetle	Y	Established at some locations; may be mixed with <i>A. lacertosa</i>
<i>A. flava</i>	Coleoptera: Chrysomelidae	root- feeding flea beetle	Y	Established at some locations

<i>A. lacertosa</i>	Coleoptera: Chrysomelidae	root- feeding flea beetle	Y	Good establishment and availability; impacting spurge at numerous sites and across varying habitats; may be mixed with <i>A. czwalinae</i>
<i>A. nigriscutis</i>	Coleoptera: Chrysomelidae	root- feeding flea beetle	Y	Good establishment and availability; impacting spurge at numerous sites
<i>Chamaesphecia crassicornis</i>	Lepidoptera: Sesiidae	root moth	N	No reported establishment; limited releases made
<i>Chamaesphecia hungarica</i>	Lepidoptera: Sesiidae	root moth	N	No reported establishment; limited releases made
<i>Chamaesphecia tenthrediniformis</i>	Lepidoptera: Sesiidae	root moth	N	Not established; limited releases made; released as <i>Chamaesphecia empiformis</i>
<i>Dasineura nr. capsulae</i>	Diptera: Cecidomyiidae	seed gall midge	-	Approved but not released due to overwintering mortality in quarantine
<i>Hyles euphorbiae</i>	Lepidoptera: Sphingidae	defoliating moth	Y	Established at numerous locations; populations generally variable from year to year with limited impact
<i>Oberea erythrocephala</i>	Coleoptera: Cerambycidae	stem boring beetle	Y	Established at numerous locations; limited effectiveness
<i>Spurgia esulae</i>	Diptera: Cecidomyiidae	tip gall midge	Y	Established; limited effectiveness
<i>Spurgia capitigena</i>	Diptera: Cecidomyiidae	tip gall midge	-	Released but DNA analysis indicates this species same as <i>Spurgia esulae</i>
PURPLE LYTHRUM (LOOSESTRIFE)				
<i>Galerucella calmariensis</i>	Coleoptera: Chrysomelidae	defoliating beetle	Y	Established
<i>Galerucella pusilla</i>	Coleoptera: Chrysomelidae	defoliating beetle	Y	Established
<i>Hylobius transversovittatus</i>	Coleoptera: Curculionidae	root	?	Released but establishment not confirmed

9.2 | SECTION 9 BIOLOGICAL WEED MANAGEMENT

<i>Nanophyes brevis</i>	Coleoptera: Nitidulidae	flower- infesting weevil	-	Not released in U.S. due to a parasitic nematode; not available
<i>Nanophyes marmoratus</i>	Coleoptera: Nitidulidae	flower- infesting weevil	-	No confirmed releases in MT
PUNCTUREVINE				
<i>Microlarinus lareynii</i>	Coleoptera: Curculionidae	seed weevil	N	Not established; not cold hardy
<i>Microlarinus lypriformis</i>	Coleoptera: Curculionidae	stem mining weevil	N	Not established; not cold hardy
RUSSIAN THISTLE				
<i>Coleophora klimeschiella</i>	Lepidoptera: Coleophoridae	defoliating moth	N	Not established
<i>Coleophora parthenica</i>	Lepidoptera: Coleophoridae	stem mining moth	?	Establishment unconfirmed
SALT CEDAR				
<i>Diorhabda carinulata</i> (<i>elongata</i> complex)	Coleoptera: Chrysomelidae	defoliating beetle	Y	Established at low levels or colonies have died out; originally released as <i>Diorhabda elongata</i> , (but recently found to be a complex of several species released at various U.S. locations); No interstate shipping currently allowed
ST. JOHN'S WORT				
<i>Agrillis hyperici</i>	Coleoptera: Buprestidae	root-boring beetle	Y	Established at several sites
<i>Aplocera plagiata</i>	Lepidoptera: Geometridae	defoliating moth	Y	Established and widespread
<i>Chrysolina hyperici</i>	Coleoptera: Chrysomelidae	defoliating beetle	Y	Established at several sites

<i>Chrysolina quadrigemini</i>	Coleoptera: Chrysomelidae	defoliating beetle	Y	Established at several sites
<i>Zeuxidipolis giardi</i>	Diptera: Cecidomyiidae	tip-gall fly	N	No reported establishment
TANSY RAGWORT				
<i>Botanophila seneciella</i>	Diptera: Anthromyiidae	flower infesting fly	Y	Released in northwestern MT; widespread but limited impact on seed production
<i>Longtarsus jacobaeae</i>	Coleoptera: Chrysomelidae	root-feeding flea beetle	Y	Released in northwestern MT; widespread in the tansy ragwort area; having an impact at many sites
<i>Tyria jacobaeae</i>	Lepidoptera: Arctiidae	defoliating moth	Y	Released in northwestern MT; widespread in the tansy ragwort area; having an impact at many sites
THISTLES - BULL				
<i>Urophora stylata</i>	Diptera: Tephritidae	flower-galling fly	?	Establishment unknown
THISTLES - CANADA				
<i>Altica carduorum</i>	Coleoptera: Chrysomelidae	defoliating beetle	N	Not established
<i>Hadroplontus litura</i> (formerly <i>Ceutorhynchus litura</i>)	Coleoptera: Curculionidae	stem-boring weevil	Y	Well established; questionable impact
<i>Urophora cardui</i>	Diptera: Tephritidae	stem-galling fly	Y	Established at numerous locations; little significant impact
THISTLES - MUSK				
<i>Cheilosia corydon</i>	Diptera: Syrphidae	stem, rosette-boring fly	N	Released but not established
<i>Psylloides chalconera</i>	Coleoptera: Chrysomelidae	rosette-boring flea beetle	-	Not released in MT

9.2 | SECTION 9 BIOLOGICAL WEED MANAGEMENT

<i>Rhinocyllus conicus</i>	Coleoptera: Curculionidae	flower weevil	Y	Well established and widespread; effective in reducing plant density; will attack native thistles; NO interstate movement
<i>Trichosirocalus horridus</i>	Coleoptera: Curculionidae	rosette-boring weevil	Y	Appears to be wide spread in western Montana; may be effective on drier sites with <i>R. conicus</i> ; NO interstate movement
<i>Urophora solstitialis</i>	Diptera: Tephritidae	flower-gall fly	?	Establishment unknown
TOADFLAXES – DALMATIAN and YELLOW				
<i>Calophasia lunula</i>	Lepidoptera: Noctuidae	defoliating moth	Y	Established at various locations; little significant impact
<i>Eteobelea intermediella</i>	Lepidoptera: Cosmopterigidae	Dalmatian toadflax root-boring moth	N	Released but known to be established; limited releases made
<i>Eteobelea serratella</i>	Lepidoptera: Cosmopterigidae	yellow toadflax root-boring moth	N	Released but known to be established; limited releases made
<i>Rhinusa antirrhini</i> (formerly <i>Gymnetron antirrhini</i>)	Coleoptera: Curculionidae	flower-feeding weevil	?	Dalmatian toadflax strain approved for release; establishment unknown; yellow toadflax strain adventive
<i>Rhinusa linariae</i> (formerly <i>Gymnetron linariae</i>)	Coleoptera: Curculionidae	root-galling weevil	?	Released; establishment unknown
<i>Rhinusa pilosa</i>	Coleoptera: Curculionidae	stem-galling weevil	-	Recently approved for release (2018)
<i>Mecinus janthiniformis</i>	Coleoptera: Curculionidae	Dalmatian toadflax stem	Y	Widespread; impacting populations at some locations on Dalmatian toadflax; originally released

		mining weevil		as <i>Mecinus janthinus</i> , but recently found to be a separate, cryptic species
<i>Mecinus janthinus</i>	Coleoptera: Curculionidae	yellow toadflax stem mining weevil	Y	Established at several locations on yellow toadflax and increasing in number; impacting weed populations at some locations
WHITETOP (HOARYCRESS)				
<i>Aceria drabae</i>	Acari: Eriophyidae	gall mite	-	Recently approved for release (2018)

* Does not include adventive agents. See comments regarding agents not approved for interstate shipment.

9.3 Obtaining & Releasing Biocontrol Agents

9.3.1 Obtaining Biocontrol Agents

Availability of biocontrol agents varies from species to species in Montana. To obtain insects, start by contacting the state biocontrol coordinator. There are school groups and commercial distributors that distribute insects for a fee, as well as collection days that you can attend where you can obtain insects free of charge. For a list of biocontrol vendors in Montana, visit mtbiocontrol.org/resources/. Regardless of how you obtain them, you will want to receive them soon after they emerge as adults and before the females lay their eggs for the season.

9.3.2 Releasing Biocontrol Agents

Biocontrol agents should be released on sites where the weed infestation is large enough (around five acres) to sustain a population of the insect. Beyond this each species has specific releasing recommendations. Details on these specifics can be found at mtbiocontrol.org. In general you will want to release the insects soon after receiving them and follow the specific instructions you are provided with for that particular species.

9.4 Monitoring & Managing Biocontrol Agents

9.4.1 Monitoring Biological Control Agents & Impact

Many variables can impact the effectiveness of biocontrol (number of insects released/present, length of time insects have been established, site characteristics, climate variables, etc.). Therefore, when you utilize biocontrol as a management tool many questions arise. How can you tell if the biological control agents released are having the desired effect on the plant community you are managing? Is the insect population increasing or decreasing? Are the weeds you are treating really going away? More importantly, is the desired vegetation returning and out-competing the weedy species? These questions can be answered by an easy, yet often overlooked part of your vegetation management plan: monitoring and evaluation. Monitoring is an essential component of any successful vegetation management program. A simple form and consistent collection of data can be used to document changes in vegetation that occur over time, allowing you to make knowledgeable decisions on whether to continue or adjust your management. This allows you to more efficiently utilize your resources and time, which will lead to a healthier plant community.

To monitor, place a steel fence post at the release site and/or mark coordinates with a GPS to allow you to return to the original release site in the future. Ideally, an annual collection of the biocontrol agent population, weed infestation specifics, and information concerning the rest of the plant community will occur by using techniques such as sweep netting for insect counts, assessing the percent cover of vegetation types, and counting and measuring the stems of the target weed. This information will give you a good idea if biocontrol is working for you. If this sounds too difficult, at a minimum, establish a photo point to visually document changes in your weed infestation and plant community over time. Be sure to use a permanent feature in the background and your release point marker in each picture. More information on monitoring, including record-keeping forms, can be accessed at mtbiocontrol.org/resources/.

9.4.2 Managing Biocontrol Agent Populations

If you discover through your monitoring that you have a collectible population of insects, you may want to consider actively managing them. This might include inviting neighboring land managers to collect and release insects on their property, collecting and moving them to nearby infestations. Biocontrol agents are collected in a variety of ways: using a sweep net, by tapping plants over a tray or into a bucket, aspirating, and hand-picking are some of the more common ways insects are collected. The collection method depends on the insect species but typically warm, sunny, and non-windy days result in the largest numbers.

9.4.3 Biocontrol as Part of an Integrated Weed Management Strategy

Biocontrol can be an effective and important weed management tool, but it does not work in all cases and should not be expected to eradicate the target weed when used alone. Biocontrol is a tool that is best suited for well-established and/or difficult to reach weed infestations. It is not an appropriate tool for small infestations or newly invading species that can be quickly eradicated through other techniques such as herbicide application and/or hand-pulling. Even in the most successful cases, biocontrol often requires multiple years before impacts become noticeable. It may not be appropriate for all landowners or every type of land but when utilized in conjunction with other management tools, biocontrol can decrease the abundance of invasive plants over time. Biological weed control is best suited for long-term weed management and is an important component of an integrated weed management strategy. How you integrate different weed management tools will vary from species to species. It is almost always a good idea to use an herbicide on the perimeter of the infestation to reduce spread while using biocontrol agents within the center of the infestation. Good results have also been observed when using grazing and biocontrol together for some species. For integrated weed management strategies utilizing biocontrol for a specific weed contact the state biocontrol coordinator.

Planning & Funding

INTRODUCTION

GUIDELINES FOR DEVELOPING A WEED MANAGEMENT PLAN

FUNDING – MONTANA NOXIOUS WEED GRANT PROGRAM

Weed Management Plans are vital to the operation and success of a weed district program. A management plan is a dynamic document that explains the organization's goals, priorities, and methods of procedure. The Noxious Weed Trust Fund is a State program that provides funding for weed management projects. This section provides information on how to write a weed management plan and apply for assistance from the Noxious Weed Trust Fund grant program. For additional information, contact the State Weed Coordinator, Montana Department of Agriculture, Helena, MT, 406-444-3140.

10.1 Introduction

The State of Montana has a comprehensive Noxious Weed Management Plan which can be used to strengthen, support, and coordinate private, county, state, and federal weed management efforts in the state, and promote implementation of ecologically-based integrated weed management programs. The plan mirrors the 2016 Montana Invasive Species Framework and is organized into five focal areas: Coordination, Prevention, Detection, Rapid Response, and Control. Weed districts are encouraged to use the State's management plan as a template when completing their county plans.

The primary goal of planning is to create long-term success. It is only through planning that organizations can effectively evaluate what needs to be done, prioritize their efforts, make sound financial decisions, and collaborate with others to successfully manage noxious weeds.

A weed management plan is considered the overall guide for a specified area and should be evaluated for effectiveness every 5-7 years. The plan should be developed along with short-term objectives (1-3 years). The objectives should address how the goals of the plan are implemented. They may not address all the goals of the management plan in a given year due to manpower, funding, or other limitations as budgets and circumstances may change from year to year. These changes are best addressed in making new short-term objectives, rather than re-writing the management plan annually.

10.2 Guidelines for Developing a Weed Management Plan

1. Define Purpose of Weed Management Plan:

- Need for action
- Mission and direction for the County
- Define and describe Weed Management Areas (WMAs)

2. Define Weed Management Areas (WMAs):

All WMAs are unique areas that are identified for planning purposes and usually follow natural or man-made boundaries. All WMAs should include the following:

- Name and legal description
- Describe boundaries
- Describe land use – timbering, recreation, grazing, farming, mining, etc. Be specific.
List crops, domestic animals, visitor days for each recreational use, wood species timbered, etc.
- Describe topography, major aquatic features, other natural resources.
- Describe wildlife and native flora
- Describe noxious and nuisance weeds within the area
- Describe threatened and endangered species
- Identify major towns, cities, resorts
- Identify archaeological and Native American cultural sites

3. Identify Weeds of Concern:

- List noxious weed species and acres infested (state and county listed)
- Describe methods of introduction
- Identify high risk areas for future infestations

4. Weed Management Priorities - Establish adherence to management of noxious weeds based on the following priorities:

- **Priority 1:** These weeds are not present or have a limited presence in Montana. Management criteria will require eradication if detected, education, and prevention

- **Priority 2:** These weeds are either common in isolated areas or widespread in many counties of Montana. Management criteria will require eradication or containment where less abundant. Management shall be prioritized by local weed districts
- **Priority 3:** These regulated plants (not Montana listed noxious weeds) have the potential to have significant negative impacts. The plant may not be intentionally spread or sold other than as a contaminant in agricultural products. The state recommends research, education and prevention to minimize the spread of the regulated plant.

5. Define Long-Term Goals:

Goals should describe the primary outcomes of your weed management plan. They should be specific, measurable, achievable, realistic, and timely. Goals should be re-evaluated every 5-7 years.

- Develop awareness, education, & training
- Develop and maintain funding and administration
- Develop and maintain an inventory
- Develop prevention and early detection tactics
- Implement integrated weed management plan
- Develop and maintain monitoring and evaluation techniques
- Develop and maintain a reporting system

6. Define Short-Term Objectives:

Objectives should answer the needs of individual weed management areas and be measurable steps towards achieving the long-term goals. The need for and prioritization of objectives will vary between weed management areas; success is greatest when an integrated plan is developed and implemented. These objectives should be re-evaluated every 1-3 years.

- See section 10.2.1 on Integrated Weed Management

7. Define Roles and Responsibilities:

- List agencies and jurisdictions involved
- Establish cooperation with residents, landowners, agencies, towns, organizations, counties, and states to effectively implement programs of prevention and control

within the weed management areas

- Obtain the signatures required
- Define planning timetable
- Define terms and time of termination if applicable
- Define insurance / liabilities
- Identify funding and resources for weed management

10.2.1 Integrated Weed Management (IWM)

Integrated weed management is crucial for the success against noxious weeds and deserves special mention. IWM is a systematic approach to vegetation management that combines multiple control techniques to achieve a long-term result that is both economically and environmentally sound. It is a holistic approach to restoring ecological processes such as fire patterns, nutrient cycling, and community dynamics by reducing weed pressure.

Successful integrated weed management begins with your plan. Your management plan should include objectives that facilitate an integrated weed management strategy for the weeds of concern. IWM includes five concepts: Prevention, Control, Monitoring, Evaluation, and Planning (Section 10.2). For each season, prevent new infestations and spread, control the existing populations, monitor the effectiveness of control, evaluate management decisions and available resources, adjust the management plan if needed for the following year, and repeat.

Prevention

Preventing noxious weeds from infesting an area is the most cost-effective component of integrated weed management. Noxious weeds can be spread by natural means, but most invasions are human-caused and may be prevented by:

- Establishing education and awareness programs for new invaders and for established state and county listed weeds
- Promoting the use of certified weed seed free forage, bedding, and seed
- Promoting the use of weed free compost, gravel, and sand
- Cleaning equipment, clothing, vehicles, and pets
- Keeping vectors such as roads, trailheads, and parking areas weed free

- Minimizing disturbance in un-invaded areas, or areas that have a high risk of invasion
- Quarantining and inspecting products or equipment that is contaminated
- Maintaining healthy native plant communities to reduce the potential for invasion
- Being vigilant when out in the field. Catching new invasions before there is time to establish a population is critical.

Control Methods

Controlling noxious weeds is, by law, required for every landowner in the state. To control means to stop weeds from competing with native or desirable vegetation. There are five components of control: no action, cultural, physical, biological, and chemical. Choosing which control method(s) to use is site-specific and should be:

- Applied at the appropriate time (growth stage, weather conditions, etc.)
- The least damaging to non-target organisms and to the environment
- Applied within resource limitations (personnel, knowledge, funding, etc.)
- The most beneficial over the long-term
- Complementary to the management goals and objectives

- **No Action**

Before any options are considered, determine if **no action** is a viable solution. No action may be the correct control option if the following conditions exist for a specific site:

- The problem will disappear without any action (e.g. annuals on newly disturbed areas).
- Policies and laws prohibit action.
- The general public prohibits action.
- The presence of Threatened and Endangered species or habitat for T&E species prohibits action
- Aquatic or other site factors prohibit action.

○ **Cultural**

Livestock manipulation

- Determine if changes in livestock grazing will affect the target weeds. Targeted livestock grazing can be used to reduce seed production on some species, and may allow for increased competition from beneficial vegetation while slowing the spread of noxious weeds.
- Determine changes in movement or type of livestock to reduce or contain the infestation due to movement of seeds on or in the animals.
- Determine if containing livestock prior to introduction into a weed-free area would prevent new infestations.

Wildlife manipulation

- Determine if wildlife or wildlife feeding programs can be managed to reduce weed infestations.
- Determine feasibility of changes in wildlife movement that would reduce or contain the infestation due to movement of seed on or in the animals

Seed Disturbance Activities

- Revegetate all bare soil following disturbance
- Select plant species that will reduce the spread of noxious weeds
- Defer soil disturbance if possible until weeds are controlled or under management
- Work with your local road department for revegetation of new roadsides and gravel pits

Public use

- Determine most feasible land use to reduce and prevent infestations
- Determine if specific public awareness programs could reduce the infestation or control the spread of weed
- Determine if exclusion is a possibility and how it would affect the weed infestation

○ **Physical Control**

Manual control

- Determine if hoeing or “grubbing” will reduce (or increase) the infestation
- Determine effectiveness of hand pulling on target species

Mechanical control

- Evaluate terrain to allow for mowing and determine if it is an acceptable option for control of the spread of seeds
- Evaluate cultivation and other conventional farming practice options that could be utilized cost effectively

Control by burning

- Determine if the terrain and vegetative cover allow for a controlled burn program
- Evaluate a controlled burn program to reduce the infestation
- Determine long-term effect of burning on non-target species
- Determine if policy and laws allow controlled burning

○ **Biological Control**

Natural competition

- Determine if there are natural-occurring agents within the ecosystem which can reduce the infestation.
- Determine which elements affect naturally occurring control agents.
- Determine if these elements can be modified to reduce the negative effect on agents.
- Determine if these elements can be enhanced to increase the effectiveness of agents on the weed infestation.

Introduced competition

- Determine the level of control that a biological agent has on the target species and whether it will provide an acceptable level of management of the infestation.
- Determine if the introduced biological agent can survive in the environment of the treatment area.

- Determine if policy and laws allow for the introduction of biological control agents.

- **Chemical Control**

Fertilization

- Determine if chemical fertilization would reduce the number of weeds by increasing competition of beneficial plant species.
- Determine if increased nitrogen (or other nutrients) would reduce weeds. For example, curlycup gumweed can be reduced by increased nitrogen fertilization.

Herbicides

- Evaluate the appropriateness of herbicides to control the infestation: weed characteristics, timing, available resources, environment, accessibility, adjoining landowner's goals and perceptions, etc.
- Determine if herbicides are labeled for:
 - Use on the target weed.
 - Use on the infested site (consider non-target plants, soil type, groundwater location, topography, climate, state labeling, etc.)
- Determine the most effective application techniques.
- Determine the most effective and cost-efficient types of conventional application equipment.
- Determine if properly trained personnel are available to apply the herbicides.

Monitoring and Evaluation

Monitoring is an on-going assessment of management decisions and can demonstrate where certain actions are effective and successful. Monitoring allows land managers to make well-informed, non-bias decisions when evaluating and modifying their management plan.

Monitoring

- Monitor for Early Detection, Rapid Response
 - Target high-risk areas such as vectors or continually disturbed sites
 - Use tools to record presence and absence such as EDDMapS West, or other mapping programs
- Monitor before and after treatments

- Use different types of monitoring techniques based on landscape, scale of infestation, accessibility, desired results, etc.
 - Qualitative: Description of what is measured based on its quality such as size, appearance, growth stage, observed density, etc.
 - Photo points: Use a permanent marker or GPS location to take pictures of the same location over time
 - Remote Sensing/Aerial Imagery: Trained programs for satellites or drones to detect certain characteristics of noxious weeds in a larger landscape
 - Quantitative: Collect measurements of an area, usually with a Daubenmire frame, in random intervals either from a set point or from a transect to get percent cover, density, frequency, etc.
- Monitor the effects on non-target species: negative and positive
- Monitor for trends of invasiveness in areas or for weeds that are not treated
- Monitor the effectiveness of control: timing, weather patterns, who is applying treatment, details of the treatment, and the response of the target weeds

Evaluation

- Did the actions meet the management objectives?
- Were the objectives met, and if not, what were the constraints?
- Are the objectives still relevant?
- What were the successes and failures? What factors made each of those possible?
- What steps will be taken to avoid repeated failures?
- What changes, if any, need to be made to the management plan: weed priorities, new or lost resources, budget, control choices, etc.?

10.3 Funding – Montana Noxious Weed Grant Program

The Montana Noxious Weed Trust Fund (NWTF) grant program was established in 1985 by the Legislature under the provisions of the Montana Noxious Weed Trust Fund Act. The program was originally funded by a herbicide surcharge and is now a \$10 million permanent Trust Fund. Interest from the Trust Fund, 1.5% of vehicle registration fees, State and Private Forestry Cooperative funds, Montana Department of Transportation,

and a small portion of the state General Fund contributes approximately \$2 million annually to the NWTF grant program.

The NWTF provides funding for the development and implementation of weed management programs in Cooperative Weed Management Areas, educational programs, noxious weed research, and the development of new and more effective weed management techniques. Noxious Weed Trust Fund grants are available to communities, landowners and land managers, county, extension, and conservation districts, research scientists, non-profits, and other individuals conducting weed management projects or research.

Grant proposals are reviewed by a ten-member Noxious Weed Management Advisory Council. Council members serve a two-year term, with no limit to the number of terms served. Applications are completed online using the Montana Grants and Loans system at <http://fundingmt.org>. Grants are funded for one year (18 months) and can be continued if applications are submitted in subsequent years. Grant applicants have the opportunity to present their proposals to the Council during the annual spring hearings in Helena, Montana. The Council makes funding recommendations to the director of the Department of Agriculture for final grant approval. A current list of Council members and previously funded grants can be found at <http://agr.mt.gov/weeds>.

For additional information on location and date of grant hearings, application deadlines, or if you have specific questions you may contact:

NWTF Grant Coordinator	Phone: 406-444-7882
State Weed Coordinator	Phone: 406-444-3140
Weed Program Specialist	Phone: 406-444-7880

Website: <http://agr.mt.gov/Noxious-Weed-Trust-Fund-Grants>

10.4 Noxious Weed Trust Fund Act and Rules

MONTANA NOXIOUS WEED MANAGEMENT FUNDING AND ADMINISTRATIVE RULES

STATE OF MONTANA
DEPARTMENT OF AGRICULTURE
PO BOX 200201
HELENA, MONTANA 59620-0201
(406) 444 5400
www.agr.mt.gov



**MONTANA DEPARTMENT OF AGRICULTURE
AGRICULTURAL SCIENCES DIVISION
HELENA, MONTANA**

**STATUTE
TITLE 80, CHAPTER 7
SECTIONS 80-7-801 THROUGH 80-7-823**

REVISED 2017

**DR. MARK NECHODOM
ADMINISTRATOR**

**BEN THOMAS
DIRECTOR**

Disclaimer-

This document contains a copy of the statutes relating to the subject matter. Although every attempt is made to ensure that the information placed in this document is accurate and timely, the Department of Agriculture cannot assure the accuracy of any specific provision, and you are urged to consult the official printed versions of these publications or to contact legal counsel of your choice. All critical information should be independently verified.

The Montana Code and Constitution is at: http://leg.mt.gov/BILLS/MCA_toc/index.htm

TITLE 80. AGRICULTURE
CHAPTER 7. DISEASE, PEST, AND WEED CONTROL
Part 8. Noxious Weed Management Funding

MCA	CONTENTS
80-7-801	<u>DEFINITIONS</u>
80-7-802	<u>RULES</u>
80-7-803 – 80-7-804	REPEALED
80-7-805	<u>NOXIOUS WEED MANAGEMENT ADVISORY COUNCIL</u>
80-7-806 – 80-7-809	RESERVED
80-7-810	REPEALED
80-7-811	<u>NOXIOUS WEED MANAGEMENT TRUST FUND</u>
80-7-812	REPEALED
80-7-813	<u>ACCEPTANCE AND EXPENDITURE OF FUNDS</u>
80-7-814	<u>ADMINISTRATION AND EXPENDITURE OF FUNDS</u>
80-7-815	<u>NOXIOUS WEED EMERGENCY</u>
80-7-816	<u>ACCOUNT—DEPOSIT—INVESTMENT</u>
80-7-817 – 80-7-820	RESERVED
80-7-821	REPEALED
80-7-822	TERMINATED
80-7-823	<u>TRANSFER OF FUNDS</u>

**MONTANA DEPARTMENT OF AGRICULTURE
AGRICULTURAL SCIENCES DIVISION
HELENA, MONTANA**

ADMINISTRATIVE RULES OF MONTANA

**CHAPTER 5
SUBCHAPTER 1 & 2**

NOXIOUS WEED MANAGEMENT FUNDING

REVISED FEBRUARY 2017

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The Administrative Rules of Montana may be found online through the internet at: <http://arm.sos.state.mt.us>

**MONTANA DEPARTMENT OF AGRICULTURE
AGRICULTURAL SCIENCES DIVISION**

CHAPTER 5

**SUB-CHAPTER 1
NOXIOUS WEED TRUST FUND**

ARM	CONTENTS
4.5.101	<u>DEFINITIONS</u>
4.5.102	<u>APPLICATION PROCEDURE</u>
4.5.103	<u>APPLICATION CONTENT FOR GRANTS</u>
4.5.104	<u>TECHNICAL, FEASIBILITY OF PROJECT</u>
4.5.105	<u>PROJECT EVALUATION</u>
4.5.106	<u>ECONOMIC ASSESSMENT OF PROJECTS</u>
4.5.107	<u>LEGAL REQUIREMENTS</u>
4.5.108	<u>EVALUATION OF PROJECTS</u>
4.5.109	<u>REPORTING AND MONITORING PROCEDURES</u>
4.5.110	NOXIOUS WEED LIST (REPEALED)
4.5.111	<u>NOXIOUS WEED IDENTIFICATION AND VERIFICATION</u>
4.5.112	<u>NOXIOUS WEED MANAGEMENT COUNCIL</u>
4.5.113	DEALER RECORD REQUIREMENTS (REPEALED)

**SUB-CHAPTER 2
DESIGNATION OF NOXIOUS WEEDS**

ARM	CONTENTS
4.5.201	<u>DESIGNATION OF NOXIOUS WEEDS</u>
4.5.202	CATEGORY 1 (REPEALED)
4.5.203	CATEGORY 2 (REPEALED)
4.5.204	CATEGORY 3 (REPEALED)
4.5.205	CATEGORY 4 – WATCH LIST (REPEALED)
4.5.206	<u>PRIORITY 1A</u>
4.5.207	<u>PRIORITY 1B</u>
4.5.208	<u>PRIORITY 2A</u>
4.5.209	<u>PRIORITY 2B</u>
4.5.210	<u>PRIORITY 3 – REGULATED PLANTS</u>

Contacts & References

CONTACTS COUNTY WEED DISTRICT

NOXIOUS WEED ADVISORY COUNCIL

NOXIOUS WEED SEED FORAGE ADVISORY COUNCIL

STATE AND REGIONAL CONTACTS INTERNET

WEBSITES RELATING TO WEED MANAGEMENT

This section provides a list of Internet websites and contacts that may be useful to your program.

11.1 Montana County Weed District Coordinators

[Find a MT Weed Coordinator](#)

11.2 Noxious Weed Advisory Council

<https://agr.mt.gov/Noxious-Weed-Trust-Fund-Grants>

11.3 Noxious Weed Seed Forage Advisory Council

<https://agr.mt.gov/Noxious-Weed-Seed-Free-Forage>

11.4 Montana Department of Agriculture Contacts

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License Registration/ Training Program Manager

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11.5 State and Regional Contacts

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406-684-5590
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DAN DOBLER, DNRC TRUST LANDS WEED COORDINATOR

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PO Box 201601
Helena, MT 59620
406-444-9726
ddobler@mt.gov

GARY ADAMS, STATE PLANT HEALTH DIRECTOR

1629 Ave D, Suite A-5
Billings, MT 59102
406-657-6282
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SHANTELL FRAME-MARTIN, MONTANA NOXIOUS WEED EDUCATION CAMPAIGN

PO Box 200202
Helena, MT 59620
406-444-9491
shantell.frame@montana.edu
www.weedawareness.org

MELISSA MAGGIO-KASSNER, MONTANA BIOLOGICAL WEED CONTROL COORDINATOR

2825 Santa Fe Court
Missoula, MT 59808
406-258-4223
mmaggi@missoulaeduplace.org

RACHEL FROST, MISSOURI RIVER CONSERVATION DISTRICTS COUNCIL

1101 11th Ave.
Helena, MT 59601
406-223-7262
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STEPHANIE HESTER, MONTANA INVASIVE SPECIES COUNCIL COORDINATOR

PO Box 201601
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TODD BREITENFELDT, WHITEHALL BIOLOGICAL WEED CONTROL PROJECT

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www.mtwow.org

CHRISTY SCHRAM, BITTERROOT BIOCONTROL YOUTH COOPERATIVE

329 Airport Rd
Stevensville, MT 59870
406-777-5842
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CECIL THARP, PRIVATE APPLICATOR STATEWIDE PESTICIDE EDUCATION

103 Animal Bioscience
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406-994-5067
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11.6 Noxious Weed Task Forces (TF)

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TANSY RAGWORT TF

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BLUEWEED TF

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HAWKWEED TF

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MT SALT CEDAR TEAM

Rachel Frost
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11.7 Sites Relating To Weed Control, Herbicide and Applicator Safety, or Information Concerning Vegetation Management

AGRIAN LABEL RESOURCE

<https://home.agrian.com/>

B.L.M. NATURAL RESOURCES HOME PAGE-WEEDS & INVASIVE WEEDS

<https://www.blm.gov/programs/natural-resources/weeds-and-invasives>

CALIFORNIA DEPT. OF PESTICIDE REGULATION

<http://www.cdpr.ca.gov>

CDMS LABEL DATABASE

<http://www.cdms.net/Label-Database>

CHECK OUT WEED MANAGEMENT ON THE INTERNET

<http://www.ipm.iastate.edu:80/ipm/icm/1996/12-16-1996/weedmonin.html>

COLORADO STATE UNIVERSITY COOPERATIVE EXTENSION

<http://extension.colostate.edu/>

COLORADA STATE UNIVERSIYT WEED SCIENCE

<http://weedscience.agsci.colostate.edu/>

COLORADO WEED MANAGEMENT ASSOCIATION

<https://cwma.org/>

COOPERATIVE AGRICULTURAL PEST SURVEY, UNIVERSITY OF WYOMING

<http://www.uwyo.edu/capsweb/>

CORTEVA AGROSCIENCES (PRODUCTS, LABELS AND MSDS)

<https://www.dowagro.com/en-us/products/united-states>

EPA MAIN WEB SITE

<https://www.epa.gov/>

EPA ENVIRONMENTAL TOPICS

<https://www.epa.gov/environmental-topics>

EPA PESTICIDES

<https://www.epa.gov/pesticides>

EXTOXNET

<http://www.ace.orst.edu/info/extoxnet>

FEDERAL INTERAGENCY COMMITTEE FOR MANAGEMENT OF NOXIOUS AND EXOTIC WEEDS

<https://www.fws.gov/invasives/>

GLOBAL INVASIVE SPECIES DATABASE

<http://www.iucngisd.org/gisd/>

INTERNATIONAL SURVEY OF HERBICIDE-RESISTANT WEEDS

<http://www.weedscience.org/>

KANSAS DEPT. OF AGRICULTURE PLANT HEALTH & WEED CONTROL

<https://agriculture.ks.gov/divisions-programs/plant-protect-weed-control>

LARIMER COUNTY WEED CONTROL

<https://www.larimer.org/naturalresources/weeds>

MONTANA DEPARTMENT OF AGRICULTURE

<https://agr.mt.gov/>

MONTANA NATURAL HERITAGE PROGRAM, NOXIOUS WEEDS OF MONTANA

<http://mtnhp.org/>

MONTANA STATE UNIVERSITY SCHUTTER DIAGNOSTIC LAB

<http://diagnostics.montana.edu/>

MONTANA WEED CONTROL ASSOCIATION

<https://www.mtweed.org/>

NATIONAL ANTIMICROBIAL INFORMATION NETWORK (NAIN)

1-800-447-6349

NATIONAL PARK IPM OF WEEDS

<https://www.nature.nps.gov/biology/ipm/>

NATIONAL PESTICIDE TELECOMMUNICATION NETWORK (NPTN)

1-800-858-7378

NATURE CONSERVANCY METHODS HANDBOOK

<https://www.invasive.org/gist/products/handbook/methods-handbook.pdf>

NEBGUIDE: LEAFY SPURGE

<https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=2707&context=extensionhist>

NIOH REGISTRY OF TOXIC EFFECTS OF CHEMICALS

<https://www.cdc.gov/niosh/docs/97-119/default.html>

NORTH AMERICAN INVASIVE SPECIES MANAGEMENT ASSOCIATION

<https://www.naisma.org/>

NORTH CAROLINA STATE UNIVERSITY WEED SCIENCE

<https://weedscienceprogram.wordpress.ncsu.edu/>

NOXIOUS WEEDS, AND EXOTIC AND INVASIVE PLANT MANAGEMENT RESOURCES

<https://www.invasivespeciesinfo.gov/plants/controlmech.shtml>

NSF CENTER FOR INTEGRATED PEST MANAGEMENT

<https://cipm.ncsu.edu/>

UNIVERSITY OF MISSOURI WEED SCIENCE HOME PAGE

<https://weedscience.missouri.edu/>

UNIVERSITY OF NEBRASKA WEED SCIENCE

<https://weedscience.unl.edu/>

US ENVIRONMENTAL PROTECTION AGENCY

<http://www.epa.gov>

USDA APHIS NOXIOUS WEED HOME PAGE

https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases/SA_Weeds/SA_Noxious_Weeds_Program

WEED SCIENCE SOCIETY OF AMERICA

<http://wssa.net/>

WYOMING WEED AND PEST COUNCIL

<https://wyoweed.org/>

WESTERN SOCIETY OF WEED SCIENCE

<http://www.wsweedscience.org/>

WSSA PHOTO HERBARIUM

<http://wssa.net/wssa/weed/weed-identification/>