Small Ranch Projects Guide

A How-To Guide on Implementing Best Management Practices on Your Property

University of Nevada Cooperative Extension
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INTRODUCTION

This book is a supplement to our first book, the Small Ranch Manual: A Guide to Green Pastures and Clean Water (University of Nevada Cooperative Extension, EB 95-02). While the Small Ranch Manual explains what small ranch owners can do to improve their land and water management, the Projects Guide supplies specific recommendations and details on design and construction of these projects for your property.

The Projects Guide will be most helpful to you if you familiarize yourself with the Small Ranch Manual. The manual will teach you the basics of how to evaluate your property and how to identify areas or practices that could be improved. It defines and illustrates “best management practices” (BMPs) with which you should become familiar. It explains the benefits of the BMPs both to you and to your local streams and groundwater quality. After reading the Small Ranch Manual, you will be able to determine which area or areas of your property you want to change or improve, and what types of projects might be appropriate.

Once you’ve decided which projects you would like to tackle, you’re ready to use the Projects Guide. It describes, in detail, how to plan, design and build your project. The guide includes instructions for real projects accomplished by small ranch owners. These projects range from simple to complex, and only a few are costly to install.

Each section of the Projects Guide focuses on a main subject area, including pastures, streams and buffers, irrigation management, and planting. In each example, we detail planning and decision points, pros and cons of alternatives, design and implementation plans and maintenance requirements. We also provide photos and graphics to guide you.

As you read this guide and its complement, the Small Ranch Manual, you might find one or more projects that you would like to implement. The accomplishment of any one of these projects on your property will be one more step toward improved water quality.

If you choose to implement one of these projects, please take a moment to call one of the authors. We are happy to offer you free consultation and technical assistance as part of the University of Nevada Cooperative Extension’s ongoing Small Ranch Water Quality Program.

The purpose of this guide is to inform people how to implement small changes in managing their property that will lead to cleaner water and more valuable property. As you learn about practices that can improve water quality, you will be learning a new set of resource management skills that will become increasingly valuable in the 21st century. While we provide this information to you free of charge, we do ask that as you learn new approaches to property management that safeguard our water quality, you share these clean water management concepts with your friends and neighbors. We all deserve clean water!
# Chapter 1

## GAINING THE UPPER HAND ON WEEDS: CREATING A MANAGEMENT PLAN

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Chapter 1

GAINTH THE UPPER HAND ON WEEDS:
CREATING A MANAGEMENT PLAN

No pasture planting and management project will be successful unless it incorporates a weed management plan. Weeds steal moisture and nutrients from new seedlings, shade out older plants, decrease the nutritional value of forage, and may even kill or injure livestock or people. They can also cause problems in lawns, household landscaping, along roads, and in parks. Keys to managing weeds are 1) identifying them, 2) understanding how they grow and reproduce, and 3) selecting the most appropriate control method or combination of methods.

Regular monitoring for weeds is essential for an integrated weed management (IWM) program. Weeds are most easily removed when they are small or few in number. It’s cheaper and easier to kill a dime-sized weed rather than one that is a foot tall. It is easier to kill a weed patch before the first seed or plant reproduces to create the patch. Identification of the species is equally important, as its biology often determines when it should be removed or which herbicide should be used if chemical control is necessary or even available.

Certain areas are more likely to have weeds than others. Monitor these first. For example, cultivation will expose previously buried weed seeds to light, encouraging weeds to sprout. Heavy pedestrian or livestock traffic can lead to bare, compacted soil, which also may support weed growth.

The long-term goal of weed control in pastures is to keep new weeds out, eradicate individual plants and small patches, and then to reduce the number of weeds to below the level at which they damage forage quality or animal health. It is often possible to use IWM techniques, including cultural, physical and biological methods, to effectively reduce or control weeds. However, there are times when the use of herbicides is necessary to reduce weed populations so that other methods can be effective. Such an IWM approach to weed control reduces the amount of herbicide needed and discourages haphazard and wasteful herbicide application.

Why should we worry about weeds?

Noxious weeds consume about 5000 acres per day on western public lands. About 17 million acres of public rangelands have been invaded by noxious weeds (a quadrupling over the last decade), costing hundreds of millions of dollars each year.

At a rate of about 5,000 acres per day, it would take only four days to cover an area the size of Manhattan (New York City) in weeds.
according to the US Department of Interior’s Bureau of Land Management. Noxious weeds problems are growing on forestlands, rangelands, agricultural lands, and wetlands throughout Nevada and the West. These weeds invade small ranches from public lands and visa versa. Public and private property managers must work together to reduce the problem.

The negative impacts from weed infestations are extensive, and often irreversible. Weed infestations reduce or eliminate wildlife habitat, wildlife and livestock forage, and recreational and property values by changing plant communities. Some weeds increase erosion and change the hydrologic and fire regimes. In Montana, researchers estimate 33 million acres will be infested with spotted knapweed by the year 2009, resulting in annual forage losses estimated at $155 million. Other impacts and costs of rapid weed invasion include decreases in crop yields, increased costs of roadside weed control, losses in property value, diminishing water quality, degradation of fisheries, and impairment of recreation availability. Weeds cause a 12 percent overall reduction in crop yields and cost an estimated $24 billion per year in losses. U.S. agriculture alone spends approximately $3 billion per year to control non-indigenous weeds.

The most obvious impact of weeds is the replacement of desired plants by weed species. Where weeds overgrow an area and then die, unsightly dead areas increase expenditures for landscape maintenance. In landscape beds, weeds can grow among desirable plantings, flowers, and

**How Integrated Weed Management Benefits Water Quality**

IWM tools allow effective weed control while reducing the risk of contamination of surface and groundwater supplies by herbicides. Controlling weeds in riparian areas and pastures allows establishment of healthy, diverse populations of plants that help control erosion and decrease sediment in waterbodies, shade water surfaces, and consume excess nutrients.

*Before the invasion of tall whitetop (Lepidium latifolium) this section of the Truckee River was vegetated in cottonwoods and willows. Without cooling from tree canopies, water temperatures increase, degrading fish habitat.*
groundcovers, create unsightly nuisances that require hand weeding and entail high labor costs.

Some common weeds are poisonous to humans and animals (e.g., black nightshade, pokeweed, poison hemlock, and Johnsongrass). Others cause inflammation when touched (e.g., stinging nettle) or cause allergic reactions (e.g., common ragweed, poison ivy, oak, sumac and goldenrod). Furthermore, many weeds or their seeds have spines, thorns, or burs that produce similar allergic effects or may cause physical damage to tires (puncturevine).

Weedy areas harbor beneficial and pest insects. They also attract rodents, rats, ticks, mosquitoes, or fleas that might attack humans and domestic animals, possibly infecting them with disease. Weeds are also hosts for pathogens and insects that attack desirable plants.

Weeds can also grow large enough to cover signs, block trails, and obstruct landscapes and vistas, interfering with recreational use of these areas. Weeds that grow on buildings can cause structural damage if they grow into cracks in mortar or bricks; sometimes they will stain buildings as well.

What is a weed?

Weeds are any plants growing where they are not wanted. Any undesirable grass or broad leafed plant species, from a small herbaceous plant to a woody shrub, vine, or tree, may be considered a weed if it is growing in a landscape bed, pasture, lawn, rangeland or other area where it is not desired. The most troublesome weeds, however, are those that rapidly multiply to dominate a site and are extremely difficult to control. These are referred to as “invasive” weeds.

Weeds are often found where soil has been exposed or disturbed by compaction, planting activities, or maintenance activities. They also occur where landscape plants are weakened by poor culture, adverse environmental conditions, diseases, or pests to the extent that landscape plants cannot compete with the weeds for nutrients, water, or light. Weeds are very common where the grass, groundcover and other landscape species are grown but are not well-adapted to their environment.

Where do weeds come from?

Many invasive weeds were introduced accidentally or purposefully to the United States from other continents, most notably Eurasia. During the era of migration and settling of the United States, it was common to use soil as a ballast for shipping vessels. This contaminated soil was dumped when the ship was unloaded. Other weed seeds arrived in shipments of crop seed such as sugar beets or in hay shipments. It is believed that tumbleweed was introduced from Russia in a crop of flax seed. Imported animals carried weed seeds on their coats or in their manure. Some weeds, such
as saltcedar, were cultivated for use as ornamentals or erosion control plants and later spread out of control. Still others are prized for their medicinal value. Most of the plants we consider weeds were introduced repeatedly, at various port cities, and then introduced to many other places. As settlers moved west, they took seeds and cuttings with them. With the arrival of the railroad, it became easy to transport plants and young trees. The great age of exotic plant introduction in the west had begun.

How do weeds differ?

Weeds differ in their growth habits. Broad-leaved (dicotyledonous) plants have two seed leaves (cotyledons) in each seed. Dicots have broad leaves and may have woody stems. Some species (e.g., sunflower) only become woody in old parts of stems and roots; these are referred to as semi-herbaceous dicots. Most dicot weeds are herbaceous, having little or no woody tissue (e.g., dandelion).

Plants that have a single seed leaf are monocotyledons. Monocots have long, narrow leaves with parallel veins and fibrous root systems. Grasses are members of the plant family Gramineae. Some grasses and other weedy monocots produce underground stems called rhizomes (e.g., Kentucky bluegrass, quackgrass) or aboveground runners called stolons (e.g., creeping bentgrass), while others produce both (e.g., bermudagrass).

It is important to understand the distinction between monocots and dicots. The selectivity of many herbicides is based on which type of plant they kill. Many herbicides kill dicotyledonous weeds in turfgrass. These herbicides do not harm the grass, which is a monocot, but they could not be used in a landscaped planting because the ornamental plants are dicots and would be injured or killed.

Life cycles

Each weed has adapted to live and reproduce in a sometimes harsh climate. Some sprout and grow when night temperatures are cold, using winter moisture. Others grow in the warmth of summer, with special adaptations for drought. Some, like annuals, produce many seeds. Other live longer to produce seeds repeatedly, or disperse the seeds more effectively.

Winter annual weeds (e.g., cheatgrass, medusahead, tumble mustard) germinate from seed in the fall to late winter. They mature and produce seed during the following spring, and die in early summer. Seeds of winter annuals remain dormant during the late spring and summer to germinate the following winter.

Summer annual weeds grow each spring or summer from seed. Examples include prostrate spurge and ragweed. They mature, produce seeds, and die in one growing season. Seeds generally remain dormant during the winter before germinating the following spring. The majority of annual weeds are
of this type. Some annuals, such as crabgrass, can root from leaf-stem junctions, forming dense colonies.

Biennial weeds may germinate at any time during the growing season. Examples include bull thistle and musk thistle. They usually produce a radial cluster (rosette) of leaves lying close to the soil during the first season. In the second year they produce flower stalks (using food stored from the first season's growth), produce seeds, and die.

Perennial weeds live for three or more years. Some species may not flower the first year, while others may produce seeds that do not germinate. Many perennials (e.g., curly dock, dandelion, and common milkweed) spread primarily by producing seeds, while others (e.g., field bindweed, tall whitetop, and purple loosestrife) spread both by seed and vegetatively. The latter occurs when attached or broken pieces of rhizomes, stolons, or stem nodes touch the soil and grow new roots.

Knowledge of the life cycle of a particular weed species is important for management. For example, mowing a patch of annual weeds to remove the flowers can prevent seed set. Refrain from cultivating areas where weeds reproduce by rhizomes. Cultivating cuts the rhizomes into pieces and each piece can generate a new weed plant wherever it is moved.

How do most weeds begin?

Most weeds owe their beginnings to seeds in the soil. The soil stores seed and acts as a growth medium for weeds. The species and numbers of seed in the soil are closely linked to how the land was used. In grasslands, a majority of weed seed is located within 1 inch of the soil surface, while in cultivated soil the majority of seed is located in the upper 6 inches of soil.

Seeds are lost from the soil due to feeding by rodents or insects, decay, or germination. The length of time a weed seed will survive depends on the species, soil moisture, depth of burial, and tillage. Seed from some weeds may only survive a year when buried in the soil, while others remain viable for 30 years or more. Seeds tend to germinate more readily when they are buried close to the soil surface and the tender sprouts have only a short distance to travel to reach sunlight. As the depth of burial increases, the rate of seed decay declines and more seeds are “banked” for growth in future years.

How do weeds spread?

Weeds spread in different ways depending on the weed, and often the actions of people. Weeds spread by wind, water, and animals may be hard to control. In our mobile society, there is little to limit their potential spread. Wind easily blows seeds from plants such as thistles, from place to place. Surface irrigation water has been shown to carry weed seeds are carried not only on cars and animals, but also on people

How do I get my weed identified?

Plant identification books contain tables called keys that help you determine the species of plant based on its physical characteristics. Without a botany background, however, it can be difficult to use a key. Some books have pictures of the more common weeds and other plants. The simplest way to identify a weed is to take a fresh sample to your local Cooperative Extension office. Place as much of the plant as possible, including roots, stems, leaves, and flowers, into a ziplock or other bag and deliver it as quickly as possible. Cooperative Extension personnel will then identify the plant and its life cycle for you.
many kinds of weed seed into cropland. A study conducted in western Nebraska showed that surface irrigation water could contain up to 77 different kinds of weed seed and deposit nine seeds per square yard, or approximately 38,000 seeds per acre during an irrigation season.

Many weed seeds pass through the digestive tracts of animals and remain viable. Some require this treatment in order to sprout. Spreading untreated manure to fertilize cropland or pastures systematically introduces weed seeds across fields.

Sometimes contaminated crop seed is the source of new weed species, as is farm equipment or road repair equipment that picks up seed from a contaminated field or roadside. Fill dirt and gravel are other common sources of weed infestations.

**What does Nevada Law say about weeds?**

Chapter 555 of the Nevada Revised Statutes addresses control of insects, pest, and noxious weeds. The legislation provides a definition of a noxious weed, as follows:

**NRS 555.005** “3. "Noxious weed" means any species of plant which is, or is likely to be, detrimental or destructive and difficult to control or eradicate.”

**NRS 555.130** “Designation of noxious weeds. The state quarantine officer may declare by regulation the weeds of the state that are noxious weeds, but a weed must not be designated as noxious which is already introduced and established in the state to such an extent as to make its control or eradication impracticable in the judgement of the state quarantine officer.”

As you can see, it takes three factors to cause a weed to be placed on the Nevada Noxious Weed List:

- it must be causing problems, or have the potential to do so and must be difficult to control;
- the state quarantine officer must add it to the designated list; and
- the Department of Agriculture must approve and amend the noxious weed list.

<table>
<thead>
<tr>
<th>Designated Noxious Weeds (2000; NRS 555.010)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Name</td>
</tr>
<tr>
<td>-----------------------------------</td>
</tr>
<tr>
<td>African rue</td>
</tr>
<tr>
<td>Austrian fieldcress</td>
</tr>
<tr>
<td>Austrian peaweed</td>
</tr>
<tr>
<td>Black henbane</td>
</tr>
<tr>
<td>Camelthorn</td>
</tr>
<tr>
<td>Common crupina</td>
</tr>
<tr>
<td>Dyer’s woad</td>
</tr>
<tr>
<td>Eurasian water-milfoil</td>
</tr>
<tr>
<td>Goats rue</td>
</tr>
<tr>
<td>Klamath weed</td>
</tr>
<tr>
<td>Horse nettle</td>
</tr>
<tr>
<td>Houndstongue</td>
</tr>
<tr>
<td>Hydrilla</td>
</tr>
<tr>
<td>Knapweed</td>
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<tr>
<td>Horse nettle</td>
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<tr>
<td>Houndstongue</td>
</tr>
<tr>
<td>Houndstongue</td>
</tr>
<tr>
<td>Leaffy spurge</td>
</tr>
<tr>
<td>Mayweed chamomile</td>
</tr>
<tr>
<td>Mediterranean sage</td>
</tr>
<tr>
<td>Medusahed</td>
</tr>
<tr>
<td>Perennial pepperweed</td>
</tr>
<tr>
<td>Puncture vine</td>
</tr>
<tr>
<td>Purple loosestrife</td>
</tr>
<tr>
<td>Rush skeletonweed</td>
</tr>
<tr>
<td>Saltcedar (tamarisk)</td>
</tr>
<tr>
<td>Sorgghum species, perennial,</td>
</tr>
<tr>
<td>including, but not limited to:</td>
</tr>
<tr>
<td>(a) Johnson grass</td>
</tr>
<tr>
<td>(b) Sorgghum alum; and</td>
</tr>
<tr>
<td>(c) Perennial sweet sudan</td>
</tr>
<tr>
<td>Sulfur cinquefoil</td>
</tr>
<tr>
<td>Thistle</td>
</tr>
<tr>
<td>(a) Canada;</td>
</tr>
<tr>
<td>(b) Musk;</td>
</tr>
<tr>
<td>(c) Scotch;</td>
</tr>
<tr>
<td>(d) Sow;</td>
</tr>
<tr>
<td>(e) Iberian star;</td>
</tr>
<tr>
<td>(f) Purple star; and</td>
</tr>
<tr>
<td>(g) Yellow star</td>
</tr>
<tr>
<td>Toadflax, yellow</td>
</tr>
<tr>
<td>Whitetop or hoary cress</td>
</tr>
</tbody>
</table>

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“Clean Water – We Can Make a Difference”
The most important section addresses the responsibilities of the owner or occupant of a given piece of land:

**NRS 555.150** “Eradication of noxious weeds by owner or occupant of land. Every railroad, canal, ditch or water company, and every person owning, controlling or occupying lands in this state, and every county, incorporated city or district having the supervision and control over streets, alleys, lanes, rights of way, or other lands, shall cut, destroy or eradicate all weeds declared and designated as noxious as provided in NRS 555.130, before such weeds propagate and spread, and whenever required by the state quarantine officer.”

This means that all property owners are responsible for controlling weeds on their own properties. There is no specific governmental agency you can count on to take care of your weed problems! If you do not control your weeds, the board of county commissioners can have the work done and bill you for the costs incurred by placing a lien on your property.

There is, however, another way in which property owners can pool resources and information on weed control: Form a weed control district.

**NRS 555.202** “Legislative declaration. The legislature declares that it is primarily the responsibility of each owner or occupier of land in this state to control weeds on his own land, but finds that in certain areas this responsibility can best be discharged through control by organized districts.”

Weed districts are formed from unincorporated lands by the action of the board of county commissioners of any county, or by a petition. The district can encompass several counties, or lands that are not contiguous. A board of directors is responsible for preparing regulations for the district, including the species of weeds to be controlled, and the methods of direct and indirect control (addressing the introduction and methods of spread). If desired, the board of county commissioners of each county having lands within the district can vote to assess a property tax on all real property within the district. The funds might be used to hire a weed control officer, buy control products, provide education, or fund other appropriate activities. This provides another tool to help control noxious weeds, and encourages the development of weed management plans.

**What is Integrated Weed Management?**

Integrated weed management (IWM) marries two or more control methods into a plan of operation. 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 general land management practices.” IWM uses crop and pest monitoring along with pest control measures that combine cultural, physical, biological and chemical means to reduce pest problems.

**How do I practice IWM to control weeds?**

The key is to create a favorable environment for growth of desirable plants. Plant competition is a good tool that is often overlooked and should be used first, but not exclusively. The IWM toolbox includes mechanical, cultural, biological and chemical controls, as described below. Effective weed management depends on the appropriate application of a combination of these tools.

All control methods have limitations. There are a number of factors to be considered when selecting an appropriate control method. Minimizing the spread of existing weeds and preventing the growth of new weeds should be the focus of a weed management program. One weed plant can produce hundreds of seeds that potentially could disperse over a wide area.

The elements of a weed control plan include:

1. **Existing or threatening weeds.** Identify the existing and likely weeds that do or could cause serious problems on the property.
2. **The identity and biology of the weed.** Make sure the weed has been correctly identified, and consider its life cycle (annual/biennial/perennial) and method of spread (seeds vs. roots). For instance, there is no point in
applying a pre-emergent herbicide for puncturevine control if there is no puncturevine. It would also be fruitless to apply a pre-emergent herbicide that acts by preventing weed seed germination to control established perennial weeds.

3. Identify the method of introduction of the weeds. For weeds that may invade or spread if not prevented, identify the vectors to control. Vectors such as seed, hay, manure, straw mulch, equipment, vehicles, camping gear, or clothes, that can be managed to prevent weed infestation, must be monitored continually and vigilantly.

4. The extent of the invasion and the environmental conditions of the site. Consider soil types, climatic conditions, and water availability, and assess existing desirable vegetation. For example, large areas of well-established invasion are more difficult to control than smaller invasions. A permanent pasture is not suited to repeated tilling, but frequent mowing may be acceptable and will disrupt seed production to help control annual weeds.

5. The most successful method of control. (See below.)

6. The ultimate objectives for the particular site. Weed control in a planned development is a different consideration than weed control in a pasture or dry lot.

7. The most economical solution to the problem. While hand-pulling of weeds is often a very effective method of control, its feasibility is limited by high labor costs in large infestations.

8. Are there any environmental or health risks of a given control method? Are there physical, legal, or political limits?

What are the different methods of control?

Many people assume that weeds are controlled in one of two ways: pulling or cutting, called mechanical control, or the application of chemicals, called chemical control. There are actually many other methods of control, as described below.

Prevention
Weed prevention is always the first step in weed control. Prevention involves proper land, crop and water management.

- Plant clean, weed-free crop seed.
- Avoid spreading weed seeds with manure. Wait at least five days after grazing in a weed infested area before moving livestock into areas that are currently weed-free.
- Sanitize tillage and harvesting equipment between fields.
- Plant and maintain desirable plant species to discourage weed establishment. Avoid disturbing the land without revegetating the area, as weeds will invade.
- Consider crop rotation to slow weed spread.
- Minimize soil disturbance by vehicles, machinery, wildlife, streamflow, and livestock to eliminate the advantage noxious weeds have developed for success in these sites.
- Avoid driving in noxious weed infested areas. Seeds can become stuck in tire treads or mud on the vehicle and be carried to unaffected areas. Check and clean tires and undercarriage of vehicles and machinery for contamination after driving in a weed-infested area.
- Likewise, request that campers, hikers and sportsmen take care to brush and clean not only their vehicles, but also their clothing when coming from weed-infested areas. Post infested areas to exclude users when possible.
- Don’t transport flowering plants that you cannot identify, or noxious weeds, many of which are beautiful.
- If you find a small number of isolated noxious weeds that have no flowers or seeds, pull the weeds and leave them where you found them to dry out. If possible, burn or bag the weeds and dispose of them in a sanitary landfill.
- If you find noxious weeds and they have flowers or seeds, pull them, place them in a plastic bag or container to avoid spreading seeds, and either burn them or dispose of them in a sanitary landfill.
- Report newly-found noxious weeds to the Division of Agriculture or Cooperative Extension office.

**Eradication**

**Ten Steps to Effective Weed Control**

1. Carefully read this chapter, “Gaining the Upper Hand on Weeds.”
2. Identify your problem weed. Whenever possible, bring a fresh sample stored in a paper or ziplock bag to your local Cooperative Extension office. Don’t spread seeds while transporting.
3. Gather information on your weed. Ask for available publications or other materials.
4. Learn the life cycle of the weed. Is it an annual, perennial, or biennial?
5. Evaluate the reproduction method and likely means of spreading the weed.
6. Determine whether the weed is a broadleaf or grass plant.
7. Create a plan for the eventual rehabilitation of the land once the problem weeds have been eradicated. Weeds take advantage of site conditions including soil disturbance, uneven soil moisture, and compaction. You’ll need to inspect your property often, to catch the presence of weeds as early as possible.
8. List and assess the treatment options: mechanical, cultural, biological, and chemical. Determine the most effective time of year to control your weed.
9. Complete your weed management plan and monitor and evaluate its success.
10. Check next year and every year to see if your weed management continues to keep weeds out.

Eradication is the removal of weeds from an area so they will not recur unless reintroduced. If eradication creates an open environment that is not managed, a weed problem may be cured simply to create another one. If eradication is achievable and desirable, it is generally important to revegetate the ground to prevent another weed infestation.

Eradication is important for small patches and new invasions, but may not be possible for well-established infestations. When eradication is no longer feasible, the goal is to contain populations by keeping them from spreading. Then, reduce weed populations to below the level at which they are damaging using the principals of integrated weed management. Education is a key component used
to emphasize what weeds are of concern, and why they are a threat.

**Mechanical Control**

Mechanical control methods physically disrupt weed growth. They are the oldest and most worldwide methods used, and include:

- **Cultivation or hoeing** - this method causes soil disturbance and may increase erosion; avoid broadscale application in riparian areas.
- **Bulldozing** - increases soil compaction, may have effects on animals and other vegetation, and may increase future weed infestations and soil erosion.
- **Burning** - used prior to herbicide application where dead material may prevent good contact. Avoid damaging non-target vegetation. Burning will affect air quality; has potential for causing or preventing catastrophic wildfire; impacts animals, insects, microorganisms and native plants. The overall impact can be quite positive on native species.
- **Hand pulling** - useful for small-scale infestations; labor intensive; be aware of toxicity from the weed. May take 10 to 15 years to deplete root and/or seed reserves of well established plants.
- **Mowing or cutting** - to reduce seed production; appropriate timing is essential. Mowing can adversely affect insect populations, including biocontrol agents.
- **Flooding** - requires a water source that can be regulated. Avoid spreading weed seeds with flowing water.
- **Shading** - establishment of competitive vegetation may “shade out” weeds.
- **Tillage** - usually limited to croplands. Be careful, tillage may spread some perennial weeds, such as tall whitetop, which sprout from cut rhizomes. Tillage affects soil structure, and erosion by wind and water may bring weed seeds to the soil surface.
- **Mulching** - Barriers and mulches often eliminate access to soil in which weed seeds can germinate. With some weeds, mulching prevents their germination. With others, the few weeds that emerge are easy to pull. While this is often a good, long-term solution to a weed problem, it is usually expensive to install. However, eliminating the need for other weed management may pay for the installation of the barrier over the long term. Most effective with annual weeds.
- **Solarizing** - Clear plastic sheeting in direct sunlight may cook weeds and other vegetation in the hothouse conditions created underneath the plastic.

Cultivation and hand-removal of weeds is most cost-effective in small areas. It is best to eliminate small, newly established weed plants during seasons (usually the spring and fall) when the soil is moist and weeds are most easily removed. There are certain times when cultivation will do more harm than good. Cultivation of annual weeds when mature seeds are on the plants is not recommended, nor is hoeing of perennial weeds that regenerate by rhizomes or tubers after these structures have formed. Regular mowing is often sufficient to control weeds over large areas, particularly when seed production in annual weeds is interrupted. In small areas, electric weed trimmers or propane burners are often used for weed control.

**Cultural Control**

Cultural control includes methods implemented by the land manager to favor desirable plant growth. Fertilization, irrigation, and planting appropriate species at optimum densities are methods that help desirable plants outcompete weeds. Common cultural methods include:

- **Planting appropriate competitive native or even non-native species.**
- **Good seed-bed preparation.**
- ** Destruction of weed competition before planting.**
- **Correct seeding rates and dates.**
- **Water and nutrient management (optimal water and fertilizer application).**
- **Grazing** – Because livestock select their grazing area in a pasture, the species of plant, and the plant parts, this tool requires knowledge and monitoring. Through trial and error, certain livestock can effectively manage some weeds. Realize that palatability and preference are always relative to what’s offered, so pick the appropriate time for control. Feed livestock weed-free products and keep them off weed-free areas for at least five days after grazing on weed-infested fields, or the weed seeds will be spread in manure.
**Biological Control**

Biological control is the intentional use of living organisms to reduce (NOT eradicate!) the population of a pest. It is not an appropriate alternative where a weed can be eradicated by other methods. Biological control may include the use of insects, nematodes, mites, plant pathogens, and vertebrates. Often more than one biocontrol agent is introduced on a weed, and each enemy affects the weed in a different way. Successful biological control depends upon the identification of appropriate organisms, introduction and adaptation to the environment (including completion of the life cycle), and a sufficient quantity of plant material to support a population of the biological control agent.

Biological control of weeds in rangelands and waterways is being extensively investigated and seems to have great potential for some weeds. It is sometimes more economical than chemical controls, and usually prevents economic damage to neighboring vegetation, since biological control agents are required to be very specific for a particular pest before they are allowed to be introduced. It is the most selective means of weed control, the most sustainable, and can provide a long-term answer to some weed problems.

However, biological control takes intensive management and planning. Successful use of biological control requires a thorough understanding of both the pest and its enemies. Often, the results of biological control are not as dramatic or quick as the results of pesticide use. North American introductions of weed-feeding natural enemies have ranged from very successful, achieving a 99 percent reduction of the pest species, to complete failure. The introduced species may prove unable to establish in the new location or environment.

Some characteristics of desirable weed-feeding natural enemies include:

- They are specific to one plant species and will not shift to desirable vegetation or crops.
- They have a negative impact on individual plants and the population dynamics of the target weed.
- They are prolific.
- They thrive and become widespread in all habitats and climates that the pest weed occupies.
- They are good colonizers of new areas.

There are three main approaches to biological control:

1. **Classical biological control** involves traveling to the country or area from which a newly introduced pest originated, and returning with some of its natural enemies that attacked it and kept it from being a pest there. New pests are constantly arriving accidentally or intentionally. When they come, their enemies are left behind. If they become a pest, introducing some of their natural enemies can be an important way to reduce the amount of harm they can do. Worldwide, classical biological control has successfully controlled introduced weeds on numerous occasions. In North America, there have been successes in controlling such weeds as nodding thistle, ragwort and klamath weed.

2. **Augmentation** increases the population of a natural enemy that attacks a pest. This can be done by mass-producing a biological agent and releasing it into the field at the appropriate time. Another method of augmentation is breeding a better natural enemy which can attack or find its prey more effectively. This method relies on continual human management. Livestock grazing can be considered a form of augmented biological control. It should be used with careful monitoring, however, since overgrazing damages the environment and creates site conditions that favor invasion by noxious weeds. Conversely, some areas where livestock provide biocontrol become weed problem areas when grazing is stopped.

3. **Conservation of natural enemies** involves identifying factors that limit the effectiveness of a particular natural enemy and changing them to help the beneficial species. Conservation of natural enemies involves either reducing factors that interfere with natural enemies, or providing needed resources that help natural enemies (such as a water source for livestock or plant residues for successful insect reproduction).

**Chemical Control**
When selecting an herbicide for use against a weed, it is essential to identify the weed species, since many herbicides are specific in weeds they kill (e.g., only grasses prior to germination, only broadleaf plants). Some herbicides are non-selective and will kill all vegetation whose leaves they contact; others are selective but are absorbed by roots of non-target plants and may injure or kill them as well. To determine which herbicides are in a product, look at the active ingredients listed on the label. The rest of the label will provide a list of approved target weeds and application precautions. Also consider that use of a non-selective herbicide for weed control may lead to an increase in weed problems in the future. The bare ground created following their use could serve as a site for invasion by new weed species.

The most commonly used herbicides for noxious weed management are 2,4-D (Weedar®), Weedone®, Savage®, Weed-B-Gone®), picloram (Tordon®), dicamba (Banvel®), clopyralid (Lontrel®, Stinger®, Curtail®), chlorosulfuron (Telar®), metsulfuron (Escort®), and glyphosate (Roundup®, Rodeo®, Accord®). With the exception of glyphosate, they are all auxin-type compounds that are selective for broadleaved plants, making them effective tools for controlling weeds while maintaining valuable grass forage species in some environments. Glyphosate is non-selective and care must be taken when it is used around desirable grass and non-target plants.

When an area is weed-free, preemergence herbicides can be used to prevent the germination or survival of weed seedlings. Preemergence herbicides must be applied before the weed seedlings emerge. Common preemergents include oryzalin (Surflan®), pendimethalin (Pendulum®, Pre-M®) and DCPA (Dacthal®).

Timing of an herbicide application is determined by when the target weed germinates, or by when the weed is in the stage that is most sensitive to the herbicide. In general, late summer/early fall applications of preemergence herbicides are used to control winter annuals, while late winter/early spring applications are used to control summer annuals and seedlings of perennial weeds.

Read the label to be aware of important requirements when using herbicides, such as licensing and training. Environmental concerns make it critical to follow all label and site directions. The label is the law, and as such, it is your responsibility to make sure to follow all precautions carefully. Herbicide injury to non-target plants is a common side effect of herbicide application by untrained individuals who allow spray and vapor drift inappropriately when applying the product. Risk of spray drift increases with increasing wind, higher temperatures, lower humidity, certain nozzle types, etc. Whenever possible, spray early in the morning, or consider the use of rope wicks or wipe applicators. Common symptoms of herbicide injury include plant or leaf yellowing and/or bleaching, root stunting, distorted growth, and death.

Increased contamination of surface and groundwater supplies can result from improper use of chemicals. Risks are greatest in areas with shallow water tables. Mix chemicals and clean containers in areas away from waterbodies and wellheads, preferably on impervious surfaces. Read and follow label directions carefully to decrease chances of personal injury and environmental contamination.

Why must pesticides be used with care?

- Each time you use a pesticide, you expose yourself to danger of inhalation or absorption of the toxin. Modern pesticides, and especially herbicides that rely on plant hormones, are less dangerous than older broad-spectrum poisons. However, the risk is not zero, and some chemicals create greater hazards than others.
• Pesticides can contaminate surface and groundwater supplies. If pesticides percolate down to the water table, your personal water supply—and your neighbor’s—may be jeopardized. Wellhead areas are often the site of such contamination because pesticides easily wash down unprotected wells.

• Continuous use of pesticides may induce tolerance and resistance in pests when the most resistant individuals survive and reproduce.

• Some pesticides break down slowly and can remain in the environment for years.

How can I use herbicides safely to minimize impacts to myself and the environment?

Herbicides are poisons and must be used with caution at all times. Follow the pesticide safety checklist below:

1. Read the label carefully and take notice of personal safety and environmental precautions. The label information isn’t advertising—it’s based on solid science and the law. It includes the proper rate of herbicide use for various conditions, the relative toxicity of the product, directions for safe mixing and application, and any environmental precautions. It lists the product manufacturer’s name and address, required protective clothing, and warnings about groundwater contamination, hazards to wildlife, and the reentry interval—how long one must wait before entering the treated area.

2. Wear appropriate personal safety equipment when handling pesticides. Start by wearing a wide-brim hat, long-sleeved shirt, long pants and chemical-resistant gloves. You should also wear sturdy work shoes or rubber boots, not sneakers or sandals. Depending on the product you are using, it may be necessary for you to wear goggles, face shield and a respirator.

3. When mixing and loading chemicals, prevent spills that might contaminate water supplies. One key spill-prevention step: Prevent tank overflow by never leaving a sprayer unattended during filling.

4. While filling sprayers, avoid backsiphoning by keeping the discharge end of the fill hose above the tank’s water level. If you put the end of the hose down into the pesticide liquid in the tank, you run the very real risk that the hose will suck water and chemicals back into the hose, and possibly into your well or home, when you turn off the water.

5. Never exceed labeled chemical rates. Always calibrate your sprayer before application. After you’ve read the label and chosen the right product to apply at the prescribed rates, it’s important to make sure your sprayer is delivering the appropriate amount of product. Carefully follow the directions on the sprayer.

6. Prevent herbicide leftovers by mixing only needed quantities. If you follow label instructions for rates and mix carefully, your tank should be empty as you complete application.

7. Never rinse equipment near wellheads, ditches, streams or other water sources. If needed, install a longer rinse water hose to move the cleaning operations a safe distance from a well or other water source. Spray the rinse water in the spray tank out over the target area, following label directions.

8. Always triple rinse or pressure rinse chemical containers before disposal or recycling. If it’s been properly rinsed and label instructions have been followed, the pesticide container is ordinary trash, but the best place for it is a pesticide container collection and recycling facility.

How do I maintain my property to decrease problems with weeds?
Once you’ve decided on a weed management plan that embraces the concepts of IWM, follow it! There is no substitute for careful monitoring of your property. Weeds are easiest to control in the first growing season. By including appropriate control methods and practicing prevention to avoid reintroducing weeds, you’ll continue to have fewer weed woes.

<table>
<thead>
<tr>
<th>Weed Management Plan Checklist:</th>
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</thead>
<tbody>
<tr>
<td>❑ Have I identified the location, species, life cycle and method of reproduction of my problem weeds?</td>
</tr>
<tr>
<td>❑ Have I identified the extent of the problem, e.g. is there one plant, a few plants, an acre with about 50 percent coverage? Will my proposed control method work efficiently on a problem of this size?</td>
</tr>
<tr>
<td>❑ What do I hope to do with the site? Does it require frequent tilling, which may favor the increase of rhizomatous perennials? Is my application of water and fertilizer uniform and appropriate? Which site conditions cannot be changed?</td>
</tr>
<tr>
<td>❑ Have I incorporated methods of prevention to keep from reintroducing weeds?</td>
</tr>
<tr>
<td>❑ Do I know what the most effective control methods are?</td>
</tr>
<tr>
<td>❑ Have I considered and should I use mechanical, cultural, biological or chemical controls?</td>
</tr>
<tr>
<td>❑ Can I afford to follow all the elements of my weed control plan? Is it economically viable?</td>
</tr>
<tr>
<td>❑ Have I read the pesticide safety information so that I will not endanger myself, others, the local water supply, or habitat when using herbicides?</td>
</tr>
</tbody>
</table>
**Weed Management Plan**

After having plants positively identified, list all problem species and their characteristics:

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Life Cycle</th>
<th>Plant Type</th>
<th>Reproduction</th>
<th>Spread</th>
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<tr>
<td></td>
<td></td>
<td>(summer annual,</td>
<td>(broadleaf or</td>
<td>(seed, underground</td>
<td>(vehicles, animals, wind, water, birds, hikers or foot traffic, fill</td>
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<td></td>
<td></td>
<td>winter annual,</td>
<td>grass)</td>
<td>roots or shoots,</td>
<td>dirt, contaminated hay, seed or manure, other)</td>
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<td></td>
<td></td>
<td>biennial or perennial)</td>
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<td>both)</td>
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What are my plans for the site after weeds have been controlled?

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**Control Methods:** Most annuals and biennials can be controlled by mechanical means. Check to determine which Integrated Weed Management tools will be effective. When chemical control is needed, contact your local Cooperative Extension office or the Nevada Division of Agriculture at 775-688-1182 for chemical recommendations.
### POSSIBLE AND ACTUAL CONTROL MEASURES

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Mechanical</th>
<th>Cultural</th>
<th>Biological</th>
<th>Chemical</th>
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<tbody>
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After listing the methods you consider applying, circle those you decide to apply and check those you ACTUALLY applied. If chemical controls are necessary, fill out the table below so you can track the success of your application and determine whether follow-up treatment is necessary.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Herbicide</th>
<th>Application Rate</th>
<th>Date and Time of Application</th>
<th>Weather Conditions*</th>
<th>Location</th>
<th>Results</th>
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* Weather conditions include wind speed, cloudy vs. sunny, humidity, and precipitation.
Chapter 2:

FERTILIZING FOR GREEN PLANTS AND CLEAR WATER

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Chapter 2:

FERTILIZING FOR GREEN GRASSES AND CLEAN WATER

Whether you are growing an irrigated pasture or a lawn, chances are you will need to add fertilizer for optimal growth. Plants require specific nutrients just like humans. But more is not better! Too much fertilizer stresses plants, and excess fertilizer in water becomes pollution, changing natural aquatic communities. Fertilizers should be used with care and only in the necessary amounts.

No planting project will be successful without appropriate soil to support plant life. Soil is a complex system of minerals, air, water, living and dead microorganisms, roots, and animals. By learning as much as possible about your soil, you will better judge the need for soil amendments, including organic matter and fertilizers.

What is soil?

In addition to organic matter, air and water, soil is made of various sized particles called sand, silt, and clay. Sand-sized particles are the largest, and clay-sized particles are the smallest. The texture of a soil is determined by the relative amounts of each of these particles in the soil (see page 37, Small Ranch Manual). You can determine soil texture yourself by the “feel” method described on the next page. Knowing your soil texture is the key to understanding how to manage your soil, from where to place your septic leachfield, to how much water is needed for optimal plant growth. Commercial laboratories analyze soils for their nutrient content as well as their textural classification.

Sandy soils allow water to move through rapidly. They do not tend to have problems with waterlogging. Since they drain quickly, they also dry out more rapidly, and may need more frequent irrigation and special care when applying fertilizers. As the amount of clay in a soil increases, water penetration tends to decrease, requiring slower application of irrigation waters to prevent overwatering. These soils usually hold water and nutrients longer, however, so the frequency of irrigation cycles may be lower. You can use feel and appearance to determine the amount of moisture in the soil. A method is provided on page 21.

You can find more information about your

Water moves differently in different soil types. In sands, water moves downward rapidly, and there is little side to side movement. In loamy soil, more lateral movement occurs. In clays, the greatest horizontal water movement occurs, but downward movement will be much slower.
Determining Soil Texture by the Feel Method

START

Place approximately one tablespoon of soil in your palm. Add water a drop at a time, and knead the soil until it feels like moist putty.

Add dry soil to soak up water.

Does soil remain in a ball when squeezed?

NO

Is soil too dry?

YES

Does soil too wet?

NO

NO

YES

SAND

Place the ball of soil between thumb and forefinger, gently pushing soil with the thumb, working it upward into a ribbon. Form a ribbon of uniform thickness and width. Allow the ribbon to emerge and extend over the forefinger, breaking from its own weight.

Does soil form a ribbon?

NO

NO

YES

LOAMY SAND

Does soil make a weak ribbon less than 1 inch long before breaking?

NO

Does soil make a medium ribbon 1” to 2” long before breaking?

YES

Does soil make a strong ribbon 2” or longer before breaking?

NO

SANDY LOAM

Does soil feel very gritty?

YES

NO

SANDY CLAY

Does soil feel very smooth?

YES

SILT OR SILT LOAM

Neither very gritty nor very smooth

YES

LOAM

Neither very gritty nor very smooth

YES

CLAY

Silty Clay

Neither very gritty nor very smooth

YES

CLAY

Clean Water – We Can Make a Difference”
soil type on your local soil survey map. Contact the USDA/Natural Resources Conservation Service field office closest to you to obtain information from soil surveys. They provide descriptions of soils and interpretations of soil properties, including percentage or content of sand, silt and clay; acidity and alkalinity (pH); flood hazard; depth to water table; natural drainage; erodibility; organic matter content; and fertility. These maps were constructed using data from actual soil samples collected by field personnel. They tend to be accurate on a scale of one acre or greater.

What nutrients are important for healthy plant growth?

Sixteen nutrients have been identified that are required for plant growth, health, and reproduction. Of these, plants need relatively large amounts of nitrogen, phosphorus, potassium, calcium, sulfur, and magnesium. Together, these six nutrients are referred to as macro-nutrients. Our Nevada soils are often low in nitrogen and phosphorus, but they usually contain adequate amounts of potassium and excessive amounts of calcium. Sometimes magnesium levels are also high. Nutrients needed in small or minute quantities are called minor or trace nutrients.

Nitrogen (N):

Nitrogen (N) is the plant nutrient most universally deficient for high crop yields. Nitrogen is the key ingredient for grass leaf growth, but the old saying “if a little is good, a lot is better” doesn’t apply. Ammonia and nitrate (forms of nitrogen) dissolve easily in water. Nitrate does not adhere to soil particles, but ammonia does.

Be cautious in using nitrogen fertilizers. Nitrates are completely soluble in water and are easily washed away or leached below the plant’s root zone by over-irrigation, especially in sandy soils. This pollutes groundwater supplies. Leaching of nitrate-nitrogen beyond the root zone can elevate nitrate concentrations in underlying groundwater to levels unacceptable for drinking water quality. The contamination could become a health hazard.

Phosphorus (P):

Phosphorus is important for developing strong root systems, and for flowering and fruiting. The best time to apply phosphorus is when you are preparing a seed bed. Manure is an excellent source of phosphorus and should be mixed into the soil immediately after application. You may also need to add phosphorus to an

Tips for Protecting Water Quality

- Test your soil.
- Avoid using fertilizers near streams, shorelines or on saturated soils.
- Use only the specific amounts of nutrients needed.
- More is not better with fertilizers—do not overfertilize.
- Do not put fertilizers over snow–plants don’t need fertilizer during the winter, and when the snow melts, the fertilizer may simply wash into a nearby body of water.
- After a soil test, fertilize only in spring and fall when plants are actively growing.
- Do not over-water after fertilization, or nutrients will be lost in surface runoff and leaching.
- Landscape with natives. These plants are adapted to local conditions and need little, if any, fertilizers or irrigation once they are established.
- Sweep all fertilizers, soil and plant clippings off of paved surfaces to prevent their nutrients from washing into storm drains or water bodies.
- An appropriate fertilization program promotes healthy plants that resist insects and diseases. However, improper use of fertilizers can damage plants and pollute lakes and streams. By understanding and following the information in this chapter, you can keep your landscape in good condition and protect our water quality at the same time.
existing pasture if a soil test indicates that it is lacking.

In general, phosphorus does not leach through soils because it is tightly bound to soil particles and chemically reacts with other elements to form insoluble soil compounds. However, if soil containing phosphorus erodes into surface water bodies such as lakes and rivers, it may cause excessive growth of aquatic plants. When the aquatic plants eventually die and decay, the decay process consumes oxygen and can cause fish deaths.

Potassium (K):

Potassium is necessary for durability and disease resistance. It seldom causes water quality problems because it is not hazardous in drinking water and is not a limiting nutrient for growth of aquatic plants. It is usually very abundant in the soil in western states. Like phosphorus, it is tightly held by soil particles, and can be lost by erosion. It is a bit more mobile in soil than phosphorus.

Calcium

Calcium is an essential part in all cell walls and membranes, and must be present for the formation of new cells. Young tissue is affected first in calcium-deficient soils. In alkaline soils where calcium availability can be quite low, supplemental calcium may be needed to adequately supply the plants.

Sulfur

Sulfur is a constituent of three amino acids and is essential for protein synthesis and nodule formation on legume roots. The characteristic odors of plants such as garlic and onion can be traced to sulfur present in oil compounds. Sulfur deficiencies occur in a wide range of soil and climate conditions, and may result in retarded growth rates and delayed maturity.

Magnesium

Magnesium is essential for photosynthesis and serves as an activator for many plant enzymes required in growth processes. While it is generally prevalent in western soils, it is more often deficient than calcium, especially in sandy soils. Yellowing of older leaves is a common sign of magnesium deficiency.

Trace Elements:

Trace elements include boron, chlorine, copper, iron, manganese, molybdenum, and zinc. They are required by plants in very small amounts. Iron and zinc are the trace elements that most often need to be added to Nevada’s soil for healthy plants. They contribute to the green color in plants. Some trace elements, such as boron, may be toxic to plants when present in excess amounts in soil or irrigation water.

Why should I pay money to test my soil?

Soils vary considerably in their ability to supply essential nutrients for plant growth. To be able to use fertilizers appropriately and efficiently, you need to know which nutrients are adequate, and which are deficient. There is no other way to get accurate information about the current amounts of nutrients present in the soil, and the amounts you need to add. Following recommended standard rates may lead to overfertilization, which wastes money and can pollute water supplies.

Commercial laboratories can test your soil’s nutrient content. They will provide information on the amounts of the most important nutrients currently present in the soil, and make recommendations for the amount of additional fertilizer needed for healthy plant growth.

Your local Cooperative Extension office may also provide certain soil analyses at a low cost or free of charge. Most commonly, the tests include measurement of soil pH.
How to Test Soil

What do you learn from a soil test? What are the disadvantages to soil testing?

- The amount and type of nutrients needed so you don’t waste money or pollute water supplies
- How much organic matter to apply to your soil
- Information that promotes successful plant growth
- The appropriateness of a given site for a given purpose
- Cost
- Time spent taking samples
- Results are not immediate
- Sometimes trial and error works to give you the level of planting success you desire without a soil test

When should I test my soil?

- Soil should be tested prior to any large project, such as planting of a lawn or pasture.
- Have at least one soil test performed prior to adding fertilizer or amendments.
- Test the soil in the early spring before or at the beginning of the growing season.
- Don’t sample immediately after fertilizer or manure applications, or when the soil is excessively wet.

What materials will I need?

- shovel
- plastic bucket
- plastic bag or unbreakable container
- marking pen

How do I collect a soil sample for testing?

(Note: The soil test reflects the sample taken.)

1. Select 10 samples from random areas. Avoid sampling near gravel, manure or compost, leachfields, brush piles, or under eaves.
2. Remove samples, using a trowel or shovel, by digging a hole 6 to 12 inches deep. Slide the shovel or trowel down the side of the hole from top to bottom to remove a “slice” of soil from the edge of the hole. You’re sampling from the soil surface to the deepest point in the hole.
3. Place all 10 samples together in a clean pail or other container, and mix thoroughly. Remove pebbles and other debris. Permit mixture to dry.
4. Place one cup of the mixed sample in a sealable plastic bag or other clean, unbreakable container.
5. Label the container clearly with your name, address, and phone number.
6. If you have several distinctly different soil types or growing conditions, you may want to take separate soil samples for each of the locations, e.g. the lawn, garden, pasture, etc.
7. Check with your local Cooperative Extension office for locations of soil test labs.
salts (electrical conductivity). Soil pH affects the availability of nutrients to plants. In Nevada’s desert soils, pH values are commonly alkaline, although irrigated soils may be somewhat less alkaline. Acid mountain soils are found in coniferous forests.

Salt buildup in desert soils is a common problem, and can result in injury to plants or changes in soil drainage. Salty soils are called “saline.” The greater the EC of a soil, the more difficult it is for the plant or seed to soak up moisture. If too saline, seed germination is inhibited and plant growth is retarded. Because salt helps electricity move through water, electrical conductivity (EC) is used to measure soil salinity. Salty soils have an EC of 4.0 or greater. Those with an EC of 12 or greater will support just a few forage species, such as tall wheatgrass or pubescent wheatgrass. No forages or ornamentals will grow on soils with an EC of 30 or more.

What’s the best type of fertilizer to use?

A variety of fertilizers are available commercially. Some provide only a single nutrient, such as ammonium nitrate, or triple superphosphate. Others contain three macronutrients: nitrogen, phosphorus, and potassium (potash). In Nevada and California, fertilizers are regulated by state law, and must contain a minimum of 5 percent of one or more of these three primary nutrients (N, P, K). Products without this minimum content are classified as Agricultural Minerals, and include gypsum, manure, and some composts.

What is the difference between slow release and fast release fertilizers?

Nitrogen fertilizers can be divided into two categories: those that are quickly available to plants, called soluble or fast release, and those that are slowly available to plants, called slow release. The quick release fertilizers are salts that are very soluble in water, including ammonium sulfate, ammonium nitrate, ammonium phosphate, and potassium nitrate. Quick release nitrogen is easily misused, resulting in waste, plant burn and water pollution. To avoid these problems, split the fertilization into two separate applications three to five weeks apart. Irrigate carefully to avoid deep leaching into water supplies and surface runoff to irrigation ditches, streams, rivers, and other waterbodies.

Slow release N sources include materials that dissolve very slowly in water (urea, IBDU), materials that have been coated to delay release (sulfur-coated urea), and the natural organic types mentioned above. Natural organic N sources such as manure must be broken down by microorganisms in the soil. The rate of release of N will depend on soil moisture and temperature.

Slow release forms of N provide lower concentrations of nutrients over a longer period of time. This decreases the likelihood of plant burn and increases the probability that nutrients will be used by the intended plants rather than pollute streams and lakes. Slow release nitrogen in inorganic fertilizers is often listed on the label as Water Insoluble Nitrogen (WIN). Nitrogen fertilizers are classified as fast, medium or slow release depending on the amount of W.I.N. they contain. Fertilizers containing less than 15% WIN are classified as fast release, between 15 and 30% are medium, and more than 30% WIN are slow release.

How do I calculate the amount of commercial, inorganic fertilizer needed?

Once you’ve determined what type and how much fertilizer is necessary, you’ll need to interpret the labels on fertilizer sacks. A
fertilizer grade of 28-14-5 means that a 100-pound bag of fertilizer contains 28% or 28 pounds of nitrogen, 14% phosphorus and 5% potassium. The remaining 53% consists of other ingredients that help in packaging and spreading. Some fertilizers contain only one major nutrient. An example is 33-0-0 (33% nitrogen, no phosphorus or potassium).

Now that you have your soil test recommendation, you’re ready to do some simple math. Your report may recommend you add a certain amount of nitrogen and/or phosphorus. For example, your report may suggest adding one-half pound of nitrogen per 1,000 square feet of lawn/pasture. But how much of a 24-4-12 fertilizer do you use to apply the one-half pound of nitrogen? Follow this example:

First, calculate the area you want to fertilize in square feet. If it is not an easy shape like a square or rectangle, divide it into sections that are close to being squares, right triangles, or rectangles (see diagram to the right) and measure the lengths of the sides of the areas in feet. To find the square footage, multiply length times width (for squares or rectangles) or multiply the length of the two shorter sides of the triangle and then multiply by 0.5, as shown below. Then, add the individual areas together to calculate the total area to be fertilized.

Next, figure out how much fertilizer is needed for the area. Read the formula on the fertilizer label (24-4-12). Calculate how many pounds of fertilizer are needed to apply one-half pound of actual nitrogen to 1,000 square feet. Simply divide the one-half pound of N needed by the percent of N in the fertilizer:

\[
\frac{1/2 \text{ pound}}{0.24} \approx 2.08
\]

\[
\approx 2 \text{ pounds of the 24-4-12 fertilizer are needed.}
\]

This is the amount of fertilizer needed to fertilize 1,000 square feet with one-half pound of actual nitrogen. Suppose your area is larger or smaller than 1,000 square feet? Then you’ll need to do a bit more math and calculate the Area Ratio (AR). Divide the actual area in square feet you calculated earlier by 1000. If the area is 700 square feet, then

\[
\text{AR} = \frac{700}{1000} = 0.7
\]

Now, multiply the AR times the amount of fertilizer needed: \(0.7 \times 2 \text{ lb} = 1.4\) pounds are needed. You can use the same method to calculate amounts of the other elements needed.

**Summary:** For this example, to apply N at the recommended rate of one-half pound per 1,000 square feet, apply approximately 1.4 pounds of 24-4-12 fertilizer to a 700-square-foot area.

If you do not have a scale to weigh out the appropriate amount of fertilizer, divide the bag into approximately equal portions. For example, a 20 pound bag of fertilizer can be divided into 14 portions, each close to 1.4 pounds in weight.

**What’s the difference between organic and inorganic fertilizers?**

Fertilizers are classified as either organic or inorganic, depending on the source of their nutrients. Organic fertilizers contain nutrients derived from the remains or by-product of once-
living organisms. Inorganic fertilizers are synthesized. The nutrient source makes no difference to a plant.

However, most organic fertilizers release their nutrients more slowly than synthetic fertilizers, making it more difficult to over-fertilize. Organic fertilizers that have a low percentage of nutrients are bulkier and heavier to handle, because they have to be applied in much greater quantities. It’s difficult to determine the nutrient composition of organic fertilizers without an analysis.

There are many types of organic fertilizers. The most common and most readily available is manure. Although bulky, manure can be an excellent source of plant nutrients and organic matter, helping to improve soil texture and water-holding capacity. It should be composted before applying, as fresh manure can be high in salts and may injure plants, or may contain weed seeds that composting may kill.

Other organic fertilizers include by-products from animals, such as bone meal, blood meal, fish emulsion, and sewage sludge. No one type of fertilizer is best for all situations. The tables on the next page will help you decide if an organic fertilizer will improve your soil and plant growth.

**How do I apply the fertilizer?**

Fertilizer can be applied in a variety of ways, including surface application, soil incorporation, and foliar application (spraying). The appropriate method for any application depends on the nutrient, soil type, the slope of the soil surface, the fertilizer type, the equipment available, and the plants to be fertilized.

### Natural Organic Fertilizers

*(Values are approximate and depend on the condition and source of material.)*

<table>
<thead>
<tr>
<th>Material</th>
<th>Percent Nitrogen</th>
<th>Percent Phosphorus (P₂O₅)</th>
<th>Percent Potassium (K₂O)</th>
<th>Rate of Nutrient Release</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood meal</td>
<td>12-15</td>
<td>1</td>
<td>1</td>
<td>Medium-Rapid</td>
</tr>
<tr>
<td>Bone Meal</td>
<td>1</td>
<td>15</td>
<td>0</td>
<td>Medium</td>
</tr>
<tr>
<td>Cottonseed Meal</td>
<td>7</td>
<td>3</td>
<td>2</td>
<td>Slow-Medium</td>
</tr>
<tr>
<td>Dried Cow Manure</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>Slow-Medium</td>
</tr>
<tr>
<td>Composted Cow Manure</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>Slow</td>
</tr>
<tr>
<td>Soybean Meal</td>
<td>7</td>
<td>1.5</td>
<td>2</td>
<td>Slow-Medium</td>
</tr>
<tr>
<td>Dried Grass Clippings</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>Medium</td>
</tr>
<tr>
<td>Bat Guano</td>
<td>10</td>
<td>4</td>
<td>2</td>
<td>Medium-Rapid</td>
</tr>
</tbody>
</table>

*slow release N forms are exceptions*
- **Surface application** is efficient and just as effective as any other method for N fertilizers. It is less effective for applying P because P moves more slowly through the soil. Fertilizer spreaders, either hand-held or push-type models, are fast surface applicators and give even coverage. The application will be most effective when the fertilizer is applied uniformly across the area. It is best to apply half in one direction, and then the remaining half in a direction at right angles to the first application to ensure spots are not missed. If applying fertilizer to bare soil, lightly rake it into the soil following application. Organic fertilizers should also be incorporated into the soil after spreading them on the soil surface.

- **Soil incorporation** is the best method for applying low solubility nutrients like P and K. The fertilizer can be placed in holes or in a trench dug around the plant to be fertilized. Incorporation will not be possible with established turf and landscape beds, which will require surface application. If fertilizers cannot be raked or tilled into the soil, then irrigate following surface application to incorporate the fertilizer into the soil. Don’t over-irrigate following fertilizer application, or leaching and/or runoff may occur.

- **Foliation spraying** is an effective way to apply iron, zinc, and other micronutrients to plants. However, it is difficult to measure the amount applied and it is not a recommended method for applying P or K. Foliar zinc and iron applications require repeat treatments every five to six weeks.

For large surface applications, it pays to have an accurate fertilizer spreader. These spreaders are made to deliver accurate rates by means of simple adjustments. Broadcasting 3 pounds of fertilizer evenly over 1,000 square feet of lawn with your hand, a can, or a box, is difficult. Good spreaders can be bought locally, or they can be rented for a nominal sum. **Avoid broadcast fertilizing near ditches or creeks to guard against nutrient pollution.**

**Is it important to irrigate after fertilizer application?**

Irrigating properly following fertilizer application is as important as using the right fertilizer, at the right time, and in the right amount. Without irrigation, the fertilizer may burn foliage. Overwatering fertilized areas, however, can cause nutrients to leave the site by way of surface runoff or to leach below the roots. Such overwatering wastes money and pollutes water, including drinking water supplies. Be careful to apply water slowly and in the correct amount so it soaks into the soil and wets only the area of the soil occupied by plant roots.

**Can I visually detect the need for nutrients if I can’t get a soil test done?**

It’s always tempting to use fertilizer as a cure-all for substandard pastures or yellow lawns. Often, however, the problem is not lack of nutrients, but lack of proper grazing management (see Chapter 4) or irrigation. If grass leaves are yellowing, and growth in the early spring is slow, you may need to add nitrogen. Consult the table on the next page for “Visual Symptoms of Macro-nutrient Deficiencies.” Irrigated grasses often require about 100 to 200 pounds of actual nitrogen per acre each year. Much of this is released from decay of last year’s vegetation or manure, or is supplied by rain or nitrogen-fixers such as alfalfa.

Use two applications: apply half the total amount in early spring at the beginning of the growing season, and the remaining half in late spring. Legumes respond to phosphate, and generally need 50 to 100 pounds per acre each year. Remember that fertilizing without soil test data may result in over or under application (too much OR too little), wastes money, and may adversely affect pasture and water quality.

**Does proper fertilization guarantee green pastures?**

Unfortunately, no! If your grass or pasture dies, it is seldom due to a lack of fertility. Plant death is usually caused by insects, diseases, improper watering, high or low pH, or overgrazing and mismanagement. If you follow fertilizer recommendations, water properly, and still have problems, you should suspect some other causes.
### Visual Symptoms of Macro-Nutrient Deficiencies

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Symptom Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>Stunted growth, small pale yellow leaves. Plant may be light green. Older leaves affected first.</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Red or purplish leaves, especially on under sides. Often a problem in cool soils in early spring.</td>
</tr>
<tr>
<td>Potassium</td>
<td>Bronzing and dying of leaf margin. Some spotting between veins. Yellowish with brown spots throughout leaf.</td>
</tr>
<tr>
<td>Calcium</td>
<td>Newest leaves hooked, die back at the terminal bud. New leaves are yellow while older leaves are dark green.</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Mottled yellowing between veins of older leaves while veins remain green. Yellow areas may turn brown and die.</td>
</tr>
<tr>
<td>Sulfur</td>
<td>Plant as a whole is affected, with plants becoming light green.</td>
</tr>
<tr>
<td>Iron</td>
<td>Yellow or white areas on youngest leaves. Veins typically green.</td>
</tr>
</tbody>
</table>
Chapter 3:

STARTING OVER: RENOVATING YOUR TIRED PASTURE

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Chapter 3:

STARTING OVER: RENOVATING YOUR TIRED PASTURE

Renovating pastures can cost more than $100 per acre, so it is not something you want to repeat often. Established pastures will last a lifetime if properly managed. This section will help you make wise decisions about the need to renovate, and the best ways to accomplish your goals. Begin by reading Chapters 3 & 4 of the Small Ranch Manual for an overview of renovation and pasture irrigation.

How do I decide whether to renovate or simply overseed?

Renovating means starting over and completely replacing all vegetation in a pasture. Renovation involves:

1. Killing weeds,
2. Plowing or disk ing the soil,
3. Leveling the ground to ensure good irrigation water coverage,
4. Renovating or installing an effective, efficient irrigation system,
5. Adding fertilizer as recommended by a soil test laboratory,
6. Reseeding with appropriate species, and
7. Proper follow-up management.

Pasture renovation may be an extensive effort involving both time and considerable expense. The expense of renovation is called for, however, when pastures become bare or very weedy, or if productivity has dropped dramatically for some reason other than lack of water, fertilizer, or proper grazing management. In these cases, extensive soil preparation will be necessary for a successful renovation.

Overseeding, on the other hand, is done by broadcasting seed over existing pasture vegetation by hand, with a spreader or by drilling the seed into the soil. It is appropriate for pastures that are still reasonably productive, have good irrigation water distribution, and are not overrun with weeds. Successful overseeding often requires weed control (see Chapter 1).

What time of year is best for pasture renovation?

For areas with more than a 100-day growing season, late fall seedings are generally more successful than spring seedings. The seed remains dormant in the soil during the winter, and is able to begin growing as soon as it warms up in the spring and water is available.

Spring seedings can be very successful where full season irrigation water is available or where the growing season is less than 100 days. Planting before March 1, or as soon as the snow melts, allows seed to be in the soil and ready to grow when spring rains arrive or the irrigation season starts.

Pastures in Poor Condition Cause:

- colic and respiratory problems in livestock from eating dirt
- weight loss in livestock
- parasites and poor coat in livestock
- erosion and water quality problems
- weed infestations to flourish

Pastures serve many needs.

“Clean Water – We Can Make a Difference”
begins. This avoids the problem of trying to plant on wet soils.

**What are the steps in the successful planning of a renovation project?**

**STEP 1: Determine the purpose.**

Your first planning landmark is to decide on your goal. Do you want a grassy turf area where the kids can play soccer? Do you want to stabilize an eroding slope? Do you want to create a highly productive pasture for livestock? What kind of livestock or wildlife will graze it? If the pasture isn’t grazed, do you want to have short grasses that require little or no mowing? Will the pasture be used for grazing, or will the forage be harvested for hay? The answers to these questions will guide your planning efforts.

**STEP 2: Evaluate your site.**

You’ll find it helpful to prepare a site evaluation using the form on the next page. If your existing pasture is no longer sufficiently productive, determine the reason. In many cases, overgrazing may have damaged forage species, resulting in invasion by weeds. Some weeds invade even well-managed pastures. If you need to change fencing, locations of watering tanks,

---

**Pasture Renovation Checklist**

1. **Determine the purpose** for the pasture.
2. **Evaluate your site** to determine slope, soil type, water availability and delivery method, soil nutrient status, and existing weed problems.
3. **Do a soil test** to see if fertilizer is needed. A soil test can determine the amount of nutrients present, as well as the soil texture and organic matter content. It is the best basis for supplemental fertilizer recommendations (see Chapter 2 for more information).
4. **Choose seed** that is suited to your needs, determined by intended use, amount of water available, soil type and fertility, and maintenance needs. Always use high quality seed from reliable dealers and make sure the seed is certified “weed free”.
5. **Reduce/remove weed competition**. Weeds steal moisture and nutrients from the new seedlings.
6. **Install irrigation systems** for even water application.
7. **Prepare your seed bed carefully**. Work the soil, ideally to a depth of 6 inches, and add organic matter as needed. Level the area, making sure to contour so water will drain away from structures and toward the pasture. Make sure the seedbed is sufficiently firm. Test by walking on it. A firm seedbed is one that allows a person’s foot to sink no deeper than one-half inch. Use a cultipacker or ring roller if needed before seeding. Soak the soil before planting the seed, or soon afterward.
8. **Sow the seed**. After the seed is sown, rake it lightly to ensure good contact with the soil, and then roll with an empty roller to firm the seedbed.
9. **Keep the soil moist while the seed germinates**. It may be necessary to water several times per day to keep the soil surface from drying out. Germination may take from 10 days (rye, fescues) to three weeks (bluegrass).
10. **Avoid grazing during the first season**. Once the grass germinates, let it grow to 4 or 6 inches before it is mowed the first time. Repeated mowing encourages greater stand density. Do not mow when soils are wet. New pastures will establish best if they are NOT GRAZED until plants and roots are well established, generally not during the entire first growing season.
11. **Control weeds in the renovated pasture** before they become well-established and spread.
irrigation systems, or other features, now’s the time! Use the form on the next page to help you map your property.

**Site Evaluation Form**

Sketch your pasture using graph paper. A typical scale would be 1 inch = 10 feet or 1 inch = 100 feet.

Using the symbols on the right, draw in the relevant features. Also include elements that relate to adjacent properties that may affect your design.

**My Pasture**

Pasture size: ___________ acres

Types and quantity of livestock:

_________________________________

_________________________________

Irrigation schedule:

Days of week:___________________

Months delivered during normal years:

_________________________________

Notes:

_________________________________

_________________________________

_________________________________

_________________________________

Legend of Existing Features

- Property Lines
- Fences and Gates
- Streams and irrigation ditches
- Springs, wetlands, areas that retain water
- Wells or septic systems
- Flood pathways
- Vegetation
- Weedy areas
- Water troughs
- Pasture
- Dry spots
- Slopes
- Low spots
- Irrigation Methods
- Drip
- Overhead
- Flood

“Clean Water – We Can Make a Difference”
STEP 3: Test your soil.

Soils are the foundation, nutrient source, and water reservoir for plants. Your soil texture and depth will determine how well it holds water and nutrients, how well water drains, and the available rooting depth. Plant species grow best in specific types of soil textures. Read Chapter 2 on soils and fertilizing to learn how and why to take a soil test and fertilize your soil.

Loamy soils contain a combination of all three soil textural classes: sand, silt, and clay. They are generally the best medium for forage plant establishment. Sandy soils drain quickly, and it can be difficult to keep enough water near the soil surface during seed establishment. Clay soils hold onto moisture well, but are easily compacted and often so dense that roots cannot penetrate and grow. Some forage species are more tolerant of “soggy” or waterlogged soils, while others tolerate prolonged drought better.

It’s also important to measure the salt content of the soil. High salt content will decrease the amount of seed that germinates, and cause plants to grow more slowly or not at all. Salt accumulations can result from irrigation with water high in salts, overapplication of manure, overapplication of fertilizers, and underapplication of irrigation water, allowing salts to rise to the surface with evaporation of the soil moisture. Alternatively, some soils are naturally high in salts, particularly desert basin soils. Commercial soil laboratories or your local Cooperative Extension office can analyze your soil for salts. See Chapter 2 for instructions on soil sampling.

STEP 4: Choose forage types.

Before beginning any pasture planting, choose appropriate grasses and/or legumes or other forb species adapted to the climate. A forb is a broad-leafed plant and a legume is a forb in the pea family with bacteria living in nodules (knots) on the roots. The bacteria (Rhizobia spp.) convert nitrogen from the air into plantusable forms of nitrogen. This “fixed” nutrient is accessible to both the legume and the grasses growing in the stand. Mature legumes with bacteria will fix between 40 and 500 pounds of nitrogen per acre annually, eliminating the need to add nitrogen fertilizers. Common legumes used for forage include clover and alfalfa. Application of nitrogen fertilizers to legumes reduces their nodulations and decreases fixation of nitrogen.

Plants are called either “warm-season” or “cool-season”, and grow best in different climates. Cool-season plants grow fastest in spring and fall. In order to grow during summer months, they need lots of extra water. Warm-season plants grow fastest in summer. They perform best with summer rain or irrigation, and hot weather.

Grasses can be differentiated by their growth habits: bunch or sod-formers. Bunchgrasses grow in bunches or clumps. Crested wheatgrass and orchardgrass are examples of bunchgrasses. They typically have more elevated leaves than sod-forming species, but need more grazing management to optimize productivity. For example, their growth is set back when their developing seed stalks are grazed. Some species produce seed stalks earlier during the growing season than others, causing grazing to causing grazing to have different effects at different times in the growing season.

Sod-forming grasses have underground shoots called rhizomes that run parallel to the soil surface. The rhizomes tie the soil together and form a sod. New above-ground shoots (stems) develop from nodes located at regular intervals along the rhizomes. These stems tend to fill in and cover bare spots on

Alfalfa is a legume.

Crested wheat is a bunch-forming grass.

Kentucky bluegrass forms sod by sending out rhizomes.

“Clean Water – We Can Make a Difference”
the soil. Examples of sod-formers include Kentucky bluegrass and smooth brome.
Pastures dominated by sod-formers are not as bumpy as those dominated by bunch-grasses. Sod-formers are more grazing-tolerant than bunchgrasses because they can send up new stems from rhizomes.

The varieties of seeds you choose will depend upon your soil type, availability of water, the amount of care you can provide, and the intended use of the pasture, including the species of livestock that will be using the pasture. Whatever seed mixture you choose, be sure to purchase seed from a reliable dealer who supplies only certified seed. Certified seed is grown under isolated conditions so that genetic purity is maintained. Fields are inspected before planting and again one or more times prior to harvest. If the fields meet certification standards, the harvested seed receives a lot number and each bag is sealed with a certification tag.

The section at the end of the Chapter (see page 43) lists common grass and legume species used for irrigated pastures. Some grasses have a rapid recovery rate (meaning a shorter time period before the field can be grazed again). However, these may not be the species your livestock will find to be the most palatable.

Should I use one species or a mixture?

While small pastures can be reseeded to a single species, mixtures are more desirable because of stand diversity. Mixtures survive disease and insect problems better, as well as extremes in climatic conditions, such as drought and flood. They are also more efficient users of available moisture, light, and nutrients through the growing season. They can also be better competitors against weeds.

The most common mixtures incorporate both grasses and legumes. Mixing legumes and grasses in a pasture can increase total forage production by as much as 30 percent, depending on available soil moisture and species.

A seed mixture of 90 percent grasses and 10 percent legumes adds nitrogen to the soil so less fertilizer is needed.

fixes the most nitrogen, with clovers and others producing somewhat less. Legumes grow more productively in the summer than grasses. The addition of legumes usually improves the forage palatability, digestibility, and nutrient content.

Because Nevada soils are quite variable, often ranging from sandy to heavy clay in the same field, a carefully chosen mixture is more likely to contain species adapted to each soil characteristic. A grass-legume mixture also reduces erosion more effectively than pure legume stands, and a mixture is more likely to provide more complete ground cover and deter the encroachment of weeds.

Legumes will grow most successfully with shorter and less aggressive grass species. If grass-legume stands will be grazed by cattle or sheep, keep the percentage of legumes that may cause bloating (alfalfa and clovers) to 40 percent or less. You’ll need to carefully monitor grazing, since legumes are often preferred by livestock and will be grazed out of the pasture if not provided the opportunity to regrow sufficiently (see Chapter 4 on pasture management).

Mixed stands should have species similar in palatability, regrowth ability, time of maturity, and competitiveness. Unbalanced mixes will have their more palatable species overgrazed preferentially by livestock, and with time, the less palatable species may take over the pasture. For this reason, it may be advantageous to use a mixture of only one grass and one legume, using about 90 percent grass and 10 percent legume. In general, mixed stands require more careful grazing management to avoid competitive shifts in species composition.

If you decide to try a solid grass stand, remember that it will require fertilization,
especially with nitrogen, to obtain the best yields. Make sure you’ve chosen species and varieties that are able to compete successfully for water, nutrients, and light. The best grass mixture should include species that mature together and have similar palatability. Check the tables at the end of the chapter to determine the best mixture for your needs and site conditions.

What do I need to consider when buying seed?

State and Federal laws require seed dealers to label all seed offered for sale. The label must list seed origin, purity, species identity, percent germination, and weed seed content. It will also include the seed lot number and the company or person responsible for label content.

Origin: The state of origin must be shown on the label. Be wary of buying seed of unknown origin, as it may have been collected in an area with soils or climate very different than Nevada’s. Locally grown seeds are more likely to be successful in Nevada’s high desert climate, but may be difficult to obtain.

Purity: Purity is the percent of desired species present in the bag of seed. When the percentages of purity, inert matter, weed seed, and other crop seed are added together, the total must be 100 percent. Inert matter includes small sticks and stems, chaff, and infertile flowers. Most grass seed should contain no more than 10 to 15 percent inert matter or it will be difficult to plant.

Weed Seed: The label should indicate that NO prohibited noxious weed seeds are present. Look for seed that has been certified weed-free.

Germination: Total viable seed includes the sum of all seeds that germinate in a lab analysis, plus the amount of hard and dormant seed. The higher the total germination, the better. Germination for most grass species should not be lower than 60 percent.

Species Identity: Forage seed is sold as Common, Variety Not Stated (VNS), or Certified. Certified seed is the more expensive of the three, but guarantees the variety that you order. When certified seed is not available, purchase seed of verifiable plant varieties. If neither is available, purchase seed of known origin and adaptation to your area from a reputable dealer. Settling for unverifiable species may cause problems in the future. It’s best to seed the specific species and varieties you have determined are best for your needs.

How much seed should I use?

The amount of seed needed varies according to the type and limitations of the soil, as well as water availability. Seeding rates are usually measured in pounds per acre. Since seeds vary in weight, a pound of one species may have considerably fewer seeds than a pound of another species. The following tables will help you determine the seeding rate for various mixtures that can be chosen based on irrigation water availability.
Seeding Rates for Irrigated Pastures
(from “Irrigated Forages for Western Nevada-Type Climate, BE-91-02)

1. Soils with no limitations other than some slight to moderate wetness

<table>
<thead>
<tr>
<th>Select ONE grass and ONE legume:</th>
<th>Pounds per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full Season Water</td>
</tr>
<tr>
<td><strong>Grasses</strong></td>
<td></td>
</tr>
<tr>
<td>Orchardgrass&lt;sup&gt;1&lt;/sup&gt;</td>
<td>5</td>
</tr>
<tr>
<td>Tall fescue</td>
<td>8</td>
</tr>
<tr>
<td>Smooth bromegrass</td>
<td>8</td>
</tr>
<tr>
<td>Turkish bromegrass</td>
<td>8</td>
</tr>
<tr>
<td>Intermediate wheatgrass</td>
<td></td>
</tr>
<tr>
<td>Pubescent wheatgrass</td>
<td></td>
</tr>
<tr>
<td><strong>Legumes</strong></td>
<td></td>
</tr>
<tr>
<td>Ladino clover&lt;sup&gt;2&lt;/sup&gt;</td>
<td>2</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>2</td>
</tr>
</tbody>
</table>

<sup>1</sup> Seed Potomac orchardgrass with Ladino clover and seed Latar orchardgrass with alfalfa.

<sup>2</sup> A longer regrowth period is recommended for alfalfa than for Ladino clover.

2. Soils with only moderate salinity-sodium problems

<table>
<thead>
<tr>
<th>Select ONE grass and ONE legume:</th>
<th>Pounds per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full Season Water</td>
</tr>
<tr>
<td><strong>Grasses</strong></td>
<td></td>
</tr>
<tr>
<td>Tall fescue</td>
<td>8</td>
</tr>
<tr>
<td>Intermediate wheatgrass</td>
<td></td>
</tr>
<tr>
<td>Pubescent wheatgrass</td>
<td></td>
</tr>
<tr>
<td>Siberian wheatgrass&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Desert wheatgrass</td>
<td></td>
</tr>
<tr>
<td><strong>Legumes</strong></td>
<td></td>
</tr>
<tr>
<td>Alfalfa</td>
<td>2</td>
</tr>
</tbody>
</table>

<sup>1</sup> Seed Siberian or desert wheatgrass on severely dry sites.

3. Claypans at less than 20-inch depth that restricts root and water penetration

<table>
<thead>
<tr>
<th>Select ONE grass and ONE legume:</th>
<th>Pounds per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full Season Water</td>
</tr>
<tr>
<td><strong>Grasses</strong></td>
<td></td>
</tr>
<tr>
<td>Orchardgrass&lt;sup&gt;1&lt;/sup&gt;</td>
<td>5</td>
</tr>
<tr>
<td>Smooth bromegrass</td>
<td>8</td>
</tr>
<tr>
<td>Tall fescue</td>
<td>8</td>
</tr>
<tr>
<td>Turkish bromegrass</td>
<td>8</td>
</tr>
<tr>
<td>Intermediate wheatgrass</td>
<td></td>
</tr>
<tr>
<td>Pubescent wheatgrass</td>
<td></td>
</tr>
<tr>
<td><strong>Legume</strong></td>
<td></td>
</tr>
<tr>
<td>Alfalfa&lt;sup&gt;2&lt;/sup&gt;</td>
<td>5</td>
</tr>
<tr>
<td>Ladino clover</td>
<td>2</td>
</tr>
<tr>
<td>Narrowleaf birdsfoot trefoil&lt;sup&gt;3&lt;/sup&gt;</td>
<td>3</td>
</tr>
</tbody>
</table>

<sup>1</sup> Seed Potomac orchardgrass with Ladino clover and seed Latar orchardgrass with alfalfa.

<sup>2</sup> Care must be taken in irrigating to prevent loss of alfalfa stands.

<sup>3</sup> Seed birdsfoot trefoil in alternate rows with grass.
Seeding Rates for Pastures \textit{(continued)}

4. Clayeyness throughout the soil profile

<table>
<thead>
<tr>
<th>Select ONE grass and ONE legume:</th>
<th>Pounds of seed per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full Season Water</td>
</tr>
<tr>
<td><strong>Grasses</strong></td>
<td></td>
</tr>
<tr>
<td>Tall fescue</td>
<td>8</td>
</tr>
<tr>
<td>Pubescent wheatgrass</td>
<td>8</td>
</tr>
<tr>
<td>Intermediate wheatgrass</td>
<td>8</td>
</tr>
<tr>
<td><strong>Legumes</strong></td>
<td></td>
</tr>
<tr>
<td>Alfalfa</td>
<td>2</td>
</tr>
<tr>
<td>Ladino clover</td>
<td>2</td>
</tr>
<tr>
<td>Narrowleaf birdsfoot trefoil(^1)</td>
<td>3</td>
</tr>
</tbody>
</table>

\(^1\) Seed birdsfoot trefoil in alternate rows with grass.

5. Dryness due to gravel at less than 20-inch depth or sandyness throughout the profile.

<table>
<thead>
<tr>
<th>Select ONE grass and ONE legume:</th>
<th>Pounds of seed per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full Season Water</td>
</tr>
<tr>
<td><strong>Grasses</strong></td>
<td></td>
</tr>
<tr>
<td>Intermediate wheatgrass</td>
<td>8</td>
</tr>
<tr>
<td>Pubescent wheatgrass</td>
<td>8</td>
</tr>
<tr>
<td>Crested wheatgrass</td>
<td>6</td>
</tr>
<tr>
<td>Siberian wheatgrass</td>
<td>6</td>
</tr>
<tr>
<td><strong>Legumes</strong></td>
<td></td>
</tr>
<tr>
<td>Alfalfa</td>
<td>2</td>
</tr>
</tbody>
</table>

6. Dryness due to hardpan or bedrock at less than 20-inch depth

<table>
<thead>
<tr>
<th>Select ONE grass and ONE legume:</th>
<th>Pounds of seed per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full Season Water</td>
</tr>
<tr>
<td><strong>Grasses</strong></td>
<td></td>
</tr>
<tr>
<td>Intermediate wheatgrass</td>
<td>8</td>
</tr>
<tr>
<td>Tall fescue</td>
<td>8</td>
</tr>
<tr>
<td>Orchardgrass</td>
<td>5</td>
</tr>
<tr>
<td>Pubescent wheatgrass</td>
<td>8</td>
</tr>
<tr>
<td><strong>Legumes</strong></td>
<td></td>
</tr>
<tr>
<td>Ladino clover(^1)</td>
<td>2</td>
</tr>
<tr>
<td>Narrowleaf birdsfoot trefoil(^2)</td>
<td>5</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>2</td>
</tr>
</tbody>
</table>

\(^1\) Frequent irrigation is needed under full season water, but care must be taken to prevent perched water table.

\(^2\) Seed birdsfoot trefoil in alternate rows with grass.
STEP 5: Reduce/remove weed competition.

Weeds steal moisture, nutrients, space, and sunlight from new seedlings, and must be controlled prior to planting to minimize stressful competition. Survey your field before proceeding further, and identify your weeds. Some weeds will require control before tilling a field to prevent their spread. See Chapter 1 for more information on weed identification and control.

One way to control many weed seeds is to use two cycles of tilling or disking, spaced three to four weeks apart, prior to seeding. Follow each tilling with irrigation, or time the tillage to occur before precipitation to stimulate seed germination. This encourages early sprouting and weed growth, and the weeds are then killed by the second tilling. If the infestation is severe, you may choose to use a chemical herbicide such as RoundUp®. Control of some weeds requires herbicide use and follow-up treatment. Some herbicides act as sterilants and nothing will grow for one or more years after application. Avoid using pre-emergent herbicides, as these products prevent seed germination, and therefore require a long fallow period. Be sure to carefully read and follow all label directions before and during use.

Sometimes the most effective weed control in pasture renovation involves seeding to only grasses so that broadleaf specific herbicides can be used over the newly renovated pasture until the weeds are gone. Once broadleaf weed control has been achieved, interseeding, partial tilling and seeding, or re-renovation can create the mixed stand.

STEP 6: Install or improve irrigation systems.

If the field is flood-irrigated, it must be carefully sloped to allow even water distribution. If you have consistently had difficulty in getting even water application, it may be a good time to have the field laser-leveled. Contract with a competent, experienced operator. Some tractor operators are able to level fields using stakes and “eyeballing” the area. While this method is less expensive, it is also less accurate.

Ten Steps to Effective Weed Control

1. Carefully read Chapter 1, “Gaining the Upper Hand on Weeds.”
2. Identify your problem weed. Whenever possible, bring a fresh sample stored in a paper or ziplock bag to your local Cooperative Extension office. Don’t spread seeds while transporting.
3. Gather information on your weed. Ask for available publications or other materials.
4. Learn the life cycle of the weed. Is it an annual, perennial, or biennial?
5. Evaluate the reproduction method and likely means of spreading the weed.
6. Determine whether the weed is a broadleaf or grass plant.
7. Create a plan for the eventual rehabilitation of the land once the problem weeds have been eradicated. Weeds take advantage of site conditions including soil disturbance, uneven soil moisture, and compaction. You’ll need to inspect your property often, to catch the presence of weeds as early as possible.
8. List and assess the treatment options: mechanical, cultural, biological, and chemical. Determine the most effective time of year to control your weed.
9. Complete your weed management plan and monitor and evaluate its success.
10. Check next year and every year to see if your weed management continues to keep weeds out.

Renovations to your irrigation system should also be completed at this time (see Chapter 3 in the Small Ranch Manual for help). If you are interested in installing a sprinkler irrigation system, see Chapter 8.

STEP 7: Prepare the seedbed carefully.

Once you’re clear on your planting goals, there are a number of factors to consider when planting from seed. The first step is to prepare the seedbed—the area of soil you want to replant. Tilling and grading may be necessary if the pasture is in poor condition, if weeds are excessive or if irrigation water delivery is uneven. Don’t work your soil when it is wet or saturated, since this can ruin the soil structure. Wait until the soil is semi-dry and crumbles easily when tilled. Till or plow and disk the soil to a depth of 6 to 12 inches. If the soil is excessively sandy or clayey, till in an organic matter amendment such as weed-free composted manure.
Fertilizers can be incorporated during the tilling process. Start by taking a soil sample to determine the nutrient needs (see page 24). The soil lab will provide recommendations for supplemental fertilizer or soil amendments such as manure or compost. This is a Best Management Practice (BMP) that helps protect local streams and ground water from contamination by excess nutrients such as nitrogen and phosphorus. Chapter 2 will help you learn how to take a soil test, calculate fertilizer needs, and apply the fertilizer appropriately.

After tilling, “firm” the seedbed. A firm seedbed is one that allows a footstep to sink no deeper than one-quarter to one-half inch. If the seedbed is too soft, go over the area with a cultipacker or ring roller. Rollers can be rented at local supply houses. Larger pastures will require mechanized rollers.

If the soil is dry, irrigate before planting to bring soil moisture to field capacity, or the point at which the soils are saturated but drained of excess moisture.

**STEP 8: Sow the seed.**

Once the seedbed is prepared and moist, seeding can be done by broadcasting, drilling or other methods. Apply the seed at the recommended rate and the appropriate depth. Whatever method you choose, your goal is to achieve even coverage. One way to accomplish this is to begin seed sowing along the northern border of your renovation site. Using half the total amount of seed, distribute the seed across the field from a north to south direction. Take the remaining seed and sow in an east to west direction. While this method ensures even coverage, you may need the aid of an assistant to mark the seeding “rows.”

The key to seeding success is to keep the seeds moist until seedlings germinate. This requires good seed-to-soil contact. Don’t just “throw” the seed onto the soil surface! It won’t survive. Instead, make sure the seed is planted at the appropriate depth, and make sure it is in close contact with the soil. When broadcasting seed, follow by tamping down the soil with a roller, or dragging a weighted sheet of plywood or chain link fence behind a pickup truck. Many seed drills have wheels for packing soil over and around planted seeds. Some of these can be adjusted for different soils and seeds.

**STEP 9: Keep the soil moist while the seed germinates.**

If your soil is sandy, frequent irrigation may be needed after planting to keep the surface soil moist. Temporary use of sprinklers during the first few weeks of establishment will allow you to apply small amounts of water as needed. You can learn to judge the degree of soil moisture by some simple field methods, as shown on the next page.

If temporary irrigation will be difficult, it may be best to plant in the late fall, winter, or early spring (for cool-season plants) so that seeds germinate while evaporation rates are low. Seasonal rain or snow may help the plants establish between labor-intensive hand irrigations or before you can flood irrigate the pasture.

**STEP 10: Avoid grazing during the first season.**

To keep the new planting healthy and strong, plan a management scheme with help from Chapter 4. **DON’T USE THE NEWLY SEEDED PASTURE FOR GRAZING FOR ONE COMPLETE GROWING SEASON.** You’ll have the best success if you don’t allow animals on the field for a full season. **UNDER NO CIRCUMSTANCES should you allow any grazing of your new grass, at least until it falls dormant in the fall.** Even then, plants with young, weak roots can be pulled up. In spring and summer, animal hooves will cut the tender plant roots, especially on sandy soils, and if the new shoots are eaten, the plants may die or take longer to establish. Reseeding is most successful when animals are excluded from pastures for a full 12 to 18 months. If grazing is necessary, monitor it closely to make sure plants are not being pulled up. Keep the grazing level light.

Periodic mowing during the first season stimulates tillering in grasses, which improves the stand. Never remove more than one-third of the total height of the stand when mowing or the roots will become stressed. For example, if the grass is 9 inches tall, mow it to 6 inches in height. Do not mow when the soil is wet.
During the first year after renovation, you can get value from your pasture by haying it. If you graze or mow the pasture, be sure to maintain a minimum stubble height (grass blade height) of at least 3” at all times. Bale the mowed forage if it is thick enough to smother the new plants.

You may wish to work on only one fenced section of your pasture each spring, leaving the other areas available for livestock use. Read Chapter 4 for advice on pasture management and rotational grazing techniques.

**Step 11: Control weeds in the renovated pasture.**

See Chapter 1 in this Guide for advice on weed management. Each weed has its own weaknesses, and using an integrated weed management plan works best. In general, any time soil is laid bare for reseeding, it is vulnerable to weed infestation. The act of disking actually plants and distributes some weed species such as tall whitetop. The best time to control any weed infestation is before it starts, or immediately thereafter when only a single plant is present. Always kill every first plant of any problem or

---

**Guide for Estimating Soil Moisture Available for Plant Use**

<table>
<thead>
<tr>
<th>Dominant Texture</th>
<th>Fine sand and loamy fine sand</th>
<th>Sandy loam and fine sandy loam</th>
<th>Sandy clay loam and loam</th>
<th>Clay, clay loam, or silty clay loam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available Water Capacity (inches/foot)</td>
<td>0.6 – 1.2</td>
<td>1.3 – 1.7</td>
<td>1.5 – 2.1</td>
<td>1.6 – 2.4</td>
</tr>
<tr>
<td>Available Soil Moisture (% field capacity*)</td>
<td>Appears dry, will hold together if not disturbed, loose sand grains on fingers</td>
<td>Appears dry, forms a very weak ball, aggregated soil grains break away easily from ball</td>
<td>Appears dry, soil aggregations break away easily, no moist soil stains on fingers, clods crumble with applied pressure</td>
<td>Appears dry, soil aggregations separate easily, clods are hard to crumble with applied pressure</td>
</tr>
<tr>
<td>0 – 25%</td>
<td>Slightly moist, forms a very weak ball with well-defined finger marks, light coating of loose and aggregated sand grains remain on fingers</td>
<td>Slightly moist, forms a weak ball with defined finger marks, darkened color, no water staining on fingers</td>
<td>Slightly moist, forms a weak ball with rough surfaces, no water staining on fingers, few aggregated soil grains break away</td>
<td>Slightly moist, forms a weak ball, very few soil aggregations break away, no water stains, clods flatten with applied pressure</td>
</tr>
<tr>
<td>25 – 50%</td>
<td>Moist, forms a weak ball with loose and aggregated sand grains on fingers, darkened color, light uneven water staining on fingers</td>
<td>Moist, forms a ball with defined finger marks, very light soil/water staining on fingers, darkened color, will not slick</td>
<td>Moist, forms a ball, very light water staining on fingers, darkened color, pliable, forms a weak ribbon</td>
<td>Moist, forms a smooth ball with defined finger marks, light soil/water staining on fingers, ribbons between thumb and forefinger</td>
</tr>
<tr>
<td>50 – 75%</td>
<td>Wet, forms a weak ball, loose and aggregated sand grains remain on fingers, darkened color, heavy water staining on fingers, will not ribbon</td>
<td>Wet, forms a ball with wet outline left on hand, light to medium water staining on fingers, makes a weak ribbon</td>
<td>Wet, forms a ball with well-defined finger marks, light to heavy soil/water coating on fingers, ribbons between thumb and forefinger</td>
<td>Wet, forms a ball, uneven medium to heavy soil/water coating on fingers, ribbons easily</td>
</tr>
<tr>
<td>75 – 100%</td>
<td>100% (At field capacity)</td>
<td>Wet, forms a weak ball, light to heavy soil/water coating on fingers, wet outline of soft ball remains on hand</td>
<td>Wet, forms a soft ball, free water appears briefly on soil surface after squeezing or shaking, medium to heavy soil/water coating on fingers</td>
<td>Wet, forms a soft ball, free water appears briefly on soil surface after squeezing or shaking, thick soil/water coating on fingers</td>
</tr>
</tbody>
</table>

* Field capacity is the soil moisture level at which the soil is saturated and excess moisture has drained away.
invasive species immediately. NEVER let it go to seed.
CHARACTERISTICS OF SELECTED GRASSES

Bluegrass, Kentucky (Introduced)

A perennial sod-forming grass that will maintain itself if no more than 60 percent of the total annual yield is grazed. Much of it is non-native but is considered an important cultivated grass for horse pasture when irrigated, fertilized, and properly managed. It produces an abundance of creeping rootstocks and fills the soil with fibrous roots to depths of 3 to 4 feet when not mowed closely or overgrazed, providing good erosion control. It is adapted to irrigated areas where precipitation is less than 16 inches, and grows well in riparian areas and rangelands wherever precipitation is more than 16 inches. Prefers deep to moderately deep well-drained loams and clay loams. Does not thrive on acid or saline-alkali soils, or in areas where water stands at or on the surface for considerable lengths of time. Planting depth ¼ to ½ inch.

Brome, meadow (Introduced)

A perennial long-lived, mildly rhizomatous grass. It reaches full productivity in two to three years. Seedlings are strong and palatability to livestock and wildlife is excellent. It is used in pasture and hay seedings under irrigation or non-irrigated areas where precipitation exceeds 15 inches annually. It is moderately shade tolerant and winter hardy, and recovers quickly after grazing. It is well adapted to the mountain brush, aspen, conifer forest and subalpine. It is less summer dormant under high summer temperatures than smooth brome. Planting depth ¼ to ½ inch. Only available variety is “Regar”.

Brome, smooth (Introduced)

A long-lived sod-forming grass. It is very palatable, productive and shade tolerant. Seedlings are often weak, but once established, plants spread vegetatively to provide full stands. It has notable ability to suppress reinvasion of undesirable vegetation. It recovers slowly when cut for hay, and tends to sod bind which often requires root cultivation and high fertility. A very useful plant for erosion control. Southern strains (Lincoln) are best for mountain brush and favorable sites in the sagebrush and pinyon-juniper zone. Intermediate strains (Manchar) are best on higher elevation mountain rangelands.
Planting depth ¼ to ½ inch. “Manchar” is recommended for forage plantings on meadows, hay or pasture. “Lincoln” is recommended for erosion control and waterways; it produces less forage but is more aggressive in vegetative spread than “Manchar”.

**Canarygrass, Reed** (Introduced)

A coarse, vigorous, productive, long-lived sodgrass, with wide adaptation. It is frost tolerant and suited to wet soils (but also somewhat drought tolerant). Initial stands are often poor because of tardy germination and weak seedlings. Once established it can withstand continuous water inundation for 70 days in cool weather. While planted for streambank erosion control, it invades wet areas along ditches, canals and drains and becomes a problem where it crowds out native wetland plants. Produces abundant spring foliage, with tremendous annual yields on moist fertile soils, high in nitrogen and organic matter. Infertile soils promote sod binding problems. Mature stands are very unpalatable, requiring close grazing and mowing management for quality production. Planting depth ¼ to ½ inch. Adaptable variety, “Rise.” Alkaloid free varieties include “Palaton,” “Venture,” and “Ioreed.”

**Fescue, tall** (Introduced)

A long-lived, high producing, cool-season bunchgrass suited for use under a wide range of soil and climatic conditions. It tolerates acid to alkaline conditions, is less palatable than other pasture grasses, and may be grazed out of a mixed stand. Suited to irrigated, subirrigated, or moderately wet conditions, as well as dryland areas where the effective precipitation exceeds 18 inches. However, it is best suited for moist alkali areas in the lowlands and produces well in open aspen and subalpine ranges. Planting depth ¼ to ½ inch. Adaptable varieties include “Alta” and “Fawn.” Use endophyte free cultivars such as “Forager,” “Johnstone,” “Mozark,” and “Martin” to avoid toxicity. “Kenhy” is a hybrid of fescue and perennial ryegrass. It is more palatable than regular strains of fescue, and retains its wide adaptation and resiliency.

NOTE: Fungal endophyte toxicity can occur when livestock graze tall fescue (especially pure stands); this problem can be greatly reduced, if
planting time.

**Foxtail, Creeping Meadow** (Introduced)

A robust, productive, vigorous-sodding perennial that thrives on wet soils. Growth starts early in the spring and continues until after the fall freeze. Excellent plant for use on waterways, but may invade canals, waste ditches and fields. Used in filter strips due to its heavy fertilizer requirements. Adapted for pasture and hay on sites too wet for good performance of other grasses. Requires 18 inches of annual precipitation or irrigation for good performance. Plant in pure stands or in alternative rows with an adapted legume. Planting depth ¼ to ½ inch. Adapted variety is “Garrison.”

**Orchardgrass** (Introduced)

A long-lived, high producing bunchgrass adapted to well drained soils. It is very shade tolerant and is highly palatable to livestock and wildlife, especially in the early part of the season. It is a widely preferred species for hay, pasture, or silage. It is less winter hardy than smooth brome or timothy and is more vulnerable to diseases than many pasture grasses. Orchardgrass is compatible with alfalfa and clover. It can be grown under irrigation or on dryland where the effective precipitation is at least 16 inches. It is used in erosion-control mixes for cut-over or burned timberland where it is valued, primarily as a forage. It is also adapted to favorable mountain brush and mountain lands except those with dry south exposures. Planting depth is ¼ to ½ inch. There are early- mid- and late-season varieties. Late maturing varieties are preferred in mixtures with alfalfa.

“Paiute” is a dryland orchardgrass that is more drought tolerant than other strains. It is adapted to pinyon-juniper and mountain brush types.

**Ryegrass, perennial** (Introduced)

A relatively short-lived, rapid developing, vigorous, perennial bunchgrass adapted to a wide variety of soil conditions. Can be grown under irrigation or on dryland where the effective precipitation is at least 18 inches. It does best where winters are mild, but will perform adequately where winters are severe. The growth of other perennials will be retarded if it is seeded too heavily in a mixture. It recovers well after grazing in the spring but becomes dormant.
in summer. It is suited for most acidic areas in the lowlands, for hay or pasture. Planting depth \(\frac{1}{4}\) to \(\frac{1}{2}\) inch. Adapted varieties are “Linn,” and “Manawa (H1).” Tetraploids are also available.

**Timothy (Introduced)**

A bunchgrass adapted to cool, humid areas. It performs well, with moderate to high yields on wet fertile meadowlands; forms cover quickly, volunteers readily on preferred sites, and is moderately palatable. Timothy hay is a premium feed for horses and is compatible with legumes. Severe damage can result from early grazing during moist conditions. It is adapted to high elevations where effective precipitation is 18 inches or more. Recommended sites include moist mountain sites, ponderosa pine zone, meadows, aspen, and open timber. Timothy is also used as a ground cover and to control erosion on cut-over or burned-over timberland. Planting depth \(\frac{1}{4}\) to \(\frac{1}{2}\) inch. Adapted varieties are “Climax,” “Mohawk,” and “Patomic.”

**Wheatgrass, crested—standard (Introduced)**

A very long-lived, drought tolerant bunchgrass adapted to a wide range of ecological sites and zones receiving as little as 8-10 inches of precipitation. Growth begins early in the spring and re-occurs with fall moisture. Palatability is excellent in the spring and late fall, but it is less palatable during summer dormancy and after seed formation. It has very vigorous seedlings that can out-compete cheatgrass after hot seed-burning fires. It is also used after late fall disking of germinated cheatgrass stands. Adapted to foothills receiving 10 to 15 inches of precipitation and sagebrush, ponderosa pine, mountain brush, and juniper-pinyon ranges. It may be successful in drier areas, but its use is more risky in these areas where establishment may take up to three years. Planting depth \(\frac{1}{4}\) to \(\frac{1}{2}\) inch. Adapted varieties are “Nordan” and “Ephriam.”

**Wheatgrass, intermediate (Introduced)**

A mild sod-forming, late maturing, long-lived grass suited for use as hay and pasture, alone or with alfalfa. Begins growth early in the spring, and remains green and palatable into the summer, producing large amounts of quality forage. It does not produce mature seed at high elevations, but spreads vegetatively.
Recommended for intermediate sagebrush sites into the high mountains up to 9,000 feet, and on dry meadows, receiving 14 to 18 inches of precipitation. Useful on disturbed sites for soil stabilization. It is moderately shade tolerant. Planting depth ¼ to ½ inch. Adapted varieties are: “Greenar” selected for forage production and compatibility with alfalfa; “Oahe” improved for seed production, forage yield, and rust resistance; and “Tegmar” which is low-growing cultivar noted for erosion-control, sod formation and seedling vigor.

**Wheatgrass, pubescent** (Introduced)

A long-lived aggressive sod-former adapted to low-fertility sites and fine-textured soils. Similar to intermediate wheatgrass, but somewhat more drought-resistant and alkali tolerant, and less palatable. It is better adapted for pasture than for hay. Its ability to remain green during the summer when soil moisture is limited is a significant advantage.

Adapted to foothills receiving 12 to 16 inches of precipitation. It is suited to areas from intermediate sagebrush sites into the high mountains, but not to meadows and shady areas. Very useful for erosion control on a wide range of sites. Planting depth ½ inch. Suggested varieties are “Luna” and most drought tolerant of pubescent varieties. Other varieties include “Mandan,” “Topar,” and “Greenleaf.”

**Wheatgrass, Siberian** (Introduced)

Siberian or desert wheatgrass is similar to crested wheatgrass, but is slightly more drought-tolerant ant. The seedheads are narrower and dominantly awnless. Siberian matures later than standard crested wheatgrass, and has a higher leaf to stem ratio. This bunchgrass is commonly seeded on rangeland for spring – fall use. It greens up early and can be used for early spring pasture. Adapted to 9 to 12 inches of average annual precipitation in a wide range of soils. Planting depth ¼ to ½ inch. Responds well to rotational grazing.

**Wheatgrass, Streambank** (Native)

A low-growing, sod-forming, perennial native wheatgrass that has excellent drought tolerance. The variety “Sodar” establishes readily from seed but does not become a weed. Commonly used for erosion control, its low growth form,
vigorous sod, and low maintenance requirements make it ideal for soil stabilization. Has low palatability and low yield, so it is generally not recommended for forage production. Cold hardy and drought tolerant, Sodar will establish where annual precipitation averages 8 inches or more. Does not tolerate wet or poorly drained sites.

**Wheatgrass, tall** (Introduced)

This is a long-lived, tall, vigorous, very late maturing bunchgrass. Established plants are tolerant of salt, alkali and high water tables. It starts growing early in the spring and reaches maturity in late summer. Reported to be the latest maturing wheatgrass. Palatability is fair early in the season, but the mature plant becomes very unpalatable and must be managed so it is utilized at earlier stages of growth. It does not tolerate continuous close grazing. Old coarse growth often prevents grazing of current growth. It is a good winter forage for livestock, especially horses, when supplemental protein is provided. It is adapted to a very wide range of soils and climates and is a useful erosion control species on critical areas. It does well in salty areas where greasewood and saltgrass grow and where the water table is a few inches to several feet below the surface. It is also suited to favorable, intermediate sagebrush, mountain brush and pinyon-juniper sites because of its drought tolerance. Recommended planting depth is ¼ to ¾ inch. Adapted varieties are “Alkar”-north, “Jose”-south.

**Wildrye, Basin** (Native)

A hardy, robust, long-lived native perennial bunchgrass. Produces high forage yields and is most palatable in early spring. Its best uses as forage are for early spring or fall grazing or as standing hay for winter grazing. Grows in areas with average annual precipitation of 8 inches to more than 20 inches. Adapted under irrigation throughout northern and western Nevada. Is not adapted to shallow soils, but tolerates salt and alkali. Basin wildrye is easily damaged by overgrazing, especially in early spring. Stands are often grazed out by grazing around individual bunches until they are gone. Leave a stubble height of at least 10 inches when grazing and 8 inches if harvested for hay or green chop.

Livestock hooves damage tender new grasses, especially on wet soils. Keep them off newly planted pastures for a minimum of a full growing season.

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CHARACTERISTICS OF SELECTED LEGUMES

Alfalfa (Introduced)

A very productive, palatable perennial legume with numerous varieties tailored to specific purposes. It is suited for use as hay, pasture, or haylage under irrigation or on dryland where the effective precipitation is 12 inches or more. It does not persist with moderate to heavy grazing on rangelands without rest periods. Taproots make it vulnerable to pocket gophers but some varieties are less susceptible to damage. Seedings can be made in the spring or late fall and seed may require inoculation with nitrogen-fixing bacteria before planting. Adapted to intermediate and favorable sagebrush, pinyon-juniper, mountain brush, and ponderosa pine sites. Does poorly at higher elevations. Alfalfa varieties are changed and improved continually to fit various situations and sites, and it is not feasible to make numerous recommendations in this guide. Contact local Cooperative Extension offices for information on alfalfa varieties adapted to local conditions. Recommended planting depth is ¼ to ½ inch; 1 to 2 pounds per acre in mixture with grass; 10-15 pounds for hay. Plant in a very firm seedbed.

Clover, alsike (Introduced)

A short-lived perennial legume that produces abundant palatable foliage on fertile soils. It is suited for hay or pasture under irrigation or on dryland where the effective precipitation is 18 inches or more. It is adapted for use on poorly drained, acid soils, especially in cool areas. Makes good meadow hay and tolerates moderately alkaline conditions. Recommended planting depth is ¼ inch. Adaptable variety is “Aurora.”

Clover, red (Introduced)

This short-lived, perennial legume is suited primarily for hay and silage under irrigation, or on dryland where the effective precipitation is at least 25 inches. Requires well-drained soil. Produces best under medium acid to neutral soil conditions. It is compatible with white clover in pasture mixtures, and will reseed itself and spread under favorable conditions.
Recommended planting depth is ¼ inch. Adapted varieties are “Kenland,” “Dollard,” “Redman,” and “Reddy.”

**Clover, strawberry (Introduced)**

A spreading, pasture-type, perennial legume suited for use under irrigation or semi-wet soils, and tolerant of very strong salty conditions. Less productive than white clover where the latter can be grown. “Salina” tolerates flooding, and is suitable for areas adjacent to overflowing waterways. Recommended planting depth is ¼ inch.

**Clover, white (Introduced)**

A long-lived, stoloniferous perennial legume suited primarily for pasture but can be used for hay and silage. Can be grown under irrigation or on dryland where the effective precipitation is 18 inches or more. Requires medium to high fertility and adequate moisture for optimum production. It does not tolerate strongly acid or strongly alkaline conditions, but does tolerate poor drainage. May present a bloat hazard when it represents a high percentage of the pasture. It provides good erosion control on streambanks and roadsides, though usually lacking in persistence.

White clover thrives best in a cool, moist climate in soils with ample lime, phosphate, and potash. In general, white clover is best adapted to clay and silt soils in humid and irrigated areas. It grows successfully on sandy soils with a high water table or irrigated droughty soils that are adequately fertilized. White clover is shallow rooted and seldom roots deeper than 2 feet, making it adapted to shallow soils when moisture is adequate.

There are three general types of white clover:

**Ladino** is the only large-type variety. It is two to four times as large as common white clover. Winter kill is common under dry winter conditions. It requires a high soil phosphate level and good management for maximum production. “Pilgrim” and “Merit” have been developed for winter hardiness.

**Intermediate**—“Grassland Huia” is a representative of the intermediate type.
Small type—“New York” wild white clover is an example of the small type that is adapted to higher elevations and colder areas. It is the most drought resistant type, is very persistent in pastures, withstands close grazing, and is the least productive of the white clovers. “Kent Wild” white clover is also a small type.

**Milkvetch, cicer** (Introduced)

A rhizomatous non-bloating legume that must be inoculated with rhizobium bacteria for successful planting. A heavy seed and forage producer with a forage quality similar to that of alfalfa. It is adapted to lowland areas that receive more than 14 inches of precipitation. Well adapted to sagebrush grass, pinyon juniper and mountain brush, except in the shade of trees or high shrubs. Recommended planting depth is ¼ to ¾ inch. Recommended varieties include “Lutana” and “Monarch.”

**Sainfoin** (Introduced)

This cool-season legume is impervious to alfalfa weevil, is non-bloating and early blooming but is not as productive as alfalfa. Adapted to deep soils of medium texture, high lime, dryland and irrigated and alkaline soils. It does not tolerate wet soils, high water table or frequent irrigation. Seedling vigor is high. Can be grazed or used for hay. It requires at least 13 inches of annual precipitation. Recommended planting depth is ½ to ¾ inches. Plant in spring and fall. Adapted varieties are “Eski,” “Remont,” “Onar,” and Renumex.”

**Sweetclover, Yellow** (Introduced)

A tall, stemmy, deep-rooted biennial legume that produces abundant forage the first two years. It reseeds itself, and maintains good stands if it is not crowded out by perennials; but produces poor quality forage during mid- to later stages of growth. Adapted sites include the sagebrush-grass to the alpine areas, also moist salty lowlands, road cuts and road sidings, wherever the average annual precipitation is 10 inches or more. Contains coumarin, a precursor of dicoumarol, a blood anti-coagulant. Animals foraging on pure stands or on hay or silage may be killed. Recommended planting depth is ¼ to ½ inch. “Madrid” and “Hubam” are recommended varieties for Nevada.
Trefoil, *birdsfoot* (Introduced)

A long-lived, deep-rooted legume suited for use as pasture or hay. Can be grown under irrigation or on dryland where the effective precipitation is 18 inches or more. Does not bloat grazing animals. It is very winter hardy, useful at high elevations and retains its quality better that alfalfa when mature. The decumbent and intermediate types tolerate close grazing better than erect types. It tolerates poor drainage, is quite vigorous, and is excellent for erosion control, big game food, and beautification. It is somewhat drought tolerant and does well in the upper half of mountain brush, openings in aspen and irrigated pasture. Recommended planting depth is ¼ to ½ inch. Adapted varieties are “Empire” (decumbent growth), “Maitland” (erect growth), and “Tretana.”
Chapter 4:

MANAGING YOUR PASTURE TO KEEP IT ATTRACTIVE AND PRODUCTIVE

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Chapter 4:

MANAGING YOUR PASTURE TO KEEP IT ATTRACTIVE AND PRODUCTIVE

Good pasture management will provide adequate forage production, maintain animal health, and discourage weed invasion. It also protects soil and increases water infiltration and soil organic matter. Learn to be a steward of your land, and you will be repaid many times over in good pasture condition, increased productivity, and improved water quality.

What is involved in managing a pasture?

In Nevada’s challenging climate, maintaining a verdant green pasture can be a formidable task. Irrigation water availability plays a large role in forage production and appearance, but the plant species present, the number of livestock, and the length and timing of grazing also determine the condition of the pasture. To be successful at pasture management, learn how these factors interrelate, and how to make the best choices for your property.

How does grass grow?

Pasture management is really plant root and crown management that is very dependent upon leaf management. It’s important that enough leaves remain throughout the growing season to manufacture food for the rest of the plant. Many factors influence how much a plant grows: water quantity, temperature, soil depth and texture, fertility, topography, and the inherent growth characteristics of the plant itself. Even when these factors are optimized, a plant can’t grow without a large enough food-producing factory—the leaves. Without stored food in the roots and crown, the plant will not survive Nevada’s long dry winters. Inadequate soil moisture results in root death, which affects the functioning of the leaves and the “energy balance” or vigor of the plant. Plants with poor vigor succumb to disease, insects, and extremes in temperature.

The first growth that perennial grasses make in spring green-up comes from food stored in roots, underground stems, and crowns. This stored food nourishes the newly-emerging leaves until enough leaf area is developed to

How Well-Maintained Pastures Benefit Water Quality

Maintaining high-quality pastures produces many water quality benefits. The plants take up nutrients from animal wastes and fertilizers, helping to decrease the amount that runs off during irrigation periods or storms. The plant roots help hold soil particles in place, decreasing erosion and the amount of sediment in local waterbodies. Healthy pastures also help exclude weeds and decrease the need for the use of pesticides.
manufacture and supply food to the young plant. The growing point of a grass plant is located at the base of the plant. New leaves are pushed upward from this point. This growing point is just above the last completed joint of the stem. In young grasses and in new perennial grasses, the joints are crowded together near the soil surface. A leaf arises from each of these joints. Once the growing point has been grazed or mowed, growth continues from a dormant bud located at the base of the stem. As additional leaf area develops, food production is accelerated.

Excess food is stored in the roots to make new growth in the spring or after its leaves are closely grazed or cut. When grazed for too long, the plant continues to draw on the food stored in the roots. Eventually, the food reserves are exhausted, and the grass plant may die. In mixed stands, selected plants weakened by overgrazing get crowded out by less palatable species or by weeds.

**How can I keep my pasture as healthy as possible?**

This is the crux of grass management: ALWAYS LEAVE ENOUGH, whether you are mowing or grazing the forage. While no one wants to waste forage, in order to continue to have enough forage production, you must avoid stressing the plants. If you do stress them by grazing away too much green leafy tissue, let the plants recover fully before grazing again.

What happens when you overgraze a plant? When too much of the leaf volume is removed, new root growth is drastically decreased. If 70 percent of the leaf area is removed, about three-quarters of the root growth is stopped; at 80 percent removal, all root growth stops. These roots don’t start growing again until the leaves are actively growing. Each year, approximately 30 percent of each grass plant’s root system must be replaced.

If only 50 percent of the leaves are removed, almost all roots continue to grow actively. This suggests the rule: “Take half and leave half” as one useful strategy for avoiding many plant stress problems. During the first year, mow to remove one-third of the foliage. This encourages tillering, or plant expansion, without negatively affecting the new root system. A mature grass plant produces twice the area of leaves needed to complete its growth function and remain productive. If you remove more than half of its leaves during the growing season, you deprive the plant of part of its food processing mechanism.

Also, avoid grazing in such a manner that only the most palatable plants are thoroughly grazed, and the less palatable but still nutritious plants gain a competitive edge. Sometimes pastures with many species should be grazed heavily and quickly enough to crop all plants

<table>
<thead>
<tr>
<th>Grasses</th>
<th>Suggested Stubble height (inches)</th>
<th>Height before re-grazing (inches)</th>
<th>Legumes</th>
<th>Suggested Stubble height (inches)</th>
<th>Height before re-grazing (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tall fescue</td>
<td>3</td>
<td>8</td>
<td>Alfalfa</td>
<td>3</td>
<td>6-18</td>
</tr>
<tr>
<td>Orchardgrass</td>
<td>3</td>
<td>8</td>
<td>Red clover</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Smooth bromegrass</td>
<td>3</td>
<td>8</td>
<td>Alsike clover</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Meadow bromegrass</td>
<td>3</td>
<td>8</td>
<td>Sweetclover</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Creeping meadow foxtail</td>
<td>4</td>
<td>10</td>
<td>Ladino clover</td>
<td>2</td>
<td>4-8</td>
</tr>
<tr>
<td>Basin wildrye</td>
<td>8</td>
<td>10</td>
<td>Strawberry clover</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Tall wheatgrass</td>
<td>8</td>
<td>10</td>
<td>Broadleaf birdsfoot trefoil</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Intermediate wheatgrass</td>
<td>4</td>
<td>8</td>
<td>Narrowleaf birdsfoot trefoil</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Pubescent wheatgrass</td>
<td>3</td>
<td>8</td>
<td>Sanfoin</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Timothy</td>
<td>3</td>
<td>8</td>
<td>Cicer milkvetch</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Kentucky bluegrass</td>
<td>3</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red clover</td>
<td>3</td>
<td>6</td>
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</tbody>
</table>

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equally and then rested to let all plants recover. While this is difficult if you only have a few animals and a few pastures, it can be done using electric fencing to temporarily or permanently subdivide the pastures. Simply reducing stocking rates for light use may cause a pasture to become understocked but overgrazed. Remember, overgrazing happens to individual plants and then to patches of plants long before it happens to whole pastures. As grass becomes less vigorous, weeds can take hold and grow where the grass roots have been too severely weakened. A weedy pasture is less productive, and often leaves soil exposed and prone to erosion.

**Why is continual grazing a problem?**

Continual grazing results in overgrazing. Overgrazing occurs when adequate time for grazed forages to regrow is not provided, or grazing time is not reduced during droughts. As you learned above, overgrazing weakens plants and eventually causes the desirable forage species to die out and be replaced by weedy, non-nutritious species. When animal access to a pasture is not restricted, the forages may be grazed too close to the ground, or regrazed before the target height of recovery or regrowth has been reached. This may occur when there are too many animals on one pasture for too long, or if animals are turned into a previously
grazed pasture too early. It happens to individual plants or small areas when even a few animals graze for too long. During hot summer months, cool-season grasses will go dormant and not regrow, leaving the plants with low root reserves.

The table on page 57 provides stubble height and grazing height recommendations for grass and legume species. Stubble height is the height of the plant that remains after grazing. Avoid letting animals graze forage below the recommended average stubble height. It is not a good idea to let livestock into pastures in the spring when forage is just starting to green-up, as the forage will not have had a chance to grow to a similar grazing height, and the root system will be weak. When grazing in early spring is necessary, make sure livestock are rotated to another pasture soon enough to allow regrowth while growing conditions are good. Early grazing followed by continued grazing damages pastures most severely.

In large pastures where horses or cows are allowed to graze freely, it may appear that they are leaving plenty of grass, but the soil will be damaged if too little vegetation remains for erosion protection. After a plant has been grazed and the animal roams over to another corner of the pasture, the horse may not return for some time. The grazed areas regrow succulent new leaves. The plants that were passed over in the early part of the grazing season, however, are now getting taller and beginning to set seed. Horses or cows will avoid these tough, rank plants and eventually grass plants will disappear and be replaced by bare spots and then weeds.

Grazing when the ground is saturated will result in physical damage from hooves, and increases the risk of water contamination.

Overgrazing during drought greatly increases the damage to plants depending on root reserves. To reduce the risk during drought periods (when irrigation water is not available), graze fewer animals less frequently.

How long does it take forage plants to regrow?

As you might expect, the time for regrowth of forage plants varies, depending on species type, temperature, and water availability. The following are average values. Remember that plants under stress from drought, cold weather, poor soil fertility, late season grazing, etc., will require more rest.

**Grasses:**
- Orchardgrass: 20-36 days
- Tall fescue: 20-36 days
- Timothy: 28-36 days
- Intermediate wheatgrass: 24-30 days
- Smooth bromegrass: 24-30 days

**Legumes:**
- Alfalfa: 28-40 days
- Trefoil: 24-30 days
- Clover: 20-26 days
- Sanfoin: 28-40 days
- Milkvetch: 24-30 days

How much feed and forage do animals need each year?

Throughout much of the irrigated West, livestock have a limited grazing season. In Nevada, livestock on small acreages are usually allowed to graze from May through October during the plants’ growing season, and fed hay the rest of the year.

Forage can be thought of as the food your animals eat when grazing. Forage production is measured in “animal unit months,” or AUMs. One AUM is equivalent to the amount of forage eaten by a 1000-pound animal in one month. Feed can be thought of as the harvested hay you provide to an animal when forage is not available. Average requirements for several species are provided below, but will vary depending on season, amount of exercise, size,

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<table>
<thead>
<tr>
<th>Controlled Grazing Will:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase animal production per acre</td>
</tr>
<tr>
<td>Reduce supplemental feeding needs</td>
</tr>
<tr>
<td>Reduce wasted pasture</td>
</tr>
<tr>
<td>Improve the monthly distribution and yield of forage</td>
</tr>
<tr>
<td>Improve distribution and use of animal waste as fertilizer</td>
</tr>
<tr>
<td>Improve pasture species diversity</td>
</tr>
<tr>
<td>Avoid the need for renovation</td>
</tr>
</tbody>
</table>

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and age of animal, and quality of forage, which decreases as plants mature.

<table>
<thead>
<tr>
<th>Species</th>
<th>Feed (Hay) Tons/Month</th>
<th>Forage AUMs or Grazing/Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 cow</td>
<td>0.4</td>
<td>1.0</td>
</tr>
<tr>
<td>1 bull</td>
<td>0.5</td>
<td>1.2</td>
</tr>
<tr>
<td>1 horse</td>
<td>0.5</td>
<td>1.25</td>
</tr>
<tr>
<td>1 sheep</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>1 llama</td>
<td>0.15</td>
<td>0.3</td>
</tr>
<tr>
<td>1 goat</td>
<td>0.1</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Pastures vary considerably in their production. Soil fertility, irrigation frequency, and pasture condition all affect the amount of usable forage. The following table includes average values for pasture and hay production. The averages may increase or decrease depending on management practices. Because a cow tramples about as much as is consumed per month, yields from hayed pastures are greater.

<table>
<thead>
<tr>
<th></th>
<th>Feed (Hay) Tons/Acre</th>
<th>Forage AUMs/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigated</td>
<td>2-4</td>
<td>1-2</td>
</tr>
<tr>
<td>Nonirrigated</td>
<td>0.1-2.0</td>
<td>0.1-1.0</td>
</tr>
</tbody>
</table>

How do I schedule grazing to keep my pastures in good condition?

Scheduled grazing requires a grazing management plan to allow grazing at the right time and intensity (number of animals) to maintain plant cover, protect the soil, maintain or improve the quantity and quality of forage and meet animal production and management objectives. Grazing management involves appropriate stocking rates, or numbers of animals on a given pasture for a given period of time; and proper grazing use, or regulating the amount of forage consumed to maintain optimal plant vigor.

To ensure proper grazing use, you’ll need to monitor the pasture regularly to see how much forage is left. This involves gauging the stubble height (the uneaten portion) and looking at the uniformity of use.

SAMPLE CALCULATION based on AUMs:

From the table at the left, you can see that irrigated pasture in fertile soils will support 1-2 AUM/acre. This means that one acre will have enough forage to provide the nutritional needs of 1-2 animal units for a month. Since horses require about 1.25 AUMs/month, you could pasture 1 to 1.5 horses on this pasture for about one month during the growing season before the horses need to be moved to another pasture.

A properly grazed pasture will have an uneven look. The majority of the plants will have been grazed to the appropriate stubble height, and most of the remaining plants will be tall or partly grazed. A minor amount may appear to be slightly overgrazed or ungrazed. A pasture is overgrazed if animals have been on the pasture for several weeks, the pasture looks like it has been mowed and the forage is uniformly very short. Some plants always seem to remain ungrazed, perhaps due to trampling, fouling by manure, or grazing patterns.

Most livestock prefer not to graze during the hottest part of the day. Instead, the heaviest grazing occurs during the early morning and early evening hours, with a third grazing period sometimes occurring around midnight. On
average, 60 percent of grazing occurs during the day, and 40 percent at night. The amount of time spent grazing varies according to species. Horses are the most likely to spend a majority of the day grazing if given the chance, or an average of 12 to 16 hours per day. Cattle graze about eight hours per day, sheep seven hours or less, and goats no more than six hours.

What's the best way to manage by stubble height?

Although more intensive management strategies can work if carefully planned and implemented, the stubble height indicator approach to grazing management provided below usually works well and can easily be followed. There are many other methods ranging from simple to sophisticated.

The easiest way to accomplish stubble height management is to divide the available pasture into several units called “paddocks” to limit grazing to one pasture at a time. While one pasture is grazed, the other paddocks are rested, allowing forage to grow and renew energy reserves. This rebuilds plant vigor and helps ensure long-term productivity of your grazing lands, and is called rotational grazing.

Rotational grazing does not mean setting up a rigid schedule where animals are moved without regard for the condition of the pasture. Instead, use cues from the forage to tell when to move animals. If you graze too early in the season, the pasture will be set back, desirable plants may die out, allowing weeds to invade. If you graze too late, the grass becomes rank, loses palatability, and production suffers. Make a habit of surveying your pastures to the stubble height and areas of over- and under-use. You can then make flexible decisions about when animals should be moved.

There is no “best” number of units. Any number of paddocks is better than grazing a single pasture continuously. The number of paddocks in your rotational system may be determined by your current fences, the topography of your pasture, access to water, or access to a barn or corral. If you find that you need to cycle among paddocks about each seven to 10 days, based on the number of animals you own, try to establish four or five units. This will allow the forage in the rested units to regrow for the necessary time period (up to five weeks).

If you must separate animals, you will need more paddocks to allow regrowth time. Each paddock can be smaller, however. One style of rotational grazing, called “intensive grazing”, places a large number of animals on a small pasture for a short period. The forage is generally used very evenly, manure is also deposited evenly, and with an adequate regrowth period, productivity can be very high.

If you currently have a single pasture, to start a rotational grazing program, you’ll need to divide your existing pasture area into several paddocks. Make a map of your pasture, and show the location of important features such as the barn, watering troughs, your holding pen, and your manure storage area. Use the map to design a series of paddocks of approximately equal forage production. This will make it easier to judge the rotation interval.
There are many types of fences that can be used to divide pastures. Electric fences are often less expensive and portable, allowing you to change the number and size of paddocks as needed. You may prefer a more permanent approach. Before you select a fence, consider the purpose (type of animal you’re keeping in or out), type of soil material (rocky vs. loamy), terrain, material and labor costs for construction, availability of power, weather, and visual impacts. See the table above for a discussion of advantages and disadvantages of common types of fencing.

You’ll need a reliable source of clean drinking water for each unit. The average beef cow needs eight to 10 gallons per day; milking cows require 30 gallons; sheep, one gallon; and horses, six to eight gallons per day. Consider locating a stock watering tank on common fence lines to make it easier to supply water. In addition, set aside a holding or confinement where you can keep your animals when grazing is not appropriate. This area may become bare, so keep it small and locate it away from waterways or drainage areas.
Once you have subdivided your pasture, installed fencing, and provided watering troughs, it’s time to implement your grazing management program. During the dormant season, when plants are not growing (about November through February), plants can be grazed slightly shorter, but grazing too severely during dormancy may damage the crown of the plant. If instead, you choose to maintain the appropriate stubble height during the winter, you’ll find that the stubble will help to trap snow, which helps protect the plants and add moisture to the soil in the spring. If you do allow grazing, check for “loafing” areas and move the livestock before too much vegetation is removed, and feed hay in a hay rack.

When pastures begin to green up in the early spring, grasses are beginning their growing cycle. If the livestock have been on the pasture during the winter dormant period while soils were frozen, take them off the field and feed hay while early growth is occurring. Begin grazing when the plants are six to eight inches in height, or the appropriate height from the table provided on page 47. Move livestock once the appropriate stubble height has been reached, ensuring optimal, strong regrowth of the forage. You may need to corral the livestock and feed them hay until the pasture regrows.

In the early spring, when the paddocks begin to green up, put the animals in a holding pen and feed them hay so the young grasses can get a good start and/or replenish their root reserves. Later in the spring, when the grasses reach the appropriate height, begin rotating the animals through the paddocks. Remember to allow an adequate recovery period for each paddock. Recovery will be more rapid in the spring when grasses are growing rapidly.

As grasses begin to mature and reach the seed stage, growth slows down. Resting periods will increase, and you may need to feed animals in a holding pen again to give the forage more growing time. Remember that mature, recreational horses only need to graze four to six hours per day, which can be spread throughout the early morning and evening. Place the animals in a holding pen the rest of the day. Continue to monitor for adequate height before grazing, as recovery periods can be substantially longer than in the spring. Near the end of the growing season, be sure to allow all pastures enough recovery time before dormancy so that adequate food is stored in the roots for winter survival and spring growth.

By keeping records of your rotation, you’ll learn what you can expect from each paddock. Also, you’ll be able to rotate the order in which you graze the paddocks from year to year, ensuring that during critical periods in the plant growth cycle, a given paddock is only impacted occasionally and not every year.

What do I do about all the manure?

Manure is a valuable resource both for its fertilizer value and for the addition of organic matter to the soil. Unfortunately, unless managed carefully, manure may also pollute waterbodies with nutrients, bacteria, salts, and organic debris. Chapter 7 in the Small Ranch Manual describes how to plan an animal waste management system for your property.

Manure is not an insignificant problem, since one cow can produce about 50 pounds or more of manure a day! If animals congregate in certain parts of a pasture, they will over-load these areas with nutrients. If you choose not to collect and compost the manure, you must drag pastures on a regular basis at the end of each grazing cycle to distribute and break up the waste. If clumps of manure are allowed to accumulate, the plants underneath will be killed. In general, animals will usually avoid eating near manure from their own species. This allows the surrounding forage to become over-mature and less palatable, decreasing productivity.
To protect water quality, schedule irrigation cycles after manure has been spread, and avoid irrigation water runoff. Never dump manure directly into waterbodies!

How do I avoid overgrazing?

Now that you know that overgrazing results from not allowing an adequate time for regrowth of forages, you’ll be a better pasture manager. Follow these tips to avoid overgrazing:

- **Increase your pasture production** by
  - irrigating appropriately,
  - fertilizing according to soil test recommendations,
  - controlling weeds,
  - after non-uniform grazing, mowing to a uniform 3-4 inches to stimulate equal growth of all plants, and
  - dragging or harrowing to spread manure.

- **Improve your grazing management** by applying stubble height indicators.

- **Graze conservatively during periods of drought**, including the growing season following the end of the drought. Drought causes a decline in root food storage and increases root death. Graze fewer animals less frequently, leaving more leaves and stems for plant survival and regrowth.

- **Reduce the number of animals** on the pasture.

- **Buy additional feed** or rent additional pasture for grazing.

- **Use a holding area or corral** to restrict animal access during regrowth.

## Tips for a Successful Grazing Program

- **Subdivide large pastures** into smaller pastures and develop a pasture-rotation grazing system to allow time for regrowth.

- **Corral livestock and feed them** hay until your pasture grasses are six to eight inches tall. Move livestock when 50 percent of the grass has been eaten (follow stubble height suggestions). Do not regraze until the grasses are at least six inches high. This will take one to three months.

- If some grasses are not grazed the first time through, consider **mowing, clipping, or haying the areas not grazed** so regrowth will be uniform. You may also want to place a temporary electric fence to force the animals to take the unused vegetation, or increase the number of animals per pasture so all the grasses are grazed the first time through.

- **Eliminate continuous season-long grazing.** When the animals start to graze the same plant over again, it is time to move them.

- **Confine animals off pastures in the late summer when grasses appear to stop growing.** This allows food to be stored in roots for next spring.

- **During winter months, continue your rotation** to distribute manure and feed wastes evenly across your pastures, or hold animals in a corral. Drag the manure during the early spring confinement period to spread it across the pasture.

- **Drag each paddock after the animals are removed** to redistribute manure and avoid uneven plant growth.

- **Avoid grazing when soils are wet** to avoid damaging roots and pulling out plants.

- **Allow long rest periods** or use a high-intensity, short-duration grazing system to rejuvenate poor condition pasture.

- **Provide a water source** for each pasture.

- **Consider fencing streams** to keep manure out, protect and maintain streamside vegetation and control erosion.

- **Irrigate each pasture** (if you have irrigation) immediately after grazing to get plants growing again.

- **Fertilize ONLY as needed.** Fertilizing in early spring when grasses are growing can increase production tremendously. See Chapter 2 for information on soil tests and fertilizer application.

- Horses DO NOT need 24-hour access to feed or forage. Their nutritional needs can be met with only a few hours of grazing on good pasture each day. **Corral animals** for the remainder of the day to prevent overgrazing of plants and extend the forage available in your pastures.

- On a limited acreage, or with too many animals, you may have only enough pasture to exercise your animals, and will need to **feed year-round.**

- Pastures can be **hayed** some years rather than grazed.

“Clean Water – We Can Make a Difference”
Chapter 5:

LIVING WITH A STREAM FOR A NEIGHBOR

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Chapter 5:

LIVING WITH A STREAM FOR A NEIGHBOR

Do you love living close to running water? Does it add life to your life, or do the risks of living next to a sleeping giant make you nervous? Many people add the sight and sound of moving water to landscape projects. Many are attracted by the opportunity to appreciate this feature “maintenance free” by living close to a natural stream. The plant life and wildlife that enriches streamside areas makes living near them all the more special.

Your stream, peaceful and serene 99 percent of the time, can cause occasional terror when it floods. The land above you that catches rain or melting snow and funnels it to your spot on the stream is called your watershed. The health or condition of your upper and lower watershed is a key factor controlling the nature of the stream where you live.

Pay particular attention to this chapter if:

♦ You live close to a stream.
♦ Your house is near the same level as a stream.
♦ You suspect or have been told you live in a floodplain.
♦ The stream channel(s) above or below your property have been altered by channel straightening, levying, extensive erosion or bank protection.
♦ Your watershed is steep, dry, poorly vegetated, or highly altered by activities such as:
  • urbanization,
  • roads or trails,
  • logging or mining,
  • fire or lack of fire,
  • livestock grazing, or
  • infestation by exotic weeds such as cheatgrass, Russian knapweed, leafy spurge, thistles, tall whitetop, or tamarisk (salt cedar).

What are my goals in living close to a stream?

For most people, their expectations for living close to a stream start with an assumption of low risk and often include problem-free stream stability. Other streamside goals might include natural beauty, wildlife and fish habitat, livestock forage, water quality, neighbors, shade, privacy, access, pleasant sounds, and space for outdoor living. With these goals, you must consider the natural functions of the stream, including its ability to transport water and sediment. What you do as a streamside landowner affects you and your neighbors, both upstream and down.

What are the functions of a watershed?

The job of a watershed is to capture, store, and later release water from rain and snow melt. Even in dry summers, streams supplied by springs run long after snowmelt has ended. However, watersheds vary in size and in their natural ability to do their job. Wide, shallow flows move slowly, allowing a wide area of vegetation to slow the flow, providing plenty of time for water to soak into the floodplain soil. Water enters the soil and is stored as groundwater. Areas downstream from broad and frequently inundated floodplains enjoy some protection from severe flooding. Not all watersheds capture enough water to make a

Your stream depends on the upper watershed to capture and deliver its water.
stream perennial (running year-round). Many times, peoples’ activities alter the natural functions of a watershed.

**How can I learn what’s happening in my watershed?**

Start with an inventory of your watershed. The best tool is a topographic map that shows the streams in your area. The figure on the next page shows how to recognize the extent of a watershed. Perennial streams that flow continually are shown as continuous lines. Intermittent or ephemeral streams that flow only seasonally or in response to wet weather show up as broken lines. These lines or the contour lines that show locations of constant elevation (like bathtub rings) tell the size of the watershed above. Runoff water tends to cross contour lines at right angles as it flows downhill. Ridge tops show up as Vs pointing downhill, with ovals for hilltops. Ravines show up as Vs pointing uphill. Use the map scale to count how many square miles your watershed includes.

Look for evidence of erosion when walking or touring your watershed, especially those areas near streams. It may take a trained eye to judge if erosion is natural or caused by human activities. If erosion is concentrated near places where human activities have changed the vegetation or altered drainageways, it’s a pretty clear sign that something is amiss. Often erosion signals that an area no longer captures or stores much water from rain or snowmelt. Surfaces that are roofed, paved, or compacted by wheel or foot traffic shed water rather than catch it. Water rushes downhill and enters the stream quickly, often carrying pollutants with it. The water may contain a variety of pollutants, including nutrients, road salts, hydrocarbons (oil and gasoline), or other wastes. Roads, trails, ditches, culverts, rain gutters and erosion-caused rills and gullies speed the flow. Water that would have soaked into the soil to be captured as groundwater for slow release instead runs off quickly, and deposits pollutants in our waterways.

### What determines the size of floods in my watershed?

One of the biggest factors controlling the size and frequency of floods is the time of concentration, or the amount of time it takes for runoff to reach streams. Rapid runoff to the stream concentrates water into a larger flood wave. Effective capture, storage and safe release of water from precipitation provides longer periods of more moderate flow and smaller floods.

Many areas of the watershed are within a 100-year floodplain. This means that in any one year, there is a one percent chance that a flood will cover that area with water. Most of the 100-year floodplain will be within the 50, 25 or 10-year floodplain. These areas have a two percent, four percent, and 10 percent chance, respectively, of being inundated by flood waters in any single year. A 100-year flood can happen more often than once in any period of 100 years, or even within one year. The person who quipped that they were 367 years old because they had experienced three 100-year floods in their 67-year lifetime didn’t admit that rare events can occur more frequently than predicted. History has shown us that repeated 100-year floods can and do occur at intervals of much less than 100 years.

### Why does it seem that we are now having more frequent or bigger floods?

Because of flood insurance laws, many 100-year floodplains are mapped. Often the map of the 100-year floodplain is not accurate, and often
Contour lines and stream lines help you find your watershed boundaries. The Bailey Creek watershed is outlined in blue on this topographic map.

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the limits of the 100-year flood become larger in repeat studies. The inaccuracy stems from having records from only a short period of time, often only a few decades. The increasing size of 100-year floodplains results from both statistical reasons and because our watersheds are changing. As we build and develop open lands, waters that in the past would have soaked into the ground over a large area are concentrated and delivered rapidly to stream channels. This increases peak flows and expands the 100-year floodplain downstream. In general, the older the floodplain map and the more the watershed has been modified to increase runoff, the less reliable the map.

If you want to build in a 100-year floodplain, you may be required to build the floor of your structure above that level. If you do so, the level of the 100-year flood rises because the water that would have been covering or flowing over your building site is displaced and goes somewhere else. This has the effect of raising the height of the water in the vicinity, as shown in the picture at the right. If many of your neighbors have also built above the supposed 100-year flood level, it is likely that the 100-year flood level on your property may be higher than it was in the past before buildings were erected. In spite of these problems, the maps help you consider the flood potential where you live. They are available at your county planning office.

**Why causes stream bank and bed erosion?**

The ability of a stream to pick up and move particles is called “stream power.” It increases dramatically with the depth and speed of the flow. In some watersheds, a great deal of erosion occurs at the streambanks because flows have increased after the watershed or stream was changed, and the stream hasn’t adjusted yet to the increased flow. The stream uses its energy to erode banks and pick up channel sediment. The steeper the channel, the faster the water will move. The looser the soil material, the more likely erosion will occur.

Channels with strong water-loving or riparian vegetation and especially channels that flood often onto a wide floodplain resist these forces. The vegetation binds together streambank soil, and its structure adds roughness or friction which slows the flow. Wide floodplains spread the floodwater, causing it to become wider and less deep. Shallow flows, no matter how wide, rarely cause much erosion.

**Why are some stream valleys wide and flat?**

Many wide, flat floodplains were created over long periods of time by slow erosion and deposition as the stream swung back and forth across the valley floor. The flow spreading water and sediment from the upper elevations over a wide floodplain is shallow and slow. However, inside the stream, the flow is just fast enough to move the sediment delivered from the watershed. Slow erosion on one side of the channel is balanced by bank building on the other, as shown in the picture on the next page.

Such a stream moves constantly but slowly. Time-lapse photography of one frame per decade would be like watching a flag flutter in the wind in very slow motion, always moving but keeping the same recognizable form. The stress of flooding is handled by spreading the water over a large area, capturing the water as it soaks into the soil, and using the water to grow strongly-rooted vegetation. The water-loving riparian vegetation allows the channel to move, but only very slowly. Bank building keeps the channel narrow and winding, or meandering, so it can move sediment effectively.
Unraveling the stream by changing the width of the floodplain, access to the floodplain, the form of the channel, or the type and strength of the vegetation is like pulling the stitching from the flag. Floods tear apart valleys when they lose the balance of stabilizing forces just as wind tears apart tattered flags.

Placing bridges that are not intended to move, or using structures to keep a stream from moving conflicts with its natural tendency to move slowly back and forth across the valley bottom. Imagine a flag that flutters against a building. It quickly wears out. Too much or too little sediment, too little vegetation, or any activity that causes a stream to cut deeply below its floodplain disrupts natural functions.

**What happens when people straighten or levee a channel to prevent flooding on their property?**

Moving water away from one house moves it to someplace else, and usually increases flooding there. Areas below straightened or levied streams experience more frequent, larger, and more damaging floods. Upstream, waters flow faster in a bigger, deeper channel and no longer gently flood across broad absorbent floodplains. Downstream, the increased power of deeper and faster water combined with the increased frequency and depth of flooding often cause severe erosion.

In general, the wider the floodplain was before development, the larger the area where flooding conditions and natural stability depend on channel shape, riparian vegetation and watershed condition. Streams that had a lot of riparian vegetation growing along them in the past will depend on riparian vegetation in the future, or the stream will continue to become more unnatural. If erosion was prevented by vegetation in the past, then the stream requires vegetation or some combination of erosion resistance factors in the future. The more water a stream must handle in a flood, the more important are channel shape, floodplain access and riparian vegetation. Big flags in stiff winds require strong stitching. The energy of large flows quickly erodes channels where soils are loose and have lost their energy-dissipating form or protective vegetation.

**What causes headcuts?**

Areas upstream from channel modifications also experience increased erosion. Incisions where streams cut into their bed often begin with the loss of floodplain access. A headcut, as shown below, is like a waterfall slicing upstream through loose, erodible valley material. During high flows, a headcut erodes toward the head of the stream as the forces of flowing water become focused and carve away the loose soils where the stream drops to a lower level.

Straightening a channel may result in loss of floodplain access because the channel slope becomes steeper, causing water to flow faster. Constructing levies along a channel also accelerates water speed by increasing the flood depth. By increasing the speed, both straightening a channel and constructing levies...
increase the power of flowing water. This causes erosion of the stream wherever bed or banks cannot resist the concentrated force. An eroded or lowered bed steepens the channel and speeds water flow, causing the effects of disturbance to accelerate and migrate upstream. In most situations, only an engineered structure carefully placed during construction at the top of the channel modification or at a headcut will prevent this headward migration.

**Where does all the sediment come from, and where does it go?**

Erosion upstream leads to deposition of sediments downstream. Streams transport excess sediment from natural or disturbed watersheds or channels until the speed of the water decreases. As the slope of the stream flattens, or the channel widens and allows flows to become shallow, water slows and sediment begins to drop out. The biggest rocks deposit first, followed by smaller particles, gravel, sand, silt, and finally clay. Clay is so fine that water often carries it far away to a lake or pond where it takes a long time to settle out of still water.

Channels that cut down also widen. As they become wider, water spreading across the bottom may no longer flow deeply and quickly enough to carry the sediment load. A new floodplain begins to form, and/or the gully begins filling. This is the natural process of recovery in some channels. Whether an area erodes, fills with sediment or both, moving just enough sediment to stay in balance depends on the climate, the nature and condition of the watershed, and the nature of the channel. Full recovery requires that a stream regain access to a floodplain that is sufficiently large and at the appropriate elevation in relation to the channel.

**How do I set goals for my stream?**

After touring your watershed, you’re ready to think about any problems that might be related to living at your location. These problems could include flood hazards, sediment or mud deposits, erosion from an unstable bank, or neighbors angry about problems that they think you may have caused.

You may also be thinking about opportunities to enhance the stream or your property to improve your quality of life. In short, you’re ready to set goals. These goals should also encompass the goals of your neighbors and goals for the entire stream system.

To set goals, list issues or concerns about the part of the watershed that is upstream of your property, and the stream both at and below your property. Are there any issues or concerns that might motivate you to do something special to resolve the problem? Does it even make sense to live in that area, or is the risk of flooding too great? Next, list the assets of the stream where you live. Does the streamside area attract you

*Gullies are formed when deeper and faster waters result in increased erosion.*

*A recovering gully*
for outdoor living or particular activities? Are there features of the stream or streamside area that you want to enhance? Are you most interested in fish and wildlife habitat, stream stability, water quality, beauty, other functions, or some combination?

**What can I do to achieve my goals?**

In most situations, the best policy is to leave the stream alone and let nature take its course. In some places, this is the law. The closer we move houses, structures, or other disturbances to streams, and the more we change the channel or the watershed, the less we can depend on natural stability. Counteracting forces usually keep most streams in balance. However, with enough disturbance, any stream can cross a threshold to instability, resulting in big changes. While this could be natural, human actions usually initiate or accelerate such unravelling.

The more we subject streams to piecemeal engineering, the less we can depend on natural stability. If letting nature take its course is not an option, then appropriate, careful consideration and design is required. Any action may precipitate off-site and unintended consequences.

**What happens if we don’t engineer a stable bank?**

In areas where investments in artificial bank protection are not made, the channel widens with each year or passing flood. This increases the frequency of peak flows that are wide and too low to escape the high banks. After continued erosion and channel widening, new riparian vegetation more frequently survives the shallower flows, becomes established, and further reduces the velocity of flood flows. These are steps in natural recovery.

However, people often move to a floodplain just when it no longer acts like a floodplain because the stream has become incised and too big. New residents may fear or resent the natural processes that allow a stream to recover its natural functions. Erosion of the high banks and deposition of sediment seem ugly. Eventually, aggradation and water-slowing vegetation increase flood heights. Ironically, many of these new residents may have moved to the site because it offered the view or sound of a natural stream. It is disappointing to learn that the recovering stream configuration results in an increased flood hazard locally to those living in the flood zone, even though the flood hazard DOWNSTREAM has been decreased by the spreading of water. If you live outside the flood zone, however, you can appreciate floods as part of nature’s majesty, much like a passing lightening storm.

Because houses and floods are often at odds, the first need for stream restoration is to keep development away from floodplains and especially away from floodplain streambanks. Green belts, parks and well-managed pasture lands are much more compatible with streams and floodways. Frequently, these land uses also increase the value of surrounding property and decrease the need for and cost of channel engineering or flood damage repair. With stream- and flood-compatible land uses, nature accomplishes recovery and regains stability.

**How do I decide if a particular project is appropriate for my stream?**

The following tables discuss instances in which it may be more or less appropriate to take certain actions in or near your stream. If you have a project in mind, first check the table to determine whether your situation falls within the “appropriate” category. Then, read the following section on permit requirements before starting your project.
## Vegetation Management Projects

<table>
<thead>
<tr>
<th>Practices and projects:</th>
<th>When and where it’s appropriate</th>
<th>When and where it is NOT appropriate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plant vegetation</strong></td>
<td>After construction or when natural revegetation will take too long to protect soil from expected high flows</td>
<td>In places where poorly managed grazing, competing weeds, or inappropriate plant species won’t allow plantings to thrive</td>
</tr>
<tr>
<td><strong>Removing willows</strong></td>
<td>Where they are above the floodable area of a stream, where they cause aggradation and flooding incompatible with surrounding land uses, and where the roughness and bank protection they provide will be replaced by snags, other vegetation, rock or some combination</td>
<td>Where willows are needed to slow water flow and protect stream banks from excessive erosion, or where they provide habitat for valued wildlife or shade needed to maintain cool or consistent water temperature</td>
</tr>
<tr>
<td><strong>Removing trees</strong></td>
<td>When they are above the floodable area of a stream, and where the roughness and bank protection they provide will be replaced by snags, other vegetation, rock or some combination</td>
<td>Where trees or roots are needed to protect stream banks from excessive erosion, or where they provide habitat for valued wildlife or shade needed to maintain cool or consistent water temperature</td>
</tr>
<tr>
<td><strong>Removing snags</strong></td>
<td>Where they cause aggradation and flooding incompatible with surrounding land uses, and where the roughness and stream habitat they create will be replaced by other vegetation, rock or some combination</td>
<td>Where snags or coarse woody debris are needed for energy dissipation and channel stability, or where the wood has become part of the channel through sediment deposition and vegetation growth</td>
</tr>
<tr>
<td><strong>Mowing</strong></td>
<td>Where riparian vegetation must protect only against shallow flows, or the roughness of erect vegetation is not needed to slow stream velocity</td>
<td>Where natural vegetation is wanted or needed for roughness to slow water or to provide habitat for valued wildlife</td>
</tr>
<tr>
<td><strong>Fertilizing</strong></td>
<td>Where fertilizers will not wash or leach into the stream</td>
<td>Where the purpose of natural vegetation growth is nutrient capture and water quality improvement</td>
</tr>
<tr>
<td><strong>Using herbicides</strong></td>
<td>Where invasive weeds will likely impair riparian functions or spread to new areas</td>
<td>When herbicides are not labeled for use near water or would kill riparian vegetation needed by the stream for various functions</td>
</tr>
<tr>
<td><strong>Using other pesticides</strong></td>
<td>When labeled for use near water, and where exotic pest populations are ready to explode</td>
<td>Where natural processes are preferred</td>
</tr>
<tr>
<td><strong>Providing livestock access to streams</strong></td>
<td>Where or when livestock access is dispersed over a large area or at hardened or erosion-resistant locations, and when it will not consume needed vegetation or impair important riparian functions</td>
<td>Where or when livestock will cause excessive bank erosion, or grazing will result in the failure of riparian vegetation to provide needed structure for riparian or stream functions, or habitat for valued wildlife.</td>
</tr>
<tr>
<td><strong>Piping water for livestock</strong></td>
<td>Where keeping livestock away from riparian vegetation or the stream helps meet stream vegetation, water quality, or wildlife habitat goals</td>
<td>Where no water rights exist and where a pipe or diversion structure would cause erosion by changing the stream’s flow pattern</td>
</tr>
<tr>
<td>Practices and projects:</td>
<td>When and where it’s appropriate</td>
<td>When and where it is NOT appropriate</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Constructed wetlands</td>
<td>When such wetlands maintain the form and vegetation needed for sustainable functions in the landscape setting, such as improved flood storage, water quality, and wildlife habitat</td>
<td>Where proposed wetlands are not compatible with surrounding land uses, the potential for success is low, or the potential for negative impacts from the construction of the wetland outweighs the benefits</td>
</tr>
<tr>
<td>Reducing bank slope</td>
<td>Where erosion from an over-steep bank can be fixed without unduly limiting floodplain area or formation of a new floodplain</td>
<td>Where continued bank erosion is viewed as normal for recovery and for the stream to regain an accessible floodplain after incision</td>
</tr>
<tr>
<td>Steepening bank slope</td>
<td>Where the bank can be protected from new erosion and no floodplain filling is required</td>
<td>Where steepening restricts stream flooding onto a floodplain or stable floodable area</td>
</tr>
<tr>
<td>Riprapbing a bank</td>
<td>Where the natural tendencies of a stream are no longer compatible with more important goals, such as protecting a house that was built in the wrong place</td>
<td>Where continued bank erosion is viewed as normal for recovery and for the stream to regain an accessible floodplain after incision</td>
</tr>
<tr>
<td>Putting boulders in creek</td>
<td>In moderate slope (2 to 4%) cobble-bed streams that can flood to at least one and a half times their annual peak width when flooded to twice the average annual peak depth (consult an engineer)</td>
<td>In streams with less than 2% slope, or anywhere that the boulders will increase flow velocity and bank and streambed erosion</td>
</tr>
<tr>
<td>Diverting flow to a pond</td>
<td>Where you have water rights and diverted quantities are not great enough to impair the stream and its riparian vegetation</td>
<td>Without a permit, or with structures that create water flow, velocity, or vegetation problems</td>
</tr>
<tr>
<td>Building a pond in channel</td>
<td>Where you have water rights/permits, where the pond is very high in the watershed and fed by spring water, and when the pond is properly engineered to be stable and pass appropriate base flow and flood flows</td>
<td>Where the runoff or sediment from the upstream watershed could overfill the pond and cause it to overtop and fail, or where the water or sediment are needed downstream to grow vegetation or balance erosion</td>
</tr>
<tr>
<td>Building a headgate</td>
<td>Where legally permitted and where it can be designed to remain in place but not cause erosion or sediment removal during floods</td>
<td>Where frequent replacement will disturb the stream bed and cause channel incision, or where it will not be adequately monitored or adjusted during floods</td>
</tr>
<tr>
<td>Straightening meanders</td>
<td>Where natural stream tendencies conflict with land uses and society wants to convert a natural channel to an engineered channel without most natural functions. There will be upstream and downstream problems</td>
<td>Where people or wildlife depend on natural stream functions to create channel stability, balance erosion and deposition, store water, and safely release clean water</td>
</tr>
<tr>
<td>Dredging</td>
<td>Where a stream channel is no longer natural, the risks of rapid runoff and faster water are controlled, and where aggravation is putting people at risk and the off-site problems will be prevented</td>
<td>Where people or wildlife depend on natural stream functions to create channel stability, balance erosion and deposition, store water, and safely release clean water, such as places where deposition is part of stream restoration</td>
</tr>
<tr>
<td>Concreting a single bank</td>
<td>Where the natural tendencies of a stream are no longer compatible with more important goals and if the increased velocity upstream and down resulting from the concrete bank will be slowed by the engineered project</td>
<td>Where continued bank erosion is viewed as natural for recovery and floodplain development, and where faster water resulting from the concrete bank will erode the channel elsewhere</td>
</tr>
<tr>
<td>Concreting a channel</td>
<td>Where a tributary stream must act as only a storm sewer and downstream channel areas are also engineered or the downstream channel is a much larger river</td>
<td>Where any natural functioning is desired</td>
</tr>
<tr>
<td>Dumping into the stream</td>
<td>Never appropriate to dump debris or materials of any sort into a stream, and may be illegal as well</td>
<td>Anywhere and anytime</td>
</tr>
</tbody>
</table>
### Off-Stream Projects

<table>
<thead>
<tr>
<th>Practices and projects</th>
<th>When and where it’s appropriate</th>
<th>When and where it is NOT appropriate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishing a conservation easement</td>
<td>Where the community gains from keeping land in a natural or floodable state, such as the riparian corridor or floodway, and the conservation easement terms meet the objectives of the landowner and community</td>
<td>Where the public gains little through conservation because the risks from other land uses, such as development outside the floodway, are small in comparison to other locations</td>
</tr>
<tr>
<td>Sediment detention basin</td>
<td>Where downstream channel form or water quality needs are not compatible with predicted sediment loads, and a basin of sufficient size will meet objectives and allow timely maintenance</td>
<td>In high sediment systems where sediment load will fill the basin during a big event, or where sediment is needed for stability in a stream that balances erosion with deposition</td>
</tr>
<tr>
<td>Developing a watershed</td>
<td>Where increased runoff and speed of runoff can be captured in detention basins, etc., streams will resist the stress from increased runoff, or society chooses to sacrifice its streams and water quality</td>
<td>Where development causes natural hazards or will put people at risk from natural hazards, or receiving streams will be overwhelmed by the changes in hydrology and society prefers natural stream function, high quality water, and wildlife habitat</td>
</tr>
<tr>
<td>Elevating a pad</td>
<td>Where it is out of the floodplain and will not cause important changes to water flow</td>
<td>Where elevating the pad will concentrate flow, causing erosion or flooding neighboring properties during floods</td>
</tr>
<tr>
<td>Building a deck</td>
<td>Where people would like to enjoy the plant and animal diversity of a streamside setting and can do so without destroying that value</td>
<td>Where the deck or the footings of the deck will catch debris during floods or cause an alteration to water flow patterns</td>
</tr>
<tr>
<td>Constructing parks</td>
<td>Outside of the riparian buffer zone where natural vegetation and channel form are most often critical to the stream. However, for buildings, fill, or structures, see above.</td>
<td>Where it is necessary to armor the stream channel to protect the park from erosion, or development of the park will concentrate flow causing erosion during floods</td>
</tr>
<tr>
<td>Building golf courses</td>
<td>Outside of the riparian buffer zone where natural vegetation and channel form are most often critical to the stream, and cut, fill, and mowing will not alter flood energy causing accelerated velocity and erosion</td>
<td>Where contouring land for the golf course or removal or alteration of riparian vegetation and channel form will alter flood energy or concentrate flow-causing erosion, and where future erosion needed for maintenance and recovery would not be acceptable</td>
</tr>
<tr>
<td>Building a road</td>
<td>Where it is out of the floodplain and will not cause important changes to water flow</td>
<td>Where building the road will put fill material onto the floodplain or concentrate flows, causing erosion</td>
</tr>
<tr>
<td>Building a bridge</td>
<td>Where the bridge can span the width of the flood flow, or after due consideration, where societal goals outweigh stream function and future consequences</td>
<td>Where the bridge will concentrate wide flood flow into a high-velocity eroding force, block fish passage, cause the stream or bridge to fail as the channel migrates, or increase unacceptable flooding</td>
</tr>
<tr>
<td>Building a levee</td>
<td>Well back from the stream so that the channel can both flood broadly and meander appropriately between the levees</td>
<td>Where the levee will greatly increase water depth and cause flows to erode channel banks, or the levee will encourage people to build in locations that create risk</td>
</tr>
<tr>
<td>Construction of a building or zoning for development near a stream</td>
<td>Outside of the floodplain, or far enough from a stream that the building will not increase water elevation during a flood nor be put at risk from natural erosion</td>
<td>In the area where riparian vegetation and channel form are important to the stream and its functions during floods</td>
</tr>
</tbody>
</table>
What permits are needed before I can start working in my stream?

The permitting process often seems convoluted and difficult to understand. As a result, often projects are begun without the appropriate permits, resulting in penalties later. By learning the process, you’ll comply with the law and will obtain more helpful information to complete your project. This discussion provides only an overview. It is suggested that you consult the regulations for more specific information.

What is a 404 permit?

The federal agency responsible for regulating activities in the nation’s waters is called the U.S. Army Corps of Engineers. Section 404 of the Clean Water Act (33 CFR, parts 320, 323, 325 – 328, and 330)) requires that a Department of the Army permit be issued prior to discharging dredged or fill materials into “waters of the United States.” The definition of “waters of the United States” includes intra-state lakes, rivers, streams (including those that only flow seasonally), mudflats, wetlands, sloughs, wet meadows, playa lakes, or natural ponds. The waters are included if the use, degradation, or destruction of them could affect interstate or foreign commerce.

The Corps’ jurisdiction is very broad, and can also extend to dry channels where water does not presently (or recently) exist. The only requirement is that it can be shown that the channel has been used to provide water at some time in the past to a location where the water could be used for interstate commerce. Interstate commerce can include cattle grazing, migratory waterfowl access, or recreation for out-of-state tourists.

Under section 404, a project that entails the movement of soil, stream channel materials, or placement of structures, even beneficial stream restoration, must have a permit from the Corps or fall into an exempt category before it can proceed. Public service stream projects also must comply with the permitting requirements, even if the project just includes the placement of structures to protect a bank.

Must all projects go through the same process?

There are three categories of permits: Nationwide Permits, Regional General Permits, and Individual Permits. Nationwide Permits are a type of permit issued by the Chief of Engineers in Washington, D.C. These permits are designed to regulate certain activities having minimal impacts with little, if any, delay or paperwork. An example is a Nationwide Permit 27 for riparian restoration and creation activities. In 1999, there were 36 Nationwide Permits available.

Regional General Permits are issued by a Corps of Engineers District for categories of activities that are similar in nature and cause only minimal impact. An example in Nevada is General Permit number 0006, which authorizes fills associated with the construction of bridges and culverts, assuming certain conditions are met. Unlike Nationwide Permits which apply to the entire country, Regional Permits are specific to a particular geographical location.

The Corps retains the authority to determine whether or not a particular activity will be authorized under a Nationwide or Regional General Permit. If you feel your particular activity fits under the authority of a Nationwide or Regional Permit, contact the Corps to verify that the activity is appropriate.

The third type of permit is an Individual Permit. These permits are normally issued for large projects, or for projects that will have other

Wetlands provide many essential water quality benefits.

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than minimal impact on the waters of the United States. At the discretion of the Corps, small projects with seemingly minor impacts may still require an Individual Permit if they do not fall into the categories covered by Regional or Nationwide Permits. The Corps will consider such factors as “cumulative,” or additive impacts from several projects on the same drainage.

Individual Permits may involve outside resource agencies, both state and federal, and may take many months to complete. Usually environmental impact statements or assessments must be completed and public meetings held before a permit can be issued to public agencies.

**How does the Corps make its decision?**

The goal of the entire 404 permitting process is to protect wetlands. The steps that must be followed to meet the requirements of the Corps include:

1. **Avoidance:** Has the applicant taken all reasonable steps to avoid impacting wetlands in designing the project?
2. **Minimization:** Has the applicant taken all reasonable steps to minimize impacts to wetlands by the project?
3. **Mitigation:** If wetlands impacts cannot be avoided, has the applicant proposed an adequate plan to mitigate for the loss?

The applicant must satisfy the Corps that this sequence has been addressed and met in order to have a project permitted.

**Who else is involved in the permitting process?**

The Corps must also follow the requirements of the National Environmental Policy Act (NEPA), which involves a public interest review of all the direct and indirect impacts of the project for which a permit is sought. The process may create special conditions or requirements on the permit. Failure to follow the special conditions may void the permit.

Remember that only Corps regulatory personnel may make definitive decisions as to whether or not a particular project requires a permit. If in doubt, get a decision from your local regulatory office to avoid the possibility of violations resulting in enforcement actions.

Section 404 is administered jointly by the Corps of Engineers and the Environmental Protections Agency (EPA). The EPA sets the water quality standards that the Corps then follows, and has the final authority to veto permit decisions made by the Corps. The EPA can also enforce Section 404 violations.

If your project requires a Corps permit, your regional EPA office will require a Clean Water Act Section 401 certification. Under this section, the state or regional Division of Environmental Protection is responsible for reviewing and certifying that activities comply with water quality standards, and that the project will not have adverse water quality impacts. Stream restoration projects that benefit public resources are normally certified without difficulty.

Other federal agencies with land ownership or administrative responsibilities over the watershed, such as the Natural Resources Conservation Service, State Historic Preservation, or the U.S. Fish and Wildlife Service, may also have authority over permits and watershed projects.

**What about state and local government?**

State agencies also have authority to prevent and control sources of water pollution. In Nevada, the Division of Environmental Protection (NDEP) is the agency charged with issuing permits for activities that may result in water pollution. For example, if excavation equipment is used for construction, maintenance, or repair work within a river or stream channel, a “Rolling Stock Permit” must be issued by NDEP to ensure the equipment is clean before it enters the channel, there are no leaks of any sort, and a minimal amount of sediment may be washed downstream.

The State of Nevada also issues required permits for certain projects. Projects in which pollution might be washed off municipal and industrial sites by stormwater, for example, and construction that disturbs more than five acres, are permitted through the NDEP Bureau of Water Pollution Control. Permits are also required from the Division of State Lands for any work done in the Truckee, Carson, Colorado, and Virgin Rivers, and Lake Tahoe.
Additional permits may be required by your county or city. These might include special use permits, grading and excavation permits, or dust control plans. Regulations may also establish a “no touch zone” adjacent to streams. Check with your local governmental agencies to see if permits are required for your project.

**How can I work with others to put the information I’ve collected about my watershed to better use?**

First, you’ll need to determine what you hope to accomplish with your information. Is your stream healthy? Are there specific land uses or problems that can be remedied? Does the upper watershed need protection? Is the water quality impaired? Is floodplain access limited or likely to become limited by development?

Next, determine what ordinances or other standards are currently in place that may apply to your stream and watershed. These regulations serve as “rules” governing water quality protection, stream protection, and land uses. There are many different layers of regulations at many different levels, from local to federal. Individual landowners make small-scale land use decisions that affect streams on a daily basis. To balance individual property rights with the rights of the public trust, local, state, and federal laws or regulations are established.

**How can federal, state, and local government help?**

The federal level provides the broadest direction. Federal agencies enforce broad national laws and policies adopted by Congress, such as the Clean Water Act. These federal-level agencies then usually work with state governments and agencies to develop specific state laws that address the federal standards.

At the state level, legislatures pass state laws intended to set minimum standards for local governments to follow. Legislators must consider many factors in making their decisions, including:

- federal laws and guidelines passed by Congress at the national level
- recommendations provided by state agencies
- input from lobbyists and constituents

State legislatures also allocate money to state agencies to enforce state laws, and may provide money to local governments for meeting state standards. For example, Nevada Revised Statutes 532.230 provides funding for channel clearance, maintenance, restoration, surveying, and monumenting. The funds are available to local governments for projects. State and federal agencies also make rules on policy to implement the laws.

At the local level, governments must meet or exceed state and federal standards and must provide information on the “rules” of law to the public. A variety of local agencies are involved in land use planning. Local planning commissions usually make recommendations on broad land use and water resource policies to city, town, county, and regional councils or commissions. Members of planning commissions are often appointed by councils or other local legislative bodies, and may not have any experience in the science of planning.

On the other hand, local commissioners, whether county or city, are generally elected by the public. They may or may not have experience in land and water resource issues. The commissions or city councils make decisions on local codes, ordinances, laws, and regulations. The decisions take into consideration the recommendations of the planning commission, but may be opposite of planning commission decisions. Commissioners or councilpersons also develop budgets and may provide revenues for enforcing established laws.

**How can I help local government?**

Local-level decisions are made through a public hearing process that will be noticed throughout the community. This public process is your opportunity to take part and be heard. After all – those who show up, make decisions. A careful watershed analysis presented to local elected and appointed officials during public hearings can be an effective way to influence your local laws and policies. Government personnel making decisions about watersheds, streams, and wetlands have variable backgrounds and experience, especially at the local level. Contributing your knowledge may be necessary for proper application of these principles.
You can get involved by learning if rules on the books are currently enforced, examining if the current rules or projects follow sound principles of stream function, and helping to change or amend those rules that are not helpful. Citizen comments are valuable to local officials, who often only hear from those subject to the regulations, and not the public as a whole. We all need clean water, and we all need to make public officials accountable for their actions and money allocation decisions.

GLOSSARY

100-year flood - The size flood that has only a 1 percent chance of being exceeded in any given year at that location.
Aggradation – The process of building up stream channels and floodplains by the deposition of sediment.
Bank armoring – The use of coarse, erosion-resistant materials such as rocks or concrete, to line a bank for erosion control.
Coarse woody debris - Logs, branches, or tree limbs that have or could become part of the fabric of a channel, causing water to mix and slow in velocity.
Degradation – The process of a stream cutting deeper into the streambed.
Deposition – The process by which eroded sediment settles out of the water column onto the floodplain or the stream bed or banks.
Dredge – To mechanically remove accumulations of sediment or other materials from within a stream channel, often for the purpose of channelization.
Engineering – Designing or creating a designed structure. In streams, engineering often creates a new form, different from what was natural or pre-existing.
Ephemeral Stream – A stream that flows only in response to storm events, not from groundwater discharge.
Erosion – The wearing away, detachment and movement of soil and other materials through natural and/or unnatural causes.
Floodplain – 1. The flat area adjacent to a river or stream that is formed by the stream or river. 2. The area flooded by an event of some specific return frequency.
Flood insurance – An insurance program often required for those living in the path of 100-year floods.
Gully – A channel that has downcut so that water no longer floods over adjacent lands except perhaps in very rare and big floods.
Headcut – A place where water in a channel falls over the edge of an erosion-resistant material and onto material that is so erodible that the location of the falls moves, or cuts, headward up the channel.
Headgate – A structure designed to divert a measured amount of water from a channel.
Herbicide – A chemical used to kill or damage vegetation.
Incision – Process of the channel cutting into the bed of the valley.
Levee – A berm or wall that keeps a stream away from some portion of its floodplain when the stream flow exceeds channel capacity.
Livestock – Cows, horses, sheep, goats, llamas, or other large animals that are kept for pleasure or economic gain.
Meander – An S-shaped curve or bend in a stream. Meanders help reduce the velocity of water in a stream by decreasing slope, or fall per unit distance.
Natural restoration – The reformation of natural features through natural processes such as erosion, deposition, and revegetation.
Natural tendencies – Changes that occur within natural channels or ones recovering on their own from disturbance.
Pesticide – A chemical used to kill or damage pests of any kind. An herbicide is one type of pesticide.
Piecemeal engineering – Engineering that does not consider off-site effects and is not part of an integrated plan.
Perennial stream – A stream that flows year-round.

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**Riparian vegetation** – Vegetation that has adapted to the moisture conditions adjacent to a stream.

**Riprap** – Stones or some energy-absorbing engineered material used to stabilize a stream bank or channel by blanketing its surface.

**Roughness** – A feature that mixes water and slows its average velocity or dissipates energy.

**Sediment detention basin** – A pond that allows water to stand relatively still while sediment settles out.

**Stream power** – The ability of a stream to transport particles out of the watershed. This depends on stream slope and discharge.

**Water quality standards** – Specific numerical or narrative limits placed on the concentration of various constituents in water, or on other physical or biological characteristics of aquatic systems. The standards are based upon the beneficial use of the water.

**Watershed** – An area of land that collects rain and/or snowmelt and discharges much of it to a stream, river, or other water body, or to groundwater.

**Watershed condition** – The ability of a watershed to capture, store, and safely release water to a stream.

**Wetland** – An area of land that is saturated at least part of the year by water. Wetlands are delineated with specific criteria related to their hydrology, soils, and vegetation.

**Wildlife habitat** – The place in the landscape where wildlife are supported because of specific characteristics such as the type and structure of vegetation, food, water, etc. For example, riparian wildlife habitat is favored by certain birds due to the presence of willows.

**Willows** – Shrubs or trees of the genus Salix. They are known for their water-loving habit, and their common long, pointed, and narrow leaf shape, and unique but not showy flowers.
Chapter 6:

NATURE’S FILTERS: DESIGNING A VEGETATED RIPARIAN BUFFER

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Chapter 6: 

NATURE’S FILTERS: DESIGNING A VEGETATED RIPARIAN BUFFER

A riparian buffer is an area of land next to streams, lakes, ponds, and wetlands in which permanent perennial vegetation, including grasses, shrubs, and/or trees, is maintained. Buffers enhance and protect water resources from the many adverse impacts of land uses. Because soil adjacent to waterbodies has abundant seasonal or year-round moisture, many species of plants grow in these areas that might not survive in other locations.

How does a riparian buffer work?

Runoff can carry sediment and organic matter, plant nutrients, and pesticides that are either bound to the sediment or dissolved in the water. When a riparian buffer works properly, it spreads runoff in the form of shallow, uniform flow through the buffer vegetation. This lets water soak into the ground and sediments with nutrients deposit within the buffer area. Because the pollutants are kept onsite, water quality improves.

What are the benefits of a riparian buffer?

Riparian buffers provide many water quality benefits. They filter sediment from runoff before it enters rivers, streams, and lakes. Particulate wastes, pathogens, and sediment-attached contaminants such as phosphorus and ammonia are filtered along with the sediment. Tall tree or shrub canopies help shade and shelter the water surface, keeping water temperatures more even and cooler. The plants in the buffer take up nutrients and sometimes metals and other pollutants. Since no fertilizers, pesticides, or animal wastes should be applied in the buffer zone, runoff through the buffer tends to improve in quality, rather than increase in pollutants. By excluding or carefully managing grazing, direct inputs of bacteria, nutrients, and organic matter in the form of livestock manure can be avoided or reduced.

The stream on the left is well-buffered and provides shade to cool water temperatures. The stream on the right lacks vegetation and protection from disturbance.
Vegetation also helps protect stream banks from erosion. The plant stems blunt the erosive force of flowing water, while the roots help hold soil in place. Plants that have fibrous root systems, such as grasses, knit the soil particles together and provide streambank protection.

Riparian buffers also provide a storage area for floodwaters. During high flow events and floods, the riparian buffer acts as a sponge, soaking up and storing water for slow release to maintain streamflow during drier periods.

Plants provide shade, food, and shelter for wildlife. Bare, unshaded, sediment-laden channels are poor habitat for fish and other aquatic organisms. Buffers also preserve open space and aesthetic surroundings for recreation and outdoor education.

**What’s the best width for a riparian buffer?**

Scientists use many methods to try to calculate the minimum or optimal width for a stream corridor. Some methods use existing data on belt meander width (the distance across the S-shaped curve of a channel) and apply equations. Others use measurements from aerial photos of stream patterns. Still others consider the size of buffer needed for wildlife. Most studies have been site-specific and designed to achieve a particular goal, such as nutrient or sediment uptake to improve water quality. Buffer widths relative to nutrient and sediment removal range from 50 feet to 500 feet, depending on the sensitivity of the water resource and the land use associated with it. There is no “right” answer, but generally it is possible to determine a minimum width necessary to achieve at least your most important objectives. Whenever possible, set aside more than the minimum to compound your benefits. Also, streams may move, and buffers than need extra room for all their benefits to be realized.

Many factors affect the width of buffer strips. Highly erosive soils may require wider buffer strips to provide adequate protection. Steeper slopes also affect buffer widths, since water flows faster on steeper slopes, decreasing the time for infiltration, and increasing erosion. The most effective buffers have minimal slope.

Before determining the width appropriate for your situation, check with your county planning department. There may be regulations governing a “no touch” zone adjacent to streams, as well as special restrictions on development. If no regulations exist, factors such as variations in soil types, hydrology, vegetation, slope, wetlands, floodplains, landforms, buildings, and land use will help you determine site-specific buffer widths. These widths commonly vary from 30 to 250 or more feet on each side of the stream.

**Should buffer strips be continuous, or are small islands sufficient?**

Islands of buffers, while better than no riparian buffer at all, are limited in their ability to address the benefits outlined above. Failure of riparian systems to treat water quality often results from channelized or concentrated flow. Areas void of riparian vegetation often act to concentrate and channel flows, resulting in more erosion and decreased water quality.

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**Water Quality Benefits of a Buffer**

- Streambank erosion control and bank stabilization
- Sediment filtration
- Nutrient uptake
- Shading of water surfaces, producing cooler water temperatures

**Scientists measure streams to determine appropriate buffer widths.**

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What activities are appropriate within a buffer strip?

In order for a riparian buffer to function properly, disturbances to vegetation should be minimized. It is tempting to want to manage a riparian buffer as a backyard “landscape feature.” Practices that may be appropriate in a backyard, however, are not appropriate in a riparian buffer. Avoid mowing and dumping vegetation, fertilizing, applying pesticides, digging, or otherwise disturbing the soil and vegetation. Remember, your goal is to maximize plant cover to slow flowing water and absorb or detain pollutants. This provides you and your neighbors with a measure of physical safety during floods, and improved water quality at all times.

Historically, riparian areas in the western United States have served as livestock grazing lands and water sources. While some riparian areas can tolerate carefully managed periods of grazing, it is often difficult to manage grazing while preserving all the functions of the riparian buffer.

Unfortunately, grazing in large pastures adjacent to streams generally results in a reduction or even virtual removal of riparian vegetation. During summer months, as upland range grasses dry out or get eaten, livestock search the riparian area for both green forage and water. Grazing is not limited to grasses. Livestock also feed on trees and brush, interfering with natural regeneration. Trampling compacts soil, disturbs plant roots, kills young plants, and may accelerate streambank erosion. Animals deposit urine and manure directly into the stream, resulting in nutrient and microbial pollution.

The absence of vegetation due to grazing sacrifices water quality benefits, the capture, storage, and safe release of flood waters, and the quality of the habitat for fisheries and wildlife. For this reason, grazing within the buffer area is not desirable, and if practiced, must be carefully managed.

Recreational activities such as bird watching and fishing may be appropriate within buffers, as long as impacts to vegetation and wildlife are minimized. Avoid soil compaction and vegetation removal. Whenever possible, keep these activities out of a primary “no touch” zone adjacent to the water.

How are buffer strips installed, if not already present?

The first step in any planting project is to assess the site. Make a map of the site and determine the goals. Is it essential to have a view through the buffer, or is it preferable to have a solid screen? Will the public have access to the buffer? Will wildlife or fish habitat be created or enhanced? This is the time to seek expert design assistance from fluvial geomorphologists, soils specialists, botanists, fish and wildlife managers, and others. Start by contacting your local Cooperative Extension office or the Natural Resources Conservation Service for advice.

Next, inventory your existing plant materials to determine those that serve a useful function in the buffer. Avoid disturbance to the existing vegetation whenever possible. Grading a riparian area and starting anew is rarely the best technique for protecting water quality! Likewise, if pathways are to be included in the buffer zone, construct them in such a way that flow through the buffer does not become channelized.
Once you’ve decided what vegetation will be protected or salvaged, determine and map existing and desired plant locations based on their mature size. High-functioning riparian buffers often incorporate many different species of vegetation so many of the benefits listed above can be achieved. However, not all buffers will incorporate a large variety of plant materials, depending on the potential of the site. Grasses are useful for spreading water, slowing velocities, and promoting infiltration of water. A mixture of shrubs, trees and other smaller vegetation may also provide an effective buffer, while adding the benefits of providing shade and lowering water temperatures.

Careful site preparation is essential to success. Inventory all noxious weeds on or near the site, and develop a management plan using the principles of integrated weed management (see Chapter 1). Implement a long-term control plan before planting desirable vegetation to avoid competition from weeds.

In some cases, it will be necessary to provide supplementary irrigation during the establishment phase. Include the design and installation of irrigation systems in the planning process. See Chapter 7 for information on designing a drip irrigation system and Chapter 8 for information on designing a sprinkler irrigation system.

During the site preparation phase, determine the appropriate time to plant the specific plant material. Some plantings must be done during the dormant season, such as pole plantings, and others may be done at any time of year if the ground is not frozen. Read Chapters 9 through 15 for information on plant materials, relative

---

**Characteristics of the Ideal Buffer Zone**

1. Dense vegetation is maintained at all times.
2. Flow is not channeled through the buffer zone; instead, it spreads and slows down.
3. Infiltration of runoff is high.
4. The buffer is protected from disturbances.
5. Annual inspections and frequent monitoring are used to maintain the buffer in good working order.

---

A successful buffer addresses the different streambank zones.

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“Clean Water – We Can Make a Difference”
What species of plants are suitable for buffer strips in your area?

Plants that are native to your area have the best chances of success, and are most likely to provide the habitat needs of local and migrating wildlife. Be aware, though, that native species can be difficult to re-establish in areas where weeds have invaded and compete for soil resources and light. Your local Cooperative Extension office, Natural Resources Conservation Service, or conservation district office can help you determine the most appropriate plant materials.

When choosing plants, consider the following factors:

♦ soil type
♦ proximity to water
♦ tolerance of or requirement for a high water table
♦ irrigation needs
♦ type of vegetation needed to stabilize the soil
♦ purpose of vegetation
♦ barriers to plant success, such as high levels of boron or other salts
♦ availability of local plant materials
♦ minimal fertilizer and maintenance needs

See the plant lists on page 45 of the Small Ranch Manual and at the end of this chapter for information on suitable plants.

How can I be sure that my buffer strip won’t be destroyed by changes in land use in the future?

Your investment in a riparian buffer strip is valuable and should be protected from future damage. There are several approaches that can be used to ensure future development will not

♦ Exclude excess or improper grazing and other disturbances to the buffer. Add fences if necessary, and alternate water sources for livestock.
♦ Avoid fertilizers, pesticides, etc. Instead, plant species with low fertilizer needs that will outcompete undesirable species.
♦ Replace plant stock that dies. Determine the reason for failure and make adjustments as needed.
♦ Control noxious weed species and other undesirable competitors.
♦ Protect tree and shrub plantings from wildlife predation when necessary. Wire fencing may be needed to protect trees from beavers.
♦ Prune willows and trees if needed for aesthetics.
♦ Repair and replant gullies that appear, as appropriate. The goal is to spread out runoff so the buffer has a chance to trap sediments and increase infiltration into the soil and groundwater.
♦ Consider adding signs to inform nearby landowners and others of the buffer zone’s status and restrictions.

This buffer was built by nature over time and should be protected from disturbance.
affect the buffer strip.

First, protect the buffer by ensuring it is shown on local and regional maps of the area. Attempt to have local Planning Boards and Conservation Commissions show the buffer zones on their maps and in specific area plans. This should help prevent future encroachment from new developments and also helps emphasize the importance of buffers to other agencies.

Another approach is to donate or sell the land to a land trust. These organizations acquire land to preserve it as open space. Alternatively, your community may have an open space program to which the land can be donated. It may also be possible to convert the land into a local park.

What is a conservation easement?

Should you prefer to maintain ownership of the land, you might consider a voluntary agreement called a conservation easement. The landowner voluntarily agrees to donate the development rights on their land to a qualified public agency such as a town, county, or state agency, or to a qualified nonprofit organization. The landowner retains the title to the land and may choose to restrict public access, or to sell, give, rent, or transfer the property as desired. The landowner decides what restrictions to place on the easement. Only the specific use rights that are donated are removed from the property. The recipient of the easement is responsible for monitoring and enforcing the easement.

Because a conservation easement is a legal agreement, it’s important to retain the services of an attorney experienced in drafting conservation easements. The easement can permanently or temporarily limit development in all or part of the property. A “perpetual easement” lasts forever and continues forever should the land be sold.

A conservation easement can significantly reduce the donor’s federal and state income taxes, local property taxes, and their heir’s estate taxes. Under the Internal Revenue Service code, qualified conservation easement donations can be treated as charitable gifts, which may reduce the value of the donor’s taxable estate. Your tax assessment may not change if the land is not currently assessed as developed land. You’ll want to contact an accountant or tax attorney to help in determining what financial benefits might be available to you.

What other financial assistance is available?

If your land is in agricultural production, one opportunity to protect your riparian buffer and receive financial benefit is the Conservation Reserve Program (CRP). Working with the staff in your local Natural Resources Conservation Service (NRCS) or Conservation District office, you identify those buffer practices, in this case, riparian buffers, available under the continuous CRP sign-up that are most suitable for your land and meet your needs. You then submit an offer to your local Farm Service Agency office. That offer will be automatically accepted if all eligibility requirements are met.

To be eligible, you must have owned the land for the previous year. Marginal pasture that is suitable for use as a riparian buffer is eligible. Marginal pasture includes any land along streams or rivers that is grazed, whether previously seeded to grass or not. Grazing land is eligible if it is along or around perennial streams, seasonal streams, or other permanent bodies of water, including wetlands. The land must be suitable for a riparian buffer, and cannot have trees on it that already function as a riparian buffer. You must plant trees or shrubs, or both, in your buffer, and livestock must be excluded from the buffer if enrolled in the continuous CRP sign-up.

CRP has financial incentives that make conservation buffers economically attractive, in addition to being good common-sense practices. Annual rental payments are based on the relative productivity of the soil type being offered and the average dryland cash rental rate for comparable land in the county. A 20 percent incentive is added to the annual rental rate for riparian buffers. Cost-sharing is available to help you install the necessary fencing and develop sources of water outside the riparian buffer.
## Grasses Tolerant of Prolonged Wetness

<table>
<thead>
<tr>
<th>Grasses</th>
<th>Recommended varieties</th>
<th>Growth form</th>
<th>Salt and alkali tolerance</th>
<th>Seeding rate, pure live seed, lbs/acre</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkali sacaton <em>(Sporobolus airoides)</em></td>
<td>–</td>
<td>Bunch</td>
<td>High</td>
<td>4</td>
<td>Native; warm season; needs summer moisture; difficult to establish</td>
</tr>
<tr>
<td>Creeping meadow foxtail <em>(Alopecurus arundinaceus)</em></td>
<td>Garrison</td>
<td>Sod</td>
<td>Moderate</td>
<td>8</td>
<td>Good on streambanks and wet sites; excellent source of hay or forage</td>
</tr>
<tr>
<td>Inland saltgrass <em>(Distichlis stricta)</em></td>
<td>–</td>
<td>Sod</td>
<td>High</td>
<td>-</td>
<td>Native; establish by sprigging; needs irrigation for establishment</td>
</tr>
<tr>
<td>Reed canarygrass <em>(Phalaris arundinacea)</em></td>
<td>Rise</td>
<td>Sod</td>
<td>Moderate</td>
<td>10</td>
<td>Good on streambanks and wet sites; can be established by sprigging; tends to be weedy and invasive</td>
</tr>
<tr>
<td>Tall wheatgrass <em>(Agropyron elongatum)</em></td>
<td>Jose Alkar</td>
<td>Bunch</td>
<td>High</td>
<td>20</td>
<td>Coarse and tall; can be used as wind buffers; broad soil adaptation</td>
</tr>
<tr>
<td>Western wheatgrass <em>(Agropyron smithii)</em></td>
<td>Rosana Arriba</td>
<td>Sod</td>
<td>High</td>
<td>16</td>
<td>Native; makes good sod; prefers fine-textured soils</td>
</tr>
</tbody>
</table>

## Shrub Tolerant of Fluctuating Water Tables

<table>
<thead>
<tr>
<th>Deciduous Shrub</th>
<th>Approximate height (ft)</th>
<th>Growth rate</th>
<th>Longevity</th>
<th>Water requirements</th>
<th>Salt and alkali tolerance</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dogwood, redosier <em>(Cornus stolonifera)</em></td>
<td>15</td>
<td>Fast</td>
<td>Long</td>
<td>Moderate</td>
<td>Low</td>
<td>Native; hedges; wildlife; windbreaks; streambanks</td>
</tr>
<tr>
<td>Quailbush <em>(Atriplex lentiformis)</em></td>
<td>8</td>
<td>Fast</td>
<td>Moderate</td>
<td>Low</td>
<td>High</td>
<td>Native; erosion control; wildlife</td>
</tr>
<tr>
<td>Shrubby cinquefoil <em>(Potentilla fruticosa)</em></td>
<td>4</td>
<td>Fast</td>
<td>Long</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Native; erosion control; landscaping</td>
</tr>
<tr>
<td>Willow, many species <em>(Salix spp.)</em></td>
<td>2 – 15; tree-like species can be much</td>
<td>Fast</td>
<td>Moderate</td>
<td>High</td>
<td>Variable</td>
<td>Native; streambanks; wildlife; erosion control; plants growing in a similar site nearby will often sprout from early growth</td>
</tr>
</tbody>
</table>
### Trees Tolerant of Fluctuating Water Tables

<table>
<thead>
<tr>
<th>Trees</th>
<th>Approximate height (ft)</th>
<th>Growth rate</th>
<th>Longevity</th>
<th>Water requirements</th>
<th>Salt and alkali tolerance</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alder, many species (Alnus spp.)</td>
<td>25+</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
<td>Low</td>
<td>Thicket forming; good on stream banks</td>
</tr>
<tr>
<td>Cottonwood, many species (Populus spp.i)</td>
<td>70+</td>
<td>Fast</td>
<td>Moderate</td>
<td>High</td>
<td>Moderate</td>
<td>Fast growing native tree from pole plantings into wet soil; use male plants only to avoid allergy problems</td>
</tr>
<tr>
<td>Mulberry, fruitless (Morus alba)</td>
<td>35</td>
<td>Fast</td>
<td>Short</td>
<td>High</td>
<td>High</td>
<td>Shade and street tree; windbreaks</td>
</tr>
<tr>
<td>Poplar, many species (Populus spp.)</td>
<td>80</td>
<td>Fast</td>
<td>Short to moderate</td>
<td>High</td>
<td>Low to moderate</td>
<td>All poplars are subject to fungal diseases and have invasive roots; do not plant near septic systems; very fast-growing; used for windbreaks</td>
</tr>
<tr>
<td>Willow, many species (Salix spp.)</td>
<td>40+</td>
<td>Fast</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Can be ornamental; plant near streambanks</td>
</tr>
</tbody>
</table>

Many options are available to protect land and water quality.

Donate or sell the land to a land trust for open space? Convert the land to a local park? Maintain ownership? Engage in a conservation easement?

“Clean Water – We Can Make a Difference”
Chapter 7:
PUTTING WATER WHERE IT IS NEEDED: THE INS AND OUTS OF DRIP IRRIGATION

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PUTTING WATER WHERE IT IS NEEDED:
THE INS AND OUTS OF DRIP IRRIGATION

Drip irrigation was pioneered in Israel many years ago in an effort to grow crops in desert areas with limited water supplies. Now this method of irrigation is used throughout the United States to water row crops, vineyards, orchards and greenhouses. In addition, drip irrigation has found a firm place in the landscape industry for watering ornamental plants and conservation plantings.

Drip irrigation is a method of watering in which water is applied slowly to the root zone of a plant. Water is delivered at low pressure through a tube to a small device called an “emitter” which releases water over an extended time period. This watering avoids waste and guards against runoff and soil erosion.

Why should I use drip irrigation?

Drip systems offer many advantages over irrigation systems that use sprinklers, bubblers and hose-end watering devices. Below, you’ll find a list of the benefits and disadvantages of using a drip system. Once installed, drip systems can provide careful application of water to the root zone of the plant, where it will be immediately available to the plant.

What are the main components of a drip system?

The basic components of a system include tubing, most often made of black polyethylene, served from main lines of buried PVC pipe. Water is delivered through emitters that have small openings to deliver water at specific low rates. Other fittings include mini-sprayers, mini-

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow application of water to the soil and roots with little waste</td>
<td>Requires periodic checking to make sure system is functioning properly</td>
</tr>
<tr>
<td>Lower pumping costs and reduced energy needs</td>
<td>Prone to rodent damage</td>
</tr>
<tr>
<td>Water large areas with a small amount of water</td>
<td>Dirt can clog emitters</td>
</tr>
<tr>
<td>Low water pressure requirements</td>
<td>Emitters may be difficult to locate during inspections</td>
</tr>
<tr>
<td>Reduced runoff and pollution of lakes and streams</td>
<td>Weeds may grow near the base of the plants</td>
</tr>
<tr>
<td>Reduced weed growth overall</td>
<td>Decreased humidity around plants</td>
</tr>
<tr>
<td>Accurate spot watering of plants</td>
<td>May restrict root development if not installed properly</td>
</tr>
<tr>
<td>Flexible design uses, including pots, ornamentals, trees, and shrubs</td>
<td>Requires occasional modifications</td>
</tr>
<tr>
<td>Can be used to distribute fertilizer</td>
<td>Initial cost is more than some systems</td>
</tr>
<tr>
<td>Saves time and labor once system is installed</td>
<td>Requires more maintenance than hose-end systems</td>
</tr>
<tr>
<td>Uses low flow rates</td>
<td></td>
</tr>
<tr>
<td>Provides better water distribution on slopes</td>
<td></td>
</tr>
<tr>
<td>Less prone to vandalism</td>
<td></td>
</tr>
<tr>
<td>Water applications are uniform if system is designed and installed correctly</td>
<td></td>
</tr>
</tbody>
</table>

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“Clean Water – We Can Make a Difference”
sprinklers, and soaker tubing. Valves are used to turn the water on and off, and filters remove particles from the incoming water to help avoid clogged emitters. Backflow preventers prevent backsiphoning of contaminants into the supply line. Pressure compensating regulators or emitters are available to maintain correct pressure and flow rates on slopes.

The system can be connected to your main water line or to a hose bib. Because many household lines operate at higher pressures, most drip irrigation systems need a pressure regulator installed between the filter and the main drip line to keep pressures between 20 and 30 pounds per square inch (PSI). A good filter is also recommended to prevent the emitters from clogging, particularly if your water supply is from a well.

What are the different types of drip systems?

The most common drip systems include:

1. Emitters with tubing
2. In-line tubing and pressure-compensating emitters
3. Sweat tubing or porous hose
4. Misters or low volume sprinklers

Emitters with tubing

In these systems, tubing delivers water to the emitter, which then delivers water to the individual plant, as shown at the right. Installation is relatively easy and inexpensive. Drip tubing is manufactured in ½- to ¾-inch diameters. The tubing size depends on the application. For example, ½-inch tubing easily services residential landscapes of less than a third acre. Large landscape projects or commercial projects use ¾-inch tubing. The tubing is usually buried in shallow trenches or laid on top of the soil and covered with mulch after the emitters are in place. Burying the tubing secures it and reduces the potential for damage, but also makes it more difficult to find and repair. Typically, one hundred feet of drip tubing costs $7 to $10, and emitters $0.25 to $1.50 each, depending on the size and supplier.

Fittings such as 90-degree elbows and “T’s” are installed by slipping the tube into the fitting. Because of their design, and since the water pressure is low, the fittings stay in place without glue.

Emitters come in different shapes and sizes and are rated according to operating pressure in pound per square inch (PSI). Emitters are designed to handle low water pressures, i.e. 10, 15, and 20 PSI. Manufacturers color code them according to the amount of water they emit, from ½ to 5 gallons per hour (GPH). Each color indicates a single delivery rate. Typically the smaller the GPH, the smaller the opening, making them more vulnerable to clogging.

Emitters are barbed at one end and are installed by punching a pilot hole in the tube for the emitter. To permit the correct fit for the emitter and eliminate leakage, always use a hole punch specifically designed for drip tubing.

Drip irrigation requires maintenance. During the growing season, monthly inspections of the emitters as well as the soil will ensure the emitters are working and plants are receiving adequate amounts of moisture.

In-line tubing and pressure-compensating emitters

In-line emitters are pre-installed in ¼ inch drip tubing, avoiding the need to punch holes and install the emitters. Emitters are spaced at regular intervals (e.g., one every 12, 18, 24 or 36 inches) to accommodate different planting spaces, and are designed to reduce the chance of clogging. In-line emitters provide slow, constant flow to the root zones of individual plants.

“Clean Water – We Can Make a Difference”
TIE INTO WATER SOURCE: MANUAL FROM FAUCET OR SOLENOID VALVE

PRESSURE REGULATOR TO COMPENSATE FOR SLOPE

EMITTERS WITH 2 OR MORE DISTRIBUTION TUBES PER PLANT

END CAP OR SELF DRAIN

½-INCH FLEXIBLE PVC TUBING

TRUNK

½-INCH PVC TUBING

EMITTER PLACEMENT USING 3 FLEXIBLE DISTRIBUTION TUBES PER TREE. AVOID PLACING THE TUBES AGAINST THE TRUNK.

Elements of a drip system
emitters are often used in vegetable gardens where spacing is critical, or placed in rings around perennials such as trees and shrubs. They cost more than a conventional tube and emitter system.

Pressure compensating in-line emitters (PCE) (shown above) differ significantly from non-compensating emitters. PCEs have a diaphragm while the others do not. PCEs compensate for variations in pressure due to elevation changes up to 20 feet and provide a steady rate of water flow to the plants while operating under low water pressures fluctuating from 7 to 25 PSI. These emitters are used if your system is on sloping ground with more than a 5-foot elevation change, if your lateral lines are longer than 200 feet, or if the emitters on the line deliver more than 100 GPH. In-line pressure compensating units are also available when regular emitters are used on slopes or runs are long. This may be less expensive than purchasing a complete PCE system.

Although this type of system has advantages over tube and emitter systems, it is not recommended for plants placed far apart because the emitters are pre-installed and spacing cannot be changed. Line layout can also be a problem because the pre-installed emitters tend to make the delivery tube less flexible.

One advantage of both these types of in-line emitters is that they are self-flushing and thus clog less frequently than regular punched-in emitters. Other benefits include easy installation and reduced chance of leaking. Pressure compensating in-line emitters also ensure even distribution of water under fluctuating water pressure and on hilly areas.

Before purchasing one of these systems, contact your local irrigation supply company or hardware store and ask about longevity of the system under local conditions, methods of proper care, and availability of spare parts. Doing so will help you decide if this is the right system for you.

Sweat tubing or porous hose

Sweat tubing or porous hose, also called soaker hose (shown below), is made from used tires or new tire trimmings mixed with polyethylene. The hose waters slowly by weeping moisture into the soil. Since there are thousands of holes, the soil becomes moist beneath the entire length of the hose.
One disadvantage of porous hose systems is that fittings may leak or come apart at high water pressure. To eliminate difficulties associated with high water pressure, install a pressure regulator and adjust it to 10 pounds per square inch (PSI). Also, because the pores are very small, install a 200-mesh filter or “Y” filter to prevent the hose from clogging.

The benefits of using a porous hose are its durability, availability, and ease of installation. It can also be buried and is self-draining to protect it from freezing. These systems are useful for vegetable and flower plantings that are replaced each year.

There are drawbacks to porous hose, however. If left uncovered, a 5/8-inch hose can be unattractive, as are the metal hose clamps used for insert fittings. Also, if unchlorinated water (e.g., well or ditch water) is used and tubing is left above ground, algae can grow inside and clog the internal pores. Gophers have also been known to chew through hoses. Lastly, and most importantly, flow rates can vary considerably from the beginning to the end of the line, resulting in dry spots or unevenly wetted soil. For this reason, the effective length of a soaker hose is limited.

Soil texture can also limit the effectiveness of drip systems. If the soil is sandy, water will tend to move down, rather than horizontally, requiring closer spacing. See Chapter 2 for an explanation of wetting and soil moisture profiles.

When are low volume misters appropriate?

Misters or low-volume sprinklers (shown above) are installed and operate in much the same way as punch-in emitters except they are used above ground. They are often used to water low-growing groundcovers, bedding plants, and potted annuals or used in conjunction with an in-line system to germinate seeds.

Their spray patterns, like pop-up lawn sprinklers, range from a 45-degree angle to a full circle. However, their spray pattern (radius) is much smaller than lawn sprinklers, but covers a greater distance than an emitter system.

Low volume mister systems cover a larger area, producing a larger and healthier plant. The system also offers the homeowner more flexibility than tubes and emitters. Another advantage is that low volume misters can be adjusted easily whereas in-line and tube emitters cannot.

However, as larger areas become wet, more weeds are able to germinate. The system can be more easily broken than other systems, and the cost is greater. Additionally, more gallons of water per minute are needed to operate spray systems, and they require more fittings than conventional drip systems, including various “holders” to keep the mini-spray heads in place as well as couplers, tees, 90 degree barb elbows, and 1/8-inch to ¼-inch “spaghetti tubing. These additional fittings can increase the cost considerably.

What do I need to know before I design my system?

Begin designing your system by assessing the water pressure and availability, if you have a domestic well. Pressure in pounds per square inch (PSI) and water availability in gallons per minute (GPM) will determine the number of valves required to irrigate a specific area, the length of tubing, and the number of emitters that can be placed on a single line. Pressure can be measured using a simple pressure gauge, available at irrigation equipment or hardware stores. Measure
the pressure at an outside faucet. First open two faucets inside the house to simulate typical water use. Then open the outside faucet completely and record the pressure shown on the gauge.

You will need to know the size of the service line to calculate the gallons per minute (GPM) output. The simplest way to determine the size of the service line is to check the size stamped on the side of the water meter, if present. Once you have determined the size of the service line and the water pressure, use the table above to determine the GPM for your water-metered system.

If do not have a water meter, but you do have a well pump, it will have a capacity rating in gallons per minute that should be provided in your well pump documents. Alternatively, you can place a five-gallon container under an outdoor faucet, open the faucet completely, and measure the amount of time in seconds needed to fill the bucket. Repeat the test several times. Divide the capacity of the bucket in gallons by the largest amount of time in seconds to calculate gallons per second. Next, multiply the gallons per second by 60 to calculate delivery volume in gallons per minute, as shown in the example on the right. Please note that this method provides only the GPM available through the faucet, which may be less than the flow through the service line. This method is useful only for systems which will attach to the outdoor faucet.

Water use by the sprinkler system should not exceed 75 percent of the available water flow at the faucet or from the pump. This allows for fluctuations in indoor water use.

Next, read Chapter 12 of the Small Ranch Manual and make a landscape plan, noting the plants’ locations and where drip systems might be used. Make note of any obstacles between the water source and the part of your landscape to be serviced with the drip system, such as walkways or patios. Also determine any slopes that may limit the components that are used.

Your plants will have different watering requirements, both in terms of quantity and frequency. Group plants with similar water needs on separate drip systems, or use separate control valves for systems connected directly to the household water lines.

<table>
<thead>
<tr>
<th>SIZE WATER METER</th>
<th>SIZE SERVICE LINE</th>
<th>WATER PRESSURE (PSI)</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
<th>50</th>
<th>55</th>
<th>60</th>
<th>65</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/8”</td>
<td>½”</td>
<td>2.0</td>
<td>3.5</td>
<td>5.0</td>
<td>6.0</td>
<td>6.5</td>
<td>7.0</td>
<td>7.5</td>
<td>8.0</td>
<td></td>
</tr>
<tr>
<td>5/8”</td>
<td>¾”</td>
<td>3.5</td>
<td>5.0</td>
<td>7.0</td>
<td>8.0</td>
<td>8.5</td>
<td>9.5</td>
<td>10.0</td>
<td>11.0</td>
<td>11.5</td>
</tr>
<tr>
<td>¾”</td>
<td>¾”*</td>
<td>5.0</td>
<td>7.0</td>
<td>8.0</td>
<td>9.0</td>
<td>11.0</td>
<td>12.0</td>
<td>14.0</td>
<td>15.0</td>
<td></td>
</tr>
<tr>
<td>¾”</td>
<td>1”</td>
<td>7.5</td>
<td>10.0</td>
<td>11.5</td>
<td>13.5</td>
<td>15.0</td>
<td>16.0</td>
<td>17.5</td>
<td>18.5</td>
<td></td>
</tr>
<tr>
<td>1”</td>
<td>¾”</td>
<td>6.0</td>
<td>7.5</td>
<td>9.0</td>
<td>10.0</td>
<td>12.0</td>
<td>13.0</td>
<td>15.0</td>
<td>16.0</td>
<td></td>
</tr>
<tr>
<td>1”</td>
<td>1”*</td>
<td>9.0</td>
<td>12.0</td>
<td>13.5</td>
<td>17.0</td>
<td>19.0</td>
<td>20.0</td>
<td>21.0</td>
<td>21.0</td>
<td></td>
</tr>
</tbody>
</table>

*Use these values for service lines without water meters

Table provided by Lawn Genie

Sample Flow Calculation for Wells with No Water Meters

1. Bucket Size: 5 gallons
2. Time to Fill*: 25 seconds (maximum)
3. Gallons per Second: \( \frac{5}{25} = .2 \) Gallons per Second
4. Multiply Gallons per Second X 60 = 12 Gallons per Minute (GPM)

*Use the time measured for your system.
How are main lines installed?

In your design phase, you determined the number of separate systems needed. Lines may be buried 2 to 3 inches below the soil surface, or placed on the surface. Buried lines last longer, are less likely to be damaged, and avoid visual distraction. On the other hand, surface lines are easier to install, find, maintain, and repair. They can be disguised by placing a few inches of mulch over them.

How many emitters can I put on a line?

Theoretically, you can use up to 225 one-gallon-per-hour emitters for each 300 feet of tubing and still have the system function properly. This will vary by manufacturer and site requirements. Since emitters are available in ½ to 5-gallon-per-hour rates, any combination can be used as long as the maximum gallons-per-hour rate is not exceeded. When the limit is exceeded, the flow rate will vary and your system may not deliver water evenly.

Where should emitters be located relative to the individual plants?

Tube systems should be laid out so that emitters can be evenly spaced around and on top of the root ball of newly planted trees and shrubs. Place enough emitters to wet the entire rootball and surrounding soil. This helps leach away damaging salts that can accumulate near roots. (See illustration on the next page.) Wetting the surrounding area allows roots to grow into adjoining soil, providing an extensive root system, which produces a healthier plant. As the tree or shrub grows, increase the number of emitters and enlarge the circle, or add a second circle.

Living in the arid west, soluble salts are common in our soils. When drip systems are installed, salt accumulates where evaporation and drying occurs—at the perimeter of wetted areas. At high concentrations, these salts can damage the roots of many plants. To protect them and reduce salt build-up, place emitters so the wetted areas overlap. Salts will then build up only beyond the plant roots where they will leach down below the root zone.

Most contractors or landscape designers will run a line of drip tubing along a planted path of trees and punch-in emitters near the rootball of trees, leaving enough room to accommodate tree root growth for at least five years. Spaghetti tubing may be used to run the water back to the rootball for young or newly planted trees or shrubs. However, a loop system works best. This allows for the installation of additional emitters as the plant matures. Misters can also be used in this case.

How do I install my drip irrigation system?

Drip systems range from simple to complicated, depending on landscape needs. The description below is provided as an overview to the process. When you’re ready to install your system, check with local irrigation suppliers or landscape maintenance businesses to ensure your system is properly designed for your needs.

First, collect the components you’ll need, including tubing, filter, pressure regulator, emitters, sprayers, or porous hose, valves, and PVC pipe. If you have a well, it’s especially important to add a back-flow preventer to protect your domestic water supply from possible contamination.

If the drip system will be connected into the main water line, install a shutoff valve between the water line and your drip system to allow you to shut off the irrigation system without affecting your other water uses. Wrap any threaded connections with teflon® tape before attaching them, and hand-tighten any plastic fittings. The arrows on the valves, filter, and pressure regulators must point in the direction of water flow.

Next, connect the tubing to the valve assembly and lay out the main distribution lines. If you follow walls or edges of patios and paths, the lines will be easier to find, and will be protected from disturbance. Once the tubing is in place, lateral or side lines can be attached with tee and elbow fittings. At this point, run water through the tubing to flush out any debris.

Now you’re ready to install the drip emitters. Using a hole punch, push to make a hole in the side of the tubing. Insert the emitter, and continue
down the line. A final flush of the line after the emitters are in place will clear out any plastic shavings or other debris. Then, close off the ends of the tubing.

To verify that you’ve placed enough emitters in the correct locations, run the system for a normal cycle. After waiting a few hours, dig into the soil in several places to check for the spread of water. If coverage is not adequate, add or move emitters.

How much water should I apply to my plants?

Because there are thousands of varieties of landscape plants, it is difficult to predict how much water each plant needs. While it would be convenient to have a chart giving us the amount of water each plant needs over its lifetime, there is none. There are complicated formulas available to calculate water needs based on soil conditions, local climate, and water loss through plant leaves.
and the soil, also known as evapotranspiration (ET).

For the homeowner, the best way to determine water needs is to monitor soil moisture. A foot-long screwdriver can provide a rough estimate of soil moisture. Push the screwdriver into the soil. If the soil is moist, it will insert easily; in dry soil, it will be difficult to push in the screwdriver. There are a variety of soil probes and moisture sensors (tensiometers) that can provide more accurate estimates of soil moisture. Use the readings to determine if you have watered enough, and when it is time to water again. If the top inch or two of soil is dry, it’s time to water. Overwatering is as bad as underwatering—avoid both.

**How do I keep my system functioning properly?**

Routine maintenance is the key to an effective drip system. Each growing season, when the system is activated, check each emitter to make sure water is dripping as designed. Locate and repair any breaks in the tubing. To avoid frost damage, completely drain the system in the fall prior to regular freezes. Contact your local Cooperative Extension office or your irrigation supplier for the appropriate instructions for your system.

As your plants grow, you’ll need to add emitters to deliver water to the spreading root systems. Check on a yearly basis to make sure your system is still providing an adequate supply of water.

### Estimating the Number of Emitters

<table>
<thead>
<tr>
<th>Plant type</th>
<th>Soil type</th>
<th>Number of emitters needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low shrubs (1-gallon containers)</td>
<td>Sandy Loam Clay</td>
<td>One 2-gph emitter next to plant, One 1-gph emitter next to plant, One ½-gph emitter next to plant</td>
</tr>
<tr>
<td>Medium to large shrubs (3- to 5-gallon containers)</td>
<td>Sand Loam Clay</td>
<td>Two or three 2-gph emitters placed evenly around plant, Two or three 1-gph emitters placed evenly around plant, Two or three 1/2-gph emitters placed evenly around plant</td>
</tr>
<tr>
<td>Small trees (6- to 8-foot wide canopy or 15 gallon-containers)</td>
<td>Sand Loam Clay</td>
<td>Three to six 1-gph emitters or two or three 2-gph emitters, installed on a loop or on two lines set on opposite sides of trunk, Two to four 1-gph emitters, installed as above, Two to four ½-gph emitters, installed as above</td>
</tr>
<tr>
<td>Larger trees (10- to 15-foot diameter or 24-inch boxes)</td>
<td>Sand Loam Clay</td>
<td>Six to ten 2-gph emitters, installed on a loop or on two lines set on opposite sides of trunk, Six to ten 1-gph emitters (or other combination giving the same amount of water), installed as above, Six to ten ½-gph emitters, installed as above</td>
</tr>
<tr>
<td>Flowerbeds or vegetables</td>
<td>Sand Loam Clay</td>
<td>Several 2-gph emitters spaced about a foot apart in a row, Several 1-gph emitters spaced about 1 ½ feet apart in a row, Several ½-gph emitters spaced about 1 ½ feet apart in a row</td>
</tr>
</tbody>
</table>
Chapter 8:

MIMIC MOTHER NATURE:
DESIGN, INSTALL, AND MAINTAIN AN EFFICIENT SPRINKLER SYSTEM

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Chapter 8:

MIMIC MOTHER NATURE:
DESIGN, INSTALL, AND MAINTAIN AN EFFICIENT SPRINKLER SYSTEM

Installing an automated underground sprinkler system provides you with freedom from hours of hand watering and hose dragging. It also puts you in control of how much water is used and how often it is applied. This allows the precise application of water when and where it is needed. Because the installation of a sprinkler system is labor intensive, proper planning to guarantee the finished product is trouble free and water efficient is important.

Why should I install a sprinkler system?

For most people, underground, automated sprinkler systems are labor-saving devices that provide the greatest ease of operation. While sprinkler systems are most often used to water lawns, they may also be used for pasture areas and shrub beds.

There are many advantages to sprinkler systems:

- Correctly installed and operated, a sprinkler system encourages a deep and healthy root system by distributing water uniformly throughout the soil profile.
- Precise water application prevents dry spots in the lawn that occur with hand-watering.
- Regular sprinkling reduces the threat of wildfire by keeping vegetation moist and healthy.
- Sprinkler systems, when properly operated, can eliminate runoff that would otherwise carry fertilizer and pesticides to lakes and streams.
- An automated system saves time and money, and ensures watering will occur, whether or not you’re home.
- Sprinkler systems increase the value of your property.

What are the basic parts of a sprinkler system?

There are a number of standard components that comprise a sprinkler system. Before you proceed, contact your local building department to determine if permits or specific system components are required.

Control valves

Control valves regulate the flow of water from your well or water source to the sprinkler heads. They operate circuits that allow you to provide water to groups of plants that have similar moisture needs. Because most homes do not have enough water pressure to provide for all indoor and outdoor water needs at the same time, separate valves are needed. By operating only one circuit at a time, you can avoid exceeding the maximum flow rate of your water supply.

Controllers allow you to automate your system, and can help conserve water by turning it on and off at specific programmed intervals. The controller activates the control valves for each circuit to water on specific days at given times, and for a given duration. This allows you to comply with watering restrictions without
These devices range in complexity from a single program, multiple station controller to a complex multi-program, multi-station instrument. Selecting a multiprogram controller allows you to schedule different watering frequencies and durations on different lines, taking into account the individual needs of your plants or lawn. First determine the water requirements of different types of landscaping. Then, establish a circuit for each. For example, the lawn will require a different watering program than established shrubs or trees. By placing each on a separate circuit with a separate program, you can closely tailor the watering schedule to the plant needs. If you plan to water trees using a controller, look for devices that allow you to program in hours, not just minutes, or ones in which cycles can be repeated several times a day. Either method will accomplish deep watering needed by trees.

Plan for the future needs of the landscape by purchasing a controller with more stations than needed currently. This allows you to add circuits in the future.

**Backflow preventers**

Backflow preventers are essential to prevent the reverse flow of water into your drinking water supply. There are several types. Atmospheric vacuum breakers (AVB) are installed between the valve and the sprinklers. When the circuit is turned on, water pushes up a small float in the AVB, allowing the water to flow out to the

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**Control valves operate circuits that allow you to provide water to groups of plants that have similar water needs. The diagram above shows an atmospheric vacuum breaker (AVB) installation. When using an above-ground unit, as shown, make sure to use an insulated box to avoid freeze damage. Alternatively, place the AVB 6 inches above the highest sprinkler head.**
sprinklers. When the controller closes the circuit valve stops the flow of water and the float falls back, blocking the supply line and sealing the line to prevent reverse flow. The AVB must be installed 6 inches above the highest sprinkler head so that water from the circuit cannot drain by gravity flow back to the AVB and out the vent, resulting in a puddle of water around the backflow preventer. Some valves are equipped with AVB.

Another type of backflow preventer is called a pressure vacuum breaker (PVB). It is installed in the line from the main water supply before any valves. Because it is installed before any valves, you only need a single PVB. It has one or two check valves to prevent reverse flow. Install the PVB at least 12 inches above the highest sprinkler head to prevent gravity backflow and puddling of water.

Rigid polyvinyl chloride (PVC) pipe

In the past, galvanized pipe was used for sprinkler systems. It was difficult to install and had a limited lifetime. Today, polyvinyl chloride (PVC) pipe is the material of choice for underground systems, because of its ease of installation and durability. PVC pipe is generally available in 10- or 20-foot lengths and is easily cut using a pipe cutter or a hacksaw. To connect different components, various PVC connectors are attached with a special glue and primer.

It’s important to ensure the pipe you select is adequate for the job. Use heavy-duty pipe where the water pressure is greatest, such as schedule 80, and use schedule 40 for laterals or lines that are under low pressure. The pipe diameter should be similar to the size of the house service line, or one size larger to reduce water friction loss. In most cases, this is either ¾-inch or 1-inch diameter.

PVC pipe fittings

A variety of fittings in different shapes are available to fit the needs of any system design. There are elbows, tees, connectors to galvanized pipe, and connectors for different pipe diameters. Some fittings screw together. Always use teflon® tape when connecting screw fittings to prevent leaks. Other fittings require the use of PVC primer and solvent cement for connection. Always use a primer before using the connecting cement. This removes the sheen on the PVC and allows a secure bond by the cement. Without primer, connections will leak.

Risers

Once underground pipe has been laid, vertical pipes called “risers” are needed for the sprinkler heads. These risers vary in length or can be cut to account for differing line depths and sprinkler head heights.

Use swing joints at the base of your risers. These fittings are soft plastic elbows that connect in series to reduce the threat of breakage at the joint between the underground line and the riser. Swing joints accommodate stress both in the horizontal and vertical directions and act like shock absorbers. They are necessary under lawn sprinkler heads to accommodate shock from mowers and to allow adjustment of the heads. They must be kept perfectly upright to work well.

Sprinkler heads

There are many sprinkler head spray patterns available, including full, half and quarter circles, and rectangular shapes, as well as various specialty heads. They vary in spray radius from 8 feet to 40 feet or more.

Pop-up sprinkler heads are commonly used in lawns. They produce a tight pattern and emit a constant flow of water in a short period of time. They are particularly useful when laying out a grid pattern for lawn irrigation. The pressure of the

“Clean Water – We Can Make a Difference”
water forces up the sprinkler head to elevate four to 15 inches during irrigation. After the water turns off, the core sinks back to ground level.

These heads can deliver water at a rate that exceeds the soil’s ability to absorb it, so they should be programmed for short watering durations. If there is still runoff, it may be necessary to use decreased rate sprinkler heads. In any case, when using different spray head patterns, make sure the delivery rates are identical. Use the same equipment throughout. Do not mix and match manufacturers’ sprinklers.

Pop-up spray heads are available in various heights to allow for different types of vegetation. Lawns require 4-inch pop-ups; select 6-inch pop-ups for low ground cover; and 12-inch pop-ups for taller ground cover, flower, or shrub beds.

Another familiar sprinkler is the rotary impact device. It is useful for watering larger areas, up to 40 feet or more. The water is thrown from the head in a moving stream, and the sprinkler must be adjusted for the appropriate coverage, from a sliver to a full circle. Because these are large volume heads, fewer sprinklers are needed. Generally speaking, the rate of application is low enough that runoff does not occur. In order to water efficiently and avoid dry spots, make sure each sprinkler is perfectly perpendicular to the slope of the land. Otherwise, the watering pattern will not be uniform.

Flood bubblers are different from pop-ups or any other fixed sprinklers. Bubblers are used to fill watering basins around trees and shrubs, and in planters. The flow is reduced, allowing water to soak into the soil. Bubblers should never be linked to the same irrigation line as a pop-up, since they apply more water than a pop-up and will reduce water pressure.

**How do I design my sprinkler system?**

Now that you’re familiar with the basic components of a sprinkler system, you’re ready to being designing your system. The first step requires that you draw a map of your property. Measure your lot and mark the locations of the house and other structures, walkways and driveways, existing landscaping, including trees, and where you will tap into the water system. Use graph paper for your diagram so that you can draw it to scale. For instance, each 1-inch square can represent 10, 20 or 30 feet. If there is any chance that you may have underground utility lines on your property, contact your utility company for line locations to map on your drawing. It may also be necessary to obtain a permit from your local building department to install an irrigation system.

**Calculating water pressure and supply**

Often, sprinkler systems fail for one simple reason: inadequate water pressure to the system. This can occur when water use in your area increases. It may also be a design flaw. To avoid this pitfall, you must determine the available pressure. In general, a minimum water pressure of 30 to 40 pounds per square inch (psi) is needed. Most systems operate best by design at 45 psi ± 10 psi.

A pressure gauge is used to measure system pressure. These gauges are available at irrigation equipment or hardware stores. Screw the pressure gauge onto an outside faucet to measure the pressure when no water is running indoors or...
outside. Open the faucet completely and then record the pressure in pounds per square inch (psi). This is called static pressure, since no water is moving. Repeat at each faucet location, taking several readings throughout the day, and then average the readings.

Of course, the pressure will drop when household water is in use or when friction slows the flow of water. To measure dynamic, or working, water pressure, again attach the water pressure gauge to an outdoor hose bib, but this time turn on two or three indoor faucets. Turn the outside water on full force and again take several readings. An average dynamic water pressure less than 20 psi will be insufficient to run a sprinkler system. In this case, a booster pump or larger water supply line may be needed to add extra pressure. If the water pressure is more than 80 psi, you’ll need to install a pressure reducer. Contact your local plumber if these problems exist.

As water flows through a pipe, the roughness of the pipe drags on the water and slows the flow rate, especially through long sections of pipe, or when water is travelling very rapidly. The longer or rougher the pipe, or the faster the flow, the greater the friction loss. This results in a decrease in water pressure. There are many friction loss charts available to help you determine the potential decreases in pressure due to friction losses.

In addition to dynamic pressure, you’ll also need to determine the available flow. If you have a well pump, it will have a capacity rating in gallons per minute (GPM) that should be provided in the owner’s manual of your pump. Alternatively, check with your well and pump dealer, or use pipe size and pressure to determine flow. Ask your irrigation or hardware supplier for a chart to help determine GPM from pipe size and pressure. Never exceed 75 percent of the available flow when designing your system.

**Drawing in the system**

Once you have drawn your site plan and determined your water system capacity, it’s time to plot the sprinkler system on your map. Remember that different areas of your landscape will have different water needs. Design separate sections for each. Also consider differences in soil texture and water holding capacity (see Chapter 2).

When drawing your design, take time to calculate the appropriate sprinkler head spacing. Because each sprinkler won’t deliver an absolutely even amount of water over the entire area it covers, plan for a minimum of 50 percent overlap.

**Sample Sprinkler Production Calculation**

Assume your home’s available water flow = 15 GPM. Never exceed 75 percent, or

\[ 15 \times 0.75 = 11.25 \text{ GPM} \]

If your diagram shows 14 sprinkler heads each with a capacity of 1.5 GPM, the water needed for the 14 sprinkler heads is

\[ 14 \times 1.5 = 21 \text{ GPM} \]

Since your maximum safe water use is 11.25 GPM, you will need to divide the sprinklers into 2 zones, each with seven sprinkler heads, for a total water use of

\[ 7 \times 1.5 = 10.5 \text{ GPM} \]
This is often called “head-to-head” coverage. Your goal is to provide uniform water distribution without wasting water. If the area you need to cover is smaller than 25 feet by 25 feet, use small to medium area sprinklers such as pop-ups. Each head will specify the radius, or distance from the head, of water coverage. If the areas are larger than 25 feet by 25 feet, choose medium to large area sprinklers, stream spray rotors, or impulse heads.

Draw in the sprinklers starting at the border where there should not be an overspray, such as a building or road. Space the heads evenly and build in the 50 percent overlap. Draw an arc the distance of the radius from the sprinkler head. For adequate coverage, the arc should pass through the

To determine the number of valves your system requires, overlay an irrigation plan on top of your landscape design.
center of adjacent sprinkler heads, or even a bit beyond. It’s especially important to allow for extra overlap in windy areas, where you should add 10 percent more for adequate coverage. Next, add up the capacity of each sprinkler head in GPM for a given circuit. You may have as many similar sprinklers on a circuit as you want, as long as the total water needed does not exceed 75 percent of your available water flow. If you do exceed 75 percent, divide the sprinkler heads into enough separate zones that you are within your water capacity, as shown in the example. If you are using different sprinkler head types, place them on separate circuits.

Now draw in your pipes and valves. You’ll need a different valve for each circuit. Valves are usually grouped together into a “valve manifold”. A typical manifold will have two to six valves, and is wired to a controller, which is simple to do. You may find it necessary to have one valve in the manifold for the front of your house, and one for the back. The manifold should be located close to your main service line to make connection easier and reduce pressure losses through the pipes due to friction.

The pipe must connect to the sprinkler heads, taking the most direct route and connecting outlying sprinklers by a tee. The main line should extend directly down the center of the property. Use laterals to reach the necessary locations. Whenever possible, avoid perimeter installations that take a circuitous route to prevent unnecessary friction losses.

When possible, avoid placing pipe in areas where there are established trees, shrubs, or ground cover to avoid damage to roots of existing plants. Likewise, pipe placed directly adjacent to a building must be placed in a hand-dug trench, as most trenching machines require at least two feet on either side to dig a trench. Whenever possible, place parallel lines in the same trench.

Once your pipe is drawn in, you are ready to make a supply list. Count up the total number of sprinkler heads, risers and swing joints, valves, controllers, and the total pipe distance needed, plus a bit extra to avoid extra trips to the hardware store. Pipe and valve sizes depend upon your flow in GPM. A friction chart will help you select the appropriate size of pipe for the sprinkler system. The size of pipe should change with distance to compensate for friction loss. Other supplies you will need include couplers, elbows, tees, adaptors and reducers, PVC primer and solvent cement, a PVC pipe cutter, teflon pipe tape, flags, stakes, trenching shovel, and string. There are many suppliers of irrigation materials. If using different brands, make sure all your materials are compatible. It is best to use one brand throughout your system.

How do I install the system?

Follow these steps for a successful installation:

1. **Place a stake or flag at every sprinkler location indicated on your layout.** Attach a string six inches above the soil between flags to show where the pipe will be placed.

2. **Dig the trenches,** following the string. Most commonly, trenches are dug 12 inches deep for laterals and 12 to 18 inches deep for the main lines. To make trenching easier, consider renting a power trencher.

3. **Cut and lay the pipe.** Begin by laying the pipe, sprinkler heads, and connectors (risers, etc.) at each stake. Measuring carefully,
determine the length of pipe needed in each trench. Cut the pipes with a PVC pipe cutter. Remove the bits and pieces from the cut ends so they don’t get into the lines and plug the sprinklers or foul the valves. Avoid setting the pipe ends into the soil to keep your pipes dirt-free inside. Assemble the system from the point farthest from the manifold and work backwards.

PVC pipe and fittings are simple to join using PVC pipe primer and solvent cement. Read the product labels and follow all safety precautions. But beware—the primer and cement dry rapidly, and once joints have cemented, they cannot be taken apart. Work directly in the trench to make sure all the sections will fit the way you’ve planned.

First, clean the sections of pipe to be cemented with a cloth to remove dirt and debris. Then, apply primer to the surfaces that will be joined: the outside of the standard pipe end, and the inside of the flared end or fitting. Next, brush solvent cement evenly over the primer. Lower the pipes back into the trench, and push the standard pipe end into the fitted end. After they have been joined, rotate one pipe about a quarter turn to distribute the cement. You’ll need to hold the pieces together for about 20 seconds. Keep the pipes as level as possible in the trench, and wait at least an hour before running water through the pipes.

4. **Connect to the service line.** Start by shutting off the main water supply to the house before you begin connecting. Remember to install an automatic drain valve at the low point of each circuit to help drain the system and avoid winter freeze damage.

If you are tapping directly into a 1-inch PVC main line, cut out a small piece of the line and replace it with a compression tee. Slip on the tee and tighten the compression nuts. If the main line is a thick polyethylene flexible line, use an insert tee fitting and attach a hose clamp at each end of the tee. These steps provide a water-tight connection without soldering or threading any pipe. Next, install a shutoff or a stop-and-waste valve to allow the system to be turned off without interrupting water to the house. The next system component should be an automatic drain valve.

5. **Assemble and attach the valve manifold and connect the backflow preventer.** It’s time to get out of the trenches! This job can be done on a table or workbench. On the back of each control valve, screw in a tee fitting. Next, attach a length of PVC pipe that will connect all your control valves. The valves should be spaced at least 3 inches apart to allow easy access. In-line strainers or filters are optional but recommended, especially if a drip line makes up one or more of the circuits.

Next, attach separate fittings to the threaded outlet (male adaptor) in the front of each control valve. These fittings will be used later to connect to the pipes leading directly to the sprinklers. Make sure all your fittings and pipe match the size of the control valves.
The final step is to connect the pipes to the manifold. Lay teflon tape around the threads and hand-tighten the screw fitting. Using a wrench may result in stripping of the threads inside the control valve. The manifold can now be tested for leaks. If leaks occur, unscrew the fitting, dry it off, and apply new teflon tape to the threads before hand-tightening. If the tape bunches, use more and lay the tape around the threads in the opposite direction.

6. **Install the risers.** It’s essential to measure riser height carefully before you install it, to ensure the sprinkler heads will be at exactly the right heights. If you use swing joints to attach risers, height adjustments can be made more readily. Pop-up heads should be aligned just at the ground level for existing lawns, or just above the ground level for areas to be sodded to allow for the thickness of the sod layer. You may want to screw on a sprinkler head to determine the precise length of riser needed. Use a precut riser of the correct length, or cut a piece to fit. If a swing joint is used, the height can be adjusted to the soil grade. Next, cut the main sprinkler pipe in the trench at each flagged sprinkler location. Install the swing joint, and attach the riser. The riser should be perpendicular, or straight up and down, when installed. Make sure the riser pipe and sprinkler heads are compatible in size.

7. **Flush the system** to remove all soil and construction debris from the system and prevent clogging of spray heads. Operate the valves manually, and let the water run to clean the lines and risers. Then begin attaching the sprinkler heads nearest to the valve box, working your way out to the last sprinkler. This will push any remaining debris to the last outlet or riser. Simply screw the sprinkler heads onto the risers, aligning the spray pattern properly. Once the system is operating, you can re-adjust the heads to properly direct the spray. When the water is clear, shut off the system and attach the last sprinkler head. Do this for each valve.

8. **Test and adjust the system.** At last—all your hard work pays off as you finally operate the system. Wire the valves to the timer using waterproof connectors, following the manufacturer’s instructions. Keep a written record of the station that runs each zone so you’ll be able to program the timer according to plant needs. This record should be placed adjacent to the timer where it is handy for use in future years.

Now it is time to test each zone. Use the timer to control the valves, and make any necessary adjustments to the distance and direction of the sprinklers. Check for leaks or other installation problems, and fix them before proceeding.

9. **Backfill the trenches,** only after you have adjusted and checked the system. Use a two step process. First, replace rock-free soil into the trench to a depth slightly below the surrounding soil. Next, flood the trenches with water to help settle the soil. After the water has soaked in, add more rock-free soil, making a small mound. Water again to complete the settling process.

Where the soil is rocky, place 2 inches of sand in the trench before laying the pipe, then cover the pipe with 2 inches of sand and backfill with the soil removed from the trench. This protects the pipe from sharp rocks.

**How do I know if I’m applying the right amount of water to my lawn?**

Despite your best efforts to engineer the system precisely, it is often useful to perform a sprinkler audit to determine the exact amount of water being provided. This is an especially valuable tool when you have purchased an existing system but have no information about its rate of application. Ask your local Cooperative Extension office for the All-Seeing Lawn Care Manual. It contains appropriate water rates for lawns.

**How do I maintain my system in good working order?**

As with most installed systems, maintenance is the key to satisfactory operation. At least twice a year, first when the system is turned on in the spring, and then later in the summer, inspect the sprinkler heads to make sure they are upright and aimed in the correct directions and that the sprays have not become blocked. Brown spots in lawns can often be attributed to sprinkler heads that are
clogged, broken, out of adjustment, or not perfectly upright.

Check for unduly wet areas around the sprinkler heads. You may have a leak or broken line. Dig up the pipe and check for cracks and breaks. Cut out the broken portion and replace it with a new piece of pipe.

Proper shut-down for winter will help prevent breaks in the system in areas where the ground freezes. When water freezes in PVC pipe, the pipe will crack. First, close the system’s water supply valve. If your system has manual drain valves, open the valves to allow the lines to drain. If the drain valves are automatic, the lines will drain without assistance. Next, open the manual drain valve up-stream of your valve manifold to allow the automatic sprinkler valves and backflow device to drain. Your operating manual will have instructions on shutting down the automatic timer, or contact your local Cooperative Extension office for assistance.

<table>
<thead>
<tr>
<th>Station</th>
<th>Description</th>
<th>Days</th>
<th>Irrigation (minutes)</th>
<th>Intervals per day</th>
<th>Start Times (all A.M.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pasture east</td>
<td>M, Th</td>
<td>30</td>
<td>3</td>
<td>5:00, 7:30, 9:10</td>
</tr>
<tr>
<td>2</td>
<td>Pasture west</td>
<td>M, Th</td>
<td>30</td>
<td>3</td>
<td>5:30, 8:00, 9:40</td>
</tr>
<tr>
<td>3</td>
<td>Back lawn</td>
<td>M, Th</td>
<td>20</td>
<td>2</td>
<td>5:50, 8:30</td>
</tr>
<tr>
<td>4</td>
<td>Front lawn</td>
<td>M, Th</td>
<td>20</td>
<td>2</td>
<td>6:10, 8:50</td>
</tr>
<tr>
<td>5</td>
<td>Back drip</td>
<td>M, Th</td>
<td>60</td>
<td>1</td>
<td>6:30</td>
</tr>
<tr>
<td>6</td>
<td>Orchard drip</td>
<td>T, F</td>
<td>60</td>
<td>2</td>
<td>5:00, 7:50</td>
</tr>
<tr>
<td>7</td>
<td>Front drip</td>
<td>T, F</td>
<td>20</td>
<td>1</td>
<td>6:00</td>
</tr>
<tr>
<td>8</td>
<td>Back mist heads</td>
<td>T, F</td>
<td>10</td>
<td>2</td>
<td>6:20, 8:50</td>
</tr>
<tr>
<td>9</td>
<td>Back bubblers</td>
<td>T, F</td>
<td>20</td>
<td>1</td>
<td>6:30</td>
</tr>
<tr>
<td>10</td>
<td>Raised bed</td>
<td>T, F</td>
<td>10</td>
<td>3</td>
<td>6:50, 9:00, 10:00</td>
</tr>
<tr>
<td>11</td>
<td>Front bubblers</td>
<td>T, F</td>
<td>30</td>
<td>1</td>
<td>7:20</td>
</tr>
<tr>
<td>12</td>
<td>Unused</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Programming your time clock requires plant monitoring on a regular basis to ensure that watering duration and quantity meet plant needs. This schedule is provided only as an example. Each landscape is different and will have different water needs.*
Chapter 9:

THE MANY METHODS OF PLANTING

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**Chapter 9:**

THE MANY METHODS OF PLANTING

No matter what part of the world you are in, plants improve the environment by stabilizing soil, cleaning the air and water, ameliorating the weather, and beautifying the surroundings. Throughout the world, methods of vegetating land have the same principles: **Select the appropriate plant for the location and purpose, plant it properly, and maintain it well.** The following seven chapters describe the correct procedures for successful planting and maintenance. Each consists of a 3-stage process: **Planning, Planting, and Maintaining.** Please note that the principles for planning and maintenance are often identical. Differences are noted specifically in each chapter.

### Planning: What do I need to consider before purchasing?

Don’t begin purchasing plants until you have analyzed your site and developed a landscape master plan that incorporates the many needs and limitations of your site. Start by reading Chapter 12 of the Small Ranch Manual. Once you have located all the elements mentioned in Chapter 12 on your plan, consider the following factors to develop a landscape master plan:

- What is the purpose of the planting project?
  - Do you want a lawn, a wildflower meadow, a stable streambank, or do you want to re-vegetate a native shrub community?
- Are you planting to reduce direct light and cool a dwelling during the summer?
- Are you trying to visually screen an unsightly view or create a sound buffer between the house and a busy road?
- Is the primary goal to increase property value?
- Are you planting to provide protection against erosion?
- Do you need a windbreak to buffer your property from the effects of strong winds?
- Is your goal to provide wildlife habitat?

*Careful consideration of the many landscape factors helps protect water quality.*
• Do you have other specific needs that you plan to address with vegetation?

Answers to questions such as these will help you develop your plan.

**How will the plant fit in the landscape once it has reached its mature size?**

Well-placed vegetation has the potential to increase the value of your property. It is an unfortunate but common mistake to place trees and shrubs too close together when first planted. Planning for the mature height and width of the plant is important for eventual landscape appearance, plant health, and safety considerations. A reputable gardening encyclopedia will provide mature plant descriptions for you.

Other considerations in planting include:
- Plant hardiness (ability to survive extremes of winter cold)
- Tolerance to summer heat and drying winds
- Pest resistance or susceptibility
- Growth rate
- Cleanliness
- Type of root system
- Moisture and fertilizer requirements
- Availability of plant stock
- Life cycle: perennial, biennial, or annual
- Ornamental characteristics including color, texture, and scent
- Whether plant is evergreen or deciduous
- Time of flowering
- Fruit desirability or nuisance potential
- Wildlife preference
- Space available and mature size of the plant
- Sun and wind exposure of the site
- Maintenance requirements

When trees are not carefully chosen, they can cause safety problems, especially when planted in spaces that are too small, or when not properly maintained. A mature tree that is incorrectly placed and poorly maintained may result in broken sidewalks and driveways; undesired interference with security lighting; damage to electrical poles or lines; damage to gutters, paint, or roofing of houses; or clogging of sewers, drains, and septic leach fields. It’s well worth your while to make sure you know the mature size and spread of any vegetation you plant.

**Is the plant zoned for my area?**

Most gardening books and catalogs will tell you what zone a particular plant will thrive in. The United States Department of Agriculture (USDA) has produced maps that indicate climate for the entire United States. For example, Reno, Nevada lies within zones 5 and 6 in the USDA system. Many gardening books follow this system. However, the familiar *Sunset Western Garden Book* considers heat, wind, and soil characteristics in classifying hardiness zone. This approach is recommended over the sole use of the USDA zone system.

Reputable nurseries carry materials that are appropriate for the area in which they do business. Plants are sometimes marketed without a claim to hardiness. Occasionally, plants are available that are not suitable for our high desert environment. A nursery will usually alert the buyer if hardiness is questionable. The buyer should double-check the plant hardiness before making any purchases, especially if the plant is intended to be a permanent landscape feature.

Use a garden encyclopedia to investigate every plant type that you plan to use. Make

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**A well-planned landscape brings visual and monetary rewards while protecting our water quality.**

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sure the plants are zoned for your area. If you are purchasing or collecting from local seed sources you have the assurance that the plant has produced a seed crop that can be resown locally with a high degree of success.

Many nurseries will replace, at no cost, a plant that does not survive within one year of purchase. However, it is far better in the long run to select plants that are appropriate for the areas you wish to vegetate. Cooperative Extension, gardening encyclopedias, and local nurseries are all good sources for helping to predict a given plant’s potential for success. If a species is thriving in your neighborhood, chances are that it will thrive in your yard, also.

**Will the plant thrive in the site-specific soil and water conditions?**

Inventory the surrounding vegetation and the vegetation next door. Begin by determining the type of plants that will be successful in your soil. A soil test is the only certain way to determine soil type, nutrient status, and pH (acidity/alkalinity). See Chapter 2 for information on soil testing. Your local Cooperative Extension office may offer free soil tests, and can also help locate soil test laboratories.

Soil drainage problems are indicated when water fails to drain from a pit in the ground within a reasonable time period. If drainage is slower than one-half inch per hour, do not plant trees and shrubs in the area until a drainage system is designed and installed. A property owner can easily perform a percolation test when drainage problems are suspected.

**How do I conduct a percolation test?**

Dig a hole 12 inches square by 12 inches deep in the area to be tested, and then fill it with water. Use a ruler or stick to record the depth of water in the hole for a 24-hour period.

- If the hole drains in three to four hours, it is considered to be a quickly drained soil.
- If it drains in five to 12 hours, it is considered a moderately drained soil.
- If it requires 13 to 24 hours or more to drain, the soil has a slow drainage rate and many plants may not survive in the soil unless the drainage problem is alleviated. Seek out a professional to design and install a drainage system. If it is not done properly, much time, effort and money will be wasted.

**How will I irrigate my plants?**

Soil texture is an important factor when planning irrigation systems. Plants will perform differently in sand than they will in clay. See “wetting patterns in sand, silt and clay” in Chapter 2. Trees planted in sand will require far more water to grow the same height in the same amount of time as the same tree would require if planted in clay. This is due to the rapid rate at which sandy soils drain.

Design your irrigation system to meet the needs of your vegetation, both in terms of quantity and quality of water needed. Start by determining the irrigation water quality. Treated municipal supplies must meet stringent drinking water quality standards that are also suitable for plants. Groundwater pumped via a well, however, may contain high levels of salts or chemicals, such as boron, that can be toxic to plants. Well water that is high in salts may result in a buildup of salts in the plant root zone. In that case, consider selecting plants that are salt-tolerant. Some groundwater supplies also are subject to water availability limitations.

Next, select an irrigation method. Overhead watering works well in many cases, but weed populations may be greater because of over-spray into unplanted areas. Overhead irrigation is best for large areas that have been seeded, such as turf or groundcover, but is less suitable for shrubs and trees. A drip system delivers water directly to the root zone of the plant. Generally speaking, there is less weeding and less water wasted when a drip system is used in place of overhead irrigation.
Chapters 7 and 8 provide information on the design and installation of drip and sprinkler systems. Refer to them as needed when designing your system.

**What about weeds?**

For successful weed control, begin weed management early in the planning process. Read Chapter 1. Weeds can out-compete plantings for nutrients, water, space, and sunlight. An area should be weed-free prior to planting, and a plan should be formulated for continued weed control after planting and establishment.

**How do I install my plants?**

You are now ready to progress to the next chapter to learn the maintenance steps necessary for a successful landscape. A summary table detailing the various methods of planting is provided on the next page. The specifics of individual planting methods for various types of plant materials are found in Chapters 11-15.
Chapter 10:

MAINTENANCE: ENSURING THE SUCCESS OF YOUR PLANTING

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Chapter 10:

MAINTENANCE: ENSURING THE SUCCESS OF YOUR PLANTING

Maintenance is the key to a long-lasting, enjoyable landscape. A landscape is a form of art that takes a lifetime to develop. It is dynamic art rather than static art as it changes both as it matures and as the seasons change. If you provide for the needs of your plants, they will reward you with years of enjoyment and monetary value. Year-round monitoring allows you to detect weeds and pests, determine fertilizer and pruning needs, and ensure your plants receive sufficient amounts of water.

What do I do after planting?

Watering is the key to success. Secure the future of your plants by providing a permanent irrigation delivery system. Chapters 10 and 11 will help you design your system. An automated irrigation system will be easiest to use. Monitor your plants on a regular basis to determine if they are receiving too much or too little water. Plant water needs change with the weather and plant maturity, so you will need to reprogram the system on a regular basis. Remember that 99 percent of plant success lies in appropriate watering and soil management. Too much water is as harmful as too little water. Soggy plant roots are prone to disease and lack vigor.

Drip Systems:

It’s important to provide adequate irrigation after your trees have grown to a mature size. When a large ball and burlap tree is first planted, the drip line of the tree is, at most, a foot or two from the base of the trunk. This is where the initial irrigation drip emitters should be placed to provide water to the newly growing roots. As the root system expands, it will grow outside this area only if the moisture is expanded. Add emitters farther from the trunk to irrigate the full extent of the branches. The area of soil below the periphery of the canopy is the major zone of water uptake for the root system during the first few years. By moving emitters farther out to match the tree’s growth, you will encourage the tree to become more extensively rooted and prevent much of the summer stress so common in Nevada.

Alternatively, you may choose to expand the wetted area by planting perennials and shrubs surrounding the tree, and adding an irrigation system for the perennial plants and shrubs. This wets a larger volume of soil and encourages the tree roots to develop outward.

One problem associated with drip systems in perennial gardens is the need to dig and divide perennials after they become large and established. A drip system can easily be damaged when digging up and dividing perennials. Use extreme caution when dividing perennials to avoid severing the lines.

With time, it may be necessary to replace sections of the drip system as they become old and worn. This can be done easily with very little cost if you have used drip system parts with common sizing. Avoid non-standard drip systems for which replacement parts are difficult to find. For more information on irrigation systems, see Chapter 7 (drip irrigation) and Chapter 8 (sprinkler systems).

How will I know if my plant needs to be staked?

Staking is necessary only to secure the rootball. Unfortunately, many people automatically stake their trees because they feel it will protect them, whether from wind or vandalism. Contrary to what you might expect, studies have shown that vandalism may actually INCREASE when trees are staked!

As your trees grow in size, it’s important to expand the drip system outside the tree’s canopy.
Research that measured the effect of rigid supports on staked trees discovered that unstaked trees had greater trunk diameters and bigger root systems than their staked counterparts. Trees with trunks smaller than 2 inches in diameter rarely require staking, while larger trees generally only require staking in areas of high prevailing winds. In any case, remove the stakes after one growing season.

Large trees planted in wind-prone areas will have a difficult time developing a strong root system due to the constant shifting action of the wind. For these trees, it is essential to stabilize the rootball until the tree has sent roots out into the native soil. Place two upright stakes, no taller than the height at which the first limb appears, into undisturbed soil at right angles to the prevailing winds. Avoid placing the stakes into the rootball itself, as this will not provide stabilization. Secure the tree trunk to the stakes with soft, flexible ties that will allow the tree to bend in the wind. Ties are often attached to the trunk a foot or so below the lowest branch of the tree. Check the ties often to prevent strangulation or bark damage. Cut the stakes off below the limbs to prevent them from damaging the limbs.

Wire may also be used to stabilize larger trees with large trunk diameters, usually 4 inches or more. Space the guy wires at 120-degree angles. Attach the guy wires to stakes, and drive the stakes into undisturbed soil. Protect the bark of the tree by using soft rubber or cloth wrapped around the wire at the trunk of the tree. For safety, tie bright plastic ribbons or other marking devices on the guy wires to prevent tripping and injury.

Stakes and guy wires should be removed after one growing season. Leaving guy wires on longer will almost always result in girdling and tree injury or death. As noted above, unstaked trees are invariably healthier trees.

**Will pests infest my plantings?**

During winter and early spring, watch for over-wintering insects such as termites and aphids. These creatures can be found under logs and on leaf litter. Prior to destroying any insects you may find, have them identified by your local Cooperative Extension office or State Division of Agriculture to avoid destroying beneficial insects.

Certain species of plants are susceptible to certain pests. Who is not familiar with elm leaf beetles, or with aphids on roses? By choosing well-suited and relatively pest free plant materials, you will minimize the need to use chemical pesticides to control problems. For more information on pest control, see Chapter 11 in the Small Ranch Manual.

**Can weeds cause my planting to fail?**

Absolutely! The key is to watch your planting very closely for the first sign of undesirable species. Weed control is an ongoing process that will mature along with your landscape. Weed them out by hand, before they have a chance to establish and make seed. Create a property weed management plan BEFORE you plant your landscape. Read Chapter 1 for assistance in developing a weed management plan. Learn to identify weeds when they are smaller than an inch across, and remove them as early as possible, when it is much easier. The longer you wait, the more tenacious the weeds will become.

Pre-emergent herbicides can be used after a planting to prevent weed seed germination. If your planting occurs near a creek, pond, irrigation ditch, or adjacent to a waterbody, avoid using a pre-emergent if there is any chance of runoff and contamination of the water during a rainfall or irrigation event. Hand weeding is the safest way to protect water quality in these sensitive areas around water.

**When should I add mulch?**

Use mulch for moisture retention, to cover a drip line, for weed control and fertilization over time, and to improve the aesthetics of your planting. Many types of mulch are available, from compost to leaves to rocks. Avoid placing mulch that absorbs heat, such as dark colored rocks, over the root zones of your plants, as increased evaporation and stress may occur. Keep organic mulches away from the trunk of the tree to discourage pests and diseases from attacking the trunk or stem.
Mulch does add to the cost of your landscape, and some people may prefer the look of clean bare dirt. If mulch is not used over a drip system, it may be necessary to bury the system.

How do I decide if pruning is needed?

Pruning can greatly assist in maintaining the health, appearance, and vigor of trees. Early training corrects minor defects that might eventually require expensive tree surgery. Pruning serves many purposes, including:

- Encouraging trees to develop their natural form
- Removing hazardous dead, damaged, weak, diseased, or crossing limbs
- Opening up the tree for better sunlight penetration, air circulation, and protection from wind damage
- Stimulating flower and fruit development
- Minimizing danger of personal injury, property damage, and potential liability

When do I start pruning trees and shrubs?

The time to prune depends on the kind of tree, the results desired, the urgency of the situation, and the availability of the necessary equipment and assistance. Most deciduous shade trees are best pruned in late winter or early spring, when the tree form can be easily seen, and the wounds left by pruning will close over most rapidly. A notable exception is the group of trees that tend to “bleed” sap, including maples, birches, elms, and poplars. Wait to prune these species until late summer or fall to avoid unsightly sap buildups and potential fungal diseases.

It is best to prune spring flowering trees immediately after flowering to provide maximum visual beauty. Trees that flower later in the season form flower buds on the current season’s growth, and should be pruned during the winter or early spring. In all cases, avoid pruning during the summer months. At this time, trees are stressed, and need all their energy for growth instead of for healing pruning wounds.

How do I prune my young trees?

This is your opportunity to shape your tree into the landscape specimen you desire. Start by considering the natural growth habit and use of each tree. Trees with a strong central leader may need little training. Other tree species grow irregularly, develop suckers, or have poor branch structure. Prune young trees only enough to effectively train and direct growth, and to correct any structural defects. Do not “round over” or “top” trees, especially newly planted trees. Their terminal bud produces a hormone that enhances root growth. If all the terminal buds are removed, the roots develop poorly, and the tree takes longer to become established.

During the first two growing seasons after planting, prune young trees as little as possible. This allows the tree to use all leaves to make food for the root systems, and avoids stress from pruning wounds. Avoid the “scalloped” look where all lower branches have been removed, and a tuft of leaves remains at the top.

<table>
<thead>
<tr>
<th>Pruning Tools</th>
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</thead>
<tbody>
<tr>
<td><strong>Hand pruners:</strong> used to prune small branches less than 1 inch in diameter. There are two general styles: anvil pruners, with a straight blade that cuts the branch against a small anvil or block as the handles are squeezed; and by-pass pruners, which use a curved cutting blade much like a scissors. By-pass pruners avoid unnecessary tearing and crushing of plant tissue.</td>
</tr>
<tr>
<td><strong>Lopping shears:</strong> used for slightly larger branches that cannot be cut with a hand pruner.</td>
</tr>
<tr>
<td><strong>Pruning saws:</strong> most have tempered metal blades that retain their sharpness for many pruning cuts. They cut on the pull strokes.</td>
</tr>
<tr>
<td><strong>Pole pruners:</strong> used to cut branches that are beyond reach. The by-pass type is preferred. For cutting larger branches, saw blades can be fastened to the pruning head.</td>
</tr>
</tbody>
</table>

“Clean Water – We Can Make a Difference”
of the long and spindly trunk. Leaving the lower branches helps increase trunk diameter and shield the trunk from sun and physical damage. Later, over a two or three year period, you will be able to remove these temporary lower branches.

If you have determined that pruning is necessary, first remove all dead, dying, or diseased wood. Using the proper tool for the size of the branch, cut back to the "callus ring" (a circle of raised tissue around the base of the branch). Be careful not to damage this ring as it is the tissue that will eventually close over the wound. Don't cut the branches off flush with the trunk, as this makes for a larger wound and removes the callus. Instead, use natural target pruning techniques in all your pruning.

Next, study the form of the tree to see which branches should be saved as major limbs. The best branches are attached to the trunk at wide angles, and are smaller in diameter than the trunk. When branches form narrow angles with the trunk (less than 35°), the crotches will be weak and prone to damage.

The distance between limbs is permanent, and will not change as the tree grows. It may be necessary to prune to achieve greater space among vertical limbs, to reestablish a dominant leader, to eliminate crossing limbs, to provide structural strength, and to create a more attractive tree. When limbs are too closely spaced, they have fewer laterals and tend to be long, thin, weak branches that break off readily. In general, try to maintain a vertical space of at least 8 inches, preferably 18 to 24 inches, between major branches.

To prevent peeling of the bark and the creation of large wounds caused when large limbs are cut close to the trunk, use the three-cut procedure. First, check your tools for sharpness to avoid ragged cuts. Then, disinfect your clippers or shears with alcohol, bleach solution, or disinfectant spray such as Lysol® to avoid spreading diseases from tree to tree. Make the first cut about 1 foot to 2 feet from the main branch or trunk. Cut upward and go about halfway through the branch. Make the second cut slightly further out on the limb from the first. Cut downward completely through the branch. This removes the bulk of the branch, and makes it easier to accomplish a clean final cut. Make the final cut just outside of the branch collar, leaving the collar to heal the pruning wound. The diagram of natural target pruning on the next page will help guide you.

**Is it necessary to use wound sealants on the cut surfaces?**

It is not necessary to apply sealants to pruning cuts. In the past, a standard practice was to seal pruning cuts with wound dressings or paints. It was thought that wound dressings would keep water, insects, and decay-causing microorganisms from entering the wound. It was also believed that wound dressings would encourage closing of the wound. However, scientific research has found that wound dressings actually inhibit or delay closing the wound, don't keep out water and insects, and may provide a more favorable environment for decay-causing microorganisms. The best way to ensure rapid healing of pruning cuts is to make proper cuts with sharp tools.

**Pruning Don’ts**

- Don’t leave large stubs—remove limbs all the way to the collar at the main trunk, or to a new leader or remaining limb.
- Don’t damage the bark or make the wound larger than necessary when cutting limbs back to the trunk.
- Don’t let a limb fall and rip the bark—always use the three-cut method for larger limbs.
- Don’t apply sealants to the cut surface.
- Don’t damage the leader of a single-stem plant, or the natural form of the tree will be destroyed.
**NATURAL TARGET PRUNING**

1. Locate the branch bark ridge (H) and the branch collar (E to B).
2. Stub cut the branch (upward at F, then downward through the branch at G).
3. Locate points A and B where the branch meets the branch collar.
4. Cut from A to B, or from B to A with care.
5. If position of B is uncertain, draw a line in your mind from A to E.
6. Angle EAD is approximately the same as angle EAB.
7. Point D is the beginning of the branch bark ridge (H).

*DO NOT LEAVE STUBS.*  
*DO NOT MAKE FLUSH CUTS.*  
*DO NOT PAINT THE WOUNDS.*

---

**Types of Pruning Cuts**

**Heading:** Heading removes part of a shoot or branch back to a bud, but not at the point of attachment of a branch to the trunk or another limb. Heading increases the number of new shoots formed from lateral buds, stimulates branching, and makes plants shorter and denser. Types of heading:

- **Pinching:** removal of part of the current season’s growing shoot, usually with the fingers

- **Snipping:** removal of part of a shoot that grew during a previous season, usually with pruners

- **Shearing:** multiple heading cuts made along a single plane, either during the growing season or during dormancy

**Thinning:** Thinning is used to remove an entire shoot or limb back to a branch point. This reduces the number of new shoots from lateral buds, inhibits branching, and lets limbs grow longer.
When should I prune my older, existing trees?

It’s best to train and shape shade trees when they are young; however, it is not uncommon for older trees to require pruning to remove low, broken, crossing, dead, or diseased limbs. Very large trees may also be pruned to avoid damage to power lines or structures. If your tree appears to threaten power lines, call your power provider before you prune. They will generally prune the trees for you. On the other hand, NEVER top your trees, or hack off all the vegetation by cutting main limbs short. This ill-considered practice removes nearly all branches and leaves from a tree, resulting in weak new small branches that are susceptible to wind, snow, and ice breakage as they age.

Can evergreens be pruned?

In general, evergreens do not need as much pruning as deciduous plants. There are several reasons why you may choose to prune them, however:

- Pruning may help thicken the branch and twig growth, giving a dense appearance.
- Pruning allows thinning and opening of the top growth.
- Pruning may be used to shape a tree to a specific form, or to slow down a tree that is growing too fast.
- Pruning may be necessary to remove dead or damaged branches.

New growth on pines can only start from the buds set on last year’s growth. Pines should be pruned when new shoots have completed their elongation growth, but before needles expand and spread from the shoot, called the “candle stage.” Each of the new needles has tissue at the base that can form a new bud. Proper pruning will cause several of these buds to form, leading to growth the next year. If you prune the shoots before elongation is complete, too many buds will form, and growth will become bunchy. Pruning after needles are spread results in a dead stub with no new growth from that spot. Pinch or cut the shoot on an angle, and a single strong bud will usually form just below the cut tip. Always leave at least one-fourth of the new growth to form new buds. If it is necessary to remove pine branches because they are dead or damaged, wait until late winter or early spring before new growth starts.

Spruces and firs can be pruned anytime from October to April. These evergreens grow from dormant buds that form along the previous year’s growth. It is often unnecessary to prune these trees, however, except when dead branches must be removed. Make the cut ¼ inch above a healthy-looking bud along the shoot.

Junipers, arborvitae, and yew form adventitious buds readily and may be pruned at any time when the wood is not frozen. Pruning in early spring allows the new growth to quickly cover and hide the pruning cut. Overgrown plants can be reduced in size by cutting at the base of unwanted branches. Be aware, however, that any branch will make new growth if it has some green needles remaining on it. Older branches deep within the canopy that do not have green foliage do not produce buds. Avoid pruning them as they will not regreen and grow. This is especially true of junipers.

Is it necessary to remove all dead plant material in the fall?

Fall is a perfect time to harvest ripened seeds from plants, particularly perennial flowers. You may also choose to leave the flower heads in place over the winter to provide food and shelter for wildlife. In the late winter, clean up material using hand shears or a power weed whip. Rake and compost the collected material. Using what you’ve learned in this chapter, you’ll enjoy your landscape for many years to come.
A close look reveals a duck in grasses left uncut for the winter.
There are many ways to introduce plants into your landscape. Consider cost, season, and availability to determine the methods to use and the techniques that best fit your needs. Then find the appropriate chapter for specific instructions. By planting trees, shrubs, and flowers, you will enhance water quality as the plant roots help stabilize the soil and absorb nutrients. Every little bit helps keep water clean!

<table>
<thead>
<tr>
<th>Description</th>
<th>Method</th>
<th>Seasons/ Availability</th>
<th>Pros and Cons</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Tree" /></td>
<td><strong>Chapter 11:</strong> Ball and Burlap</td>
<td>Easiest way to get big trees instantly. Can be planted any time of year as long as the soil is not frozen. Staking of large trees is essential.</td>
<td>Available locally from most nurseries, commonly in spring. Often requires heavy equipment for planting.</td>
<td>High</td>
</tr>
<tr>
<td><img src="image2.png" alt="Bareroots" /></td>
<td><strong>Chapter 12:</strong> Bareroots</td>
<td>Soil is removed from plant for shipping purposes. Only available in the spring locally. Usually purchased from mail order catalogs for spring planting.</td>
<td>Good way to get plants for conservation and mass plantings. Must be handled and stored carefully and planted while dormant.</td>
<td>Low to Moderate</td>
</tr>
<tr>
<td><img src="image3.png" alt="Plant in Container" /></td>
<td><strong>Chapter 13:</strong> Containers</td>
<td>Sizes can range from 4-inch to 6-foot boxes. Can be planted at any time of the year. Trees require staking in undisturbed soil if 10 gallons or larger.</td>
<td>The most common method of planting. Unusual items may not be available.</td>
<td>High</td>
</tr>
<tr>
<td><img src="image4.png" alt="Divisions" /></td>
<td><strong>Chapter 14:</strong> Divisions</td>
<td>Made from herbaceous perennials and rhizomatous shrubs. Perform divisions in early spring or after flowering. Common and rare species available through mail order.</td>
<td>Easy way to increase diversity in the garden with little or no cost. Avoid accidental transplanting of invasive weed species.</td>
<td>Low, if obtained locally</td>
</tr>
<tr>
<td><img src="image5.png" alt="Seed" /></td>
<td><strong>Chapter 15:</strong> Seed</td>
<td>Used to cover a lot of ground inexpensively. Seed should be sown in late summer up to six weeks before frost, in late fall, or in early spring.</td>
<td>Get assistance from experts when choosing seed species or mixtures. The right choices can result in maintenance-free solutions.</td>
<td>Very low</td>
</tr>
</tbody>
</table>
Chapter 11:

PLANTING BALL AND BURLAP TREES AND SHRUBS

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Chapter 11:

PLANTING BALL AND BURLAP TREES AND SHRUBS

Ball and burlap (B & B) large trees and evergreen shrubs are dug with soil left surrounding the roots. The root ball is then wrapped in burlap and tied with twine around the root ball and the trunk. Planting B & B stock is an excellent way to bring instant green and shade to the landscape. Because these trees can be quite expensive, be sure to plan their locations carefully so that your money is not wasted.

What kinds of plants are sold as ball and burlap stock?

Large trees, both deciduous and evergreen, are most commonly planted as B & B, as are evergreen shrubs. The table below provides a selection of evergreen and deciduous trees commonly available in Northern Nevada as B & B stock.

How much money should I expect to spend?

On average, ball and burlap trees cost between $50 and $300, although rare specimen trees may be far more expensive.

How do B & B trees arrive at the site?

These plants will most likely be transported to the site by trucks. The root balls should be moist enough that traveling in an open truck will not cause them to dry out. It is not uncommon for root balls to arrive moist and muddy.

Most often, large B & B trees are planted with heavy equipment such as backhoes or front-end loaders. Plan adequate access for the equipment to avoid damage to other parts of the landscape. Not all B & B plants need to be planted with heavy equipment. Shrubs and smaller trees can be moved and planted by hand.

What do I do when the B & B trees arrive?

Handle your plants carefully. Avoid using the trunks as handles when moving trees. It is essential to avoid dropping the root ball, as this may fracture and split the root system. Subsequently, the split can travel up the trunk of the tree. Several people may be needed to assist in moving the ball slowly and closely to the ground. Wheelbarrows and wooden skids are

<table>
<thead>
<tr>
<th>Plants Commonly Available as Ball and Burlap Stock</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Evergreens</strong></td>
</tr>
<tr>
<td>Austrian Pine</td>
</tr>
<tr>
<td>Bristlecone Pine</td>
</tr>
<tr>
<td>Colorado Blue Spruce</td>
</tr>
<tr>
<td>Douglas Fir</td>
</tr>
<tr>
<td>Japanese Black Pine (in protected areas; never in lawns)</td>
</tr>
<tr>
<td>Lodgepole Pine</td>
</tr>
<tr>
<td>Mugho Pine</td>
</tr>
<tr>
<td>Norway Pine</td>
</tr>
<tr>
<td>Norway Spruce</td>
</tr>
<tr>
<td>Ponderosa Pine</td>
</tr>
<tr>
<td>Scotch Pine</td>
</tr>
<tr>
<td>Southwestern White Pine</td>
</tr>
</tbody>
</table>

“Clean Water – We Can Make a Difference”
useful for handling B & B stock.

**How do I care for my B & B tree before planting?**

If B & Bs must be stored prior to planting, keep the root balls moist and shaded. The balls should be checked daily for moisture content by pressing the tip of your thumb into the soil of the root ball. It should yield to slight pressure, much like a ripe pear. If the root ball is dry, it will not yield to gentle pressure, and needs to be soaked. If the tree will be stored for more than three days, place the root ball into a small trench and fill the trench with water so that the root ball can soak it up from the bottom. Alternatively, cover the ball with moistened old blankets, mulch, etc., to keep it from drying out.

**When is the best time to plant?**

While B & B trees can be planted any time that the ground can be worked, early spring and early fall are the best times to put in large B & B material. During these cooler months, less water is needed by the tree, and evaporative loss is reduced, minimizing stress on the tree. When B & B trees are planted in the early fall, they are forming roots only and not expending energy on green top growth. Make sure to read the warranty policy on your plant, and keep the receipt in case replacement due to failure is necessary.

**How do I prepare the ground?**

Dig your hole at least twice as wide as the root ball (three times wider is preferable), whether planting by hand or with heavy equipment. Determining the correct depth is the most difficult part of the job. Use a shovel handle or other long pole to measure the correct depth for the hole, as shown below. The hole should be only as deep as the height of the root ball. If the hole is too deep, the trunk will be encased in soil at the base, and soil organisms may invade the tender bark layer. If the tree is not planted deep enough, the root ball will dry out. Avoid disturbing the soil under the root ball to prevent the tree from settling deeper into the hole than natural grade level of the soil. If this occurs, water will accumulate at the base of the tree, making it susceptible to crown rot.

It is not necessary to add any soil amendments to the hole. In fact, amendments may discourage plant roots from leaving the planting hole and expanding into the surrounding area. If the sides of the hole are slick, use a shovel to roughen and loosen them, encouraging root expansion and preventing bound roots.

**How do I plant the B & B?**

Now that your hole is prepared, lower the ball down into the hole by laying the tree on its side and rolling it in slowly so it does not drop into the hole abruptly. For large trees, cut a side out of the hole as a ramp, place a plank or piece of plywood on the ramp, then maneuver the root ball onto the wood and slide the tree into the hole.

After the ball has been lowered into the hole, double-check the elevation of the root ball by laying your head on the soil adjacent to the hole and eyeballing across to the top of the root ball. The top of the root ball should be at the elevation of the surrounding native soil, or no more than 1 inch above grade, but never below grade. You can also place a shovel or other straight edge across the hole to check the root ball elevation.

Make sure your tree trunk is straight from all angles before you back-fill the hole with soil. Now is the time to cut the twine that is around the trunk and remove the burlap from the root ball. Remove as much burlap as possible, since in Nevada’s dry climate, it may not decompose and will impede root growth. It is not necessary to remove the burlap, twine, and wire directly.
When planting B & B trees, dig the hole at least twice as wide as the ball.

under the ball. Few, if any roots grow directly down. Most grow out from the sides of the ball.

If by chance, when you begin to remove the burlap, the soil falls away from the roots, STOP. Leave the burlap in place to keep the root ball intact and cut as many slits in the burlap as possible. Make sure to cut away and remove the burlap covering the top of the ball after you have backfilled with soil. If the tree was shipped in a wire basket, remove the basket once the tree has been placed in the hole. Completely remove any wire and twine tied around the trunk to prevent damage from occurring after several years as the tree tries to grow.

Once you have cut the twine, you should not remove the tree from the hole. Have someone hold the tree upright and steady while the hole is being back-filled. Wet the soil as you backfill the hole. Use excess soil to create a basin around the hole to hold water. Make the basin
just outside the diameter of the hole. Fill this basin with water and allow it to soak into the soil that surrounds the root ball. Refill the basin as many times as necessary to settle the soil and to irrigate the root ball. Avoid overwatering, as this can float the ball right out of the hole, especially if the surrounding soil is clayey. Watch for the water to drain adequately. This is very important to the health and survival of the plant.

**Will my planting need to be staked?**

Because the root ball is small relative to the upper part of larger B & B nursery-grown trees, staking is necessary. Large canopies, especially with evergreens, create a sail effect and wind will lay them over. If you have just provided your newly planted evergreen tree with a large drink of water in a planting hole that is slowly drained, it is now floating in the hole and incapable of remaining vertical against wind.

Your tree will need to be staked against the wind only until the tree’s root system has become firmly established in the native soil. The stake must be located outside the root ball, as shown in the diagram below. Improper staking can prevent a tree’s root system and trunk from becoming strong, because wind movement may cause constant shifting of the root ball. Consult Chapter 10 for information on tree staking.

**When should the stakes be removed?**

Remove the stakes one to two years after planting. At this point, the root system will have developed to the point that staking becomes counter-productive. When the tree is subjected to strong winds, the trunk bends or sways. This causes the cells in the tree to stretch and elongate, which helps the tree become stronger and more flexible.

---

*When staking ball and burlap trees, be sure the stakes are placed into undisturbed soil perpendicular to the prevailing wind direction. Remove the stakes after one growing season.*
Chapter 12:

PLANTING FROM BAREROOT DECIDUOUS PLANTS

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Chapter 12:

PLANTING FROM BAREROOT DECIDUOUS PLANTS

Using bareroot plants is a great way to cover large areas with good-sized stock for a fraction of the cost of containerized plants. Deciduous bareroot stock is shipped or moved with the roots free of soil. These deciduous trees and shrubs shed their leaves seasonally, and include such plants as fruit and shade trees, flowering shrubs, and roses. Bareroot stock is relatively inexpensive and available locally or through mail order catalogs for dormant spring planting.

Why plant bareroot stock?

It’s often tempting to wait for the lovely mild weather of late spring before planting, and to purchase ready-to-go container stock. There are two very good reasons for planting bareroots, however:

1. Bareroot stock is MUCH less expensive, often half or less the cost of the same plant purchased in a container.
2. Because bareroots are planted directly into the native soil of the site, the roots will grow more readily. When you plant container stock, the soil around the roots is different from the soil at your site, and water penetration into the rooting zone may not be uniform.
3. Bareroot plants often establish better and may grow better for several years than containerized plants.

What do I need to consider before purchasing?

Deciduous bareroot stock can be purchased locally, or ordered months in advance. The traditional ordering window for deciduous bareroot material is from January through March. You can specify a delivery date for the material that corresponds with the approximate date of soil thaw. In northern Nevada, by the first two weeks in March, the weather has become more mild, but the dormancy of deciduous plants is usually still intact. Plant bareroot stock between February and mid-April in northern Nevada.

By ordering direct from the grower, large quantities of the same species of plant can be purchased. Be sure to have a system for storing the materials upon arrival. Remember—these plants come to you with no soil on their roots and need special care to keep the roots healthy.

What is the best time to plant deciduous bareroots?

Bareroot stock must be planted when the plants are dormant, and after the ground has thawed. In some years that occurs in January and in others, March. Generally speaking, if you place an order and request your bareroot material be delivered during the first two weeks of March, you will have time to plant the trees before leaf or flower bud dormancy is broken.

Deciduous Bareroot Stock for Northern Nevada

<table>
<thead>
<tr>
<th>Alder</th>
<th>Elderberry</th>
<th>Rose hybrids</th>
</tr>
</thead>
<tbody>
<tr>
<td>American bittersweet</td>
<td>Forsythia</td>
<td>Russian olive</td>
</tr>
<tr>
<td>Ash</td>
<td>Hackberry</td>
<td>Sand cherry</td>
</tr>
<tr>
<td>Birch</td>
<td>Hawthorn</td>
<td>Serviceberry</td>
</tr>
<tr>
<td>Burningbush</td>
<td>Hedge Rose</td>
<td>Spirea</td>
</tr>
<tr>
<td>Chokeberry</td>
<td>Honeysuckle</td>
<td>Sumac</td>
</tr>
<tr>
<td>Crabapple</td>
<td>Locust</td>
<td>Viburnum</td>
</tr>
<tr>
<td>Dogwood</td>
<td>Maple</td>
<td>Wild cherry</td>
</tr>
<tr>
<td>Eastern redbud</td>
<td>Potentilla</td>
<td>Willow</td>
</tr>
</tbody>
</table>
What types of plants are sold as deciduous bareroots?

A list of shrubs, trees, and perennials that are appropriate for northern Nevada and are commonly available from deciduous bareroot growers is provided on the previous page. Consult a gardening encyclopedia to learn about the appearance and final size of each plant. Some of the plants may be available in many different species. Make sure the species you have chosen are suitable for your planting site.

How much money should I expect to spend?

When purchasing bareroot stock from a grower, you will typically be required to purchase at least 25 plants of the same species. Prices generally decrease as the number purchased increases. A typical pricing schedule is provided below. For example, using the table, the price for 100 2- to 3-foot tall, three-year old seedlings is $130. The same quantity of stock purchased in containers would cost about $500. The greatest financial advantage results when large quantities of plants are needed. This method of planting is especially advantageous for a first-time landscape design and installation.

How do I store the materials until I’m ready to plant them?

The bareroot stock will be shipped in easy-to-manage cardboard boxes, with the plants bundled in groups of 25. Unpack the plants immediately upon arrival, and check to make sure the order is correct and complete. Be very careful. Without soil to protect the roots, plants can be easily damaged. For successful planting, the roots should be fresh and plump, not dry and withered, broken or rotting, with an odor much like sewage. It’s a good idea to soak the roots in water for 30 minutes.

Cover the roots of plants held for a few days to a week with moist peat or burlap. Store them in an unheated shed or outside on the north side of a building. Keep them cold and moist to prevent premature root and bud growth. Do not let them freeze.

If storing the stock for several weeks or months, the next step is to “heel” the bundles in until you are ready to plant them. Dig a hole in the ground, place the root bundle(s) in the hole, and then backfill the hole with soil to cover the roots. Lean the trunks toward the sun so they shade themselves. This prevents the sun from striking the trunks, drying them out, and making them susceptible to disease. You don’t need to separate the bundles at this time. Remember that this is only a temporary location for your plants until you are ready to plant them in their permanent spots in your landscape. Decreases in survivability result if the materials are stored for more than a few weeks, depending on temperatures.

Water the plants thoroughly at this time, and check the soil moisture frequently. If there has been no measurable precipitation for two weeks, water again to keep the soil moist, but not soggy. Continue this practice until the time of planting.

How do I prepare the ground for planting?

For each plant, dig a hole two to three times the width of the root system. The hole should be broad and deep enough to fit the roots easily without bending or cutting them to fit. The depth of the hole should be about the same level

<table>
<thead>
<tr>
<th>Quantity Purchased</th>
<th>Price Each</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-99</td>
<td>100-499</td>
</tr>
<tr>
<td>Serviceberry</td>
<td></td>
</tr>
<tr>
<td>Amelanchier canadensis</td>
<td></td>
</tr>
<tr>
<td>2-year seedlings, 1 to 2 foot</td>
<td>$1.12</td>
</tr>
<tr>
<td>3-year seedlings, 2 to 3 foot</td>
<td>$1.36</td>
</tr>
<tr>
<td>3-year seedlings, 3 to 4 foot</td>
<td>$1.59</td>
</tr>
</tbody>
</table>

*Prices are provided as examples only. Similar prices may not be available in your area.*
as the grade level of the surrounding soil. Loosen the soil in the bottom of the hole. If the hole is dug deeper than necessary, fill it back with soil and lightly tamp the soil in place to avoid settling. It is not necessary to add soil amendments to the soil. In fact, plants will adapt faster to their new location if they are planted directly into the native soil.

Be sure to remove any large rocks from the hole, and never dig when the ground is wet. Digging in wet soils slicks the sides of the hole and can create a barrier for roots trying to grow beyond the hole. Rough up any slick surfaces inside the hole with a shovel before placing the plant in the hole.

How do I plant?

First, remove the plants from their temporary location. If you are not prepared to plant all of the stock at one time, take out what you will use and re-heel the remainder. Be careful not to cut the roots with a shovel. If the plants are still bundled, remove the ties and separate the plants. Check the roots of the plants. Return those with one-sided, j-shaped, kinked, or circling roots near the crown. These plants are easily stressed and don’t grow well.

Keep the roots of the plants moist at all times. While you prepare to plant them, either put the plants in a large plastic bag in the shade, or wet them down with a hose and place them in the shade. You may also soak the roots in a bucket of water until planted.

Prior to planting, shake out the roots and remove 1/2 to 1 inch of the roots with pruning shears. Remove roots that have died or been broken during the shipping and storing process. This root pruning stimulates vigorous new root production. Inspect the plant for any poorly-shaped roots or roots that circle the trunk. The goal is to encourage a well-branched root system that spreads out in all directions. This is especially important in windy areas where plants depend on a strong root system for stability.

If the roots are long and loose, spread them out evenly over a cone of soil in the bottom of the hole. As you place your plant into the hole you have prepared, make sure that the main root system fits without touching the sides of the hole. This will ensure that the root system grows down, out and evenly in all directions. Some trees will have a callus where a new shoot or branchlet has been attached to an existing plant. The callus is called a graft union, and is sometimes marked with red paint. If there is a graft union near the top of the roots, point the union away from the sun to protect it from sun damage.

Next, hold the bareroot plant so that the branching of the root system begins just below the grade level. Look for a soil line from when it was in the nursery, and plant so that the line is at grade. Spread the roots and replace the soil back into the hole slowly and evenly, making sure that the root system’s shape remains down and outward. As you are filling the hole, you can adjust the elevation of the plant by lifting up or pushing down ever so slightly. This should only be done for the most minor of adjustments. When in doubt, carefully remove the plant and start over.

It is important to have good root to soil contact, but never tamp the newly back-filled soil around the plant with your feet. This can injure the roots. Instead, allow for a slow trickle from the hose to settle the soil evenly as you backfill the hole. Build a temporary basin around the plant to hold water around the plant so that distribution is even and thorough.

Follow the maintenance instructions in the Chapter 10, and you’ll enjoy your new plants for many years to come.
Chapter 13:

PLANTING FROM CONTAINERS

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Chapter 13:

PLANTING FROM CONTAINERS

Planting stock from containers is a popular method of adding instant color and enjoyment to landscapes. Container-grown plants are expensive, but are readily available at any time of the year. Most broad-leafed evergreen shrubs and trees are only offered growing in containers or as ball and burlap stock in the spring. They are clean, easy to transport and can be stored (with proper care) until ready for planting. Buying plants in containers also allows you to see them in bloom so that you can choose the precise color and variety you prefer.

What kinds of plants are in containers?

Nursery stock in containers offers the most diverse selection of plants. With the exception of some native species, practically all plants can be bought and sold in pots. Nurseries sell plants in a variety of containers, from plastic and clay pots for smaller plants to wooden boxes for larger shrubs and trees.

How much money should I expect to spend?

Containerized plants come in a variety of shapes and sizes. They are priced according to size, from small 2-inch plastic liners (pots) to 72-inch wooden boxed trees. Availability and uniqueness are also factors in the cost of container plants. The average cost of one 5-gallon containerized tree or shrub in Nevada was approximately $20 in 1999.

When is the best time to plant container stock?

Containerized plants can be planted any time of the year when the soil is not frozen. If it is not possible to plant the stock immediately, protect it within mulch piles or by surrounding it within hay bales. Remember to provide water and avoid strong sunlight shining on black pots, which can get very hot and may damage plant roots. As a general rule, supplemental watering is needed following a two or three week dry period during the winter, and as frequently as daily during hot summer weather.

The optimal time to plant containerized stock, however, is from late summer to early fall. Soil temperatures are still warm, and roots will continue to grow rapidly for four to six weeks before cold nights begin. Thereafter, they will continue to grow slowly whenever soil temperatures are above freezing. At this time, plants are preparing for winter and putting all of their energy into their root systems. When planting in the spring, plants are concentrating their energy on producing vegetation and flowers. In the fall, the upper portions of plants are not growing rapidly due to cooler temperatures and

One-gallon potted plants are generally available year-round.

A 72-inch boxed tree in transport.
shorter day lengths. Fall-planted trees are larger than the same spring-planted trees, all else being equal, by the end of the next summer.

How do I select healthy stock?

First, select healthy, vigorous plants with branching frameworks. Avoid plants with broken branches, wounds, missing limbs, or evidence of insect damage to their leaves. Trunks with lower limbs are best, but not often available.

Shade trees should have straight trunks and evenly spaced branches with wide, 90-degree crotch angles. When possible, buy trees with low-growing branches. These trees produce larger, stronger, tapered trunks that are less susceptible to sun damage.

Check the root development by having a nursery person knock the plant out of the container. Healthy plants will have firm white roots on the outer surface of the rootball. Beware of “parking lot” plants—soil temperatures can reach 120 °F to 130 °F in containers that have been sitting on hot pavement, causing root damage and browning. Also avoid plants with long roots growing out of the drainage holes. They will grow poorly, have too large a canopy for the roots to supply water, are slower to become established, and often remain root-bound rather than extending their roots into the surrounding soil.

How do I prepare the hole for planting?

Dig a hole at least twice as wide as the pot. Three times as wide is preferable. The key to successful planting is to make the hole as wide as possible. The depth of the hole should be equal to the height of soil in the container. Do not dig the soil at the bottom of the hole to loosen it, or the plant will settle below soil grade, making it susceptible to crown and root rot diseases.

Avoid amending the soil with various bagged products that are marketed as planting mixes. By adding compost into the planting hole, you create a pot-like atmosphere that the roots won’t want to leave. By planting directly into the native soil, the roots will rapidly adjust to and extend outward into the native soil. Save the compost for use as a top dressing or mulch surrounding the newly installed plant.

Next, fill the hole with water and let it soak in. This will provide a moist site for the new plant. If you have not tested your soil for adequate percolation, do it now (see Chapter 2). Most plants will not survive in soils that have poor

Plant Care During Transport and Prior to Planting

- Plants must be well watered before leaving the nursery. Windy conditions during transport, especially during hot weather, dries out and damages foliage.
- Lay plants down to prevent wind damage. Broken branches are difficult to repair.
- Avoid dropping the containers. Some root balls can be shattered or may lose their soil mass.
- Shade the containers to avoid burning the roots.
- After plants arrive, check the moisture content of the soil again. Hot weather can cause plants to use large amounts of water.
- Until you have planted the stock, provide a nursery setting for them and check them daily for adequate soil moisture.
drainage and lack aeration.

**How do I complete the planting?**

Now that the hole has been prepared, you are ready to install the plant. Gently remove the stock from the container. Inspect the root ball for pests and overgrown roots. Roots that encircle the pot may grow to choke the plant in later years. Avoid planting such specimens. At this time, you may also gently tease some of the smaller roots out of the root ball to encourage them to move into the native soil. You can also make a few 1/8-inch deep vertical slits around the rootball. Never expose roots to freezing air temperatures, excessive wind, or direct sunlight, which may all damage or kill roots.

Immediately place the root ball in the hole by handling the root ball, not the trunk. The top of the container stock’s soil should be level with the surrounding ground. If the plant has a graft location on the trunk where a new shoot or branchlet has been attached to the main trunk or branches, turn the flat face of the graft away from the south to avoid sun damage. The graft union may be marked with red paint. Straighten the plant and begin to back-fill the hole, dribbling back in the soil you removed along with some water. After the hole is about one-third full, fill the hole with water to settle the plant and eliminate any air pockets. Finish filling the hole with soil. When fully settled, the top of the rootball should not be exposed nor should it be below grade.

Once you have replaced the soil, use a gentle stream of water from your hose to help settle the soil around the plant roots. Replace additional soil as needed. Continue to water frequently initially to ensure good root growth. Do not overwater or the roots will rot.

**How do I know if a plant needs to be staked?**

A small seedling tree that has the opportunity to grow up in windy conditions will never need staking, since the root system will develop adequate strength as the plant grows. Large materials, such as 8- to 12-foot tall trees sold in relatively small containers (less than ten gallons) planted in highly wind prone areas, will have difficulty developing strong root systems because they are constantly being shifted by the above-ground wind movement. Large, newly planted wind-catching material must be staked. For specifics on staking methods, see Chapter 10.
Chapter 14:

PLANTING FROM DIVISIONS

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Chapter 14:

PLANTING FROM DIVISIONS

The easiest way to propagate perennials, bulbs, and shrubs that form groups of stems that have rooted bases is by division. A division is a segment from an existing plant that will grow into a new plant. Many perennials must be divided on a regular basis to keep them strong and healthy. Planting from divisions is an easy way to increase variety in the perennial garden at low or no cost.

What should I consider before purchasing and/or taking divisions from existing plants?

Working in perennial gardens is an art. In order to blend the different colors and seasons of bloom in a pleasing manner, consult a perennial gardening book. It will provide detailed descriptions of heights, seasons of bloom, colors, and cultural requirements. Division can be a good way to maintain and increase certain plant types that you particularly enjoy.

Every year, the typical perennial plant increases in girth by growing new roots and stems from the crown, usually outside the previous year’s growth. After two to four years, the clumps may become so large that they must be divided in order to stay healthy and strong. As clumps of plants become too big for their space in the garden, growth will become less vigorous due to crowding and competition.

What kinds of plants are planted from divisions?

Herbaceous perennials, ornamental grasses, bulbs, and rhizomatous shrubs can be easily divided in the garden or purchased from a grower specializing in bareroot perennials. The following list gives a brief sampling of plants that are typically divided successfully in Nevada gardens. Many other plants are available from bareroot nurseries and can be successfully grown when special consideration is paid to their cultural requirements, including watering needs, sun exposures, and soil preferences.

Not all plants are suited to dividing. Perennials that form a taproot and grow from a compact crown are best propagated by making stem cuttings or sowing seeds.

How much money should I expect to spend?

Planting from divisions is far less expensive than purchasing plants in containers. Many

<table>
<thead>
<tr>
<th>Easily Divided Herbaceous Perennials and Grasses</th>
<th>Easily Divided Rhizomatous Shrubs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aster</td>
<td>Buddleia</td>
</tr>
<tr>
<td>Bee balm</td>
<td>Coral berry</td>
</tr>
<tr>
<td>Campanula</td>
<td>Forsythia</td>
</tr>
<tr>
<td>Daylily</td>
<td>Lilac</td>
</tr>
<tr>
<td>Echinacea</td>
<td>Oregon grape</td>
</tr>
<tr>
<td>Galliardia (blanket flower)</td>
<td>Red-twig dogwood</td>
</tr>
<tr>
<td>Hollyhock</td>
<td>Snowberry</td>
</tr>
<tr>
<td>Red-hot poker</td>
<td>Sumac</td>
</tr>
<tr>
<td>Gay feather</td>
<td>Willows (basal)</td>
</tr>
<tr>
<td>Maltese cross</td>
<td></td>
</tr>
<tr>
<td>Shasta daisy</td>
<td></td>
</tr>
<tr>
<td>Snow-in-summer</td>
<td></td>
</tr>
</tbody>
</table>

“Clean Water – We Can Make a Difference”
companies specialize in the sale of perennial divisions. If you purchase from catalogs, you can expect to pay $1 or more per plant, depending on the availability and rarity. Rare collectable plants can be very expensive. If you can divide existing plants on your own property or on a neighbor’s, division can be an excellent method of beautifying your landscape at little or no cost.

**How will my ordered materials arrive and how do I care for them?**

When stock arrives, unpack and place the divisions in water for 15 minutes. Then either plant them directly in their permanent location or heel them in a temporary location until planting time. A heeling-in bed can be as simple as a loose, well-dug area in a vegetable garden or a bucket of moist sand in a cool garage. Protect your materials from hard freezing by covering the bed with mulch. Never store materials in a hot, dry location.

**When is the best time to plant?**

Perennials can be dug and divided in early spring, after bloom, or in the fall. It is most common to divide plants when they are dormant. If dividing in the spring, you may do so any time after the ground has thawed. If you want to move a plant during the growing season (during the summer months), wait until the plant has completed its blooming cycle. After a plant has finished blooming, it is concentrating its energy on root production. This is a natural time for relocation and re-establishment.

Take divisions from deciduous shrubs either in early spring when the ground thaws or in the fall after leaf drop. Do not attempt divisions of shrubs during the summer.

**How do I prepare the ground?**

Triple digging is the best method of bed preparation, especially when a perennial bed is first constructed. Triple digging is accomplished by turning the soil over with a shovel or spading fork, then letting it sit for one to seven days. Next, turn the soil over again, and let it sit for one to seven days, but this time apply two to four inches of composted organic matter as a top dressing over the entire area. Lastly, dig the bed for a third time. Your bed is now ready to receive the divisions.

If you are planting flowering perennials in specific locations in an established landscape, dig your transplant holes at least twice as wide as the division itself. Provide enough loose soil for the newly forming root system to become established easily. It is not necessary to add more compost to the soil. Instead, use it as a top dressing around the base of the plant after planting to help retain moisture, control weeds, and provide nutrients.

**How do I make a division?**

If you are digging and dividing perennials from your own garden, the first step is to determine how many divisions you can make from an existing clump. A small shovel-full, approximately the size of a one-gallon container, makes a nice sized division. For deciduous and semi-deciduous perennials, cut the foliage back to about 4 inches from the ground. Don’t cut back evergreen perennials, but do remove any dead leaves.

Place a sharp-edged shovel at the division location and use a swift downward movement to make a clean cut. You will be able to gently pull apart individual plants from clump-forming perennials such as daylilies. Those that form bulbs, tubers, or rhizomes can be broken apart or cut into pieces. Replant immediately after division.

**How do I plant perennial divisions?**

Perennial divisions should be planted in a hole that is at least twice the size of the root system. Before planting, the root system of the new division should be cut back by 25 to 33 percent depending on the size of the root system. A seemingly small root system still needs some trimming to promote root vigor. Place the division in the hole and backfill the hole with loose, fine soil. Avoid tamping the soil with your feet. Instead, build a small, temporary berm around the plant, add water to the basin, and let the water settle the dirt. Check the soil moisture frequently after planting to ensure vigorous growth and establishment.
How do I care for my new divisions?

As always, water is the key to success. When dividing perennials in the fall, make sure to provide adequate water for the newly-planted divisions, as their root systems will not yet be extensive enough to withstand drought. Water every one to two weeks if measurable precipitation has not occurred. Some species will require more water than others. Watch carefully for new growth to help you determine plant health and water needs.

Use a swift, downward movement of a shovel to divide an overgrown clump of perennial plants.
Chapter 15:

PLANTING FROM SEED

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Chapter 15:

PLANTING FROM SEED

While most people may think first of seeding a lawn, many different plants can be grown from seed to vegetate bare or disturbed ground and add aesthetic appeal to the landscape at a relatively low cost. Planting from seed is the least expensive way to rapidly cover a large expanse of ground. Plant cover enhances water quality by stabilizing soil, reducing sediment movement into creeks and rivers, and taking up nutrients, which keeps excesses out of waterbodies.

When is it appropriate to plant from seed?

There are practical uses for planting from seed: lawns, pastures, vegetable and flower gardens, and conservation cover. This chapter will help you successfully seed areas for dust and erosion control in sites such as streambanks, construction zones, or roadside areas. Vegetation cover not only helps protect the area from erosion, but also improves appearance and helps control noxious weeds. For information on seeding pastures, see Chapter 3. Consult a gardening book for information on starting vegetables and flowers from seed.

How do I know which seed mixes are appropriate for my area?

To make decisions about seed mixes, it’s essential to know your soil type and annual precipitation or irrigation availability. Is irrigation water available during establishment, or permanently? What soil limitations exist? A seed mix that is appropriate for California’s heavy clay soils may not be as successful on a hot southern sandy slope in Nevada. Many seed companies sell various pre-formulated mixtures for different climates. It is generally preferable to purchase from local seed vendors who are familiar with all of the specific growing requirements of your area.

You must also consider the purpose of the seeding. Grasses, legumes, and other herbaceous plants provide the best ground cover, but shrubs

![Image: This area was successfully seeded with wildflowers and provides a beautiful landscape accent that requires very little irrigation.](image)
and trees may be needed to add interest to the landscape or provide habitat for a variety of species. In general, try to select either native or adapted species, because they will be more successful. Avoid purchasing commercial generic meadow blends. These are sold nationwide, and are not selected specifically for your area. However, the right choice of wildflowers can add beauty to your planting. Species appropriate for our area include:

- blanketflower (*Gaillardia* spp.),
- brittlebush (*Encelia* spp.),
- butterweed (*Senecio serra*),
- California poppy (*Eschscholtzia* spp.),
- desert marigold (*Baileya* spp.),
- Fremont dalea (*Dalea fremontii*),
- globemallow (*Sphaeralcea* spp.),
- lupine (*Lupinus* spp.),
- phacelia (*Phacelia* spp.),
- purple sage (*Salvia* spp.),
- western coneflower (*Rudbeckia hirta*), and
- wild daisy (*Erigeron* spp.).

Some of these species may need to be started in containers and then transplanted to the site (Chapter 13).

**How much money should I expect to spend?**

It is common to spend about $200 to $300 per acre for a common grass, flower, and shrub seed mix. If you incorporate less common, hand-harvested species, the price will increase accordingly.

**Where can I purchase seed?**

Look in the phone book under “Seed.” There are also many seed catalogs available from various locations around the world, but keep in mind that seed from other areas may be a source of weeds (see Chapter 1).

For sources of inexpensive seed, contact your local Native Plant Society. They may be able to provide information on local seed sources, and most societies have a yearly seed exchange in which you may participate.

**How will my seed arrive, and how do I care for it?**

Seeds come in seed packets or cloth bags depending on the weight of the product. Always keep seeds dry until the time of sowing. If storing on a cement slab floor for any length of time, pick up the bags daily and turn them over to guard against mold formation. Seed also can be attractive to hungry rodents, so the storage area should be kept meticulously clean and pest-proofed.

**When is the best time to plant seed?**

When planting seed mixes for large-scale projects or re-vegetation cover, it is important to remember to:

- Sow seeds anytime up to six weeks before the first frost, or in the late fall (October through November) after frosts have occurred for spring germination. The goal is to allow the seed to remain dormant during winter, and then germinate with the spring moisture.
- Follow directions on seed packets or ask your seed supplier for the best time to plant.
- Consider water availability when deciding on a planting time. Newly sprouted seeds that lack sufficient water will die. Keep them moist, but do not over-water, or they will rot and die.

**How do I prepare the ground?**

The success of your seeding project depends on the effort expended on preparation. Take the time to prepare the bed properly, and you’ll be rewarded with healthy, thriving vegetation.

Start with a weed-free planting bed. Weeds will compete with your tender new seedlings and will decrease their vigor and success. To decrease the population of weeds, water the area regularly and allow the weed seeds to germinate. After sprouting, till the site to disrupt and kill the seedlings. A shuffle-hoe or hula-hoe is an effective method of mechanical removal. **NEVER** use a pre-emergent herbicide prior to seed sowing, as these chemicals prevent the germination of all seeds. More information on weed control is provided in Chapter 1.

Your soil should be loose and friable, not compacted. If you have 2 to 4 inches of loose soil on top of your seed bed, tilling is unnecessary. If, on the other hand, your soil has been driven over by vehicles or used as a livestock corral for many years, it may be necessary to loosen the soil with a rake, a
rototiller or other method to allow good seed-to-soil contact. Be aware, however, that tilling will expose weed seeds that have lain dormant in the soil for years. Weed control is especially important for disturbed soils.

While loosening the soil, smooth and shape the area, and remove any stumps, large rocks, or construction debris. If working in streamside areas, shape the banks to slopes no steeper than 3-to-1. Construct and install permanent irrigation systems, if planned. Information on drip and sprinkler system planning and installation is found in Chapters 7 and 8.

It is best to have soil analyzed to determine fertilizer or amendment needs (Chapter 2). Arid desert areas are often low in fertility and organic matter. Wait to apply nitrogen fertilizers until the first signs of germination are observed. This avoids waste and leaching of nitrogen during the period when plants cannot use it. Other less soluble fertilizers and amendments should be tilled into the soil prior to sowing.

**How do I plant the seed?**

Follow these steps for success:

1. **Calculate the amount of seed needed** for the area, and use the appropriate amount. Do not over-seed. Too much competition will result in crowding and death of some of the less competitive but highly desirable seedlings. Calculate the amount of seed on a pure live seed (PLS) basis. The seed you purchase must be tested before it is sold for its ability to germinate and for its percentage of true-to-type seed. Some species are notoriously poor germinators, and sometimes only 60-70 percent of the seed is viable or not “hard” (alive, with a thick or oil seed coat that resists germination for several seasons). Likewise, the seed you buy may be contaminated with other seed that can’t be removed by cleaning the seed. Calculating the PLS content for your sowing is important so that you don’t underseed and get a poor stand. Don’t just double or triple the rate, or the stand will be too thick, the competition too great, the potential for disease increased, and the planting will fail. Make the following calculation:

   Percent PLS = Percent Germination X Percent of Total Crop Seed
   (seed to be sown in the seed purchased)

   For example, suppose the seed label shows the following content:

   **Wildflower Mix**
   
   **Percent Germination = 95%**
   
   **Contents by percent:**
   
<table>
<thead>
<tr>
<th>Seed Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blanketflower</td>
<td>20%</td>
</tr>
<tr>
<td>California poppy</td>
<td>30%</td>
</tr>
<tr>
<td>Wild strawberry</td>
<td>45%</td>
</tr>
<tr>
<td>Weeds</td>
<td>2%</td>
</tr>
<tr>
<td>Broken seed/chaff</td>
<td>3%</td>
</tr>
</tbody>
</table>

   Then the percent PLS in the wildflower mix is 95 percent germination X 95 percent actual flower seed (eliminating weed and broken seed) = 90.25 percent. If the recommended seeding rate is 4 pounds per 1000 square feet, then 4 pounds divided by .9025 = 4.43 pounds of seed mix needed per 1000 square feet.

   For an acre (43,500 square feet), it would be necessary to apply 4.43 X 43.56 = 193 pounds of seed, rather than the amount calculated by assuming 4 pounds per 1000 square feet is adequate, or 4 X 43.56 = 174 pounds of seed. The difference is substantial at 19 pounds, and is needed to give a 100 percent stand.

2. **Mix seed with sand** or organic matter to increase volume, making it easier to achieve even coverage.

3. **Roughen the soil surface** with a steel landscape rake, and create small furrows.

4. **Divide sand and seed mixture in half** and first sow half of the area in a north/south pattern. Then sow the other half of the mixture in an east/west pattern. This is the best way to achieve an even distribution of seed. A whirly-bird-type spreader will
provide a more even distribution than broadcasting by hand.

5. **Rake to cover the seed** with \(\frac{1}{4}\) to \(\frac{1}{2}\) inch of soil. Avoid deep planting, as this is the most common cause of failure of seeding projects. If necessary, cover with a thin layer of topsoil, sterilized, weed-free organic matter, or steer manure and sand. This will protect the seed from insects and will help maintain soil moisture. On slopes, cover the mulch with a net to keep it in place.

6. **Firm the seed into the soil using a roller or other means.** Good seed-to-soil contact is essential for success.

**What do I do after sowing the seed?**

Adding organic (non-mineral) compost on top of newly seeded areas helps increase seedling germination because it increases the water-holding capacity on the soil surface and provides slow release nutrients. Mulching is especially important on any slope of 3-to-1 or steeper to protect the area from erosion until plant cover is established. Mulching with leaves, weed-free straw, or aged sawdust creates shade and habitat for emerging seedlings. Make sure the covering is not too heavy. A half-inch of manure may be as heavy as 2 inches of leaves. A binder can also be applied to seeded soil at the rate of 1 to 2 pounds per 1000 square feet to help prevent wind-blown erosion and loss of seeds. Some seeds require light to germinate, such as bluegrass, and if covered, they will not germinate.

Watering is the key to success. When seeding during summer or times of drought, supplemental watering is required. To obtain good germination rates during these time periods you must water enough to keep the soil surface moist at all times, but not water logged. Follow the schedule provided below.

**Watering Schedule for Seed Establishment**

- Apply water two or three times per day for first three weeks, or as needed to keep the soil surface moist.
- Apply water once a day for the next three weeks. The goal at this point is to encourage deeper root growth.
- After the first six weeks, water two to three times per week for one month, then one time per week for another month, then two times per month until the first hard frost occurs.
Chapter 16:

TAMING THE WILD WINDS:
DESIGN, INSTALL, AND MAINTAIN A WINDBREAK

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Chapter 16:

TAMING THE WILD WINDS:
DESIGN, INSTALL, AND MAINTAIN A WINDBREAK

If there’s one dependable feature in Northern Nevada weather, it’s the prevalence of windy conditions. Taming the howling winds produces many benefits, from decreasing soil erosion to reducing energy costs and water consumption. Windbreaks are rows of trees or shrubs that provide a buffer to reduce the force of the wind. A well-designed windbreak will achieve multiple benefits, including privacy, dust control, noise reduction, and increased property values.

There are many reasons for planting a windbreak. Trees which lose their leaves in the fall, called deciduous trees, that are planted on the south and west sides of a house provide welcome shade by blocking more than 75 percent of the sun’s rays in summer. It’s been estimated that the cooling effect of one mature deciduous tree is equal to 10 room-sized air conditioners. In winter, when the leaves have fallen, sunshine will warm your house for free.

Trees and shrubs can also be used to buffer against cold winter winds or channel cooling summer winds. Planting a windbreak will make life more comfortable for you and your animals, and will reduce your heating and cooling bills. It has been estimated that windbreaks can reduce

The Benefits of Windbreaks
♦ Reduced soil erosion
♦ Reduced irrigation needs
♦ Increased shade and shelter for livestock and pets
♦ Reduced food needs for livestock health
♦ Increased property values
♦ Privacy for home and family activities
♦ Reduction of traffic and other noise
♦ Protected landscape plants
♦ Reduced heating and cooling costs
♦ Increased wildlife habitat

A properly designed windbreak provides food and shelter for wildlife.
winter fuel consumption by 10 to 30 percent. Windbreaks also protect other landscape plants from severe exposure and dehydration. They ameliorate the effects of climate and create microclimates suitable for a wider variety of plants.

Plants used as foundation plantings that block the wind may also prevent heat loss by adding a layer of insulating “dead” air around buildings. If evergreen shrubs are used around the north, east, and northwest sides of a home, and deciduous shrubs used on the south and southwest, the sun will be blocked in summer and the wind blocked in winter.

Livestock and pets benefit from windbreaks by using them for shade in the summer and shelter in the winter. Windbreaks can actually reduce the amount of food livestock require by moderating temperatures. Wildlife likewise benefit from windbreak plants that provide them with valuable cover, nesting areas, and food, especially during the snowy winter months.

Windbreaks also help to protect water quality by decreasing soil erosion. Strong winds are moderated, so they no longer pick up soil particles, and less soil moisture is lost as a result of decreased evaporation. Moist soils are less likely to be disturbed by winds, and fewer sediments end up contaminating water supplies.

**What’s the most effective design for a windbreak?**

Careful planning is the single most important factor in designing a windbreak. A well-designed and well-maintained windbreak is useful and beautiful. If you don’t carefully consider the site and terrain characteristics, however, your established windbreak may become a liability rather than an asset.

Start by drawing a sketch of the site’s physical features, including the direction of prevailing winter and summer seasonal winds; the location of existing trees; hard structures such as house, shed, or fence; property lines and utilities; and areas where there may be soil problems that could limit the establishment of your vegetation. Then determine the optimal location for your windbreak by following these guidelines:

1. Sketch the position of the windbreak on your plan.

For wind protection, position the row containing the tallest growing tree species about two to five times the mature tree height from the primary area or object needing protection. Use the estimated height (H) of the tallest tree species at 20 years of age for planning purposes. Since wind reductions from a windbreak can be measured up to 30 x H from the windbreak, your protected zone will be more than sufficient.

Position the planting as perpendicular as

**Example:**
Assume your tallest tree species is Austrian Pine. At 20 years, the trees may have reached 50 feet in height (H). The row of trees should be placed from 100 feet (2 x H) to 250 feet (5 x H) from the area to be protected.
possible to troublesome winds or noise for the best effect. All areas in need of wind protection should be located within 10 x the height of the tallest tree row. Draw the approximate location of the windbreak on your diagram. Because wind tends to bend around the ends of a barrier, extend the windbreak as far as possible beyond the area it is meant to shelter. To be most effective, the windbreak length should be at least 10 x H, and gaps that might funnel the winds should be avoided.

2. Determine the density of vegetation and number of rows needed to serve your purpose.

The number of rows you plant depends upon the density of the specific species of trees and shrubs you choose to plant. Windbreak density is the ratio of the solid portion of the barrier to the total area of the windbreak. You can judge density by the amount of light that can be seen through the leaves, twigs and branches along a windbreak’s face. If light appears to be spread evenly throughout half of the face, the density is medium. If light can be seen through more or less than half of the face, its density is low or high, respectively. A deciduous tree in full leaf has a density of 65 percent or greater, but once the leaves have been shed, the density will drop to 30 to 65 percent, depending on the number of branches and the branching pattern. Evergreen trees are often used for windbreaks because they provide the same protection in winter and summer.

Most of us might think that a solid windbreak would provide the most protection. Instead, high-density windbreaks can create wind turbulence on the lee side that can cause damage. A windbreak with medium density will actually protect the largest area of land by reducing wind speed over the greatest distance.

The number of rows you plant depends on the desired density. More rows will create a more

### Approximate Within-Row Spacing Requirements

<table>
<thead>
<tr>
<th>Type of Shrub/Tree</th>
<th>Single-row plantings</th>
<th>Multiple-row plantings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small shrubs (less than 10 feet tall)</td>
<td>3 to 6 feet</td>
<td>3 to 6 feet</td>
</tr>
<tr>
<td>Large shrubs (more than 10 feet tall)</td>
<td>5 to 8 feet</td>
<td>5 to 8 feet</td>
</tr>
<tr>
<td>Evergreen trees</td>
<td>6 to 16 feet</td>
<td>8 to 18 feet</td>
</tr>
<tr>
<td>Medium deciduous trees (less than 25 feet tall)</td>
<td>6 to 10 feet</td>
<td>8 to 14 feet</td>
</tr>
<tr>
<td>Tall deciduous trees (more than 25 feet tall)</td>
<td>6 to 12 feet</td>
<td>8 to 18 feet</td>
</tr>
</tbody>
</table>
dense windbreak. In most cases, if the goal is to provide wind protection, a single row of trees is sufficient. However, because trees and shrubs are subject to insect and disease problems, the recommended minimum design is two to three rows, with each row consisting of a different species. Planting a variety of species and rows improves wildlife habitat and landscape aesthetics and reduces the potential for disease and insect damage.

3. Plan the row arrangement.

To be effective, shrubs, short trees, and slower growing trees should generally be located in the outer rows. They should not be positioned between two taller-growing species, as shown in the picture at the top left. Placing them in the outer rows provides them with adequate light and allows room for plant development.

4. Determine the within-row spacing.

Adequate spacing of trees and shrubs in the windbreak is essential for proper plant development and long-term health. Each species has its own spacing needs. Some deciduous trees have a narrow, columnar shape, and will need as little as 6 feet of space. General spacing requirements are found in the table at the bottom of the previous page.

Remember that crowding trees together causes a loss of vigor due to severe competition among the trees as they grow to mature size. Crowded plantings are also more susceptible to losses from insects, diseases and drought. Lower limbs die out early from too much shade in an overcrowded planting, making the windbreak less effective.

5. Determine the between-row spacing.

Between-row spacing depends on the mature size of the vegetation and the method you choose to maintain the planting. If you’re planning to use mechanical cultivation to control weeds, plan enough space to allow passage of the cultivation equipment, often 16 feet. In general, row spacing of 12 to 20 feet will allow sufficient space for mature tree size, but will also provide ground shading that may help to control weeds.

6. Design an irrigation system.

Next, you’ll need to plan your irrigation system. In most cases, a drip system will be the most efficient and trouble-free method of irrigation. Read Chapter 10 for information on designing an effective drip system. Remember that as the plants mature, you will need to reposition the drip emitters to match their root growth.
zones, and you’ll need to provide more water.

7. Select the plant materials suitable for your area.

Finally, you’re ready to select plant species for your windbreak. The species you select must be adapted to the planting site, provide the desired density, and have the potential to provide a reasonable amount of protection. Prior to selecting species, test your soil to determine texture, fertilizer needs, and drainage (see Chapter 2). Next, consider the following requirements:

♦ Plants must grow and block the wind;
♦ they must thrive in your specific USDA climate zone (zone 5–6 for Reno, Nevada); and
♦ they must be pleasing additions to your overall landscape plan.

A list of plant species suitable for use in Northern Nevada windbreaks is provided at the end of the chapter to aid in the planning process. The following information is provided to explain the categories in the plant list:

♦ Growth rate: Relative rate of growth after establishment. Fast means an average of 3 feet or more per year; slow means less than 1 foot of growth per year.

♦ Life span: An expression of longevity. Long means the plant lives more than 150 years; medium from 25 to 150 years; and short, less than 25 years.

♦ Shade tolerance: How will the tree perform as the canopy grows and shades itself? A low rating suggests a species will have low vigor and eventually die when shading becomes moderate to heavy. A high rating indicates a species will perform well under heavily shaded conditions.

♦ Through-the-crown density: An estimate of the amount of viewing area through the crown. Low density means 25 percent or less of an object being viewed is obstructed by the crown. Medium indicates 25 to 65 percent of an object is obstructed, and high indicates more than 65 percent of an object being viewed is obstructed by the crown.

♦ Spread: Will the species reproduce and spread under Great Basin growing conditions? “N” indicates the species is not likely to easily spread; “S” indicates the ability to spread by natural seeding; “V” means the species has the ability to spread by root suckers.

♦ Drought tolerance: A relative estimate of a tree’s ability to survive long periods with neither rainfall or nor supplemental irrigation after establishment.

♦ Wetness tolerance: Saturation tolerance level for areas where the soil is saturated close to

Appropriate types of vegetation must be planted in multiple-row plantings for effective wind control.
land surface for most of the year. A high tolerance classification means the plant can withstand saturation at the 3.5-foot depth or higher; medium means the water table should remain at or below 3.5 feet; and low means the water table should be well below the root zone of the plant.

♦ **Cold hardiness:** The natural ability of a tree to withstand cold temperatures. A high hardiness rating means the tree can sustain itself in well below-freezing temperatures for extended periods of time. Medium means a tree will likely be damaged by below-freezing temperatures. Low means a tree may be killed or severely damaged by extended below-freezing temperatures.

♦ **Soil pH tolerance:** A measurement indicating the soil condition in which the plant will grow best. Acid soils have pH of 6.5 or less; neutral soils have pH 6.5 to 7.5; alkaline soils have pH 7.5 or more.

8. **Plant carefully using the appropriate techniques for your plant materials.**

Your windbreak is a major, long-term investment that may increase property values as well as provide wind protection. Careful site preparation and planting will ensure your investment pays off for many years. Consult Chapters 8 through 14 for instructions on planting methods and maintenance.

9. **Maintain the windbreak into the future.**

Maintenance is the key to a long-lasting, effective windbreak. In addition to the maintenance information provided in Chapter 14, the following elements may be necessary to maintain a windbreak’s efficiency:

♦ **Continue to control weeds aggressively.**
Weeds steal moisture and nutrients and reduce the growth and vigor of desirable vegetation. Read Chapter 1 for more information on creating a weed management plan.

♦ **Protect the windbreak from livestock.**
Livestock browse the leaves, break off branches, compact the soil, and reduce the density of the lower growing portions of the windbreak. Weeds and grass creep into these openings, and the windbreak becomes less effective. If possible, construct a fence 8 to 10 feet away from the trees and shrubs. This will allow your young vegetation to grow undisturbed, and the livestock will still reap the benefit of shade and wind protection.

♦ **Resist the urge to prune windbreak trees to look like residential yard trees.** Remember that the effectiveness of a windbreak depends on the overall structure of the windbreak, and not on the shape of any individual tree. In most cases, avoid pruning unless a limb dies, or there is a very specific reason, such as damage by ice, wind, animal grazing, or bird roosting. Inspect yearly to look for damaged or deformed trees. See Chapter 10 for more information on pruning.

♦ **Thinning is an essential component of maintenance.** If you have spaced the young trees close together for immediate benefit, as the trees grow, their crowns will begin to touch and intermingle. By removing every second tree, you’ll prevent the branches on the remaining trees from dying. This selective thinning may be required several times as the windbreak matures. The goal is to avoid the loss of lower branches on all the trees, thus decreasing the effectiveness of the windbreak.

♦ **Replace dead trees as needed** to maintain the integrity of the windbreak. Dead trees leave gaps that funnel the wind and create more problems than exist in unprotected areas. Even the healthiest windbreak will not last forever. Make plans to replace your windbreak vegetation before gaps become troublesome.
## Evergreen Trees for Windbreak Plantings

<table>
<thead>
<tr>
<th>Species</th>
<th>Growth Form (crown shape)</th>
<th>Growth Rate</th>
<th>Life Span</th>
<th>Shade Tolerance</th>
<th>Through-the-Crown Density</th>
<th>Drought Tolerance</th>
<th>Wetness Tolerance</th>
<th>Cold Hardiness</th>
<th>Soil pH Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona cypress <em>Cupressus arizonica</em></td>
<td>Pyramidal</td>
<td>Med</td>
<td>Med</td>
<td>Long</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>N</td>
<td>High</td>
</tr>
<tr>
<td>Blue spruce <em>Picea pungens</em></td>
<td>Pyramidal</td>
<td>Slow</td>
<td>Slow</td>
<td>Long</td>
<td>Med</td>
<td>High</td>
<td>High</td>
<td>N</td>
<td>High</td>
</tr>
<tr>
<td>Giant sequoia <em>Sequoiadendron giganteum</em></td>
<td>Pyramidal</td>
<td>Fast</td>
<td>Med</td>
<td>Long</td>
<td>Low-Med</td>
<td>High</td>
<td>High</td>
<td>N</td>
<td>Low</td>
</tr>
<tr>
<td>Norway spruce <em>Picea abies</em></td>
<td>Pyramidal</td>
<td>Slow</td>
<td>Med</td>
<td>Long</td>
<td>Med</td>
<td>High</td>
<td>High</td>
<td>N</td>
<td>Med</td>
</tr>
<tr>
<td>Rocky Mt. Juniper <em>Juniperus scopulorum</em></td>
<td>Pyramidal</td>
<td>Slow</td>
<td>Med</td>
<td>Long</td>
<td>Low-Med</td>
<td>High</td>
<td>High</td>
<td>N</td>
<td>High</td>
</tr>
<tr>
<td>Singleleaf pinyon <em>Pinus monophylla</em></td>
<td>Pyramidal</td>
<td>Slow</td>
<td>Slow</td>
<td>Long</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>N</td>
<td>High</td>
</tr>
</tbody>
</table>
# Deciduous Trees for Windbreak Plantings

<table>
<thead>
<tr>
<th>Species</th>
<th>Growth Form (crown shape)</th>
<th>Growth Rate</th>
<th>Life Span</th>
<th>Shade Tolerance</th>
<th>Through-the-Crown Density</th>
<th>Soil pH Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black locust</td>
<td>Irregular</td>
<td>Med</td>
<td>Med</td>
<td>Long</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Robinia pseudoacacia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Golden willow</td>
<td>Globose</td>
<td>Fast</td>
<td>Fast</td>
<td>Med</td>
<td>Low</td>
<td>Med</td>
</tr>
<tr>
<td>Salix alba var. vitellina</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Green ash</td>
<td>Globose</td>
<td>Med</td>
<td>Med</td>
<td>Long</td>
<td>Low</td>
<td>Med</td>
</tr>
<tr>
<td>Fraxinus lanceolata</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hackberry</td>
<td>Irregular</td>
<td>Med</td>
<td>Med</td>
<td>Long</td>
<td>Low</td>
<td>Med</td>
</tr>
<tr>
<td>Celtis occidentalis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Honey locust</td>
<td>Irregular</td>
<td>Slow</td>
<td>Med</td>
<td>Med</td>
<td>Low-Med</td>
<td>Med</td>
</tr>
<tr>
<td>Gleditsia triacanthos</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Russian olive</td>
<td>Irregular</td>
<td>Fast</td>
<td>Med</td>
<td>Med</td>
<td>Low</td>
<td>Med</td>
</tr>
<tr>
<td>Elaeagnus augustifolia</td>
<td></td>
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<td></td>
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<tr>
<td>Manchurian crabapple</td>
<td>Globose</td>
<td>Med</td>
<td>Med</td>
<td>Long</td>
<td>Low</td>
<td>Med</td>
</tr>
<tr>
<td>Malus baccata mandshurica</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Siberian elm</td>
<td>Globose</td>
<td>Fast</td>
<td>Fast</td>
<td>Med</td>
<td>Low</td>
<td>Med</td>
</tr>
<tr>
<td>Ulmus pumila</td>
<td></td>
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</tbody>
</table>
## Shrubs for Windbreak Plantings

<table>
<thead>
<tr>
<th>Species</th>
<th>Growth Form (crown shape)</th>
<th>Growth Rate</th>
<th>Life Span</th>
<th>Shade Tolerance</th>
<th>Through-the-Crown Density</th>
<th>Soil pH Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Early</td>
<td>Later</td>
<td>Winter</td>
<td>Summer</td>
<td>Spread</td>
<td>Drought Tolerance</td>
</tr>
<tr>
<td>Big sagebrush&lt;br&gt;Artemisia tridentata</td>
<td>Vase-shaped</td>
<td>Med</td>
<td>Med</td>
<td>Long</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Bladder senna&lt;br&gt;Coleata arborescens</td>
<td>Irregular</td>
<td>Slow</td>
<td>Med</td>
<td>Med</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>European sage&lt;br&gt;Artemesia abrotanum</td>
<td>Vase-shaped</td>
<td>Med</td>
<td>Med</td>
<td>Short</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>
## Shrubs for Windbreak Plantings
(continued)

<table>
<thead>
<tr>
<th>Species</th>
<th>Growth Form (crown shape)</th>
<th>Growth Rate</th>
<th>Life Span</th>
<th>Shade Tolerance Winter</th>
<th>Summer</th>
<th>Spread</th>
<th>Drought Tolerance</th>
<th>Wetness Tolerance</th>
<th>Cold Hardiness</th>
<th>Soil pH Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rabbitbrush Chrysothamnus nauseosus</td>
<td>Vase-shaped</td>
<td>Fast</td>
<td>Med</td>
<td>Low</td>
<td>Med</td>
<td>High</td>
<td>N</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Siberian peashrub Caragana arborescens</td>
<td>Vase-shaped</td>
<td>Fast</td>
<td>Med</td>
<td>Low</td>
<td>Med</td>
<td>High</td>
<td>N</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Skunkbush sumac Rhus trilobata</td>
<td>Irregular</td>
<td>Med</td>
<td>Med</td>
<td>Low</td>
<td>Med</td>
<td>High</td>
<td>N</td>
<td>High</td>
<td>High</td>
<td>Acid N Alkaline</td>
</tr>
<tr>
<td>Woods rose Rosa woodsii</td>
<td>Vase-shaped</td>
<td>Med</td>
<td>Med</td>
<td>Low-Med</td>
<td>High</td>
<td>High</td>
<td>V</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>
References and Further Reading


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