

Climate Ready Landscapes:

A Reference Guide

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Photo by Delani Wood

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Part One: Background and Introduction

Historic Objectives of American Landscapes

Lawns are typically understood today as expanses of closely mown perennial grass, often seen on golf courses, parkways, and in suburban yards. They originally came about as examples of status and wealth in early European society, showcasing the resource and labor surplus needed to grow a purely aesthetic crop with no productive value. Eventually, turf lawns worked their way into the lives of the American middle class. The invention of the lawnmower coupled with the rise of subsidized suburban dwellings and inexpensive fertilizers led to the mass production of residential and commercial turf lawns. The rise of marketing campaigns for lawn care products eventually intertwined the American Dream with the vision of a well-manicured lawn.

However, incorporating a widespread monoculture crop around single family homes has had profound effects on the environment. To maintain their uniform and green appearance, lawns generally require intensive management and resources including fertilizers, pesticides, and water for irrigation. Nerve agents and explosives developed in World War II were later converted for home and lawn use as insecticides and synthetic nitrogen fertilizers. Despite the uproar from nature conservationists following Rachel Carson's publication of *Silent Spring* in 1962, Americans continue to dump 80 million pounds of chemical fertilizers and pesticides onto their lawns every year, contaminating groundwater and causing nitrogen runoff and eutrophication of surface water bodies¹.

Despite 44% of the contiguous United States falling into the moderate to extreme drought categories at the end of July 2022², homeowners continue to use on average between 50-70% of their household water consumption for outdoor lawn irrigation³. This comes out to an estimated nine billion gallons every day⁴. Over 40 million acres of turf grasses occupy 1.9% of the land surface of the continental United States, making it the largest irrigated crop in the country, covering three times as much land area as irrigated corn⁵. Not only do monoculture crops invite insect pests and diseases, but the maintenance required to mow and maintain these landscapes are wasteful and emit harmful greenhouse gasses into the atmosphere⁶. Americans use up to 800 million gallons of gasoline per year just to mow their lawns. At least 17 million of those gallons are attributed to spills while filling lawn equipment (this adds up to more than the Exxon Valdez oil disaster, every single year)⁷.

Objectives for Climate Adaptation and Biodiversity Loss

¹ Robbins, Paul. Encyclopedia of Environment and Society. Sage Publications, 2007.

² National Centers for Environmental Information. "July 2022 Drought Report." July 2022 Drought Report | National Centers for Environmental Information (NCEI), 2022

³ Ogle, Dan, et al. "Lawn Watering Guide - USDA." Plant Materials Program.

⁴ US EPA. "Start Saving." EPA, Environmental Protection Agency.

⁵ Milesi, Cristina et al. "Mapping and modeling the biogeochemical cycling of turf grasses in the United States." Environmental management vol. 36,3 (2005): 426-38.

doi:10.1007/s00267-004-0316-2

⁶ Banks, Jamie L, and Robert McConnell. "National Emissions from Lawn and Garden Equipment - US EPA." EPA, 2015.

⁷ Robbins, Paul. Encyclopedia of Environment and Society. Sage Publications, 2007.

Expanding urgencies for climate change mitigation and biodiversity protection are enhancing the need to reconsider land use objectives at multiple scales. In the American southwest, temperatures are projected to increase by 3.7 to 8.6 degrees fahrenheit between the years 2036-2100⁸. Warmer winters may amplify existing stressors to ecosystems such as the introduction and proliferation of invasive species, insect pests, and plant pathogens⁹. Precipitation will be more variable year-to-year, with a higher frequency of intense precipitation events¹⁰. Reduced snowpack and more frequent drought are also predicted¹¹.

Current landscape management practices are responsible for numerous detrimental actions toward natural systems including carbon emissions from gas powered lawn equipment, widespread biodiversity loss from pesticide and herbicide use, and the reduction of soil health through poor soil management. Transitioning the 40 million acres of irrigated turf in the U.S. to regionally appropriate, ecologically-based landscaping will enhance healthy soils that store water instead of using it, provide biodiverse plantings to support insects and wildlife, and protect people and the environment from the impacts of synthetic chemicals and extremities of climate change.

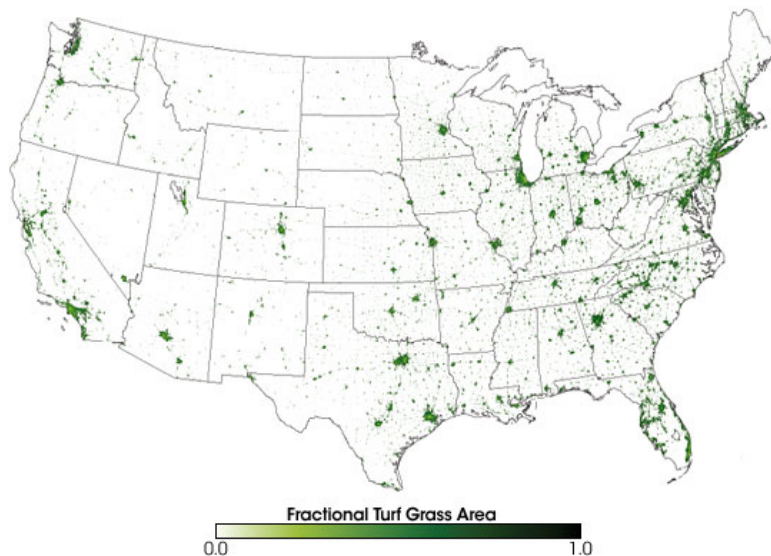


Photo by NASA Earth Observatory

Irrigated turf makes up almost 2% of land cover in the continental US. If all this land were condensed into one place, it would cover an area approximately the size of Florida.

What are “Climate Ready Landscapes”

⁸ USGCRP, 2017: Climate Science Special Report: Fourth National Climate Assessment, Volume I [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 470 pp.

⁹ Joyce, Linda A, and Steven W Running. “Forests.” National Climate Assessment.

¹⁰ Easterling, D R, et al. “Climate Science Special Report: Precipitation Change in the United States.” Precipitation Change in the United States - Climate Science Special Report, 2017.

¹¹ Reidmiller, D R, et al. “Fourth National Climate Assessment: Chapter 25: Southwest.” NCA4, 1 Jan. 1970.

Climate Ready Landscapes, for the purpose of this resource guide, are areas in which land use decisions prioritize ecosystem health and resiliency in ways that enhance the ability of these landscapes to protect human communities from intensifying climate change impacts. These landscapes maintain or enhance cooling, aid in storm water absorption, prioritize biodiversity, increase air quality, and provide fire risk mitigation. The concept of Climate Ready Landscapes came as a response to the increasing impacts of global climate change being experienced locally and the need for more widespread nature-based climate solutions. Developing Climate Ready Landscapes at multiple scales across the city gives an opportunity to proactively utilize land management for building resilient and regenerative communities.

The literature reviewed for the formation of this guide came mainly from reports on native landscaping and biodiversity habitats, green infrastructure project implementation, and nature based climate solutions. Themes include:

- Prioritizing Locally Adapted Species - Plants native to the region in which they evolved are better adapted to the climate and provide more services to native pollinators and invertebrates than nonnative vegetation. Species invasive to the region should be avoided and when seen, pulled early and often.
- Incorporating Green Infrastructure - In contrast with gray infrastructure - systems of gutters, pipes, and tunnels - designed to move stormwater away from an area as quickly as possible, green infrastructure is designed to capture and absorb rainwater where it falls, allowing for more natural infiltration into the water table and less demand on stormwater systems. Green infrastructure uses a combination of plant or soil systems, permeable pavements, stormwater harvest or reuse, and landscaping to store, infiltrate, and reduce stormwater flows to sewer systems or water bodies.
- Investment in Nature Based Climate Solutions - defined as “actions to protect, sustainably manage, and restore natural and modified ecosystems... simultaneously benefiting people and nature”, nature based climate solutions are aimed at targeting major challenges like climate change, disaster risk reduction, food and water security, biodiversity loss and human health, and are critical to sustainable economic development¹².

Purpose of this Guide

This guide was designed as an internal facing document, guiding the City of Boulder on landscape management decisions with the intent to:

- Build resilient ecosystems and community against climate change and biodiversity loss
- Mitigate negative effects from urban heat and extreme weather events
- Provide beneficial ecosystem services to the community

The findings from this report will help inform potential policy development intended to expand the use and adoption of the approaches discussed in this guide.

This guide will include desired characteristics of Climate Ready Landscaping, a photo gallery to showcase various combinations of these characteristics, followed by an opportunities for implementation section that includes associated partnerships in the area.

¹² “Nature-Based Solutions.” IUCN, <https://www.iucn.org/our-work/nature-based-solutions>.

While Climate Ready Landscapes can mitigate some of the problems caused by climate change and biodiversity loss, it is important to note that land management practices must be paired with a broader set of actions for systems change. This includes updates to land use policy, alternative transportation, renewable energy systems, and a shift away from a consumption-based economy towards a more circular and regenerative system. These conversions must take place rapidly, with significant progress occurring in the next 10 years, to maintain a livable world into the next century.

Climate Ready Landscape planning is meant to guide toward a future in which:

- Decision makers view urban land management as an opportunity to address the consequences of climate change, environmental injustice, and biodiversity loss by proactively utilizing landscapes to create a greener, healthier, and more resilient city.
- Projects are implemented through a lens of equity and climate justice, distributed across the city in a way that is best suited to the needs of both the natural ecosystem and the human populations who have been historically marginalized and underserved in the community.
- Holistic ecosystem health is integrated into all levels of land policy, planning, and maintenance. Adequate ecological training is provided for the design, conversion, and management of all Climate Ready landscape sites. Site care is viewed as stewardship of the land, rather than total conquest of it.



Photo Credit: EPA

Green Infrastructure and Climate Ready Landscaping in the Semi-Arid West, Rooftop parking lot garden at Denver REI store.

Part Two: Climate Ready Landscapes in Boulder, Colorado

The following section outlines objectives to be prioritized in creating and managing Climate Ready Landscapes. Additional considerations and examples of well adapted plant species are included within the objectives. Recommendations are meant to serve as examples only, and should by no means be the only plants sourced or techniques utilized when designing a landscape. Biodiversity is key to creating healthy ecosystems that can withstand pests and disease, and additional, more robust plant lists are provided in the appendix of this document. Native and regionally adapted varieties should be prioritized, while invasives and plants not suited to the climate are to be avoided. Climate Ready Landscapes can appear in many ways, and mimicking naturally occurring landscapes is a good guiding principle to keep in mind.

Boulder is host to numerous ecological zones, which results in some difficulties with broad plant recommendations. A team of experts from Colorado State University, the Butterfly Pavilion Horticultural Program, and the Xerces Society are developing lists specific to each zone that will include maintenance guidelines for optimizing for characteristics such as habitat value, water retention, and soil health. These additional lists will provide invaluable supplemental guidance to this reference guide.

General Considerations and Planning

Before deciding on desired characteristics of a site's Climate Ready Landscape, a few general considerations are to be noted:

1. Make a Site Specific Plan
 - Soils, drainage, sun exposure, intended use, fire risk, and water access all heavily influence the types of landscapes recommended in a given area. Working with the built environment and taking time to observe the existing landscape and leverage its natural processes can save many future hassles and failures. Be mindful of how plants will grow, change, and respond to their environment and resources. Certain recommendations throughout the guide may seem contradictory (tree canopy vs fire risk, avoiding herbicides vs ease of large grass extermination), and tradeoffs will have to be considered based on desired characteristics for each landscape.
2. Prioritize a Healthy Soil Microbiome
 - The importance of soil health is becoming ever more present in both scientific literature and land stewardship. Microbes living in the soil provide essential health services to plants through nutrition and immune system support and are the foundation of a thriving landscape. Prioritizing an environment supportive of these organisms will produce dividends in cost savings on inputs like pest control, fertilizers, and vegetation replacement.
3. Watering and Continued Maintenance
 - Climate Ready Landscapes have different landscaping requirements than traditional turfgrass lawns. Most plants require higher water inputs during the establishment phase of about 3-6 months, with those needs decreasing over time. Reduced needs for fertilizer and herbicides are also expected. Trees require a higher water and time commitment than smaller vegetation, though the benefits received, such as urban greening and reduced heat island effect, have

been shown to outweigh the costs of maintenance. Long-term tree survival should be prioritized during droughts and considered when making landscaping decisions.

4. Cultivate Community Support

- Humans will also benefit from Climate Ready Landscapes, and engaging the community throughout the entire process, from planning to maintenance, is the best way to ensure ongoing success. Supporting communities, particularly those traditionally underserved and with limited resources, to promote resource dissemination, peer-to-peer learning, and materials sharing will help shift the culture of landscape management at a grassroots level, garnering support and easing the transition to more regenerative land use policies and practices.

Climate Ready Landscape Objectives

Shade and Evapotranspirative Cooling

Quick Summary:

- All plants, especially trees, offer cooling benefits.
- Trees require long term commitment and higher water consumption than other native vegetation.
- Diversity of species is important to protect against pests and disease.

Surface land cooling can be achieved either through shade or evapotranspiration provided by living plants. Studies show that shade from tree canopy cover will be essential in maintaining liveable areas and combating urban heat island effect into the future. Where environmental conditions prohibit planting of trees, structures within the built environment may be optimized for shade such as awnings, buildings, or canopies. Trees not only provide shade, but serve as valuable habitat for birds and insects. They also sequester and store carbon within their biomass, provide economic benefit, and can be repurposed into lumber and chipboard products at end-of-life. Although growing trees in this climate is considered “harsh”, our livelihoods depend on it, especially in a hotter future climate. Shade from trees planted on the south or west sides of a building can aid in cooling costs during summer months while also protecting soil microbes, insects and pollinators from strong sun and winds.

When sourcing trees, it is important to keep diversity in mind. Creating monocultures of crops in any given area makes them more prone to disease and pests, such as the Emerald Ash Borer. Trees require significantly more water than other Climate Ready Landscape options, and it is recommended to water 10 gallons per inch of trunk diameter weekly for small trees, and 15 gallons per inch of trunk diameter twice a month for large trees during drought conditions¹³. Watering along the tree’s drip line will ensure all the critical root zone has access to water and avoiding turf above tree roots ensures less competition for resources. Thick mulching or low lying ground cover plants are instead recommended to retain soil moisture. Shade-loving native plants are often difficult to find, but regionally adapted varieties of partial sun and groundcover plants can be sourced from local nurseries.

The City of Boulder offers a street tree planting program for residents looking to commit to tree support and maintenance over an extended period of time. Robust root systems require

¹³ Community Tree Alliance. “A Guide to Tree Care During Drought Years.” City of Boulder.

tree siting to be carefully considered to avoid disruption of nearby infrastructure or utilities. In fire prone areas, Firewise landscaping needs to be considered during siting and maintenance; tree canopies are recommended not to be within 30 feet of a structure, with breaks between mature canopies and well pruned up to 10 feet off the ground to minimize fuel for fires. For more information on Firewise landscaping, see the section *Fire Resistance* below.

Popular tree varieties in Boulder include maples, fruit trees, chokecherries, and oaks¹⁴. Trees that can withstand drought, do not have flammable resins, and are more tolerant to summer high heat are favored for Climate Ready Landscapes. Further plant lists are provided in the appendix of this guide.



Photo by Community Tree Alliance
A tree's critical root zone, shown in the box above

Fire Resistance

Quick Summary:

- An increasing number of Coloradans live in fire prone areas.
- Home hardiness and a tidy landscape with frequent breaks in vegetation reduces fuel loads and structure fire risk.
- How and where you plant is more important than what you plant. While no vegetation is completely “fire-proof”, lists of fire resistant species are included in the appendix.

More than half of Colorado residents live in the Wildland-Urban Interface (WUI) and are at some risk of being affected by wildfire¹⁵. This region and its vegetation have coevolved with fire for millions of years, and recent historic regimes of fire suppression have caused a build up of fuel along the Front Range. For structures within the WUI, strategic actions can be taken to protect the home from fire risk.

¹⁴ “Best Trees for Boulder.” City of Boulder, 2022, <https://bouldercolorado.gov/best-trees-boulder>.

¹⁵ CSFS WUI Risk Assessment 2017

The most effective proactive step homeowners can take to protect their property from wildfire is to maintain a defensible space within their landscape. City of Boulder Fire-Rescue categorizes the home zone as the home (or structure) itself and the area immediately surrounding it, from 0-5 feet. This zone requires the most vigilant maintenance to prevent structure ignition. Gutters and yards should be regularly cleaned of any debris, and covering vents with a metal screen will prevent embers from entering the home.

5-30 feet from the home is the transitory area where fuels should be reduced to minimize a fire's intensity, with the most effective fire mitigation efforts completed 5-10 feet from a structure. This includes choosing noncombustible building materials such as concrete, flagstone, or rock for the structure itself, including any fences, decks, siding, or roofs attached to the home. Stone pathways and gaps in vegetation can prevent fires from spreading.

Grass lawns should be well-mowed to a maximum of 8 inches, with low flammable plantings planted individually or in small clusters with frequent breaks. Tree branches should be trimmed away from buildings and lower branches pruned 10 feet from the ground. Tall shrubs under trees are to be avoided as there is potential for them to become "ladder fuels" and allow fire to climb into tree canopies, where fires are much harder or impossible to control¹⁶.

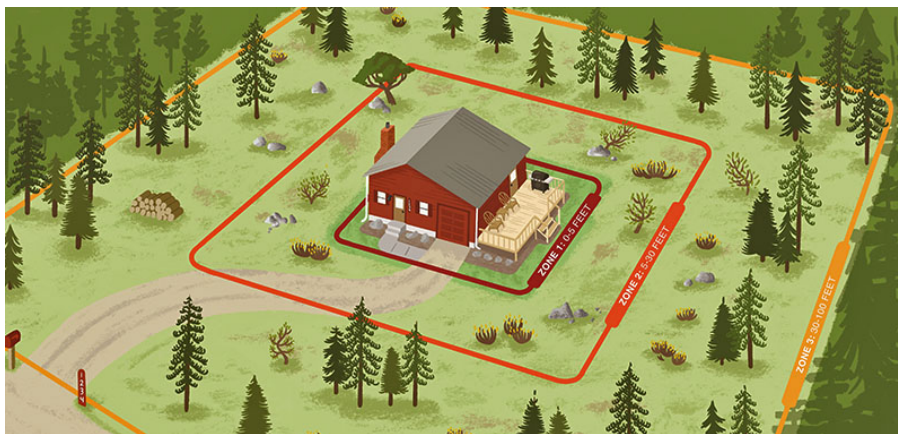


Photo by Colorado State Forest Service

Defensible Space and the Home Ignition Zone for FireWise landscape maintenance.

Deciduous trees that shed their leaves in the fall and broadleaf evergreens are usually more fire resistant than conifers since their leaves hold water, and will char or shrivel rather than ignite when exposed to high heat. Conifers, on the other hand, have a high resin content that ignites quickly and burns hot, so it should be avoided near homes. Fruit trees are also relatively fire-safe; California wildfire crews are even trained to utilize orchards as natural firebreaks¹⁷. Fruiting trees have been known to attract bears, therefore should be planted with caution where wildlife activity is a concern.

¹⁶ United States, Fire Rescue, et al. Wildland Fire Preparedness Guide, City of Boulder Fire Rescue, 2022, pp. 1–8.

¹⁷ Egbert, Dave. "Trees in the Fire-Safe Landscape." Pacific Horticulture, 5 Aug. 2013.

CSU's extension office FireWise plant material list states that plants more resistant to wildfire have one or more of the following characteristics¹⁸:

- They grow without accumulating large amounts of combustible dead branches, needles or leaves (example: aspen*).
- They have open, loose branches with a low volume of total vegetation (examples: currant and mountain mahogany).
- They have low sap or resin content (examples: many deciduous species).
- They have high moisture content (examples: succulents and some herbaceous species).
- They grow slowly and need little maintenance (do not need frequent pruning).
- They are short and grow close to the ground (examples: wildflowers and groundcovers).
- They can resprout following fire, thus reducing re-landscaping costs (example: aspen*).

* Certain Front Range tree planting lists advise against planting aspens due to their easily spreading nature. Be mindful of this when choosing a desired species.

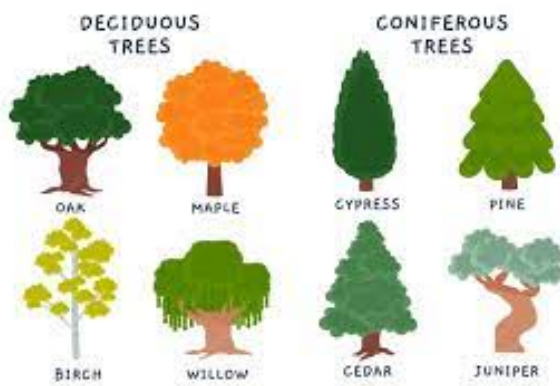


Photo by Sachin Professor

Graphic showing types of deciduous and coniferous tree species. Deciduous trees are often less combustible than conifers due to their higher moisture content and lack of flammable resin¹⁹.

Ongoing maintenance is crucial as landscapes are constantly evolving and over a period of time, what once was FireWise may no longer be. Even the most fire resistant species can go up in flames if there is an excess of brush and dead material. Rock mulches and other hardscapes are often recommended for landscaping in the Wildland Urban Interface, but these inorganic materials tend to collect sediment and grow highly flammable weeds if not maintained. Succulents and other water retaining vegetation are good substitutions here²⁰. Having a

¹⁸ Dennis, F.C. "Firewise Plant Materials ." Colorado State University Extension, 3 Feb. 2022.

¹⁹ Professor, Sachin. "Deciduous & Coniferous Trees: Definition, Description, and Types." *Info About Trees*, 29 July 2022.

²⁰ Wood, Delani, and David Bailey. Interview, "David Bailey of Urban Oasis Landscaping in Boulder." 9 Sept. 2022.

diversity of species is important for maintaining healthy ecosystems that are resilient to inevitable fire events.

Some examples of Fire Resistant species adapted to this climate include:

- Wildflowers and Groundcovers - Native Yarrow (*Achillea lanulosa*), Small Leaf Pussy-Toes (*Antennaria parvifolia*), Columbine (*Aquilegia spp*), Native Bee Balm (*Monarda fistulosa*), Oriental Poppy (*Papaver orientale*).
- Shrubs - Mountain Mahogany (*Cercocarpus montanus*), Antelope Bitterbrush (*Purshia tridentata*), Golden Currant (*Ribes aureum*), Banana or Broadleaf Yucca (*Yucca baccata*), Russet Buffaloberry (*Shepherdia canadensis*).
- Large Shrubs and Trees - Rocky Mountain Maple (*Acer glabrum*), Wasatch Maple (*Acer grandidentatum*), Crabapple (*Malus sp.*), American Wild Plum (*Prunus americana*), Western Chokecherry (*Prunus virginiana melanocarpa*), Western Mountain Ash (*Sorbus scopulina*).

Complete plant lists can be found in the appendix of this guide.

Water Management

Quick Summary:

- Climate Ready Landscapes can reduce outdoor water consumption.
- Watering deep and infrequently creates stronger vegetation and protects against pests and disease.
- Grouping plants by water needs can aid in maintenance and water conservation.
- Trees should be on separate irrigated lines as they require additional water resources.



Photo by Matthew Reamer, New York Times

The “Bathtub Ring” in Lake Mead is a stark indication of the reservoir’s low water supply. 40 million people in the American West rely on Lake Mead for their water.

“Water equivalencies” can be utilized to reduce water consumption in arid environments. These factors include drought resistant plants, mulch, wind breaks, natural or artificial shade, and grouping plants by water needs. Climate Ready Landscapes have higher water needs

during the initial plant establishment phase of about 3-6 months, with those needs decreasing over time. Once established, native landscapes use on average 50% less water than traditional turf lawns²¹. Soil type and health can affect water absorption rates, and amendments should often be considered. See *Healthy Soils* section below for more information.

Climate Ready Landscapes contribute to a broader soil rehydration moisture regime, prioritizing water absorption into the ground on which it lands and filtering pollutants and sediment from runoff of impervious surfaces. Many shrubs, perennials, and ground cover species require additional irrigation. Drip systems where water is delivered directly to the plant roots and covered with mulch to retain moisture are highly efficient, preventing water runoff and evaporation, further conserving water supply. Sprinkler systems that throw water high into the air or release a fine mist cause high levels of water loss. The most efficient sprinklers release large drops of water close to the ground. Sprinkler-to-drip conversion kits can be found online or through ReSource Central and are suitable for Do-it-Yourself projects. Larger projects involving the mainline should be completed by an irrigation professional.

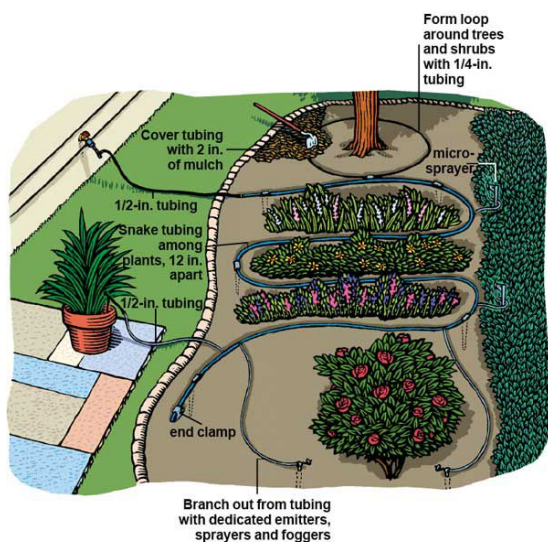


Photo by "This Old House"

Drip irrigation takes planning to properly implement, but can save water and time once established. Systems should be equipped with a mechanism that turns water off when it rains.

Watering should be avoided midday, between 10 am and 6 pm, due to high evaporation rates. Gutter downspouts, shade, or low-lying drainage areas and berms could be utilized to direct water and provide more support for trees or other more water intensive plants. Climate Ready Landscapes are to be irrigated less frequently with longer sessions, allowing the soil to dry out between waterings. This causes the root system to grow deeper in search of water and gives the aerobic soil microbiome access to oxygen needed to survive, which ultimately leads to stronger, more resilient plants.

Watering 1 inch deep, once to twice a week during the growing season is a good guideline to start. Spring waterings should be less frequent, ramping up during the height of

²¹ <https://extension.colostate.edu/topic-areas/yard-garden/xeriscaping-creative-landscaping-7-228/>

summer heat and tapering off again in the fall. It is important to observe both vegetation and precipitation events and adjust water schedules frequently and accordingly. If an automated system is implemented, a sensor that delays watering in the event of rain is recommended to avoid unnecessary watering. Trees require additional needs and should not be on the same watering schedule as smaller vegetation. 10-15 gallons per inch of trunk, once to twice a week depending on the size of the tree is recommended during drought conditions. See *Shade and Evapotranspirative Cooling* Section above for more information on trees.



Photo by Delani Wood

At the Kelley Green Environmental Center of the Rockies, rooftop gutters and parking lot curb cuts drain stormwater into rain gardens on the property. This allows for reduced irrigation needs as well as stormwater runoff filtering and management.

Healthy Soils

Quick Summary:

- Colorado soils are often in need of some type of soil amendment, though native plants can grow well in harsh soil conditions.
- Cultivating a healthy underground ecosystem from the start will result in decreased inputs and need for maintenance.
- Synthetic chemicals such as herbicides kill beneficial microbes and are to be avoided when possible.

Knowing the soil type and its contents are the foundation to planning any Climate Ready Landscape. Carbon rich and healthy soils have an increased water holding capacity, helping to mitigate flood risk and aid in times of drought, while native vegetation have much deeper root structures than traditional turfgrass, reducing the chance of mudslides and soil erosion.

Colorado soils can generally be divided into two categories: sand or clay. Clay is composed of flat microscopic crystals that cement particles together, creating a compact soil that opposes air or water infiltration. These conditions result in slower absorption and release of water, causing problems like water runoff, oxygen starvation, and low water availability to plants. Sandy soils have the opposite characteristics. Very large particles create space for air pockets, causing water to drain rapidly, imposing drought like conditions²². A loam soil consisting of a combination of soil types is considered best for planting. For sandy soils, well-decomposed organic matter application such as compost, manure, and peat will improve water holding capacity. Clay soils benefit from fibrous materials such as composted wood chips, peat, and straw that improve structure for aeration and infiltration²³.

Creating healthy soil takes time, often more than a year. Amendments can be applied either once at the establishment of new landscapes, or over time in vegetable and garden beds. Be careful of over-amending as many Colorado native plants are adapted for harsher conditions. For new landscapes, apply 2-3" of a low-salt amendment 6-8" deep by turning it into the soil. This encourages deep roots and reduces the need for frequent waterings. Use a combination of materials that decompose at various speeds for quicker, more lasting results. Plant based amendments are often low in salt content, while biosolids and manures have higher rates and should be used sparingly unless needed²⁴.

Research is increasingly showing that microbes in the soil provide immune system function and communication networks for plants within a healthy functioning ecosystem. Conventional lawn care services spray harsh chemicals that kill off these essential microbes, causing the plants to rely on synthetic fertilizers and herbicides to stay alive. Investing resources in cultivating soil health upfront can save a lot of time and money on feeding and weed prevention down the line.

As soil organic content increases, the need for additional nitrogen fertilizer decreases. Aerating the soil and applying an organic amendment allows the microbiome to thrive, giving plants the symbiotic support they need to be adaptive and resilient. Mycorrhizae, compost, and fish emulsion are popular soil additions among organic farmers and natural landscapers. New studies with the use of biochar are also taking place with promising results. A thriving soil microbiome breaks down the components of compost amendments into chemical ions that plant roots are able to absorb. Avoid over-amending as this process takes time and large quantities cannot be broken down in a single season²⁵.

Mulching around plant bases offers multiple benefits: it keeps roots cool, minimizes evaporation, and suppresses weed growth. Self-mulching shrubs and low ground cover plants can be grown for this benefit. If purchasing organic mulch, application should be at least 4" deep as the material will decompose and have to be reapplied. In starter beds, new plants will fill in empty spaces as mulch breaks down over time. Once vegetation begins to crowd, extras can be harvested from the landscape for use on other local properties.

Inorganic mulches include rock and pea gravel, which require very little maintenance and can be a good choice in windy areas, though they do collect sediment and will eventually grow

²² Wilson, C., et al. "Xeriscaping: Creative Landscaping." *CSU Extension*, 16 Sept. 2019.

²³ Whiting, David, et al. "CMG Gardennotes #241 Soil Amendments." *Colorado Master Gardener*, 2015.

²⁴ Ibid

²⁵ Ibid

weeds if not maintained properly. Inorganic mulches retain and radiate heat, so application in southern or western areas should be limited to reduce increased temperatures. Weed cloth and other artificial ground covers create dry, unhealthy and compacted soil and are to be avoided in place of living ground cover²⁶.



Photo by the Ecological Landscape Alliance

Biohabitat and Integrated Pest Management

Quick Summary:

- A diverse array of native plants is the most supportive habitat for local pollinators, insects, and other animals.
- When a healthy, balanced ecosystem is achieved, maintenance and pest control is minimal.
- Less is more; leave fall clean-up for late in the spring, as decomposing plant materials provide food and habitat for overwintering species.

Many resources exist to support pollinator habitat. A key takeaway is that plant diversity lends itself to a diverse array of associated pollinators and insects. Native plants are best adapted to local growing conditions and support pollinators and other wildlife²⁷. Special care should be taken with imported varieties so that they do not spread and take over the landscape, crowding out other plants. Some nonnative regionally adapted varieties can be used to complement a native garden and provide longer flower blooms. Pesticide-free plants should be purchased to avoid harming pollinators and insects. Different species can be chosen based on soil, light, and water conditions of each site and vary in size, shape, texture, and color. See *Microclimates* section for more information on site planting considerations.

Pollinator-friendly sites require a different form of maintenance than conventional lawn care. In fire-prone areas, keeping a tidy landscape and defensible space is important in limiting the amount of fuel available for burning. However, come fall and spring, leaving some dead

²⁶ Wood, Delani, and Jody Ash. "Wild Heritage Gardens and Design ." 15 Sept. 2022.

²⁷ Colorado Native Plant Society. "Low-Water Native Plants for Colorado Gardens - Colorado State University." *CSU Extension*, 2017.

plant material gives pollinators the opportunity to overwinter or make their nests. Leftover seeds from sunflowers and other plants provide food for birds well into the winter. Synthetic covers such as weed cloth or plastic tarps inhibit ground nesting bees from accessing suitable hibernation areas, and heavy pruning and cleanup should wait until at least the month of May in Colorado to protect overwintering organisms. Deadheading, or cutting off spent flower blooms, throughout the growing season can increase density and encourage additional flower growth. Flowering vegetation planted in small clusters will help pollinators find flowers and navigate the area. Planting thick vegetation and crawling ground covers act as a living mulch and suppresses weed growth.

When dealing with pests, if they are covering less than 10% of the plant and doing no visible harm, it is best to simply leave the plant alone. These pests create excellent meals for beneficial predatory insects, and help support animals higher up the food chain. Pesticide and chemical use is lethal to essential soil microbes, pollinators, and other organisms, including humans and pets, and should be avoided at all costs. A well-balanced Climate Ready Landscape will function as a robust ecosystem, requiring minimal- if any- additional inputs other than water and occasional pruning or soil amendments. One resident interviewed reported having a yellowjacket nest appear in her garden rockwall. A few days went by when she woke to find a large rock turned over and the entire nest was gone. Upon further research, she concluded that a bear had come through and consumed the pests, ridding her of the problem! Quite a memorable experience showcasing that a healthy ecosystem will set in motion its own remedies.



Photo by the Denver Post

Microclimates

Quick Summary:

- Microclimates vary across a single location.
- Group together plants with similar growing requirements.
- Work with, not against, existing environmental conditions.

Plant species should be chosen based on the specific soil, light, and water conditions of a site. Grouping together species with similar conditional needs will improve plant health and appearance while minimizing maintenance. South-facing areas in full sun do best with dryland or desert adapted plants. Forest-edge type plants grow well on north-facing facades where the ground tends to be moist, shaded, and cooler. Western areas are similar to southern exposures, even if they only receive half a day of sun, and dryland or prairie plants are well suited. Eastern-facing sides of a structure typically have the most benign climate with the morning sun, and a wide variety of plants can be grown²⁸. Utilize low-lying, shaded, or areas near downspouts by planting vegetation with higher water needs.

Be sure to address plant interactions since microclimates can change as plants grow and mature. A heat-loving, low growing plant may not be as successful once its neighbor grows tall and blocks the sun. Alternatively, some creeping ground covers may do better once they have access to nearby shade. Observe the area often and make adjustments as needed.

Dry shade plants suited to the Colorado climate include:
lady's mantle (*Alchemilla mollis*), sweet woodruff (*Galium odoratum*) and coral bells (*Heuchera*), and shrubs like mahonia (*Mahonia*), golden currant (*Ribes aureum*) and thimbleberry (*Rubus parviflorus*).

Moist shade conditions can house plants such as:
False goat's beard (*Astilbe*), Japanese anemone (*Anemone hupehensis*), foxglove (*Digitalis*) and various ferns²⁹.

Bulb plants are often well suited to shade with dappled sunlight. Most Colorado native perennials and shrubs grow in full sun to partial shade conditions. Avoid large shrubs under trees to prevent fuel for ladder fires.

²⁸ Ibid

²⁹ "Shade Garden Perennials." *PlantTalk Colorado*, 2022.



Photo by Mario Bertelmann, Assistant Curator of Shade Gardens at Denver Botanic Gardens

Turf Lawn Replacement and Grass Alternatives

Existing turf or weeds need to be properly smothered or removed before planting. There are generally four main ways of doing this³⁰.

1. Solarization - During a warm, sunny summer week, water the section of turf until well saturated. Cover with a clear, plastic tarp, and place bricks or planters on top to hold into place. The sun's heat will kill vegetation under the tarp over the next 6-8 weeks. Once the grass underneath is dead, remove coverage and dead organic material, then prep the soil for planting. This method works well, but does use large amounts of plastic that cannot be recycled.
2. Physical Removal - The most labor intensive method, but one with the quickest results without use of harmful herbicides. Smaller areas are conquerable with a hand tiller or shovel, but in larger yards it is recommended to rent a turf-cutter. Before beginning, make sure to know where any underground irrigation or utility lines are. Once tilled, physically remove the grass from the site and bring it to a compost facility for processing.
3. Smother with Layers - Also called sheet composting or the lasagna method, this involves covering a patch of lawn with several layers of newspaper or cardboard. Wet with a hose then cover with a thick layer of grass clippings or mulch. Sunlight will not be able to penetrate through, halting photosynthesis. This method may take several months to completely smother grass, though the layers will break down into compost, giving a natural boost to the soil quality of the area.
4. Herbicides - Chemical herbicides should be used sparingly and with caution as they are indiscriminate killers with lingering toxicity that is harmful toward soil microbes, local vegetation, wildlife, and human beings. Though many opt for this choice for large areas of turf lawns, since a single application can kill off any existing grass. After about two weeks, plugs or seeds for native grasses and perennials can be planted directly into the dead grass, which acts as ground cover until breaking down while the new plants get established. For more natural methods, horticultural vinegar, baking soda, salt, and

³⁰ Silva, Brenda. "How to: Kill Grass." *Bob Vila*, 19 July 2021.

boiling water are all options that can be applied to indiscriminately kill any grass or weeds in an area. Keep away from any wanted plants and be wary of runoff. Multiple applications may be necessary.

While imported varieties of turf such as Kentucky Bluegrass have short root structures and require heavy inputs and maintenance, there are alternatives available if a grass lawn remains to be desired. Enviro Turf is a cultivated variety with roots that reach over 3 feet into the soil, a better alternative to the 3 inch root structure seen in most cool season grasses. Deeper roots allow the plant to be more drought resistant and aid in water infiltration. For seeds or plugs, local companies offer native and Colorado friendly grass mixes. Fescue, Buffalo Grass, Blue Gramma, and Carex are some other recommended varieties for this climate³¹.

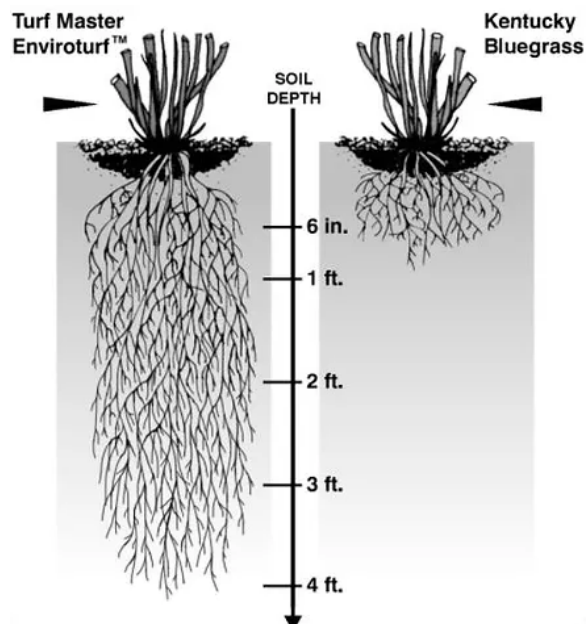


Photo by Turf Master

Enviroturf™ has been cultivated with longer root systems to be more drought resistant, which also aids in soil structure.

³¹ Provaznik, Michelle. "Lawn Alternatives for the Mountain West." *Fine Gardening*, 7 June 2021.



Photo by CSU Extension

Buffalo Grass is a perennial, warm season grass species native to the Colorado region. Newer turf varieties are dark green, short-growing, more resistant to weed invasion, and are a low water alternative to nonnative Kentucky Bluegrass.

Additional Social Values

Not only does Climate Ready Landscaping reduce water consumption, provide habitat, and contribute to soil health, it also has a profound impact on the humans living near these areas. Adding natural landscapes to populated regions increases measures of satisfaction, health, and economics. Natural, biodiverse areas allow for a healthier population by reducing air and water pollutants, providing recreation areas, and promoting greater social cohesion. Economic benefits include higher work productivity, reduced sick leave, and more infrequent employee turnover. Enhanced walkability contributes to reduced burden on the healthcare system, including reduction of stress and associated illnesses. Massive amounts of money can be saved by mitigated disaster costs from flooding, fire, and pollinator ecosystem collapse. With proper planning, new markets and sustainable jobs can be created in tree and landscape maintenance, forest thinning, and waste to resource circularity practices. Growing food in nearby landscapes reduces transportation emissions, increases nutritional value, and promotes community resilience³².

³² Gómez-Baggethun, Erik, et al. "Urban Ecosystem Services." *SpringerLink*, Springer Netherlands, 1 Jan. 1970.

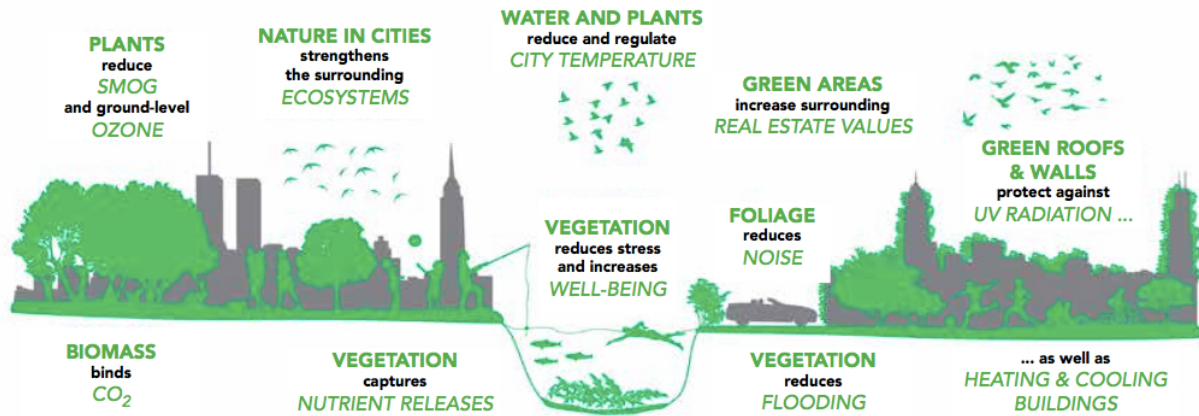


Photo by % City

Urban Ecosystems provide numerous benefits to the humans living nearby.

Gallery Showcase of Climate Ready Landscape Characteristics



Photo by Delani Wood

Application of organic mulch helps to retain moisture, suppress weeds, and will naturally decompose, returning nutrients to the soil. Large shrubs with defensible space from the home provide habitat and visual interest.



Photo by Delani Wood

A portion of the front yard has been converted to a diverse landscape, with ground cover plants behaving as living mulch and hardscape features to break up vegetation and provide some degree of fire resistance. The tree in the background is on a separate irrigation system than the foreground landscape to accommodate for varying water needs.



Photo by Delani Wood

An apple tree provides shade for creeping ground covers and low shrubs. Hardscape features give visual interest even in the winter, with terracing to provide a flat surface, reduce erosion and allow plants at a lower slope to grow in. Fruit trees typically hold moisture, making

them more fire resistant than other species, especially coniferous varieties with high flammable resin content. While the garden itself requires little additional watering, the trees on the property are given a long soak for about 45 minutes - 1 hour, once every one to two months.



Photo by Delani Wood

This landscape is very well established, and has been growing for the past 20 years! A variety of textures, colors, and heights provide interest for both humans and local pollinators. Successful plant growth often leads to crowding, which is remedied by the homeowner removing some vegetation and sharing with the neighbors; the driveway across the street is lined with irises pulled from this garden. Out of view from this photo is a patch of buffalo grass for sitting and entertaining. The homeowners say they barely water outside of the hottest days of summer, use absolutely no herbicides, and rarely have weeds. The sunflowers do spread rather dramatically and get pulled out toward the end of the season.



Photo by Delani Wood

Creeping ground cover replaces much of an irrigated turf yard, resulting in less waterings and ease of maintenance. Stones lining the sidewalk prevent soil erosion, while the shrubs underneath the tree could be better trimmed to reduce ladder fuels that could result in tree canopy fires.



Photo by Delani Wood

This newly established landscape has been planted in 6" of compost and covered with mulch. The plants will fill in gaps as the mulch decomposes over time, with a variety of species to attract pollinators and other insects. Aspen trees planted to the southwest of the property (right of photo) will provide shade in the late afternoon summers, and are located in a low lying portion of the property fed by the rain gutter downspout to help reduce outside irrigation needs. Hardscape adds additional visual interest and reduces both soil erosion and water requirements.



Photo by Delani Wood

Not a good example of Climate Ready Landscaping. Ornamental plants with little diversity do not attract local pollinators. Broken and inefficient sprinklers are leaking water all across the sidewalk, causing high rates of evaporation and runoff.



Photo by Delani Wood

This property has well groomed trees, but the vast lawns require copious amounts of water with additional fertilizers and herbicides to keep them maintained. This landscape remains green far later in the season than the surrounding homes, and provides very little additional services to local pollinators and beneficial insects.

Part Three: Initial Recommendations for Opportunities and Partnerships

Many organizations within and around Boulder are already working toward versions of Climate Ready Landscapes, while others could benefit from these specified practices. Coordinated partnerships among community members and organizations are crucial for enacting the cross-sectoral, multi-scope rewilding necessary to achieve mitigation and resilience to future climatic events. Full scale community engagement will help to ensure projects are executed with success and equity, as well as properly cared for with ongoing maintenance. Project implementation considerations and partnerships for Climate Ready Landscapes have been grouped into the following categories, with each discussed in further detail below:

- ❖ Knowledge Sourcing
- ❖ Outreach and Engagement
- ❖ Opportunity Sites
- ❖ Materials and Resources
- ❖ Implementation and Maintenance
- ❖ Cost Mitigation
- ❖ Other Considerations

Knowledge Sourcing

A wealth of knowledge around Climate Ready Landscapes already exists, though may be referred to by different names. Native landscapes, land stewardship, indigenous practices, green infrastructure, and biophilic design all have overlapping characteristics to Climate Ready Landscapes. Proper implementation will include engagement of the entire community, specifically those in frontline populations who bear the worst consequences of climate change and have historically been excluded from land use decisions. Black, Indigenous, and Persons of Color have long-standing knowledge passed down by generations of land stewards, and relationships to this wisdom could be leveraged to promote sustainable and regenerative practices on urban and suburban landscapes. This must be done within a respectful and symbiotic relationship, so as to not perpetuate past harm and trauma resulting from colonial practices such as land seizure, slavery, and indentured servitude.

Municipal governments can participate in large trials of various land use practices such as biochar application, native prairie restoration, or restriction of chemical fertilizers and pesticides. This will position governments to be on the forefront of research into sustainable management and incubate these techniques to scale. Institutional scientific research coupled with ancient land stewardship practices creates a framework on which Climate Ready Landscapes can grow and evolve. Constant willingness to implement new projects rooted in science, environmentalism, and community will provide a robust network of communication and knowledge sharing.

Partners

Potential partners for knowledge sourcing and sharing include native landscapers, organic farmers, Indigenous tribes, gardening clubs, Denver Botanic Gardens, CSU Extension, nearby communities, and organizations such as Colorado WaterWise, the Native Grasses working group, and Resource Central.

Outreach and Engagement

Cultural Shift

Individuals are often most familiar with conventional turf maintenance techniques of chemical herbicide and fertilizer application, followed by regular mowing with gas powered lawn equipment. Information and examples must be showcased to promote transition to Climate Ready Landscapes. Monitoring and communicating trends and best practices can foster a network of peer-to-peer learning between residents, landscapers, and environmental advocates.

Community Goal Setting and Resource Sharing

Direct, cohesive goals and resources around implementing Climate Ready Landscapes need to be developed with and shared among the community. Alternatives to turfgrass lawns are gaining in popularity, but many people lack the time, knowledge, or resources to convert landscapes on their own.

- ReScape California has a scorecard for measuring desired traits when rescaping an area. Something similar specific to the Colorado Front Range could help ease decision making for Climate Ready Landscaping.
- Resource Central's dedicated inspiration hub at <https://waterwiseyards.org/inspiration-hub/> allows individuals to upload photos and showcase their turf conversion projects, sharing information like costs, failures, and plant selection.
- Colorado WaterWise hosts multiple educational events throughout the year, and a similar program around landscape conversions could be leveraged in Boulder. Local demonstration plots that allow people to interact with the site and receive hands-on learning from master gardeners would encourage them to create Climate Ready Landscapes in their own yards and communities.

Partners

Keep it Clean Partnership, Resource Central, and Eco-Cycle are some existing partners in this space. Local native landscapers, CSU Extension staff, environmental nonprofits, regenerative farms, and eco-ambassadors are all well positioned potential partners for outreach and engagement.

Opportunity Sites

Residential

Many Boulder homeowners are curious about Climate Ready Landscapes, and when given appropriate knowledge and financial incentive, are willing to sacrifice significant portions of their turf lawn to dedicate to ecosystem services.

- Homeowners Associations often have rules regulating landscaping in favor of green turf lawns. Overcoming these barriers with education and engagement will provide the opportunity for more lawn conversions at the residential scale.
- Free access to informative do-it-yourself videos and financial rebates on plants and equipment can help to engage participants who cannot afford to hire a professional landscape service.

Commercial

Commercial properties can be required to invest in Climate Ready Landscapes through city ordinances and design codes.

- The City of Fort Collins requires any new development to employ green infrastructure stormwater management systems on site, or pay to fund offsite projects nearby.
 - The City utilities department has developed resources to aid developers in navigating this process, and requires inspection for approval during each stage of development.
 - Acceptable projects include bioswales, green roofs, permeable pavements, and rain gardens.



Photo by Delani Wood

A rain garden with accompanying informational signage outside the Fort Collins Water Utilities offices.

Institutional

Institutional sites are key opportunity areas since they tend to be well-connected to the broader community. This characteristic makes them prime locations to disseminate resources, showcase demonstration plots, or provide land share services to urban farmers and gardeners. Establishing Climate Ready Landscapes on institutional sites such as school yards, for example, provides the opportunity for students to learn about the ecosystem services provided along with concepts of sustainable land stewardship. Houses of Worship often have large turf grass areas that could be utilized in partnership with urban gardeners, for example.

Government

Government owned and managed properties can be used to spearhead demonstration sites, normalizing a different landscape aesthetic while impassioning people to convert their own spaces.

- Climate Ready Landscaping utilized along city streets provides beautification, noise and pollutant reduction, and creates a safety buffer between automobile transit and bike or pedestrian lanes. Landscaping used in conjunction with medians or roundabouts has been shown to provide traffic calming benefits, reducing speeds and associated accidents³³.
- Parking lots and garages are notoriously vast, empty swathes of heat retaining pavement void of nature and biodiversity. Greening them with Climate Ready Landscaping can reduce urban heat island effects, filter pollutants from stormwater runoff, and provide habitat for birds and other organisms.



Photos by Delani Wood

Openings in parking lot curbs coupled with berms or recessed rain gardens allow for water to be directed toward landscaping for irrigation and pollutant filtration. Vegetation also provides shade and habitat.

- Protection and connectivity of existing green and blue corridors such as rivers, floodplains, and wetlands is crucial for holistic Climate Ready Landscapes. Repurposing roadways or rehabilitating land along railroad lines are some creative ideas for connecting habitats through biodiversity corridors.

Partners

³³ <https://www.pps.org/article/livememtraffic>

Partnerships with community advocates, homeowners associations, utilities departments, school districts, urban gardeners and farmers, property owners, Land Use Planning and Development, transportation, the Greenways Program, Go Boulder, among others could all be leveraged to achieve these goals.

Materials and Resources

It is important to allocate the capital involved in creating Climate Ready Landscapes toward local small businesses and nonprofits operating in this realm to create steady, sustainable jobs for community members.

Plant Sourcing

Purchasing locally sown and grown species provides the best chance of success in Colorado's harsh climate. Developing relationships with local nurseries and establishing secured procurement contracts may allow for bulk purchase cost saving and ensure that favored species will be available for the planting season.

Seed saving, propagation, and plant sharing within the community can increase the number of sources available for plant procurement. Local nonprofits such as Wildland Restoration Volunteers and MASA Seed Foundation are well-versed in seed saving techniques. Supporting local community gardening meetups for plant and seed sharing is a valuable technique for establishing new landscapes and promoting regional biodiversity.

Some local nurseries known to have information and materials related to Climate Ready Landscapes include: Harlequin Gardens, The Green Spot, MASA Seed Foundation, Longs Gardens, and The Tree Farm. Landscape designers include EcoScape, Urban Oasis, Wild Heritage Gardens, and Native Suns. Andy Creath is a green roof installer in the Boulder area.

Water and Irrigation

A major benefit in converting to a Climate Ready Landscape is that native plants often require much less water in comparison to thirsty nonnative turf grass. Investing in efficient irrigation systems with rain sensors can nearly eliminate wasted water and reduce irrigation needs. Collecting rainwater into rain barrels or cisterns within Colorado water law allowances can also reduce the amount of metered water required on outdoor irrigation. Rain gutters, parking lots, and roadways could all be graded so that runoff feeds into planters, bioswales, and other permeable surfaces.



Photo by CSU Extension Office

After overturning a previous ban, residential rain barrels are now allowed in the state of Colorado. Collecting stormwater runoff can save thousands of gallons of potable water per year from outdoor landscape irrigation.

Partners

Partners currently operating in this space include local nurseries, seed saving programs, gardening clubs, residents, and Resource Central. Additional outreach to regional seed banks, regenerative farms, and private property owners in the WUI could develop new partnerships for seed and plant sourcing.

Implementation and Maintenance

Climate Ready Landscaping can be integrated into new development codes while retrofitting existing nonnative landscapes with turf replacement incentives. This allows for multi-level implementation across sectors and scales in the community. Clear guidelines around maintenance for each site must be established and upheld throughout changes in tenants, politics, or natural failures. Incorporating Climate Ready Landscapes into public works projects, planned urban development, and building retrofits are a good way to cut costs by leveraging multipurpose project objectives. The vegetation in these landscapes are an investment in which the first 1-2 years after implementation are the most crucial for long term establishment and success.

Partners

The City of Boulder street tree planting program, the Cool Boulder campaign, and Play Tree Trust are all well positioned partners for tree canopy work in Boulder. The Bee Chicas, Audubon Society, and other local gardening clubs can be leveraged as partners for pollinator habitat maintenance. Resident and property manager engagement may provide the most robust opportunities for Climate Ready Landscapes across the residential sector, while Planning and Development along with Utilities can control regulations and code around implementing these designs within public projects.

Cost Mitigation

Landscape conversion costs are often the most prohibitive factor to creating Climate Ready Landscapes. Turf removal, materials sourcing, and labor all require funding and time that property managers may not be able to afford or consider a priority. Governments may assist by providing tax breaks, subsidies, and resource sharing to encourage uptake.

- The State of Colorado recently announced a \$2 million turf removal grant matching program to be administered by the Colorado Water Conservation Board (CWCB) through local municipalities and water utility providers beginning in July 2023 that could have major benefits to Climate Ready Landscape conversion.
- The City of Boulder partners with nonprofit organization Resource Central to subsidize turf removal efforts and provide sustainable landscaping alternatives, a program which has been extremely successful since its inception.
- Other financing opportunities such as plant sharing, rebates on irrigation equipment, or turf-for-plant credit systems could also be explored.

Partners

Potential partners for cost mitigation include government funding for green infrastructure, air quality, and stormwater management through the EPA, possible funds from the new Inflation Reduction Act, Resource Central, municipal funding through Boulder County Partners for a Clean Environment (PACE), and public-private partnerships.

Other Considerations

Needs within the community for Climate Ready Landscaping not previously identified above include the following:

- Workforce development and guidance for landscapers and property managers looking to become knowledgeable in Climate Ready practices.
 - Workshops and community engagement disseminates information while informing of barriers to transitioning toward these methods.
- Programs and outreach to alleviate decision making around turf conversion, hauling of waste material, plant purchases, and landscape design.
 - The desired outcome can be cultivated by developing processes that are easy to follow with minimal inconvenience to the decision-maker. Educational programs, outreach, and incentives should be streamlined and easily accessible to the community.
- Integrative partnerships with policymakers and planning departments to guide community development toward Climate Ready Landscape decisions.
 - Outreach and education should be developed and utilized before incorporating regulations to code and policy.
- Chemical applications to the landscape to be drastically reduced to prevent further poisoning of soil microbes and organisms on higher trophic levels.

- This can include working with landscape companies and property managers on the alternatives to chemical sprays, or creating a city ordinance limiting their use.
- A local biomass processing facility that can handle the increase in material expected from landscape maintenance and tree thinning operations.
 - This facility can turn waste products into valuable compost or biochar for soil amending while providing sustainable jobs and promoting a circular economy.

The above guide and its recommendations have been formed through both independent scientific research and robust community outreach. Project planning and implementation should be approached in a similar fashion.

**Thank you to all community partners interviewed that helped
the formation of this Climate Ready Landscapes Guide**
(Hyperlinks direct to the author's personal notes for the interview)

Government:

[Candice Owen, Stormwater Quality Manager City of Boulder](#)

[Sarah Anderson, Green Infrastructure Program Manager City & County of Denver](#)

[Robert Glenn, Utilities Department City of Boulder](#)

[Cross Departmental Meeting on Fire Resistant Landscapes with Boulder Fire Rescue](#)

[Rachel Steeves, Nature in the City, Fort Collins](#)

[Colorado WaterWise and the Fort Collins Utilities Department, Green Infrastructure Tour](#)

[Kate Rentschlar, Environmental Planner, City of Fort Collins](#)

Research:

[Jennifer Boussetot, CSU Green Roofs Professor and Researcher](#)

[Chad Julian, Former employee of Boulder County Parks Department, CSU researcher](#)

[Claudia Brown, Western Bioregions Operations Leader, Biohabitats](#)

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[Nicholas, Native Suns Landscaping](#)

[David Bailey, Urban Oasis Landscaping](#)

[Jody Ash, Wild Heritage Gardens and Design](#)

Community Program Leaders:

[Andrea Montoya, Urban Biodiversity Program Coordinator, Suelo Bueno](#)

[Kate Larson, Program Director, ReSource Central](#)

Glossary of Terms

adaptation a change or the process of change by which an organism or species becomes better suited to its environment.

aeration the introduction of air into a material.

aerobic relating to, involving, or requiring free oxygen.

Biochar charcoal produced from plant matter and stored in the soil as a means of removing carbon dioxide from the atmosphere.

biodiversity the variety of life in the world or in a particular habitat or ecosystem.

combustible able to catch fire and burn easily.

compost decayed organic material used as a plant fertilizer.

coniferous (of a tree) producing cones, and having leaves that do not fall off in the winter.

deciduous a tree that loses its leaves in the fall and grows new ones in the spring.

defensible space the buffer created between a building on one's property and the grass, trees, shrubs, or any wildland area that surround it.

evapotranspiration the process of turning from liquid into vapor.

fertilizer a chemical or natural substance added to soil or land to increase its fertility.

greenhouse gas gasses in the earth's atmosphere that trap heat.

green infrastructure the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspire stormwater and reduce flows to sewer systems or to surface waters.

urban heat island an urban or metropolitan area that is significantly warmer than its surrounding rural areas due to human activities.

herbicide a substance that is toxic to plants, used to destroy unwanted vegetation.

infiltration the process by which water on the ground surface enters the soil.

irrigation the supply of water to land or crops to help growth.

landscaping inputs water, fertilizers, or other applications required to maintain a landscape.

land stewardship caring for a piece of land regardless of its ownership taking into consideration ecological, economic, social, and cultural dimensions.

microclimate the climate of a very small or restricted area, especially when this differs from the climate of the surrounding area.

mitigation the action of reducing the severity, seriousness, or painfulness of something.

monoculture the cultivation of a single crop in a given area.

mycorrhizae a fungus which grows in association with the roots of a plant in a symbiotic or mildly pathogenic relationship.

nature based climate solutions sustainable management and use of natural features and processes to tackle socio-environmental challenges.

plant pathogen an organism that causes a disease on a plant.

perennial a plant that lives for more than one growing season.

pesticide a substance used for destroying insects or other organisms harmful to cultivated plants or to animals.

resiliency the capacity to recover quickly from difficulties.

soil amendment anything added to soil to improve its abilities, including water retention, structure, and biochemical function.

soil microbes a group of microscopic life forms that live within the soil and significantly affect soil and crop health by performing activities such as nitrogen-fixation, phosphorus solubilization, suppression of pests and pathogens, improvement of plant stress, and soil building through organic decomposition.

soil rehydration restoring water into the soil.

turf grass narrow-leaved plants that can provide a uniform cover and can tolerate low mowing and traffic.

Wildland Urban Interface (wui) an area where a built environment meets or intermingles with a natural environment. Human settlements in the WUI are at a greater risk of catastrophic wildfire.

Appendix

Supplemental Information on Climate Ready Landscape Characteristics

Cooling and Tree Planting

- ❖ Colorado Front Range Tree Recommendation Lists:
 - Collaboration between the American Society of Landscape Architects, the Colorado Nursery & Greenhouse Association, the Colorado Tree Coalition, and the CSU Extension evaluated over 250 tree species based on critical and cautionary cultural factors.
 - <https://extension.colostate.edu/docs/pubs/garden/treereclist.pdf>
 - Tree list recommended by City of Boulder
 - <https://bouldercolorado.gov/best-trees-boulder>
 - CSU guide for selecting, planting, and caring for trees in the Front Range
 - https://static.colostate.edu/client-files/csfs/pdfs/trees_for_fronrange.pdf

- ❖ Tree Planting:
 - <https://www.coolboulder.org/news-updates/tree-planting-instructions>
 - https://static.colostate.edu/client-files/csfs/pdfs/trees_for_fronrange.pdf

- ❖ Tree Watering and Maintenance:
 - <https://bouldercolorado.gov/tree-planting-care-and-watering>
 - <https://www.coolboulder.org/news-updates/best-ways-to-water-colorado-trees>
 - <https://bouldercolorado.gov/media/4116/download?inline>

- ❖ Heat Island and Mapping:
 - EPA study on using trees and vegetation to reduce heat islands
 - <https://www.epa.gov/heatlands/using-trees-and-vegetation-reduce-heat-islands#:~:text=Researchers%20have%20found%20that%20planting,part%20of%20the%20building's%20roof>
 - Cool Boulder's community heat mapping campaign
 - <https://www.coolboulder.org/news-updates/community-heat-mapping>

- ❖ City of Boulder Forestry Department Street Tree Planting Program:
 - <https://bouldercolorado.gov/services/street-tree-planting-program>

Native Biohabitat and Pollinators

- ❖ General information on pollinator pathways
 - <https://www.coolboulder.org/news-updates/rewilding-pollinator-pathways>
 - <https://bouldercolorado.gov/services/pollinator-gardens-and-pathways>

- ❖ Information on insecticides and their influence on the food web
 - <https://xerces.org/publications/scientific-reports/how-neonicotinoids-can-kill-bees>
 - <https://www.pnas.org/doi/10.1073/pnas.2017221117>

- <https://www.nrdc.org/stories/neonicotinoids-101-effects-humans-and-bees>
- ❖ Boulder's Goss Grove pollinator project in the news
 - <https://www.dailycamera.com/2019/09/28/boulders-goss-grove-pollinator-project-a-movement-not-a-hobby/>
- ❖ Boulder County pollinator habitat conservation activity plan
 - <https://assets.bouldercounty.gov/wp-content/uploads/2018/01/pollinator-habitat-conservation-plan.pdf>
- ❖ Native plant lists to support pollinator habitat
 - Colorado Native Plant Society
 - <https://bouldercolorado.gov/media/546/download?inline>
 - CSU Extension
 - <https://extension.colostate.edu/docs/pubs/native/FrontRange.pdf>
 - Wildflowers
 - <https://boulder.extension.colostate.edu/wp-content/uploads/sites/7/2020/05/07233.pdf>
 - Native herbaceous perennials
 - <https://extension.colostate.edu/topic-areas/yard-garden/native-herbaceous-perennials-for-colorado-landscapes-7-242/>
 - Native trees
 - <https://extension.colostate.edu/topic-areas/yard-garden/native-trees-for-colorado-landscapes-7-421/>
 - Native shrubs
 - <https://extension.colostate.edu/topic-areas/yard-garden/native-shrubs-for-colorado-landscapes-7-422/>
 - City of Boulder
 - <https://bouldercolorado.gov/native-plants-growing-tips>
 - Low water native plants for pollinators
 - <https://conps.org/wp-content/uploads/2015/05/Low-Water-Native-Plants-for-Pollinators-brochure-6-8-15.pdf>

Water Management

- ❖ EPA
 - Watering Tips
 - <https://www.epa.gov/watersense/watering-tips>
 - Stormwater management and green infrastructure research
 - <https://www.epa.gov/water-research/stormwater-management-and-green-infrastructure-research>
 - <https://www.epa.gov/green-infrastructure/green-infrastructure-semi-arid-west>
 - Green parking lot guide

- <https://nepis.epa.gov/Exe/ZyPDF.cgi/P100D97A.PDF?Dockey=P100D97A.PDF>
- ❖ United Nations
 - Green Infrastructure guide to water management
 - <https://www.unep.org/resources/publication/green-infrastructure-guide-water-management>
- ❖ ARUP
 - cities alive, rethinking green infrastructure
 - <https://www.arup.com/perspectives/publications/research/section/cities-alive-rethinking-green-infrastructure>
- ❖ Denver Water
 - Xeriscape plans
 - <https://www.denverwater.org/residential/rebates-and-conservation-tips/re-model-your-yard/xeriscape-plans>

Fire Resistance

- ❖ Fire history and risk in Boulder County Forests
 - https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd480749.pdf
 - https://cfri.colostate.edu/wp-content/uploads/sites/22/2018/03/Kaufmann_HistoricFireRegimesFrontRange1.pdf
- ❖ The Home Ignition Zone, Colorado Forest Service
 - https://csfs.colostate.edu/wp-content/uploads/2021/04/2021_CSFS_HIZGuide_Web.pdf
- ❖ Firewise plant lists
 - <https://extension.colostate.edu/topic-areas/natural-resources/firewise-plant-materials-6-305/>
 - <https://www.lamtree.com/great-plants-for-firewise-landscapes-in-the-colorado-foothills/>

Healthy Soils

- ❖ Soil Microbiome
 - <https://asm.org/Articles/2021/May/Unearthing-the-Soil-Microbiome.-Climate-Change,-C>
 - <https://bmcmicrobiol.biomedcentral.com/articles/10.1186/s12866-019-1572-x>
 - <https://www.science.org/doi/10.1126/science.abe0725>
 - <https://www.ecocycle.org/files/pdfs/Compost/Microbe-Brew-Brochure.pdf>

Additional Social Values

- ❖ Ecosystem services to humans provided by native landscaping
 - <https://www.buildinggreen.com/feature/native-landscaping-biodiversity>
 - <https://wedocs.unep.org/bitstream/handle/20.500.11822/36586/SSRC.pdf?sequence=1&isAllowed=y>
 - https://link.springer.com/chapter/10.1007/978-94-007-7088-1_11
 - https://www.fs.fed.us/nrs/pubs/jrnl/2015/nrs_2015_larson_001.pdf