

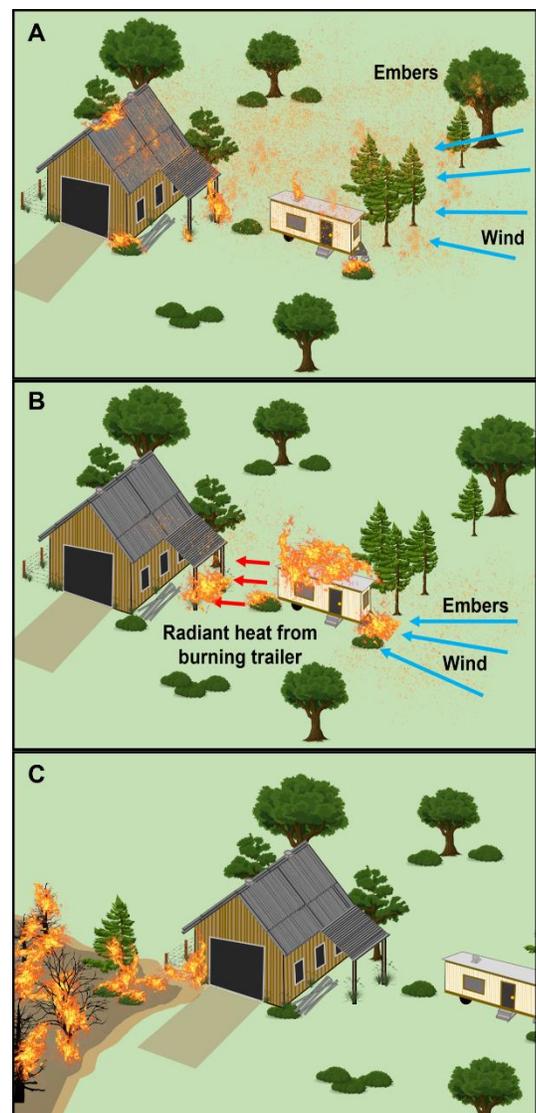
## Wildfire Preparedness for Farms, Ranches, and Agricultural Operations

Although wildfires are part of California’s landscape, properties can be designed and maintained to reduce their vulnerability. Agricultural infrastructure (e.g., barns, wood fences, hay, and other key buildings) have inherent vulnerabilities to wildfire and first responders may need extra time to reach and defend every structure depending on their location and access. However, buildings and infrastructures can be designed and maintained to reduce their vulnerability to wildfire and fire-related damage to agricultural resources (e.g., soil, crops, pasture, and rangeland). This guide will help you understand vulnerabilities on your property and prioritize actions based on your needs.

Structure loss during a wildfire occurs because of one of the three main types of exposures: **embers**, **radiant heat**, or **direct flame contact** (Figure 1). While distinguishing these exposures can help prioritize actions, keep in mind that they all happen at the same time, and they are all equally important. Additionally, smoke exposure can be as damaging as flames.

1. **Embers (A)**: Embers can be transported by wind miles away from the fire front. Embers can easily find a way into a building from an open door, window, hay chute, or gap in the siding. Once inside, they can start a fire within the building. Embers can also land on roofs or near buildings, and possibly collect and ignite flammable materials like hay, dry grass, or other wood piles. To protect a building from embers, seal up openings, close doors during wildfire, and remove flammable materials around buildings.
2. **Radiant heat (B)**: During a fire, radiant heat can ignite structures including fences, vegetation, or melt vinyl components. Increasing the separation between structures, or protecting specific house components, can reduce the vulnerability to radiant heat
3. **Direct flame contact (C)**: Vegetation, wood fences, and other combustible materials can create a direct fire path to a structure. Removing or interrupting these paths is called defensible space and it can prevent flames from reaching a structure.

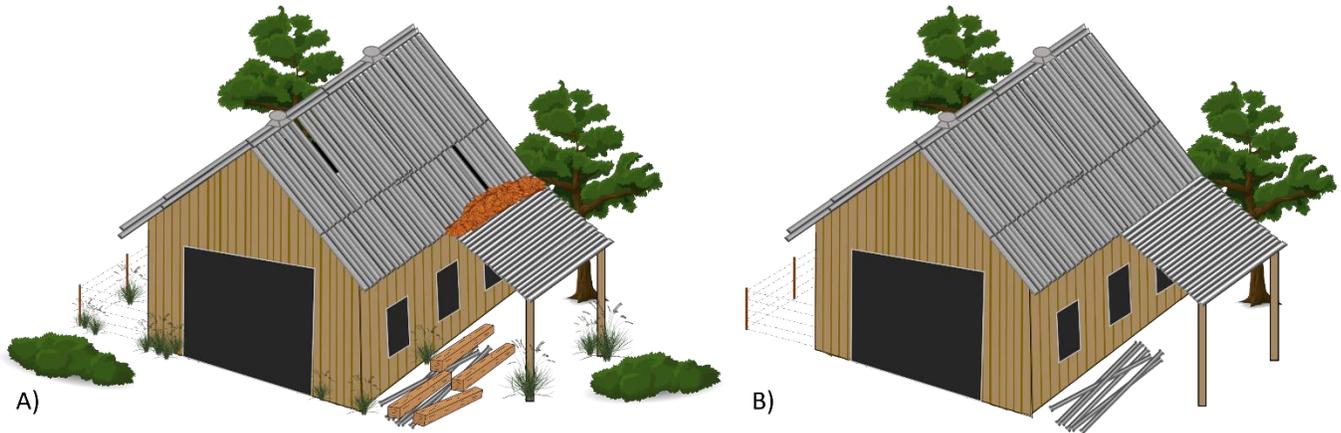
A combination of structure hardening and defensible space strategies help buildings survive wildfires. Start by assessing your situation and identifying potential risks and solutions by using the resources below.



**Figure 1:** Illustration of the three different types of fire exposures: A) embers, B) radiant heat, and C) direct flame contact.

## Protecting Agricultural Structures

Preparing for wildfire can feel daunting. If your property or operation has old wooden buildings or buildings with many openings, these buildings are more vulnerable to wildfire. Use this guide to help prioritize actions and make a plan to protect these key resources for that are most critical to you and your operations and resuming normal agricultural activities quickly after a wildfire.



**Figure 2:** Interpretation of a barn A) before and B) after hardening building components for fire resistance.

**Hardening a structure means improving building components, such as roofs, gutters, and vents to reduce exposure to flames and ember ignition** (Figure 2). Some vulnerable components are common among structures, regardless of the type of building. Table 1 outlines the fire vulnerabilities of major structural components and lists ways to retrofit or maintain these components to be more fire resilient.

Building Component	Fire Vulnerability	Retrofitting Recommendations
<p><b>Roof</b></p> 	<p>Due to their large surface area, roofs are highly exposed to embers. Roofs tend to ignite at the edges and vertical intersections where debris and embers can accumulate.</p>	<ul style="list-style-type: none"> <li>• Keep your roof clean from debris.</li> <li>• Roof edges should be protected with metal flashing when gutters are installed.</li> <li>• Seal up gaps in the roof to prevent embers from entering.</li> <li>• Keep your roof in good condition and repair it when necessary.</li> </ul>
<p><b>Gutters</b></p> 	<p>Leaves and debris can accumulate in gutters, and ignite with embers. This could directly expose the roof edges.</p>	<ul style="list-style-type: none"> <li>• Regularly clean the gutters. Maintenance is more important than gutter material.</li> <li>• Gutter covers are helpful though they still require regular maintenance.</li> </ul>

<p style="text-align: center;"><b>Vents</b></p> 	<p>Vents with 1/4 inch screen size are vulnerable to embers and flames. Once embers pass through vents, they can ignite flammable materials inside the structure.</p>	<ul style="list-style-type: none"> <li>● Retrofit traditional vents by adding 1/8 inch additional metal mesh screening or install flame- and ember-resistant vents.</li> <li>● Keep flammable items away from vents both inside and outside the structure.</li> </ul>
<p style="text-align: center;"><b>Doors and Windows</b></p> 	<p>Embers easily enter buildings through openings, windows, doors, hay chutes, and other gaps in the siding. Single-pane windows are the most vulnerable to radiant heat from adjacent structures.</p>	<ul style="list-style-type: none"> <li>● Remove vegetation and combustible materials near doors and windows.</li> <li>● For large openings, consider installing a metallic screen (1/8" mesh) or deployable metal shutters.</li> <li>● Close windows and doors upon evacuation.</li> <li>● If needed, prepare plywood boards to cover openings before evacuation.</li> </ul>
<p style="text-align: center;"><b>Attached Fences</b></p> 	<p>Wood fences are often ignited by dry grass, debris, or other combustibles stored at their base. Fences then can serve as a wick bringing fire directly to the structures if they are connected.</p>	<ul style="list-style-type: none"> <li>● Clean vegetation and combustible materials in contact with the fence.</li> <li>● If a fence is attached to a structure, replace the last 5 feet with a noncombustible section or gate.</li> </ul>
<p style="text-align: center;"><b>Exterior Walls</b></p> 	<p>Exterior walls can be vulnerable when exposed to flames or radiant heat for extended periods. Older wooden barns often have gaps between boards or at their base. These locations are easy places for embers to enter the building.</p>	<ul style="list-style-type: none"> <li>● Remove flammable materials within 5 feet of the structure.</li> <li>● At the bottom of walls, create a noncombustible vertical zone of at least 6".</li> <li>● Seal up openings with metal flashing or caulk where possible.</li> </ul>

**Table 1:** Fire vulnerabilities and recommendations for common structural components.

In addition to the common building components, some structures have specific features that could be improved to increase their resilience to wildfires. Listed below are examples of specific recommendations for some common structures and infrastructures.

## Barns



**Figure 3:** A) Pole barn used to store equipment and materials and B) Enclosed wooden barn surrounded by vegetation.

Barns are vulnerable to embers. Remove combustible materials within the first 5 feet of walls and openings (doors, windows, etc.). Consider storing only non-critical equipment and resources in barns that cannot be retrofitted or improved. In these cases, improve the defensible space by removing dead grass and brush, trash, or stored wooden materials within the first 30 feet from the building.

## Trailers

Trailers are very vulnerable to both flames and embers (Figure 4). Since they are elevated, embers could accumulate underneath the trailers and ignite stored combustible material. Keep the area surrounding the trailers free of wood, trash, brush, and weeds or skirt the building with metal to protect the underside. Prepare plywood boards (or metal tape) to cover windows and vents before evacuation. When a fire is approaching, close all the windows, skylights, and doors.



**Figure 4:** Example of trailers used as office space.

## Greenhouses



**Figure 5:** Examples of: A) Glass greenhouse, and B) Hoop house.

Greenhouse and hoop house construction materials and functionality can vary significantly (Figure 5). Glass can shatter when exposed to high heat, whereas plastic coverings tend to melt and burn. Since greenhouses are unlikely to withstand a wildfire, it is critical to improve their defensible space, as well as to avoid storing critical equipment and materials inside them during the wildfire season.

## Other Critical Infrastructure

The area surrounding critical infrastructure such as water pumps, water filtration systems, power generators, packing sheds, cold storage containers, etc. should be clear from debris, stored materials and vegetation to protect them from flame contact and embers (Figure 6). Water and other critical resources that could be used to defend your property during a wildfire should be marked and made known to the fire department prior to a fire event.



**Figure 6:** The area around critical infrastructure like wells should be clear from vegetation and other combustible materials.

## Defensible Space for Your Farm or Ranch

Defensible space describes the area surrounding a structure or asset where vegetation and combustible materials are carefully maintained to eliminate pathways that wildfire can burn directly to structures, reduce potential for ignition of nearby vegetation and combustible materials from embers, and provide a safe zone to easily evacuate and for firefighters to defend structures.

Preparing your defensible space does not have to be costly. Below are recommended actions you can take to implement an effective defensible space strategy within different zones within 0-100 feet of your structures (Figure 7).

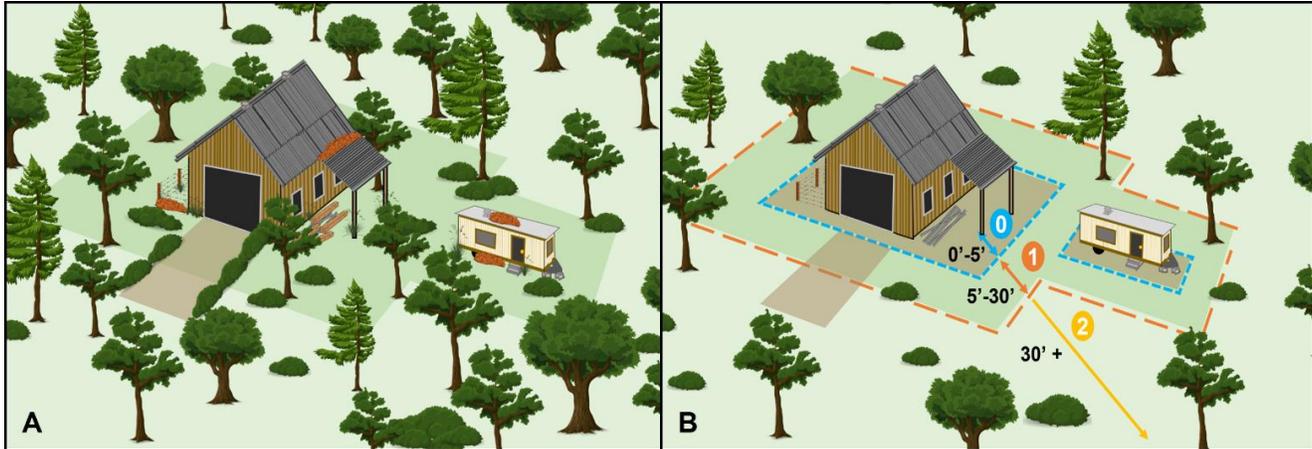


Figure 7: A) Before and B) after implementation of the three-zone defensible space strategy.

### Zone Zero: the ember-resistant zone (0-5 ft from structure)

- **The most critical part of an effective defensible space strategy.** Zone Zero is the horizontal area within the first five feet around the structure and any outbuildings, attached decks, or stairs. It also includes areas under attached decks and stair landings. Eliminating combustible material and vegetation in this zone reduces the likelihood of direct flame contact and heat exposure from fires near the structure.

### Zone One: the lean, clean, and green zone (5-30 ft from structure)

- Zone One reduces the likelihood of fire burning directly to the structure. This zone can provide a defensible zone for fire personnel to stage and take direct action. Increase the spacing between shrubs, trees, and other combustible materials in this zone so if a wildfire enters this zone, vegetation will not burn to the structure or crowns of mature trees.

### Zone Two: the reduced-fuel zone (30-100 ft from structure)

- Modifying spacing of vegetation and combustible materials to reduce flame heights of an approaching wildfire. This zone may need to be extended depending on slope (Figure 8).



Figure 8): Use of rock mulch around building in Zone Zero.

Table 2 outlines actions you can take to implement an effective three-zone defensible space strategy.

Zone	Recommended Actions
<p><b>Zone Zero</b> <i>0-5 ft from structure</i></p>	<ul style="list-style-type: none"> <li>● Remove and dispose of woody vegetation and combustible mulches.</li> <li>● Relocate wood piles, unprotected hay, and other flammable material.</li> <li>● Consider concrete, gravel, or rock mulch around buildings to keep the area free of vegetation.</li> <li>● If fences are attached to the building, upgrade the attachment point with a noncombustible panel or gate.</li> <li>● Aboveground fuel tanks should also have 5-foot Zone Zero.</li> </ul>
<p><b>Zone One</b> <i>5-30 ft from structure</i></p>	<ul style="list-style-type: none"> <li>● Remove and dispose of all dead and dying vegetation.</li> <li>● Space shrubs two times the height of mature plants, increasing spacing on steeper slopes.</li> <li>● Remove limbs of tall trees from 6-10 ft off the ground. For younger/smaller trees, prune over time, but only remove branches in the lower one-third of the tree.</li> <li>● Remove branches of trees that are within 10 ft of a structure.</li> <li>● Mow or graze grasses to a maximum height of 4 inches.</li> </ul>
<p><b>Zone Two</b> <i>30-100 ft from structure</i></p>	<ul style="list-style-type: none"> <li>● Remove and dispose of all dead and dying vegetation.</li> <li>● Thin trees so all branches or groupings of trees are separated by at least 10 ft.</li> <li>● Limb lower branches of taller trees up to a height of at least 10 ft.</li> <li>● Mow or graze grasses to a maximum height of 4 inches.</li> <li>● Store hay or other flammable feedstock on bare ground. If not possible, mow or graze fuels next to storage areas.</li> <li>● Aboveground fuel tanks should be kept on a noncombustible pad and clear of all vegetation.</li> <li>● Large equipment should be spaced 20 ft apart from each other and adjacent structures and kept on a noncombustible surface (bare ground, gravel, concrete).</li> </ul>

**Table 2:** Recommended actions to effectively implement a defensible space strategy by zone.



**Figure 9:** Remove and dispose of vegetation that collects around the first 5 feet of structures.



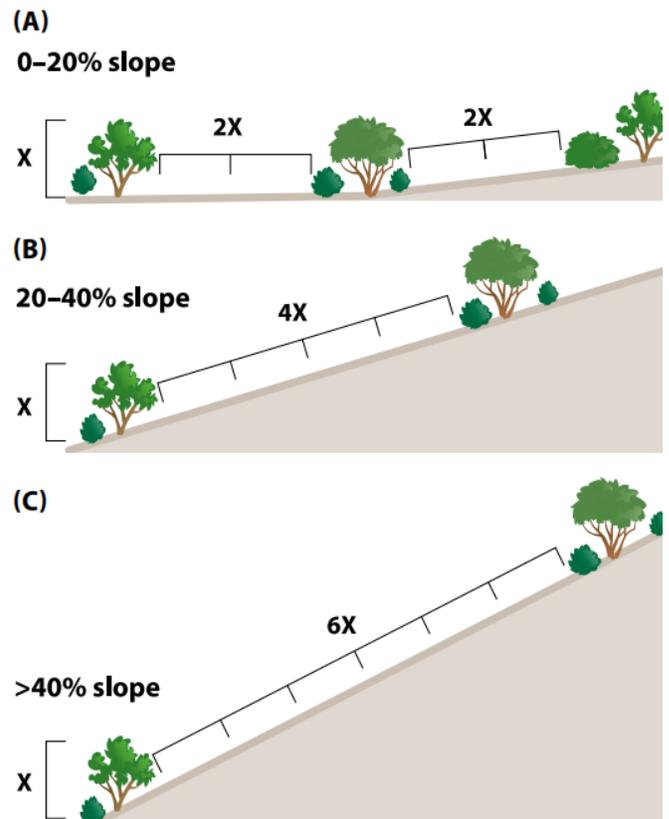
**Figure 10:** Defensible space zones may overlap. Consider looking at building footprints as one larger structure and implement your Zone One or Two strategies accordingly.

## Addressing sloped terrain in your defensible space strategy

If your structures are located on a steeper slope (Figure 11), in a drainage, in a windy area, or in an area surrounded by unusually tall, dense vegetation, the need for thinning and greater clearance and separation between plants increases. How much spacing is needed between trees, shrubs, or groupings is a function of slope and the height of vegetation (Figure 11). If a structure is at the top of a slope, remember that fire and heat rise, allowing for the preheating of upslope fuels, which can result in more intense fire behavior. When a building is located at the top of a slope, enhanced fuel modification below the building is critical to interrupt the pathway and reduce the intensity of an approaching wildfire.

### Space limitations

If you do not have 100 feet or more surrounding any of your structures or certain assets, prioritize actions recommended for Zones Zero and One (Table 2). Consider working with your neighbors so that each side supports the other's efforts. Additional resources may be available from CAL FIRE or your local fire department, Fire Safe Council, or Firewise Community.



**Figure 11:** Distance between groups of vegetation increases as slope increases – in the figure, from 0-20% A), 20-40% B), and greater than 40% C). The distance between groups of vegetation will vary with the height of the tallest plant in each group. Spacing distance, shown as “X”, is a function of the slope and the height of the vegetation (Valachovic et al. 2021).



**Figure 12:** Graze grasses around critical structures or infrastructures to a maximum height of 4 inches.

## Fire Protection for Crops, Vineyards, and Orchards

Many large wildfires have been stopped around vineyards, fields and orchards. This is because agricultural fields are often irrigated or include roads, well-maintained vegetation, and other natural fire breaks. However, there are steps that can be taken to decrease the amount of damage done to agricultural crops and the surrounding agricultural infrastructure.

### Roads

Roads can be used to control a fire and can assist fire personnel in their work. For example, roads help facilitate access for equipment or aid in fire suppression activities. Keep vegetation to a minimum height immediately adjacent to roads and maintain bare mineral soil or rock/gravel on roads that have potential to serve as a holding resource in case of a wildfire. Working with your local fire department can be helpful to share information about your road transportation network, access and gate locations, turn-around locations, and where there may be road width barriers or bridges with weight restrictions that could limit their access (Figure 13).

### Fences

Wood fences, as well as the dry grasses along any fence line, have the potential to carry fire. In general, keep all fences clear of brush, grass or other vegetation, and where fences are near to structures, do not plant vegetation along the fence (Figures 14A and 14B). Wooden fences have the most potential to ignite and carry fire. A fence with wood posts and a metal wire is not likely to transmit the fire, but the individual wood posts may be damaged during a wildfire (Figure 14C).



**Figure 13:** Perimeter roads (yellow) can be used as fire breaks by fire fighters.



**Figure 14:** A) Fence post that was burned but fire did not carry due to metal fencing material. B) Metal fence but line not maintained and kept clear of vegetation that can easily carry fire. C) Metal and wooden fence clear of vegetation and well maintained.

## Fields, Vineyards, and Orchards



**Figure 15:** A) Open rows in a vineyard. B) Citrus orchard with open rows and trees pruned. C) Avocado orchards with sprawling branches and mulch layer.

To help protect against embers, maintain infrastructure and keep natural or cover crop vegetation to a minimum height during fire season in the alleys through either mowing or grazing. Hoops, poly tunnels and plastic covers should be kept free of vegetation along the edges. Some crops need space between the rows such as citrus orchards, vineyards, and other row crops which helps with fire protection by maintaining lines of sight and discontinuity of fuels (Figure 15A & 15B). For crops like avocado orchards that are densely planted and need the mulch layer, consider creating blocks that are separated by roads that can act as fire breaks (Figure 15C). Depending on the pruning strategy and ground cover, vines and orchards can act as a fire break or a potential fire hazard.

## Equipment Storage

If you have a hardened structure large enough to accommodate your equipment, store those machines in the hardened structure. When wildfire is approaching, if you don't have a large enough building, or have not made structure hardening upgrades yet, park equipment in a large area that is clear of vegetation (e.g., bare soil, concrete, or gravel; Figure 16). Be sure to leave some space between each piece of equipment in case one ignites. Check each piece of equipment for any vegetation that might have collected on or under during operation and for fuel or other flammable liquid leaks. Keep windows and doors closed to keep embers out or cover with a fire-resistant tarp.



**Figure 16:** Equipment parked on bare soil with space between each machine.

## Hay and Crop Storage

Hay and crop storage containers such as cardboard or wood boxes can be receptive fuel beds for embers. If possible, move hay to enclosed buildings, or if in fire-prone areas, considering hardening your hay barns. If you must store hay outside, stack neatly on bare mineral soil, gravel, or a concrete pad with defensible space around the stacks. For large amounts of hay, think about different locations on the property to store them so not everything is together, mitigating the risk of losing the entire inventory.

## Other Information and Relevant Resources

### Help emergency responders

Connect with your local fire department and share key information that they could use during a wildfire. Having this information could be beneficial so they know where to go for water or how to evacuate neighbors. You can benefit from this partnership by having firefighters familiar with your property, increasing the potential for your property to be protected. Remember that first responders may come from different regions across the country, so it is recommended to use signs and information that can be easily interpreted. Key information includes:

- Gate codes and where gates are located. If possible, leave gates unlocked during a wildfire.
- Post weight limits on any bridges or water crossings.
- Maps of your property labeled with roads and access points, gates, water sources, septic system, hazardous materials (pesticides) storage, or water lines.
- Maintain lateral and vertical access clearance along roads and indicate turnaround points.



**Figure 17:** Wells and tanks can be used to refill water tenders and engines during a fire.

Label water sources (pools, ponds, tanks and wells) using a blue reflector and indicate if you have a pump that can help them fill their engines if they need to draft (Figure 17). A blue reflector is also an indicator of a water source. If possible, clearly label all emergency water sources with reflective signs (Figure 18). Consider providing a small “trash pump” if your water source does not have a pump since drafting takes longer for firefighters to refill. Helicopters can use ponds and pools to refill.

### Prepare before the emergency

Being prepared for wildfire can go a long way. Here are some things you can do before each fire season:

- **Create and update an emergency plan.** Ensure all employees know what the plan is and how they can contribute.
- **Sign up for mobile emergency alerts.** Check with your county’s Office of Emergency Services to determine what emergency notification programs are available in your county.
- **Apply for your local Livestock/Ag Pass Program.** This provides you a form of verification to access your properties and tend to your crops and livestock during disaster evacuations when conditions are safe to return. Qualifications vary by county.
- **Backup and store business records, inventories, vaccination records, and other key information** to aid in the disaster relief process. Consider cloud-based storage for digital files.
- **Harden the structures** on your property.
- **Create and maintain a defensible space strategy** for all structures and assets.
- **Prepare plywood covers for vulnerable openings** (windows, doors, etc).



**Figure 18:** Clearly label all emergency water sources with reflective signs.

## Resources

### Emergency Plans

- OSHA – Emergency Preparedness for Farmworkers Fact Sheet: <https://www.osha.gov/sites/default/files/publications/OSHA3870.pdf>
- Ranch Fire Preparation Plan: <http://ucanr.edu/sites/Livestock/files/288890.pdf>
- Wildfire Preparation Strategies for Commercial Ranches: <http://ucanr.edu/sites/Livestock/files/288889.pdf>

### Wildfire Information

- Check the CAL FIRE Incident Information Page (<https://www.fire.ca.gov/incidents>), your local Office of Emergency Services or sheriff's department websites, and local news stations for the most up-to-date information.

### Wildfire Preparedness Resources

- **Know how to implement a successful defensible space strategy**  
*Valachovic et al. 2021. Reducing the vulnerability of buildings to wildfire: vegetation and landscaping guidance. UC ANR Publication #8695: <https://doi.org/10.3733/ucanr.8695>*
- **Understand how to plan fuels reduction projects on your property**  
*Valachovic et al. 2022. Planning and permitting forest fuel-reduction projects on private lands in California. UC ANR Publication #8716: <https://doi.org/10.3733/ucanr.8716>*

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