



# Community Planning & Permitting

Courthouse Annex • 2045 13th Street • Boulder, Colorado 80302 • Tel: 303.441.3930  
Mailing Address: P.O. Box 471 • Boulder, Colorado 80306 • [www.bouldercounty.org](http://www.bouldercounty.org)

## BOULDER COUNTY BOARD OF COUNTY COMMISSIONERS

March 17, 2022 – 1:00 PM

Hearing to be Held Virtually Due to COVID-19

### PUBLIC HEARING with PUBLIC TESTIMONY

STAFF: Hannah L. Hippely, AICP

#### **Docket DC-22-0001: Article 19 Marshall Fire - Land Use Code Text Amendments**

Text amendments to the Boulder County Land Use Code to add Article 19-500, which will establish an interim permitting procedure for rebuilding structures destroyed by the December 2021 Marshall Fire.

*Action Requested by the Board of County Commissioners: Approval*

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#### **SUMMARY**

The Marshall Fire (“Fire”) began on Sunday, December 30, 2021, and burned over 6,000 acres in Boulder County. The Fire is the most devastating in Boulder County history, affecting the towns of Louisville and Superior, as well as the surrounding unincorporated areas. In unincorporated Boulder County, 158 residences were destroyed and on those same properties approximately 153 Accessory Structures were also destroyed. On 21 other properties, approximately 43 Accessory Structures were destroyed. 102 residences were destroyed in nine different subdivisions, and 56 residences were destroyed in unplatted areas. As has been done after previous disasters in the County, The Board of County Commissioners authorized staff to work on an amendment to Article 19 Procedures Following Disasters to add Section 19-500 in order to provide a tailored response to this Fire.

## **PROJECT GOALS**

The purpose of the proposed text amendment is to provide a streamlined process for property owners to rebuild by exempting redevelopment from Site Plan Review, while also providing flexibility in the way rebuilding occurs by providing allowances for changes to pre-existing structures. Under the current Boulder County Land Use Code (the Code), Site Plan Review is the planning review process that is typically required for new dwellings prior to issuance of a building permit. *See* Article 4-800 of the Code. While the current Code exempts property owners from Site Plan Review if they rebuild a structure in the original location with the same floor area and height that existed before the disaster and commence that work within one year, Site Plan Review is required if modifications from the original structure are desired. *See* Article 4-802.B.3. The proposed text amendments will substitute for Site Plan Review, allowing prescribed changes that can be reviewed concurrently as part of the review of the building permit and reducing the timeframe by 6 to 8 weeks. In addition to removing the Site Plan Review requirement, the proposed text amendment also establishes parameters around site clean-up, allows temporary housing and structures, ensures that accesses are safely reconstructed, details the allowances and requirements for the rebuilding of destroyed structures, extends the timeframe for rebuilding under an expedited process, responds to the ongoing wildfire risk in the area, and requires final property restoration after rebuilding.

Knowing Boulder County residents may want to make changes to the homes they previously had, the proposed text amendment provides owners with the flexibility to rebuild modified and improved structures, if they submit a building permit application within a five-year period and meet the requirements of the proposed text amendment and the Boulder County Building Code. Nonconforming structures and uses must also apply for a building permit within the same five-year period, replacing the current 6-month limitation. Allowable modifications of Nonconforming Structures and Uses remain subject to the Article 4-1002 and 4-1003 of the Code which control the enlargement or alteration of a Nonconforming Structure or Use.

The proposed text amendment is designed to support flexibility and provide predictability in outcomes while still implementing the County's Comprehensive Plan and essential land use principles intended to retain the unique, scenic and rural character of the County.

The Board of County Commissioners authorized staff to prepare Land Use Code text amendments and related regulations to facilitate rebuilding in the aftermath of the Fire, at a public Business Meeting on February 8, 2022. The Board of County Commissioners hearing on the proposed text amendment is anticipated to follow the Planning Commission hearing on March 17<sup>th</sup>, 2022.

## **DISCUSSION**

The proposed Code amendment is contained in a new section of Article 19, specific to the Marshall Fire (Article 19-500). As with previous sections of Article 19, Article 19-500 is organized in the chronological sequence that would be anticipated for a rebuilding effort, starting with the demolition/deconstruction of Fire-damaged or destroyed structures followed by provisions for applying for building permits to restore residential use on the property. The main components of Article 19-500 are summarized below:

**Section 19-500.A, Structure Deconstruction/Site Clean-Up:** This section addresses the need for deconstruction and site clean-up to occur in a timely manner. The ash and debris present a public health hazard that must be quickly remediated, the foundation holes and remnants of structures and dead vegetation are a safety hazard, and untreated sites have the potential to result in erosion and run-off creating water quality problems. The proposed text amendment establishes timeframes and conditions that every property with a destroyed structure must meet for the close out of a Deconstruction/Site Clean-up permit. Overall, this section establishes predictability on how basic health and safety conditions will be established.

Section 19-500.B, Temporary Structures on Fire-Affected Properties: This section allows property owners whose homes were destroyed by the Fire the opportunity to create temporary housing for themselves on their properties. It expands the allowed types of housing to include Recreational Vehicles and other temporary dwellings on a chassis with wheels. Timeframes for how long temporary housing is allowed to remain on a site and long-term outcome for these structures are also included. This section also includes an allowance for temporary on-site storage.

Section 19-500.C, Fire-Damaged/Destroyed Structures Eligible for Expedited Rebuilding: This section establishes what proposed redevelopment is eligible for review under Article 19-500 and clarifies which portions of the Code these structures are exempt from.

Section 19-500.D, Access Requirements to Construct Eligible Structures and Floor Area: This section provides guidance related to when demonstration of legal access will be required, when proposed driveways must meet the Multimodal Transportation Standards (MMTS), and allows for the use of the design exception of the MMTS.

Section 19-500.E, Timeframe for Eligible Structures Including Nonconforming Structures and Structures Containing Nonconforming Uses: This section establishes extended permit application timelines for the rebuilding of nonconforming structures or structures with nonconforming uses. The timelines are extended four years beyond the standard Site Plan Review requirement and 3.5 years beyond the standard use cessation regulations.

Section 19-500.F, Allowances and Requirements for Eligible Structures: This section establishes that eligible structures are not required to remain the same as the preexisting development, and provides specifics related to what changes to total floor area, modifications to location, and increases to height and bulk are allowed through the Article 19-500 rebuilding process. These changes are intended to provide flexibility in rebuilding, a streamlined review process, and a predictable outcome. The standard Site Plan Review (Article 4-800) process remains the path for redevelopment that proposes changes and modifications beyond the scope of what is allowed under this text amendment. This section also establishes required wildfire mitigation measures that must be incorporated in the redevelopment of the site and structures. Water quality and erosion control issues are also addressed through the inclusion of revegetation and erosion control requirements.

This section also allows for the modification of Nonconforming Structures and Uses as currently allowed in Article 4-1002 and 4-1003 of the Code to the extent the proposed modifications are also allowed in the proposed text amendment.

Section 19-500.G, Appeals Related to Eligible Structures: Since the Director of the Community Planning & Permitting Department may approve, approve with conditions, or deny a building permit, this section provides a property owner with an appeal process. This process is the same as that currently used in the Site Plan Review process where appeals are heard by the Board of County Commissioners at a public hearing.

Section 19-500.H, Compliance with Other County Permitting Requirements: This section explains that other provisions of the Code apply, provides the Director of the Community Planning & Permitting Department with flexibility in the application of those other sections, and confirms that where there are conflicts between Article 19-500 and other portions of the Code, Article 19-500 regulations will apply.

Section 19-500.I, Enforcement: This section clarifies that the existing means for enforcement set for under the Code continue to apply to Article 19-500.

### **TEXT AMENDMENT CRITERIA ANALYSIS**

Article 16-100.B contains criteria for amending the text of the Code. Staff finds that these criteria are met in the context of this Docket, as follows:

*The existing text is in need of amendment:* Article 19 was created to allow the County to provide a focused response to disasters. The Fire has precipitated the need for such a response and an alternate set of regulations that focuses on the relevant issues for rebuilding in the Marshall Fire affected area, while also providing property owners flexibility to make specified modifications to structures.

*The amendment is not contrary to the intent and purpose of this Code:* While this Docket proposes some departures from standard Code procedures, it does so to respond to the exigencies of the Fire disaster. New structures would be subject to a modified building permit review process ensuring any proposed changes to previously existing structures' bulk, mass, and location do not create serious land use impacts. The proposed text amendment conforms to the intent of the Code and does not significantly deviate from the current Code requirements and regulations.

*The amendment is in accordance with the Boulder County Comprehensive Plan:* The proposed review procedures in Article 19-500 do not make changes to the Code that in any way alter the current Code's consistency with the goals and policies of the Comprehensive Plan (the "Plan"). The proposed modified building permit review procedure is designed to assure continuation of the Plan's essential goals.

### **PUBLIC INVOLVEMENT**

The regulations were posted on the Community Planning & Permitting Department's website and sent out to the Land Use Code update listserv on Wednesday March 9, 2022. Prior to drafting the regulations, staff met virtually January 20, 2022 and February 23, 2022 with affected residents to understand their concerns and discuss Article 19 concepts. Staff sent out a questionnaire regarding rebuilding to impacted residents and received 18 responses (Exhibit C). At the community meeting on February 23, 2022, staff polled the attendants on a number of issues and those results are included as Exhibit D. Staff will provide the Planning Commission and Board of County Commissioners (BOCC) with copies of any written public comment received after the publication of this memo and draft of Article 19-500.

### **PLANNING COMMISSION**

A Planning Commission public hearing will be held on March 16, 2022 at 5:00 pm. At the hearing, public comment on the draft regulations will be taken. Planning Commission will discuss the text amendment and provide a recommendation to the Board of County Commissioners. As such, we expect that the 3/9/2022 draft Article 19-500 regulations that are part of this BOCC staff packet may change based on the public process.

In the effort to adopt regulations as expeditiously as possible, Community Planning and Permitting (CP&P) scheduled a BOCC public hearing for the text amendment on March 17, 2022 1:00 p.m. and consequently have included the draft regulations that were released on 3/9/22 along with this staff memo. Any changes recommended by Planning Commission will be enumerated and explained at the March 17th BOCC hearing. However, if there are substantive changes that come out of the Planning Commission hearing, CP&P may reschedule the BOCC hearing date to April 5, 2022 12:30 p.m. instead of holding the hearing on March 17, 2022. Updates will be on the docket webpage and Marshall Fire webpage (<https://www.bouldercounty.org/property-and-land/land-use/planning/land-use-code-update/dc-22-0001/> and <https://www.bouldercounty.org/disasters/wildfires/marshall/#1643999111899-9f42841f-3616>).

### **STAFF RECOMMENDATION**

STAFF RECOMMENDS THAT THE BOARD OF COUNTY COMMISSIONERS APPROVE OF DOCKET DC-22-0001, MARSHALL FIRE LAND USE CODE TEXT AMENDMENT.

DOCKET DC-22-0001: PROPOSED TEXT AMENDMENTS TO ARTICLE 19, PROCEDURES FOLLOWING DISASTERS, TO ADD ARTICLE 19-500 (MARSHALL FIRE 2021) - Text amendments to the Boulder County Land Use Code to add a new Article 19-500 responding to the December 2021, Marshall Fire.

#### Article 19-500 MARSHALL FIRE 2021

On December 30, 2021 Boulder County and the communities of Louisville and Superior experienced a tragic disaster from high winds and wildfire. Boulder County declared a local disaster emergency pursuant to § 24-33.5-709, C.R.S., as amended, in response to the Marshall Fire (the "Fire"), which caused severe damage and loss of life and property in Boulder County.

The following code provisions provide for an efficient rebuilding and recovery process. These regulations provide flexibility by extending time frames for rebuilding following the Fire. The regulations also allow flexibility in structures' location, size, and height while considering potential impacts on neighbors and the environment. In addition, the requirements set forth in these code amendments reduce risk from future wildland and urban fires to help build a more resilient community.

The provisions in this Article pertain to structures destroyed or damaged by the Marshall Fire and wind event and any necessary land restoration efforts resulting from the Fire.

#### A. Structure Deconstruction/Site Clean Up

1. A Deconstruction/Site Clean-Up Permit is required for each property where a structure(s) was destroyed by the fire. This permit is required prior to issuance of a building permit for new construction, eligible structures, temporary structures.
  - a. The deconstruction recycling requirements of the Boulder County Building Code, commonly known as "Boulder County BuildSmart," shall not apply to the Deconstruction/Site Clean-Up Permit.
  - b. A Deconstruction/Site Clean-Up Permit must be applied for by June 30, 2022.
  - c. Deconstruction/Site Clean-Up Permits must be closed out by September 30, 2022 unless an extension is granted by the Director for good cause. Extensions shall not be longer than 30 days.
  - d. Site condition requirements include:
    - i. IF REBUILDING IMMEDIATELY: If a property owner intends to build on the property within 180 days of the Deconstruction/Site Clean-Up Permit final inspection date, a temporary construction fence shall be installed around the perimeter of the disturbed area and erosion and sediment control measures must be in place until construction begins.
      1. If a complete building permit application for a new structure(s) has not been submitted within 180 days of the deconstruction/site clean-up final inspection and close-out date, the Not Rebuilding Immediately requirements below must be implemented.
        - a. A one-time extension of the 180-day timeframe allowing a property owner to maintain temporary construction fencing and erosion and sediment control measures (versus re-grading and stabilizing the site) following clean-up completion may be granted for good cause by the Director for up to 90 days.
    - ii. IF NOT REBUILDING IMMEDIATELY: If a complete building permit application for a new structure(s) will not be submitted within 180 days of the deconstruction/close-out permit final inspection date, any excavated area(s) must be backfilled and the site returned to its natural grade, areas of disturbed soil must be seeded and stabilized,

and erosion and sediment control must be in place until vegetation is at least 70% established.

2. Other requirements, including but not limited to permits related to hazardous material removal and water quality administered by the Colorado Department of Public Health and Environment, may be required.

B. Temporary Structures on Fire-Affected Properties

1. A Deconstruction/Site Clean-Up Permit must be closed out prior to issuance of a building permit for any temporary structures on a property.
2. Temporary structures require a building permit and shall comply with zoning setback requirements, unless the Director determines that existing site conditions make such location impractical or unnecessary.
3. Temporary Housing Units
  - a. Temporary housing is intended to house those whose residence was destroyed by the Fire on a short-term basis while preparing for or rebuilding the new residence. Temporary housing units shall only be occupied by the property owner and the owner's family.
  - b. Only one temporary housing unit shall be permitted per property, unless the owner can demonstrate that an additional unit is necessary.
  - c. The final status (i.e. removal, decommissioning, etc.) of the structure used for temporary housing must be approved prior to the issuance of the building permit for the temporary housing unit and the structure must be removed or converted to the approved final condition upon final inspection of the permanent dwelling unit.
    - i. Structures that remain on site will count towards the total Residential Floor Area on the property.
    - ii. Only one permanent dwelling unit is allowed to remain on the property unless an accessory dwelling unit is approved.
    - iii. Once a building permit to rebuild a permanent dwelling unit has been issued, the temporary housing unit may remain while a valid County building permit for work on the permanent dwelling unit is in effect. Within two weeks of County issuance of a certificate of occupancy for the permanent dwelling unit, the temporary housing unit must either be removed from the property along with the site of its location being fully restored, or must be converted to a legal, permanent accessory structure.
  - d. The use of a Recreational Vehicle (RV) or other temporary dwelling on a chassis with wheels are allowed provided:
    - i. Electrical service is provided and a building permit for Temporary Electrical service is issued;
    - ii. An on-site connection to the potable water supply is provided;
    - iii. A method for the safe disposal of effluent is approved of by Boulder County Public Health;
    - iv. The use of an RV or other temporary dwelling on a chassis with wheels as a temporary housing unit shall be limited to two years from adoption of this amendment. This timeframe may be extended by the Director for up to 180

- days if a building permit application for a permanent dwelling unit has been issued; and
  - v. Recreational Vehicles or other temporary dwellings on a chassis with wheels must be safe for temporary occupancy. They must be licensed and operable or installed according to manufacturer's specifications and adhere to applicable County safety requirements such as being properly secured/tied down.
2. Temporary Accessory Structures
- a. A temporary accessory structure may be located on an affected property to assist with rebuilding on, or cleanup of, the property, provided a building permit is issued for the structure if required.
  - b. Temporary accessory structures may not exceed 500 sq. ft.
  - c. Temporary accessory structures are allowed for up to 5 years from the adoption of this Code or must otherwise be permitted as a permanent structure. Structures that remain on site will count towards the total floor area on the property.
- C. Fire-Damaged/Destroyed Structures Eligible for Expedited Rebuilding
- 1. Any legal structures or floor area (residential or non-residential) that was damaged or destroyed by the Fire, may be rebuilt or repaired if approved through the process set forth below. New construction within the defined parameters is exempt from Land Use Code site plan review approval (Article 4-800) and special use review approval (Article 4-600). Development Credit acquisition exemptions and requirements (Article 4-1300) apply.
  - 2. A Deconstruction/Site Clean-Up Permit must be closed out prior to issuance of a building permit for any new structures and floor area on a property.
  - 3. Eligible Structures and Floor Area include:
    - a. Structures and Floor Area erected according to a valid County building permit.
    - b. Structures and Floor Area erected without a valid County building permit, if the owner can demonstrate that the structure or Floor Area preexisted the effective date of building permit requirements in the County (January 27, 1966 for Subdivided Land, and December 22, 1975 for Unsubdivided Land), or was exempt from applicable building permit requirements. This information can be obtained through County Assessor's records, photographs, maps, and surveys, property damage assessment or other documentation deemed acceptable by the Director.
    - c. Nonconforming Structures and Structures containing Nonconforming uses. Nonconforming structures and uses are those that do not conform to the zoning district regulations (such as setbacks) in which the nonconforming structure or use is located as a result of the adoption or amendment of this Code.
    - d. Accessory structures, such as outbuildings, may be built prior to the construction of the anticipated principal use (i.e., the permanent dwelling unit).
    - e. A ground-mounted Accessory Solar Energy System that otherwise requires a site plan review waiver under this Code associated with an eligible structure, provided the Director determines that the proposed location of the system will not have a significant adverse visual impact on neighboring private and public property.
  - 4. Proposed construction that is outside the scope of the defined parameters outlined in Section 19-500.F may be undertaken if approved under the applicable provisions of the other articles of this Code, such as Site Plan Review.



DOCKET DC-22-0001: PROPOSED TEXT AMENDMENTS TO ARTICLE 19, PROCEDURES FOLLOWING DISASTERS, TO ADD ARTICLE 19-500 (MARSHALL FIRE 2021) - Text amendments to the Boulder County Land Use Code to add a new Article 19-500 responding to the December 2021, Marshall Fire.

- D. Access Requirements to Construct Eligible Structures and Floor Area
  - 1. If the previous access point is being reused, demonstration of legal access is not required. If the access point is being relocated, demonstration of legal access is required. Modifications to pre-existing driveways should meet Multimodal Transportation Standards.
- E. Timeframe for Eligible Structures (Including Nonconforming Structures and Structures Containing Nonconforming Uses)
  - 1. A property owner must submit a complete building permit application to build an eligible structure or Floor Area to the Community Planning & Permitting Department within 5 years after the adoption of this Code. A one-time extension of up to one year may be granted by the Director if good cause is demonstrated.
  - 2. Work under a valid building permit must continue within the timelines provided for under the Boulder County Building Code.
- F. Allowances and Requirements for Eligible Structures and Floor Area
  - 1. Eligible structure(s) may be issued a building permit upon the Director determining the following parameters are met:
    - a. Size. The Residential Floor Area of eligible structure(s) shall not exceed the lesser of either:
      - i. the size presumed to be compatible with the defined neighborhood (125% median residential floor area) on December 30, 2021, or
      - ii. 1,000 square feet in Floor Area over that existing on the parcel as of September 8, 1998.
      - iii. When new construction results in Residential Floor Area over 6,000 square feet, and exceeds the Residential Floor Area that legally existed on the property as of December 30, 2021, Development Credits must be purchased for any Residential Floor Area that exceeds what was legally existing as of December 30, 2021, pursuant to Article 4-1300 of this Code..
    - b. Location. Structures must be located in the same general location as the previously existing structure and shall reuse 50% of the footprint of the previously existing structure.
      - i. Nonconforming Structures and Structures containing Nonconforming Uses may be permitted to relocate to a larger degree when the relocation will result in a higher degree of conformity. Setbacks for Nonconforming Structures and Structures containing Nonconforming Uses from an irrigation ditch shall be 20 feet from the centerline of the ditch.
    - c. Height. Allowable increases in height include:
      - i. On an eligible structure that was previously one story, the height of the replacement structure may be increased up to a maximum total height of 20 feet from existing grade.
      - ii. Height may also be increased up to the maximum height allowable in the zoning district if the new second level on a structure that was previously one-story does not exceed 800 sq. ft., or if a previously-existing second story is expanded by a maximum of 500 sq. ft.

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- iii. Impacts on neighboring views should be considered, and the stories above (particularly if in a shifted footprint) shall be stepped back or broken up to mitigate the visual impacts from the massing.
    - d. Earthwork. Non-foundational earthwork of up to 500 cubic yards associated with modifications to the driveway or structure relocation is permitted.
    - e. Previous approvals. Rebuilding under this section shall remain subject to explicit limitations that were imposed on a property through a prior County land use approval or conservation easement.
  - 2. Redevelopment must mitigate the risk of wildfire both to the subject property and neighboring properties in the surrounding area by incorporating the list of Boulder County Building Code wildfire provisions set forth in Appendix A. Appendix A is applicable until amendments to the Boulder County Building Code wildfire provisions become effective.
  - 3. Revegetation and erosion control are required on the property. The property owner must include a revegetation and erosion control plan with the building permit application for review and approval by the Community Planning & Permitting Department. The full installation of the approved plan must be inspected and approved prior to issuance of a certificate of occupancy for the permanent dwelling unit.
  - 4. Nonconforming Structures and Structures Containing Nonconforming Uses. Any alteration of nonconforming structures and uses must comply with the provisions of Article 4-1002 and 4-1003. Altering the location of a structure to have a higher degree of conformity with the setback is permitted.
- G. Appeals related to Eligible Structures and Floor Area
  - 1. If the Director finds that the building permit application does not comply with the applicable standards or requirements, the application cannot be processed through this expedited review process and may require the applicable review process (such as Site Plan Review or Special Use Review). The Director may delay a decision on any application, if the Director finds that insufficient information has been presented to evaluate compliance with the parameters and requirements set forth in this Section.
  - 2. While the Director is not required to make a decision on a building permit application within a specified time and may delay a decision on a reasonable basis as provided herein, the Director shall make a good-faith effort to process requests as soon as practicable after a complete building permit application has been submitted.
  - 3. The applicant may appeal the Director's final decision on a building permit application using the same process as set forth in Article 4-808 for appeals of Site Plan Review determinations.
- H. Compliance with Other County Permitting Requirements
  - 1. Any other County permitting requirement or related provision not specifically addressed in Article 19-500, shall be presumed to apply, unless the Director determines that strict application is contrary to the intent and purposes of this Article. The Director may grant appropriate relief from the strict application, subject to reasonable mitigating measures.

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2. In the event of a conflict between this Article 19-500 and any other code provision, this Article shall apply.

I. Enforcement

The County may enforce Article 19-500 through the provisions set forth in Article 17-300 of this Code. Nothing in this Article shall limit the County's existing enforcement authority under Articles 14 or 17 of this Code, the Boulder County Building Code, or other applicable law.

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#### 19-500 - Appendix A

R327.4 Restrictions in Wildfire Zone No. 2. Buildings constructed in Wildfire Zone 2 shall comply with this section.

R327.4.1 Roof covering. Roof covering materials installed in Wildfire Zone 1 shall be listed Class A roof covering materials or be constructed as a Class A roof assembly. For roof coverings where the profile allows a space between the roof covering and roof decking, the space at the eave ends shall be fire stopped to preclude entry of flames or embers, or have one layer of 72-pound (32.4 kfg) mineral-surfaced, non-perforated cap sheet complying with ASTM D 3909 installed over the combustible decking.

R327.4.1.1 Roof valleys. When provided, valley flashings shall be not less than 0.019 inch (No. 26 galvanized sheet gage) corrosion-resistant metal installed over a minimum 36-inch-wide underlayment consisting of one layer of 72-pound mineral-surfaced, non-perforated cap sheet complying with ASTM D 3909 running the full length of the valley.

R327.4.2 Gutters and downspouts. Gutters, downspouts, and gutter covering devices shall be constructed of noncombustible material. Gutters shall be provided with an approved means to prevent the accumulation of leaves, pine needles and debris in the gutter.

Exception: Buildings meeting one of the exceptions to Section R401.3 of this code may be constructed without gutters and downspouts.

R327.4.3 Spark arrestors. Chimneys serving fireplaces, barbecues, incinerators or decorative heating appliances in which solid or liquid fuel is used shall be protected with a spark arrester. Spark arresters shall be constructed of woven or welded wire screening of 12 USA standard gauge wire (0.1046 inch)(2.66 mm) having openings not exceeding ½ inch (12.7 mm). The net free area of the spark arrester shall not be less than four times the net free area of the outlet of the chimney.

R327.4.4 Fences, retaining walls and similar appurtenances. Fences, retaining walls or other appurtenances that connect to buildings must be constructed of *noncombustible materials* or *ignition-resistant materials* for a distance of 3 feet beyond the exterior walls.

R327.4.5 Protection of eaves. The leading edge of the roof at the fascia must be finished with a metal drip edge so that no wood sheathing is exposed.

Eaves, fascia, and soffits, covered decks or covered porch ceilings shall be protected on the enclosed underside by one of the following materials or methods:

1. *Noncombustible materials.*
2. *Ignition-resistant materials.*
3. Materials approved for a minimum of 1-hour fire-resistance-rated construction.
4. 2-inch-thick nominal dimension lumber.

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5. 1-inch-thick nominal *fire-retardant-treated wood*.
6.  $\frac{3}{4}$ -inch-thick nominal *fire retardant-treated* plywood labeled for exterior use.
7. Any materials permitted by this code.

Exceptions:

1. Vinyl or plastic soffits, fascia or *trim* are not permitted.
2. Rafter tails or roof beam ends may be exposed if they are *heavy timber* having minimum dimensions not less than 6-inch nominal in width and not less than 8 inches nominal in depth.

R327.4.6 Exterior walls. Exterior walls of buildings or structures shall be constructed with one of the following methods:

1. *Noncombustible materials* approved for a minimum of 1-hour fire-resistance-rated construction on the exterior side.
2. Approved *noncombustible materials*.
3. *Heavy timber or log wall construction*.
4. *Fire-retardant-treated wood* labeled for exterior use on the exterior side.
5. *Ignition-resistant materials* on the exterior side.

Such material shall extend from the top of the foundation to the underside of the roof sheathing.

Exception: *Trim* is not required to meet the materials requirements for exterior walls.

R327.4.7 Unenclosed under floor protection. Buildings or structures shall have all underfloor areas enclosed to the ground with exterior walls in accordance with Section R327.4.6. For decks, see Section R327.4.8.

Exception: Complete enclosure may be omitted where the underside of all exposed floors and all exposed structural columns, beams, and supporting walls are protected as required for exterior 1-hour fire-resistance-rated construction or *heavy timber construction* or *fire-retardant-treated wood* labeled for exterior use.

R327.4.8 Decks, appendages, and projections. Decks and other unenclosed accessory structures attached to buildings shall be constructed of the following materials:

R327.4.8.1 Deck surface: *Non-combustible* material, approved wood thermoplastic composite lumber with an ASTM E84 flame- spread index no greater than 200, *ignition- resistant building materials* or any *approved* Class A roof assembly.

R327.4.8.2 Deck framing: Deck framing shall be constructed of one of the following:

1. 1-hour fire resistance-rated construction

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2. *Heavy timber* construction.
3. *Approved noncombustible materials*.
4. *Fire-retardant-treated wood* labeled for exterior use.
5. *Ignition-resistant building materials*.
6. Wood with a minimum nominal thickness of at least 2 inches for joists and 4 inches for beams and columns or posts.

R327.4.11 Vents. Attic ventilation openings, foundation or under-floor vents, or other ventilation openings in vertical exterior walls and vents through roofs shall not exceed 144 square inches each. Such vents shall be covered with noncombustible corrosion-resistant mesh with openings not to exceed 1/8 inches or shall be designed and *approved* to prevent flame or ember penetration into the structure. Gable end and dormer vents shall be located at least 15 feet from property lines and shall be designed and *approved* to prevent flame or ember penetration into the structure. Underfloor ventilation openings shall be located as close to grade as practical.

R327.4.12 Detached accessory structures. Detached accessory structures shall have exterior walls constructed in accordance with Section R327.4.6.

R327.4.12.1 Underfloor areas. Where the detached structure is located and constructed so that the structure or any portion thereof projects over a descending slope surface greater than 10 percent, the area below the structure shall have all underfloor areas enclosed to within 6 inches of the ground with exterior wall construction in accordance with Section R327.4.6 or underfloor protection in accordance with Section R327.4.7.

Exception: The enclosure shall not be required where the underside of all exposed floors and all exposed structural columns, beams, and supporting walls are protected as required for exterior 1-hour fire-resistance-rated construction or *heavy timber construction* or *fire-retardant-treated wood* on the exterior side. The *fire-retardant-treated wood* shall be labeled for exterior use.

R327.4.13.1 Weed barrier and gravel or crushed rock. A weed barrier and gravel or crushed rock not less than 3/4-inch in diameter applied at least 2 inches thick must be installed beneath decks, unenclosed floors, and around the perimeter of the building to extend at least 3 feet beyond the exterior walls and at least 2 feet beyond the driplines of decks, bay windows and other eaves and overhangs.

Exception: Noncombustible surfaces, such as poured concrete or asphalt, or other *approved noncombustible* materials, such as a weed barrier and brick, concrete or stone pavers, may satisfy this requirement.



# Community Planning & Permitting

Courthouse Annex • 2045 13th Street • Boulder, Colorado 80302 • Tel: 303.441.3930 • Fax: 303.441.4856  
Mailing Address: P.O. Box 471 • Boulder, Colorado 80306 • [www.bouldercounty.org](http://www.bouldercounty.org)

## Exhibit B

### BOARD OF COUNTY COMMISSIONERS BUSINESS MEETING

February 8, 2022 – 10:30 AM  
Via Microsoft Teams

#### Authorization under Article 16-100.A of the Boulder County Land Use Code for Text Amendments to the Land Use Code related to Article 19 (Procedures Following Disasters)

*Staff:* Hannah Hippely, AICP

*Public testimony will not be taken – action requested*

#### SUMMARY

On December 30, 2022, Boulder County declared a local disaster emergency pursuant to § 24-33.5-709, C.R.S., as amended, partially in response to the Marshall Fire, which caused severe damage and loss of property in Boulder County.

The County is committed to working with property owners in their recovery from damage or destroyed structures and intends to streamline the rebuilding process. The County's aim is to allow property owners to rebuild in a timely, safe and responsible manner.

Current Land Use Code regulations (Art. 4-802.B.3) allow someone to rebuild without Site Plan Review if they rebuild what previously existed (original location, floor area, height) and obtain building permits within one year of the destruction. However, if someone wanted to change the design to their home with a different footprint, location, size, or height, it would trigger Site Plan Review.

The County recognizes that people may want to make changes to their pre-existing structure when rebuilding. After previous disasters, the County adopted specialized regulations to allow people to make minor changes to their homes without triggering the full Site Plan Review process. It is the intent of this code amendment to adopt a similar approach which would, extended timeframe for rebuilding and through a streamlined approach replacing Site Plan Review, evaluate focused issues while also allowing some flexibility in the design of the homes that are rebuilt. The proposed regulations will be designed to accommodate this flexibility while still implementing the County's essential land use principles intended to retain the unique, scenic and rural character of the County.

Fires drastically change the landscape in obvious ways and while the recently impacted properties do not face the same degree of danger from excessive runoff, debris flows, and rockfall hazard as when fires occur in steep mountainous areas the County is committed to resilient rebuilding. Rebuilding in a resilient way requires the consideration of longer term wildfire mitigation in areas previously not designated as being in a wildfire hazard zone and any other hazard that may be identified through the process.

Staff intends to develop a focused approach to rebuilding after the Marshall Fire in Article 19 (Procedures Following Disasters) of the Land Use Code, and will make any other Code revisions necessary to integrate the changes.

**ACTION REQUESTED**

Staff requests the Board of County Commissioners authorize staff to pursue the text amendments to Article 19 of the Boulder County Land Use Code to ensure streamlined and resilient rebuilding.



# Exhibit C

Do you plan to participate in the coordinated debris removal program? See Marshall Fire Debris Removal Program for more information.	Are you planning on rebuilding	Are you unsure on how / if / when you'll move forward?	If rebuilding, what is your timeline?	If rebuilding, what are your current thoughts (knowing that things may change) about the type of house you will build? Are you considering the same footprint / location? Same size? Smaller? Larger? What kinds of modifications are you considering?	Have you sold the property or are you thinking about selling?	Do you need help finding architects/builders/designers who have experience constructing high performing homes? What green building resources or information would be helpful?	Do you need general information on what high efficiency and clean energy options you may want to consider as you start the rebuilding process?	Do you need information on electric car options, and electric car charging at home, that you may want to consider as you start the rebuilding process?
Yes	Yes	Unsure	within 2 years	Same location, smaller, firewise, sustainable, passive haus	no	Yes	Yes	Have electric car Chevy Bolt, Lost Tesla Model S in the fire.
Not sure	Possibly	Yes - home is underinsured	Unknown	Will have to be smaller due to insurance	No	Yes	Yes	Yes
Yes	yes	yes	ASAP	Same footprint	no	need help finding architects/builders/designers in general	no	no
No	yes	no	ASAP	We had just finished a total remodel/rebuild in 2019. We will be changing the footprint but same sf	NO	Unsure	no	no
Yes	Yes		18 months+	Same size (6K sq ft) but with a different footprint, style, etc.	No			
Not sure	likely	yes	asap	similar but potentially slightly larger	likely not	yes	yes	yes
Not sure	Yes	No	18-24 months	Same location, same size or slightly smaller, No more friendly to aging in place, fireproof as much as possible		Information on what current building codes require as our home was built in the early 1990s	yes	Not sure
Yes	Yes	As soon as possible, likely within 6 months I think	6 months plan, 18 months build. Shooting for 24 months at most	Likely slightly smaller, more efficient, all electric with lots of solar, more fire resilient, good air filtration. High attention to insulation and envelope.	No	Links to most efficient HVAC tech and insulation systems	Sure	We plan to have two electric cars and at least 9kw of solar
Not sure	yes	yes	asap	smaller	no	yes	yes	no
Yes	No need to							

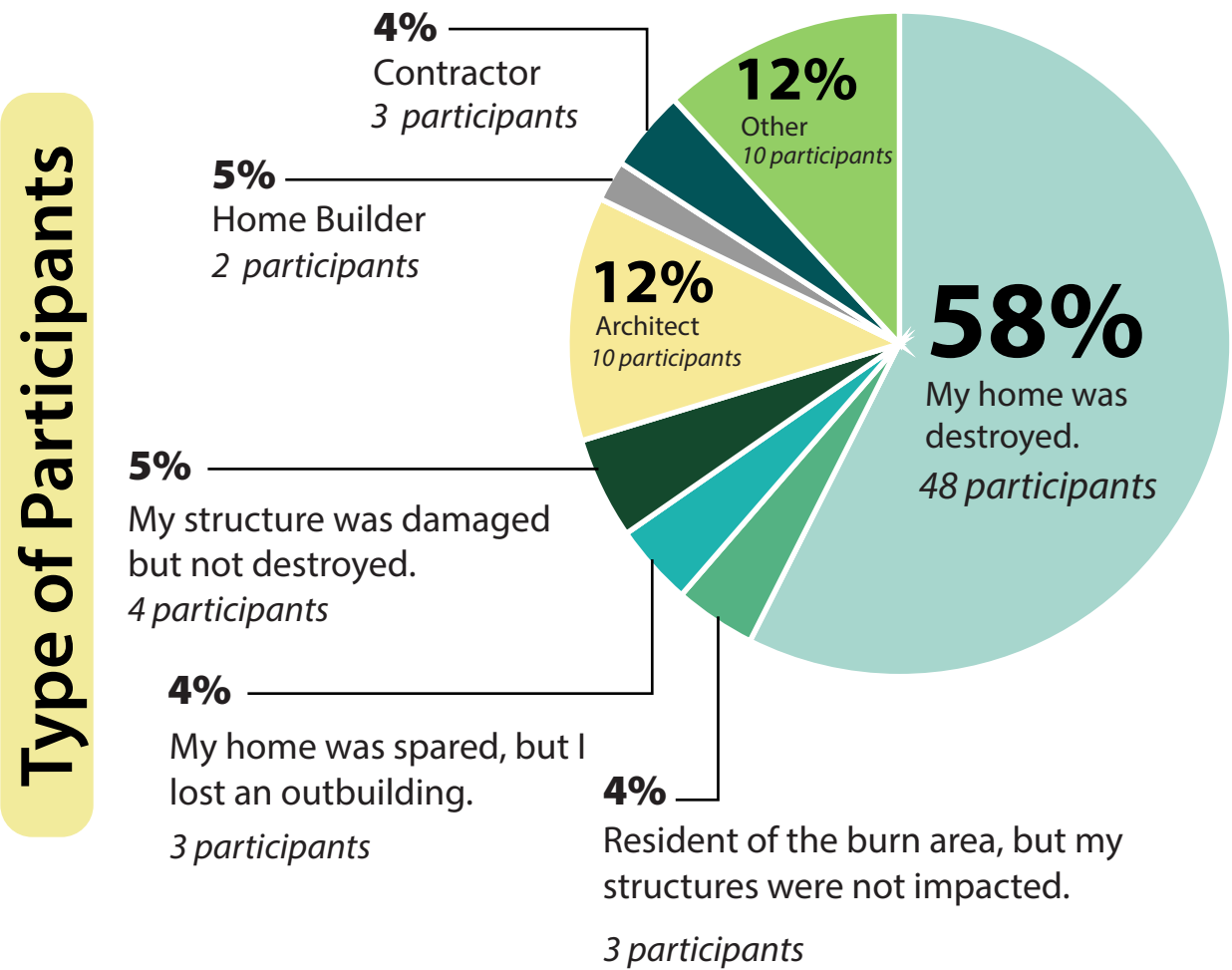
Yes	Yes	We'd like to move forward as soon as possible	<24 months, maybe even <12 months.	We already had an approved site plan for an addition. We're hoping that we could make minor modifications to the plan without incurring delays to the timeline.	No and no	Luckily, we already have architect and builder lined up since we were about to being an extensive remodel/addition.	Yes	Yes
Yes	Yes	Need to build a ADA compliant modular home	Next three years. Want to live in an RV the summer of 2022	Something small and cool looking.	No	Yes	Yes	Yes
Not sure	Yes!	We will rebuild and working on that process now.	As quickly as possible	We plan on building a passive home and make updates for an energy efficient new home. We want to have solar, all electric and move the location of the house on the lot. We are considering a smaller home that is designed more efficiently.	No!	Yes, any information would be helpful and appreciated.	Yes, any information is helpful.	Yes, that is a goal for the new house as well.
Yes	YES	We don't know all the details but we do know we are going to move forward	the house will be basically the same as we had before with some modifications. We do have an architect and they are helping us navigate the process	basically the same but may expand the footprint some and move the foundation a bit . Certainly modifications to include better fire resistant siding, better roofing, tolerating the winds in Marshall, the lack of water-no fire hydrants near us,build better	NO	We do have an architect as of last week. It would be helpful to have these meetings accessible to them and the builders so they know any of the changes, and decisions being made.	Yes	yes
Not sure	yes	yes	sooner rather than later	shifting footprint slightly to better suit the property. Slightly larger property and rebuilding outbuildings/equipment sheds approx same size as before. Will be seriously considering solar, geothermal heating and cooling. bury in power lines.	only if it takes too long	would appreciate any resources available	we will do solar, more info on geothermal would be great	we will wire it in as an option to install when needed
Not sure	Yes	A bit; we have a big picture idea, but are unsure of how to accomplish all the little details like dealing with the well, septic, testing the soil, etc.	Ideally would like to be rebuilt within a year, but that's unlikely so next best case is 18 months.	We want to keep a similar total size, but ideally would build a small cottage (ADU kind of thing, for age in-place) in addition to the main house. Hoping the combined square footage of the two buildings would be close to what was lost.	No	Yes, we have a referral for an architect, and a couple builders, but a list of vendors experienced in Boulder county would be helpful.	Yes	Yes, is this a requirement for all new homes?
Yes	yes if we can afford it	Already in contract with architect and contractor for pre-construction	Hope to be completed in 2 years	same or smaller in size, single level with walkout basement	hopefully no	no	no	no
Not sure	Yes, and we have many questions about temp structures	Yes, but we certainly want to move forward	Quickly if possible	Smaller, better, different location, fire and wind resistant	no	yes	yes	yes
Not sure	Yes	yes	Well, insurance will cover our living expenses for only 12 months unless there is a change in state legislation, so I guess our timeline is 12 months.	Same house, same location, little bit smaller	No	Yes, we need help finding architects/builders.	sure	i don't think so.
Yes	Yes		ASAP	Want to build a home to age in place. Do not plan on using foundation, but roughly same location. Would very much like to understand size limitations, whether an ADU is possible for aging parents, etc.	No	We think we have a builder but always appreciate resources	Yes	Yes
No	Yes	No	We hope 18 months	Similar rebuild, build back better, fireproofing	No	We have a contractor and architect	Yes	Yes

No	Unsure	Yes	24-36 months	Was 5600 square, new home probably a little smaller, more green, age in place structure,	Possibly, but probably will hold for at least a year.	No	No	
Not sure	Yes	Yes, due to being under insured	As fast as possible	Same footprint with minor changes	No	I would appreciate building green information	Yes	Yes
Not sure	Yes. Asap	No	As quickly as we can. 18 month	A little smaller conditioned space, larger garage and workshop for our vegetable gardening. Ideally move the location 30 feet. Fire resistant and super insulated with net zero	No	Yes, that would be very helpful. The most helpful would be adopting a more advanced building code because that would help us with the insurance	Yes, it can help. I already did some research and know I want a zero carbon home. I think information what is most cost effective to achieve that would be helpful	I would definitely add a car charging option
Not sure	Yes	Yes	Two years would be amazing	We would like to build with the same square footage and another ranch. Hope to an attached garage as the house did not have one. Perhaps with a room above the garage	No	Yes	Yes	No
Yes	Yes	not quite	asap, within 2 years	considering smaller size due to insurance coverage vs building costs	no	no	yes	yes
Yes	yes	No	as soon as possible	Plan to rebuild in the same location and changing some of the footprint of the house but probably close to the same size footprint.	no	no	yes	yes
Yes	Possibly	Yes	Depends on debris removal and BOCO permitting process	Same footprint/location. Considering smaller or tiny house option. Possibly very small living area with 3-car garage and/or additional garage/workshop area	Possibly selling if permitting process is long and arduous	No	No	No

# COMMUNITY MEETING 2/23 FEEDBACK

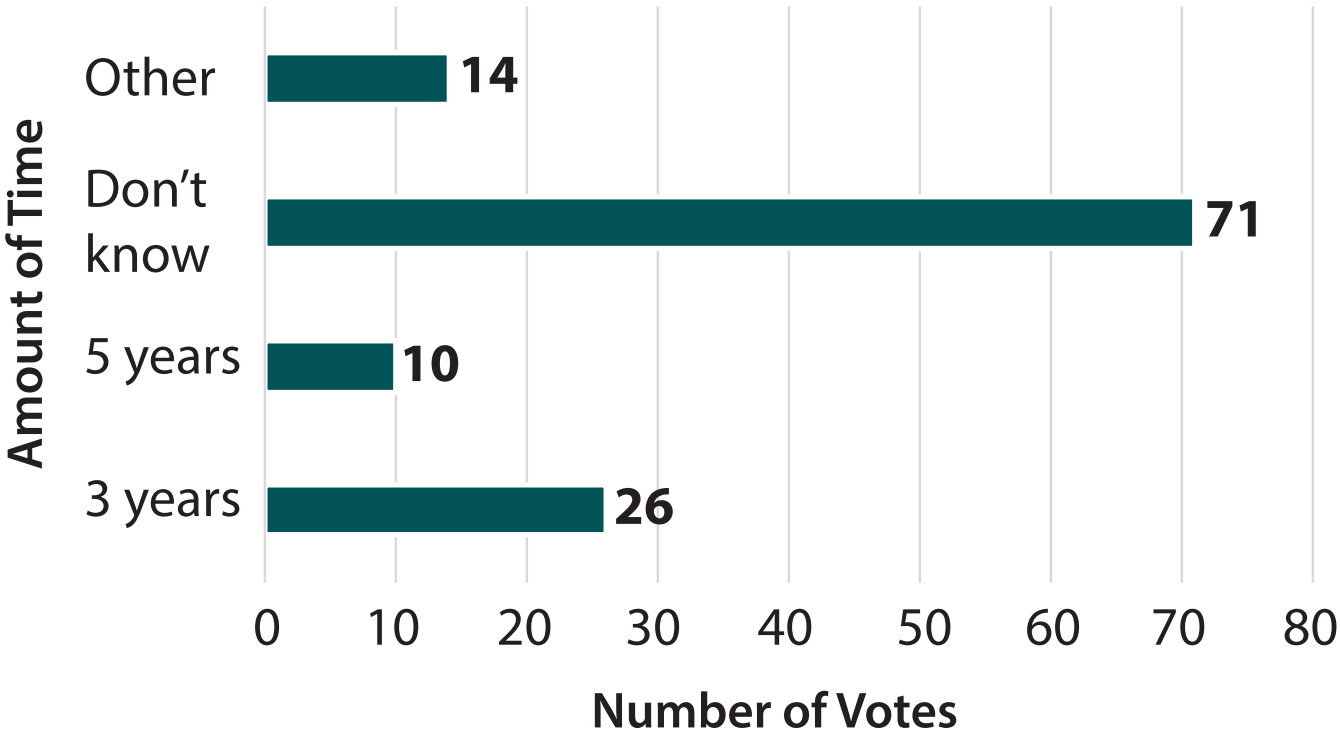
Exhibit D

## ATTENDANCE



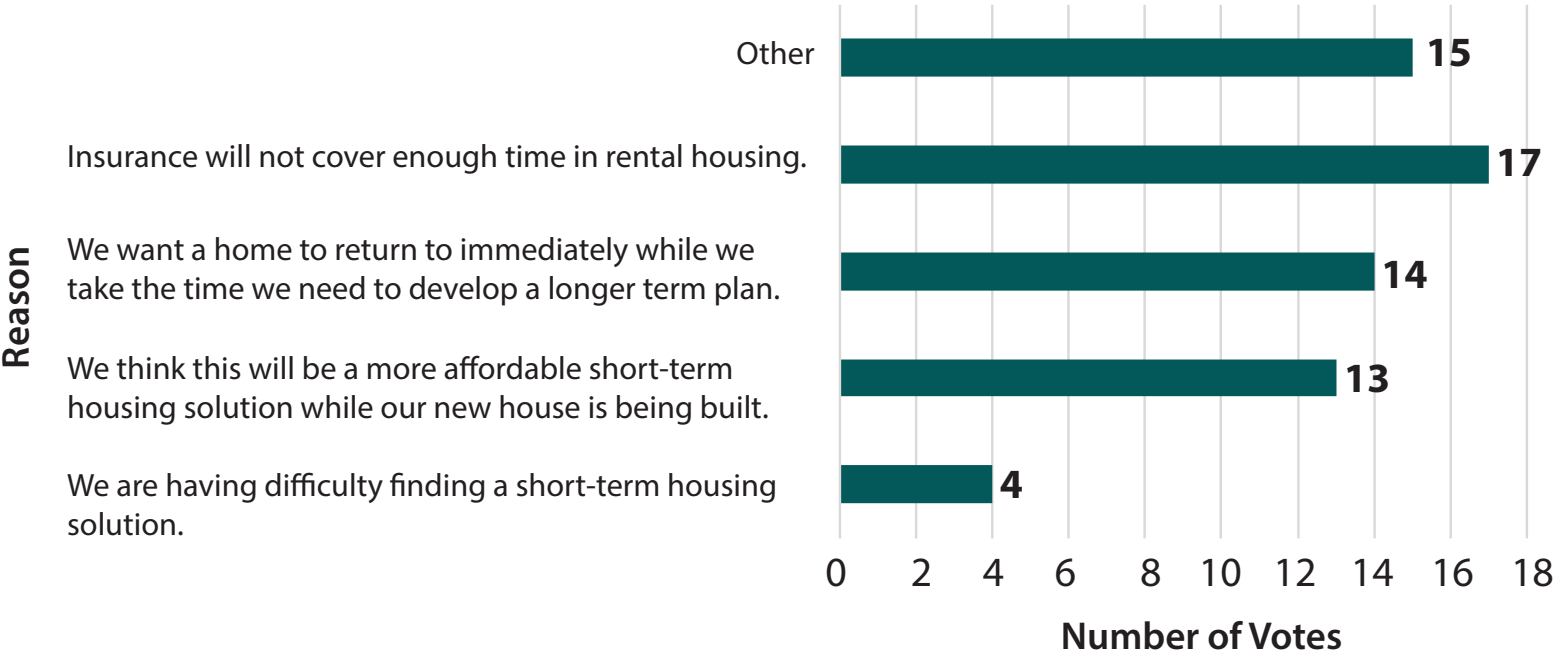
## TIME TO REBUILD

How much time do you think you will need to rebuild?

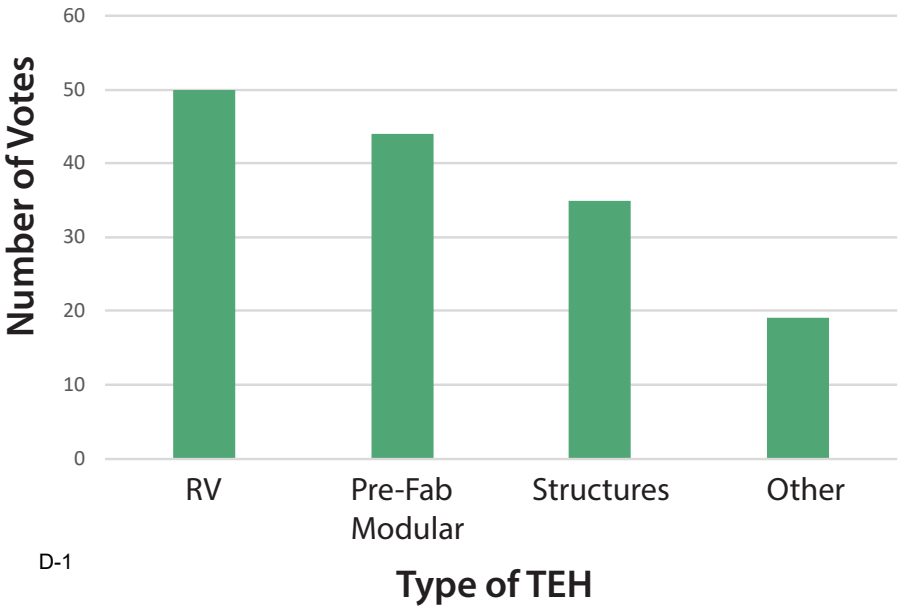


## TEMPORARY EMERGENCY HOUSING

Why are you interested in TEH?



Which types of things should be allowed as TEH?



How long should RVs be allowed?

- Themes**
- 0-11 months
  - 1-2 years
  - 3-5 years
  - Until house is complete

# COMMUNITY MEETING 2/23 FEEDBACK

## COMMUNITY CHARACTER

What did you appreciate about your neighborhood or home that you hope redevelopment will not change?

What concerns you the most about how redevelopment could change things?



Rural character



Views



Variety of architectural character and design styles

**Other Themes**

- House size is appropriate for lot
- Privacy
- Safety
- Community and neighbors
- The charm of Marshall characterized by a mix of housing sizes, styles, and design
- Open space and environmental health
- Unique and personal feel

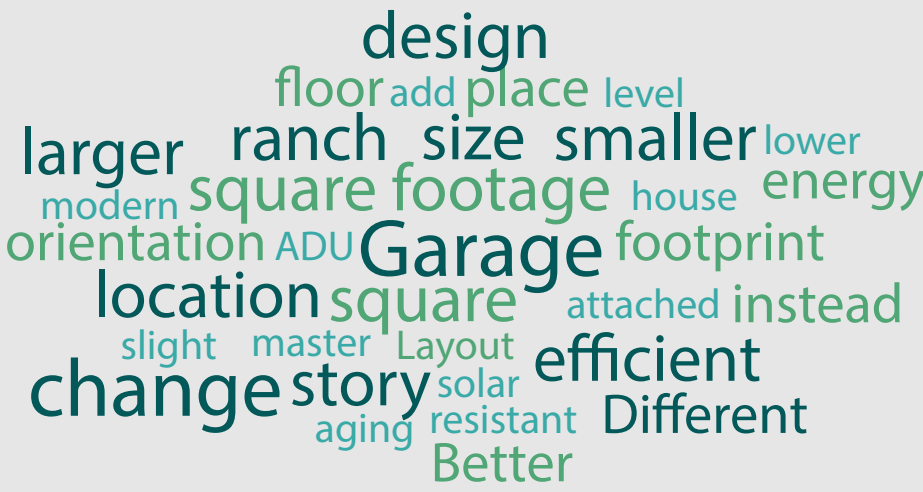
*Participants are most concerned about losing the things they love most about their neighborhoods: rural character, views, and diversity in housing types and styles.*

**Other Themes**

- Cookie-cutter homes
- Concerned about Marshall becoming like a traditional subdivision instead of a casual, quirky townsite
- Concern about height limits, increases in house size, and moving house locations and access points
- Construction traffic and noise during rebuilding

I would like my new home to be different than my previous home in the following way(s):

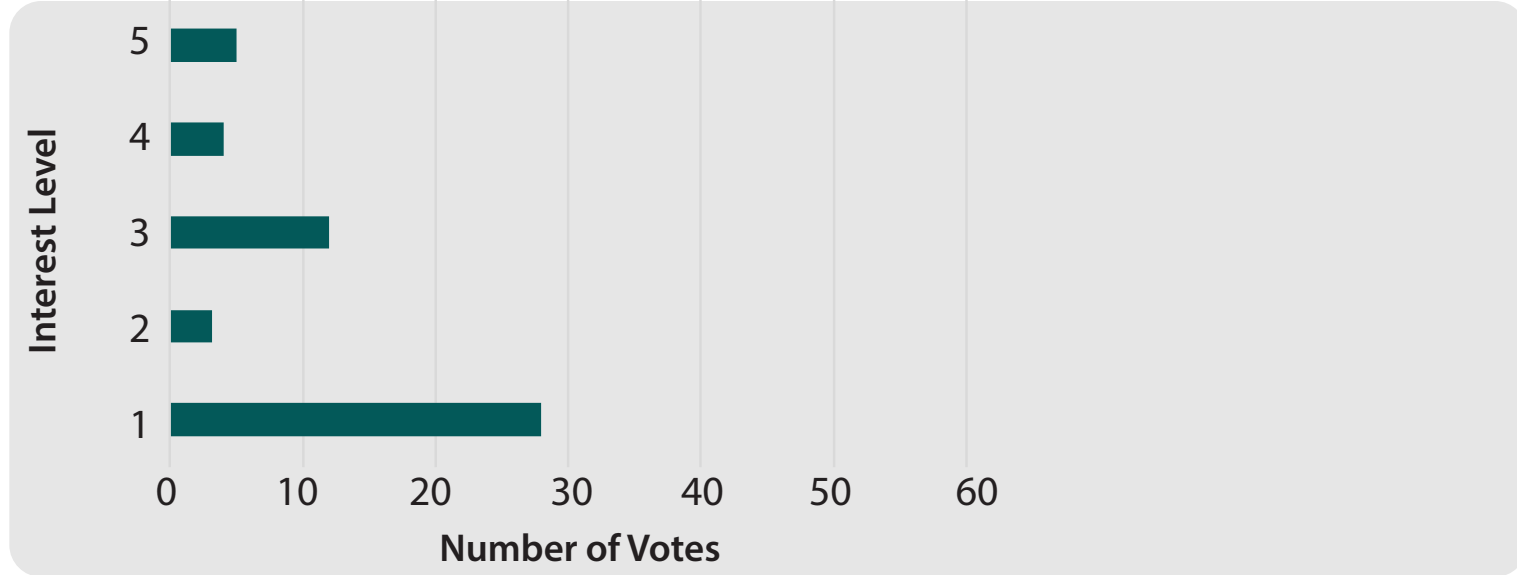
Level of Interest in pre-approved master home plans (1 is lowest interest level, 5 is highest):



design, floor, add, place, level, larger, ranch, size, smaller, lower, square, footage, house, energy, modern, orientation, ADU, Garage, footprint, location, square, attached, instead, slight, master, Layout, efficient, change, story, solar, aging, resistant, Different, Better

**Themes**

- Improved sustainability and energy efficiency
- Better for aging in place
- Change in house size (many smaller, some larger)
- Change in location or orientation

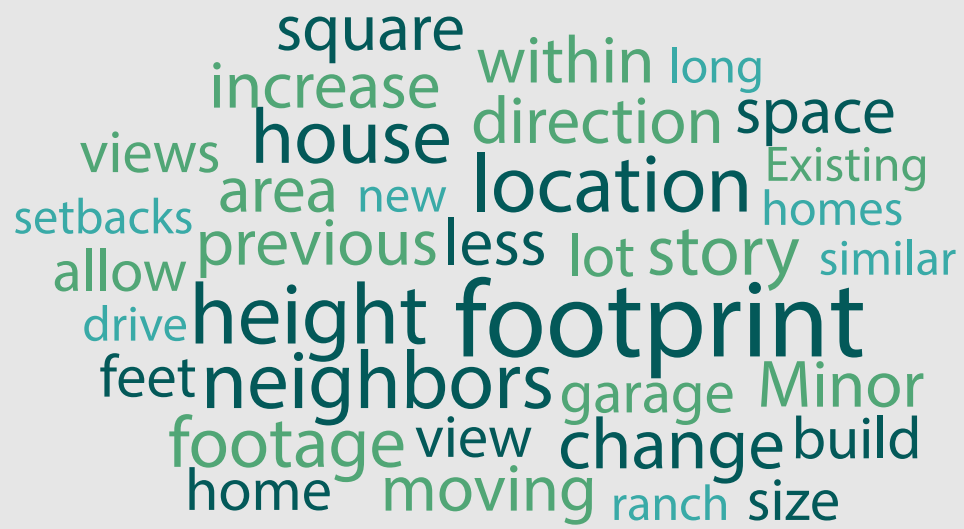


# COMMUNITY MEETING 2/23 FEEDBACK

# COMMUNITY CHARACTER

## What modifications to the footprint would you consider to be minor/moderate changes?

## In what instances should modifications to the location not be allowed?



## Themes

- 5-20% changes in square footage or location
- Location shifts as long as setbacks are met
- Height and size modifications that do not impact views
- Orientation changes
- ADUs
- Desire to be thoughtful to neighbors

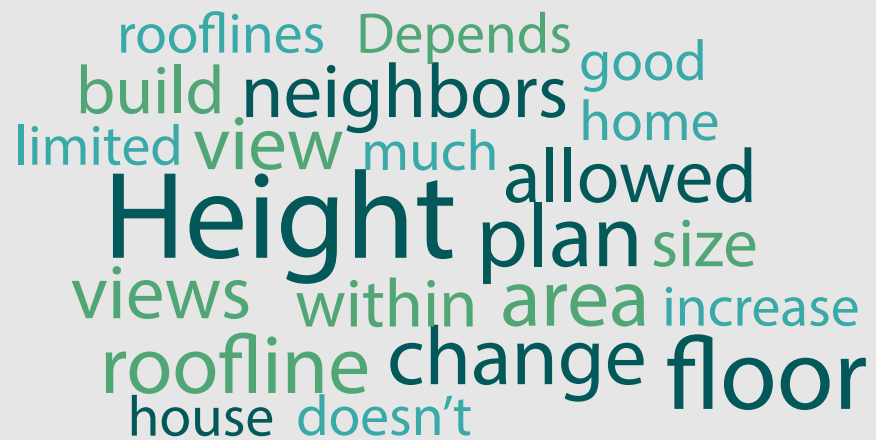


## Themes

- Impacts to views
- Significant changes in size or location
- Should not encroach on setbacks
- Determined on a case by case basis

## What do you think are acceptable changes to height, floor plan, and rooflines?

**In what instances should these types of changes not be allowed?**



## Themes

- Determined on a case by case basis
- Should not impact views  
Floor plans should not matter
- Allow RFA increase up to PSM
- Less than 20% increase in height



## Themes

- To protect views
- Excessive change in size or height
- None

# Poll Questions and Answers/replies - February 23, 2022 community meeting on Article 19 Provisions for Rebuilding after the Marshall Fire

 Polls

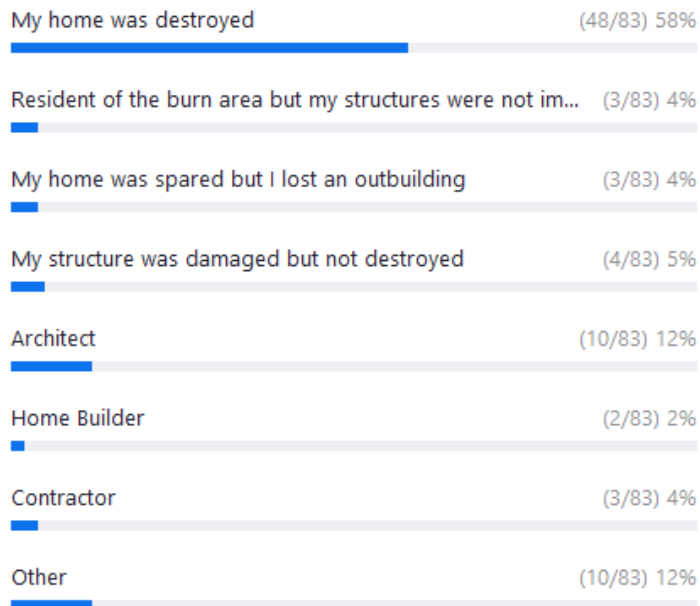


## Question 1

Poll | 1 question | 83 of 99 (83%) participated

1. In which category do you best fit? (Single Choice) \*

83/83 (100%) answered

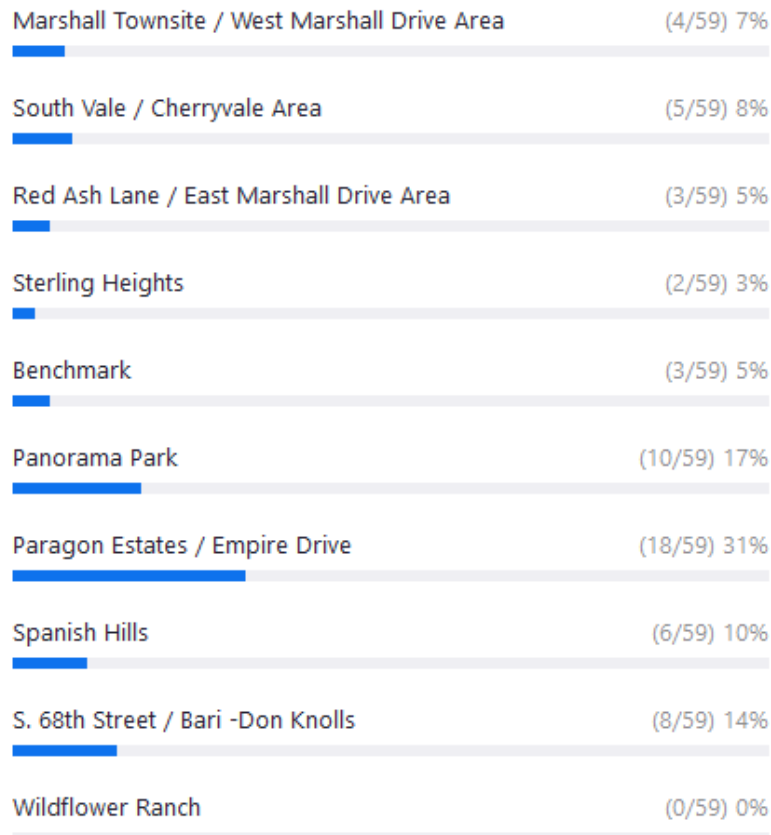


## Question 2

Poll | 1 question | 59 of 100 (59%) participated

1. If you are a resident of the fire impacted area where do or did you live? (Single Choice) \*

59/59 (100%) answered



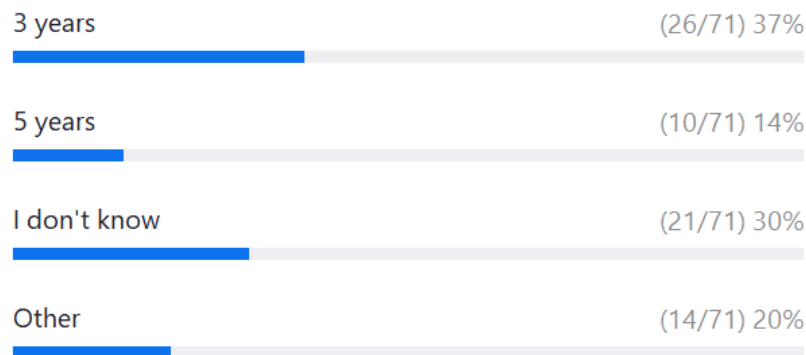


## Question 3

Poll | 1 question | 71 of 103 (68%) participated

1. How much time do you think you will need to rebuild? (Single Choice) \*

71/71 (100%) answered

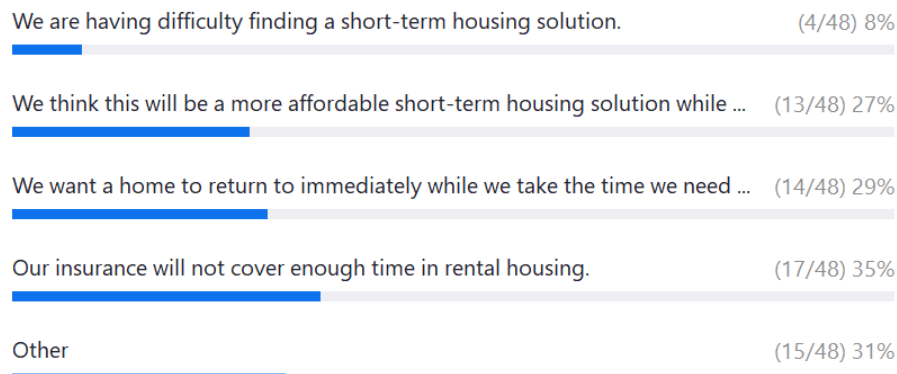


## Question 4

Poll | 1 question | 48 of 104 (46%) participated

1. If you are you interested in living in temporary emergency housing on your property while your home is being rebuilt, why? (Multiple Choice) \*

48/48 (100%) answered

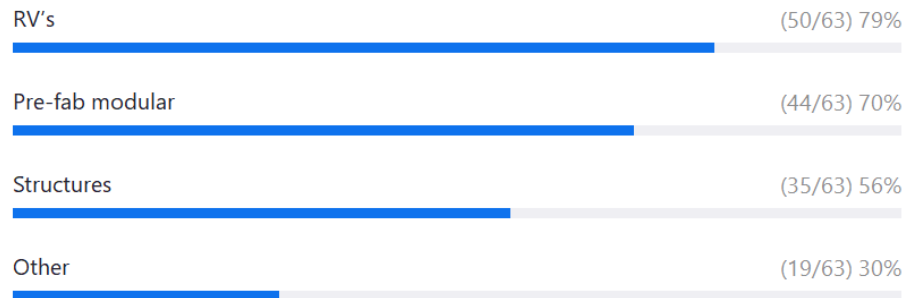


## Question 5

Poll | 1 question | 63 of 103 (61%) participated

1. What types of things should be allowed to be used as temporary housing? (Multiple Choice) \*

63/63 (100%) answered



## Question 6: If you do think RVs should be allowed what is the appropriate length of time to allow this? (51 participated)

- 3-5 years
- Until rebuild of home is complete
- 3 years
- 3 years
- Zero days.
- 5 years or as long as needed to rebuild
- As long as needed
- 3 years
- until the house in question is complete
- Three years
- 3 Years from today

- 1 yr increments renewable annually with a three year limit unless you can show hardship.
- 18-24 mos
- 5,000,000 seconds
- until the home is certified for occupancy
- 1 year
- Until home is ready for move in
- Equal to art 19 building timelines
- 1 YEAR
- time to complete new home
- n/a
- 3 years provided waste is handled properly
- Until the house has a certificate of occupancy
- 1 year maximum. These have a big impact on neighbors.
- zzzz
- The full Article 19 timespan
- indefinitely
- 18 months
- Up to 5 yrs
- 5 years
- 1 year
- 15 months
- 3 years or time to design and rebuild home.
- 2 years
- Until house is rebuilt.
- Till the home is rebuilt...

- 3-4 years
- 3 years
- Don't know
- As soon as possible.
- As long as it takes to build their home, as long as they are actively engaged in rebuilding. Should comply with rebuild rules set forth
- 1 year
- As long as Article 19 is in effect
- Up to duration of the build back, in part to provide security for materials to be safely stored and protected from theft.
- Until house is rebuilt. 3 years?
- 18 months
- as long as it takes to rebuild your home
- Until Certificate of Occupancy is received
- 1 year
- Until the house is rebuilt
- forever

**Question 7: What did you appreciate about your neighborhood or home that you hope redevelopment will not change? What concerns you the most about how redevelopment could change things? (47 participated)**

- no apartment buildings or condos. However, homeowners should be able to rebuild whatever they want.  
Example: a better, smaller footprint for “aging in place”
- We appreciated that the neighborhood was not built up with massive McMansions and that there weren't a lot of big homes bordering height restrictions.

- The site plan review delete is good. Understanding some changes to the house are nice as long as they are not negatively impacting neighbors size or height issues.
- Preserve individual expression. No sidewalks, worried defense able space will result in stark industrial type landscapes. Want pleasing appearances
- No concerns. We live on acreage with large setbacks from each other so minor changes in size, shape and location are not a concern. People need to have flexibility to change as they age in place.
- Mostly split rail fencing with chicken wire, so that we could see our neighbors, but animals were contained. I hope we don't have chain link or unsightly fencing trying to address fire mitigation.
- Maintain rural character with maximum square footage limits (so the lots still have a balance with large amounts of yard space relative to the house).
- - unobstructed view - individual houses, not in a pre-designed community, not "cookie-cutter" - concerned rebuilding will take too long for our aging neighbors to be able to return home
- Country living and privacy and safety
- Some semblance of design consistency so it still looks like a neighborhood.
- None of our homes are huge mansions. They are modest sizes but on about an acre or so. If it takes years to get through Boulder County's regulations, I'm concerned that houses will not be rebuilt.
- we were in the historic marshall townsite, where most structures were considered "non-conforming" by the current land use code, and it had a feeling of a town, not a "rural residential" suburb
- I am a builder. My client is interested in lowering the overall height slightly, but is also considering a flat or 1:12 or similar roof line to modernize the look of the home.
- LACK OF TRAFFIC--CONCERN=CONSTRUCTION TRAFFIC
- like marshall historic neighborhood, however we need increased PSM to rebuild modern homes in old marshall that can accommodate extended family and age-in-place concerns. move away from mine fire site
- i liked that there was privacy in the way the homes were positioned. we also had a view that was diminishing from trees / foilage but would be greatly hampered if the height requirement is raised.
- The county's stated #1 priority appears to be "affordable housing." If this is true, how can you allow single-family homes to be (re)built at all? Why not put up thousands of affordable housing units?
- N/A not a home owner.

- Character of homes, different architectural styles and personal feel
- Concern - if we want to rebuild our house in a different area of our lot, will that be subject to review by our neighborhood? Could that be prevented from happening?
- A minimum reasonable quality of rebuilt homes...
- In my area of Spanish Hills - Empire Dr, most lots were large, roughly 2 acres. Many had horses. I had cattle one year and opened my land to the rancher west of me. That was tremendously special.
- No standardized design regs
- Height and location on lot of neighbor homes
- This is 2 questions: 200 char limit makes this hard to answer.. Appreciate: my neighbors. we have an awesome community. Concern: Cost to rebuild. Both driven by inflation and buildsmart.
- View to northwest, wildlife, peace and quiet, size of lots
- Views to Flatirons, open space, access to Denver and Boulder. Great neighbors with similar goals, access to walking and biking trails. Access to good restaurants and bars.
- Peaceful, quiet and natural setting. Mostly concerned about construction traffic and noise in the rebuilding process.
- The mountain views. If my neighbor is allowed to build unreasonably higher or move the footprint, we would lose the views.
- Control storage of materials for long term. Keep quality equal to existing. Control building to licenced experienced contractors.
- Keep the historic charm of old Marshall by allowing cabins etc to be rebuilt.
- The mix of types of homes in the neighborhood. Large...not so large...different styles.
- Every house is different, no cookie cutter houses. Houses too large compared to property size
- preserving views- we are concerned about height limits and setbacks- and moving structures The diversity of home and lifestyles in our neighborhood and want to ensure this remains possible
- The health of the environment. I want the soil to get back to healthy levels, help the water table. Trees and vegetation planed. habitats restored.
- We had beautiful homes. Concerned that due to codes/underinsurance, some won't be rebuilt, and those that are may need to downsize significantly. Hope the rural, casual feel can be maintained.

- THE VIEWS and the open nature of the area - large space between dwellings. Limited height of buildings. We like the variety of architectures.
- Appreciate different home styles in the neighborhood . No HOA. Concerned about about road and driveway access locations being moved.
- 1. Our view 2, We don't want the reconstruction to affect our view
- My home was originally built in 1865, which was the year the Civil War ended. I miss my Sony 4K TV and my bike.
- Not applicable.
- Every house was different. Sight lines were primary considerations for alterations. We would like every house to remain roughly where it was before. We would like heights to be about the same.
- Unique houses - no one home like the next. My concern is that houses will look more alike with current styles/trends
- The individuality or even funkiness of very old neighborhoods should be recognized, valued, and supported.  
Ex: Marshall is not and should never be a covenant controlled subdivision type of neigh bo
- keep SFH as SFH - not apartments Allow permanent ADU build to bridge the housing gap Rebuild county roads after heavy construction and debris removal
- I don't really care what my neighbors do as long as they don't cause bad snow drifts on the roads: I have county or city open space between me and the view..

**Question 8: I would like my new home to be different than my previous home in the following way(s):\_\_\_\_\_ (44 participated)**

- Probably smaller - more appropriate for my uses.
- healthier, safer
- better utilization of floor space/square footage
- Added square footage (for us 1000sq/ft)
- Smaller; more modern design.
- same sq ft, diff location, single story vs multi

- more bathrooms, more square footage,
- Lower (mostly one story), more energy efficient, A
- Main floor master or ranch instead of two story.
- More covered porches, master on first floor, large
- I would like to change to lower profile
- Changing the footprint
- Better suited to aging in place.
- rooftop access, attached garage, vaulted ceilings
- ONE STORY/ONE LEVEL
- to be ranch instead of tri level.
- add solar
- Rotate the footprint and slightly expand, add a couple hundred sq ft of finished space, new freestanding garage (previously part of basement)
- slight increase in size, location & height/design
- We are thinking a ranch house instead of full 2 story
- Interior changes and smaller square footage ranch
- Change the bedroom layout. Larger garage
- garage would be attached, bigger kitchen & moved
- Multi-generational: Age in place design. Allow ADU
- Adjust orientation for more direct view of flatirons
- Larger (maybe 10% larger). combine FA for home + ac
- Better designed, energy efficient, site responsive
- My client would like to connect the garage to the
- More modern, smaller, private and efficient.
- Layout and that may have some impact on the size.



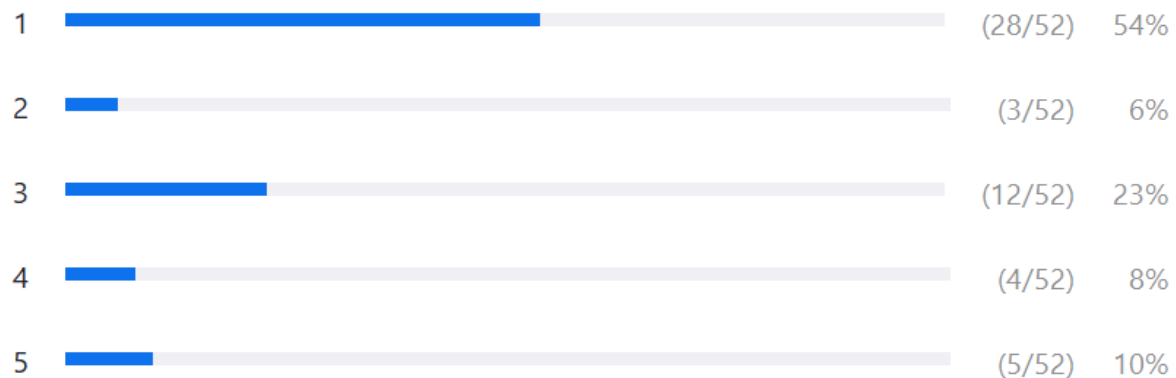
- orientation on ~ same sized & shaped lot
- Bigger/more square feet.. Higher. Extra Garage.
- A little different layout/floorplan, same sq ft.
- with a floorplan that allows me to age in place -
- More or less the same.
- larger, taller, change orientation, more windows
- Change in size, change in slight location of house
- fire resistant, different footprint completely,
- no change
- more solar, more ignition resistant, ADU for grand
- Different location, size and new design
- More energy efficient, updated design
- More aging friendly (Fewer staircases/ranch).

## Question 9

Poll | 1 question | 52 of 95 (54%) participated

1. If pre-approved master home plans were available to you, how interested would you be in using one of these plans for your new home? Respond with 1 to 5 with 1 being lowest interest level and 5 being highest interest level. (Rating Scale)

52/52 (100%) answered



### Poll Question 10: What modifications to the footprint would you consider to be minor/moderate changes? (46 participated)

- Any height change up to the highest point of the previous home. Reorientation of footprint expansion in any direction within 50% of the center point of the previous home within new maximum footprint.
- Make space between homes, get out of set backs/easement areas, rotation around the existing footprint axis, small expansion to existing footprint to allow for things like converting to a ranch style
- minor 20 % or less
- Shifting the house by 20-40% of the previous footprint would allow for some homes to be oriented for passive solar access
- Would not obstruct neighbors view or access

- within setbacks and allowable height for the zone district
- Increase of square footage by 15%. Replacing HVAC to the latest technology. Solar panels.
- Same or similar square footage, same amount of footprint size with allowances to adjust geometry as long as there is not significant site disturbance. Similar height and adjacencies to neighbors.
- I live on Spring Drive. One of those red dots was me. I don't care much about what others do as long as we are thoughtful of our neighbors.
- Minor would be footprint and to some degree the location. The largest impact would be if the building gets much higher, that might block views and sun.
- 20% change in footprint sq. ft.
- 5% increase in square footage.
- 10% increase in floor area if using the same footprint / position. Repositioning within the setback constraints if keeping the same floor area. Moving a structure downhill may increase height.
- Minor is something that impacts only the home owner
- Improve drainage, attached garage vs detached, go from two story to ranch but change to daylight basement (lower overall height)
- I'm not in a normal neighborhood so these questions don't make sense
- Slight change in square footage allowed, but different shapes of no concern at all.
- Reorient direction, spread out slightly in another direction
- Just enough to accommodate the moved foundation (due to cut off piers). So 3-5 feet, maybe?
- septic changes will likely dictate the extent of the change. Existing views of neighboring lots should be considered.
- Moving footprint location okay.
- No idea at this time.
- The shift depends on lot size. For a 2 acre lot or more, I would allow up to 100 feet in any direction. For a 1 acre lot or bigger maybe allow 50 feet in any direction. For less than 1 acre, 25ft
- anything that doesn't effect a neighbor's view or property privacy
- 500 sq ft

- On Panorama, so your example applies to us. A major change would be our neighbors moving into our view path.
- same location, but about same sq foot. we are thinking ranch style instead of 2 story.... but with same garage and barn. similar, but different layout since we are older kids are out of house.
- I want my house in the same area as my burned house but a different floorplan and footprint. I had a two story house that wasn't good for aging in place. I want to build a house that is one story.
- if floor plan is approx. the same, rotation of the layout shifting withing previous footprint by a designated/percentage amount based on size of overall property will vary widely based on location
- +1000 sg ft seems fine. Also 125% seems fine. Moving footprint slightly also seems fine.
- As long as you build on the same footprint and are within the setbacks to neighboring property you should be able to build back with square footage you had plus what you need.
- Moderate changes would be conditioned area increase, height and sq footage. Minor would be overall look on the same footprint, or unconditioned space, ie garage location
- Modifications that do not impinge on others homes, especially on a large lot.
- I think if home is in general area and meets setbacks ok. Should consider height size and location together. If shorter more modification ok.
- Extended to easements prior to fire
- Minor if it does not impede the views that neighbors previously had.
- Less than 500 sf addition and no impact to neighbor views.
- up to 30% of the original footprint
- Don't know
- Changes of a few feet to the position of the structure. Height increases of less than a foot or two in height.
- if location of new build is 5 percent or less closer to all neighbors. Panorama drive not moving footprint too much closer to spring drive properties from an outdoor noise perspective
- changing to one story, new location, ADU, outbuildings, move footprint if doesn't affect neighbors.
- In giving more space and ADA allowances to 3 of the bedrooms, we want to bump up to a 2nd story two of the previous 5 bedrooms.

- attaching garage, adding more covered deck space, redesigning kitchen for more light and room, possibly increasing 2nd level deck space
- Rotate orientation of house 90 degrees to maximize view and move site higher up on hillside

**Question 11: In what instances should modifications to the location not be allowed? (31 participated)**

- Discriminatory land use practices should be allowed. There are many large homes unburned in Marshall and we all need to be able to rebuild at greater PSM
- Height & width increases
- drainage issues on sloped terrain not blocking another home's views no additional dwelling for rental property
- ?
- Can't think of anything
- Anything that exceeds setbacks or bulk plane for the the given neighborhood.
- building a 3 story huge home that blocks a view when there was a single story home before
- If topography dictates it
- Into easement/set back issues; unduly impact neighbor's views or encroach on their ability to enjoy their property
- Significant impacts to sight lines of neighbors should not be allowed.
- Adversely affecting neighboring properties. Should be site specific
- if you have close neighbors or block view corridors
- Don't know
- Significant location change on property of house
- None
- When it impacts the views of the neighbors.
- Blocking views

- Any new location that must move existing utilities gas, water, electrical...
- If it decreases view for neighbor's home (before fire), or is placed closer than allowed by SPR along boundaries
- When they present a significant impact to neighboring properties.
- When infringement on neighboring properties might be involved.
- Clear and obvious blockage of a neighbor
- Be thoughtful to your neighbors, which will do anyway.
- Only if they interfere with property setbacks and easements
- if it's going to be above SPR/LISR limits for site disturbance
- case by case
- 3-story residences, homes too large for the lot, blocked views
- No ideas at this time.
- dramatic changes to previous sight lines for easterly neighbors..
- Blocking views that previously existed
- obstruction of view

Question 12



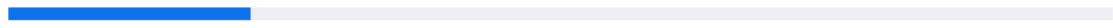
## Question 12

Poll ended | 1 question | 55 of 93 (59%) participated

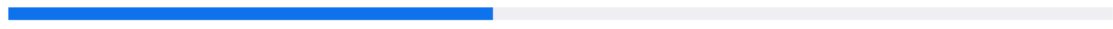
1. How do you suggest we describe the allowed location modification parameters?  
(Multiple Choice) \*

55/55 (100%) answered

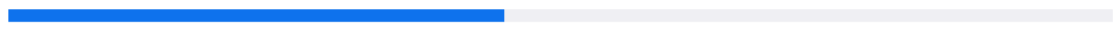
Allow an expansion of the footprint in any one direction by a certain numb... (12/55) 22%



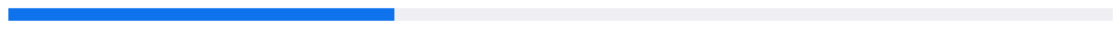
Allow an expansion of the footprint in all directions by a certain number of... (24/55) 44%



Allow an expansion of the area of the footprint by a certain percentage of ... (25/55) 45%



Allow an expansion of the area of the footprint by a certain number of squ... (19/55) 35%



Allow an expansion of the footprint by certain percentage of the allowed R... (28/55) 51%



## Question 13 - What do you think are acceptable changes to height, floor plan, and rooflines? (39 participated)

- Again, depends on the individual home -- and who decides what is "acceptable"? 100 people will have 100 different ideas on that.

- its ok to change everything about the house, especially to build passive house, age in place design, take advantage of views, add solar. and its OK to see solar panels from open space!!!!!!

- any change is acceptable as long as views are not newly obstructed.

- If it had two stories, it could be one or two stories - but a different floorplan. If it was 2,700 sq ft, it could go smaller or up to 3,000. It shouldn't obscure a neighbor's view.

- Modifications are fine, County needs to come up with a quick review procedure to allow for changes without taking a year to get the proposed design approved.
- depends on the location of the house and the size of the property. is there a way to
- up to 12ft for height, any changes to floor plan, any changes to roofline so long as it doesn't impede neighbor's views
- Keep the Option Open...just my opinion...
- Depends on proximity of neighbors/total acreage.
- 2 floors ok, less than 20 % increase ft2 ok
- No concerns except height.
- As long as the square footage is < or =1000 ft2 bigger, you can build anything to either the pre-existing height or the height allowed in the 2015 building code. No constraint on rooflines.
- all are good and should be allowed as owners try to modernize their homes and take more current advantage of energy and light.
- Floor plan should not matter, height and roofline matter if they block views
- Height most important. Floor plan changes ok if area limited.
- Height within 10%, no restrictions on roofline, floor plan within 15%
- picture 2 is ok. The others go too much higher. So, minimal height changes. Don't care about floor plans or rooflines.
- The first two examples seem reasonable.
- Floor Plan in our area should be more open as long as increased height isn't too much.
- Any Change the homeowner wishes to make. We should NOT dictate this.
- floor plan change, slight change in roofline (although not much higher than previous home), increase in square footage by 20%
- Changes in height and rooflines limited to a percentage of the original height and no view impacts. Changes in floor plan limited to percentage of original SF as decided in previous question.
- I favor homeowner rights as long as neighboring properties are not negatively impacted monetarily. Impact must be supported by fact



- 2-story, size appropriate for lot
- If the wide variety and sizes of homes in our area was an asset to be preserved, the allowable changes would be pretty permissive.
- Only immediate structure to right
- all of above
- this doesn't seem like the time or place for an aesthetic review. you have setbacks, height and PSM already to control bulk and form. If these are not enough, they should be universally modified
- I don't know
- Same or lower.
- People should probably be able to build up to similar sizes as a critical mass of neighbors (the 125% for the neighborhood metric seemed good). 1 story should be able to add a second. Not sure.
- 5-10% increases in size, height, window area, roofline, footprint, etc.
- Changes that keep the floor area and dimensions within 20% of the original footprint.
- I would be most concerned about height - not wanted to have view blocked by new build where roof height would now block our view, but didn't previously
- No restrictions as long as it is considerate of the neighbors (views and access)
- The most significant of these is height. We do not have a good idea about how far this should be allowed to change but without other considerations no more than going from a ranch to a 2 story.
- Minor - like slide 1 - 2 should be allowed no SPR. 1 to slide 4 may be allowed with no SPR if neighbors approve (sign plans, meet with architect
- same as previous question. As long as roofline doesn't interfere with view, size of home and foundation and drainage issues don't create structural problems for properties below.
- Height adjustment within the neighborhood limits, floor area re-arrangement & slight increase. Siding using ignition resistant construction.

#### **Question 14: In what instances should these types of changes not be allowed?**

- If they block neighbors views

- Multi-stories where none existed
- when the change significantly inhibits/negatively impacts the views of the neighbors
- If they impact the neighbor's views.
- Impedes neighbors views
- when they impact neighbors
- Major blockage of views
- Changes that do not meet current Planning and Zoning codes, extensive changes need to go through standard Site Plan process.
- Neighborhood sightlines and neighbor blockage
- Any substantial change in size, rooflines, etc.
- Hard to say, but generally want neighbors to feel like they can still enjoy their properties. I want people to be able to rebuild their dream homes as much as possible.
- Changes should be allowed in all instances with neighbor approval of plans after meeting homeowner, architect etc.
- Neighbors being impacted by height obstructing views. However, this could be hard to assess!
- going from 2-story to 1-story okay. going from 1-story to 2-story not ok
- If the location obscures a neighbor's view. If the house is out of character to the neighborhood.
- No more than twice the size of the original footprint, plus height limitations
- if it compromises safety of life. If it's grossly different from the area.
- Excessive % size change upwards...
- I think it needs to be a case by case basis on what the individual home owners suggesting.
- Depends on proximity of neighbors and size of property
- want all houses to have fire resistance. don't want new houses with flammable designs, including landscaping. generally all changes can be ok
- No restrictions on any particular instance
- significant increase in size of rebuilt home. sight line impact. drainage issues impacting homes below.

- applicants should be allowed to change their house for their own needs within setbacks, height and floor area limits and not be limited by subjective individual judgements.
- more than 2 stories high, review if over 5000 ft2 if increase request is more than 5 %
- Where they are asking to exceed the maximum square footage and they are changing height such that it significantly interferes with neighbors vistas.
- Significant change needs more review.
- Blocking of views, homes too close together, % of home on lot, retaining privacy
- Impact on solar shading
- when views are newly obstructed
- Maybe related to a percentage of what was in existence previously.
- an increase in height as well as a dramatic roof line should not be allowed
- I cannot think of an instance in which home owner rights should be totally ignored
- Blocking neighbor view
- We shouldn't dictate design unless it impacts a neighbors previously unobstructed view.
- None, this is a great opportunity to embrace some architectural diversity.
- none
- Where it impacts other structures adversely, block sunlight or view or too close.
- When there are negative impacts on neighbors- views, privacy
- In this example, 3 and 4 should not be allowed. Single story should stay single story.

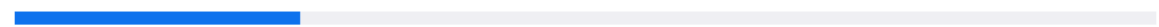
## Question 15

Poll | 1 question | 53 of 93 (56%) participated

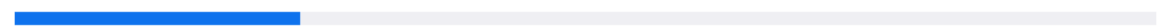
1. How do you suggest we define these parameters? (Single Choice) \*

53/53 (100%) answered

Allowed changes in height by a certain number of feet (13/53) 25%



Define the amount of new floor area that could be added to a second stor... (13/53) 25%



Allow increases in height up to the maximum allowed by zoning in a perce... (27/53) 51%





(<https://headwaterseconomics.org/>)

# Building a Wildfire-Resistant Home: Codes and Costs

November 2018

- Wildfire disasters will be more common if unmitigated home development continues in the wildland-urban interface.
- A new home built to wildfire-resistant codes can be constructed for roughly the same cost as a typical home.
- Costs vary for retrofitting an existing home to be wildfire-resistant, with some components such as the roof and walls having significant expense. Some of these costs can be divided and prioritized into smaller projects.

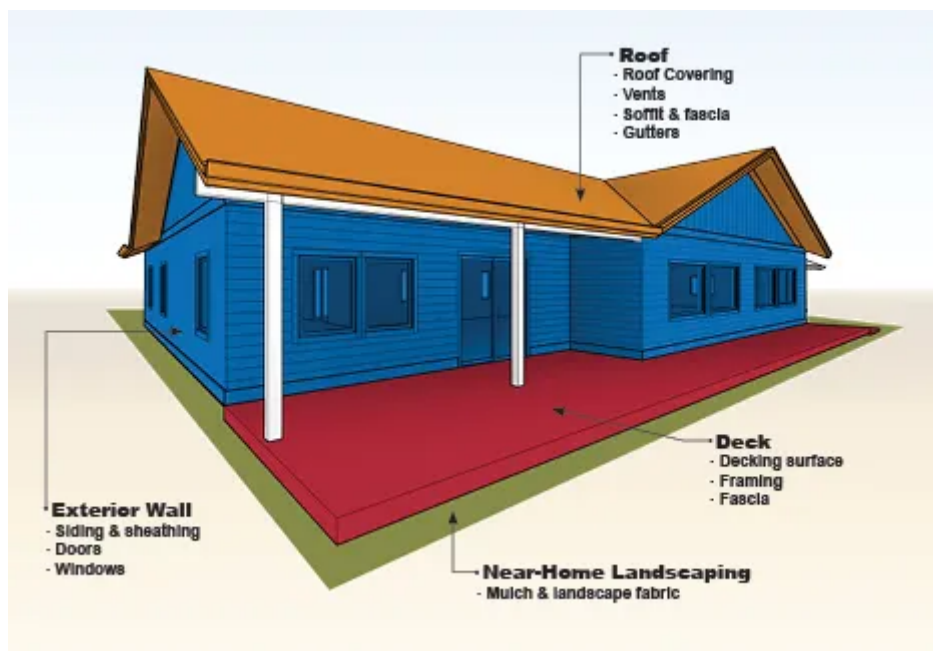
- Technology and standards exist today that will make communities safer. Cities, counties, and other jurisdictions can implement wildfire-resistant building codes to reduce their vulnerability to wildfire.

**Download Full Report (<https://headwaterseconomics.org/wp-content/uploads/building-costs-codes-report.pdf>)**

Components of this research have been published in: Manzello S. (Eds.), *Encyclopedia of Wildfires and Wildland-Urban Interface (WUI) Fires* ([https://link.springer.com/referenceworkentry/10.1007%2F978-3-319-51727-8\\_241-1](https://link.springer.com/referenceworkentry/10.1007%2F978-3-319-51727-8_241-1)). New York: Springer.

## Introduction

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([https://i0.wp.com/headwaterseconomics.org/wp-content/uploads/2018HE-HomeRendering-FOR-COVER\\_HR\\_01.jpg?ssl=1](https://i0.wp.com/headwaterseconomics.org/wp-content/uploads/2018HE-HomeRendering-FOR-COVER_HR_01.jpg?ssl=1)).

s study finds negligible cost differences (<https://headwaterseconomics.org/wp-content/uploads/building-costs-codes-report.pdf>) between a typical home and a home constructed

using wildfire-resistant materials and design features. Decades of research and post-fire assessments have provided clear evidence that building materials and design, coupled with landscaping on the property, are the most important factors influencing home survivability during a wildfire.

Today, one-third of all U.S. homes (<http://www.pnas.org/content/115/13/3314.short>), are in the wildland-urban interface, the area where flammable vegetation and homes meet or intermingle. And with more than 35,000 structures lost (<https://www.predictiveservices.nifc.gov/intelligence/intelligence.htm>), to wildfire in the last decade, more communities should consider adopting building codes that require new home construction to meet wildfire-resistant standards.

While codes and standards have been developed for building in wildfire-prone lands, the perceived cost of implementing such regulations is a commonly cited barrier to consideration and adoption by some communities. However, little research has previously examined how much it would actually cost the homeowner or builder to comply with such regulations.

For this research, a full report (<https://headwaterseconomics.org/wp-content/uploads/building-costs-codes-report.pdf>), an executive summary (<https://headwaterseconomics.org/wp-content/uploads/building-costs-codes-summary.pdf>), and appendix (Excel) (<https://headwaterseconomics.org/wp-content/uploads/building-costs-codes-appendix.xlsx>) are available. The work was completed in partnership with The Insurance Institute for Business & Home Safety (<https://disastersafety.org/>) (IBHS) and Bechtle Architects (<http://bechtlearchitects.com/>), and was prepared at the request of Park County, Montana, as part of the Community Planning Assistance for Wildfire (<http://cpaw.headwaterseconomics.org/>) (CPAW) program. CPAW is a program of Headwaters Economics and is funded by the U.S. Forest Service, the LOR Foundation, and other private foundations.

## Wildfire-Resistant Codes and Standards

While certain jurisdictional codes have been established, three existing statewide or national building codes and standards guide wildfire-resistant construction. They are:

- the International Code Council's International Wildland Urban Interface Code ([https://codes.iccsafe.org/content/IWUIC2018/preface?site\\_type=public](https://codes.iccsafe.org/content/IWUIC2018/preface?site_type=public)) (IWUIC),
- the National Fire Protection Association's Standard for Reducing Structure Ignition Hazards from Wildland Fire (Standard 1144) (<https://www.nfpa.org/codes-and-standards/all-codes-and-standards>)

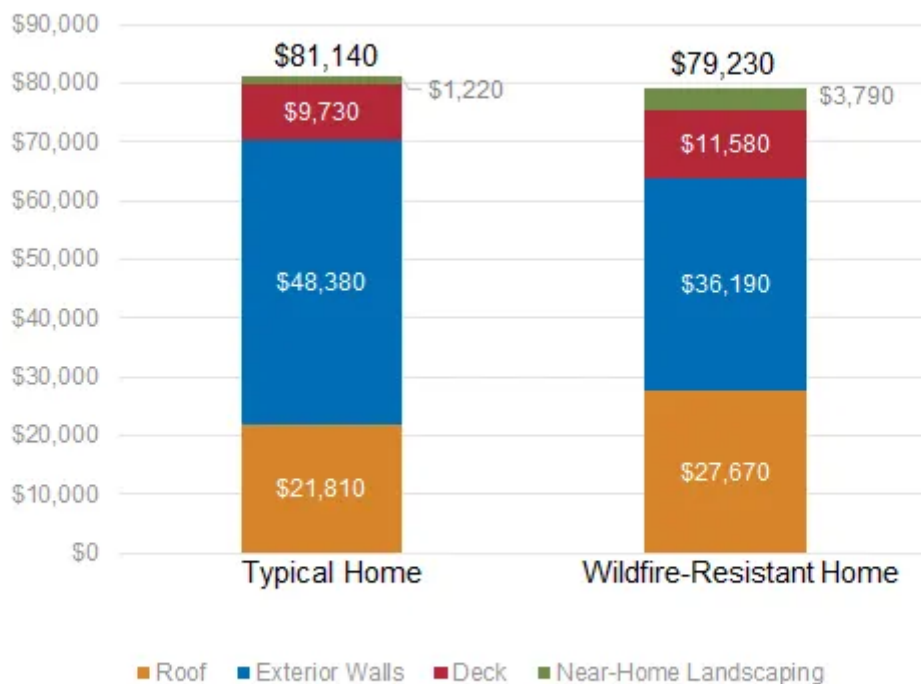
[standards/list-of-codes-and-standards/detail?code=1144](#))), and

- the California Building Code [Chapter 7A](https://codes.iccsafe.org/content/chapter/9997/) (<https://codes.iccsafe.org/content/chapter/9997/>).—  
Materials and Construction Methods for Exterior Wildfire Exposure.

These three documents address construction requirements of the home by component parts (e.g., roof, walls, etc.) and often provide multiple options for complying with the provision. Many of the requirements in these documents are based on standard laboratory testing methods that evaluate the ability of a material or assembly to resist ignition or fire spread. California is one of only a few states to have adopted a wildfire-related building code at the state level for areas of high hazard, but many cities and counties have adopted portions of the IWUIC or other wildfire-related codes. In some communities, the inaccurately assumed cost of constructing a home to comply with a wildfire-resistant building code is a barrier to implementing such codes.

## Wildfire-Resistant Construction Costs Are Similar to Typical Costs

### New Construction Cost Comparison



(<https://i0.wp.com/headwaterseconomics.org/wp-content/uploads/total-chart-with-header-logo-2.jpg?ssl=1>).



To identify whether the cost of constructing to a wildfire-resistant building code differs from typical construction, this study priced new construction and retrofitting expenses for a three-bedroom, 2,500-square-foot, single-story, single-family home representative of wildland-urban interface building styles in southwest Montana, one of the fastest-growing regions in the country.

The typical home was assumed to have an asphalt shingle roof, wood siding, dual-pane windows, and a wood deck. Wildfire-resistant materials were selected for similar aesthetics but also comply with wildfire-resistant building codes. Costs were primarily derived from RSMeans (<https://www.rsmeans.com/>), a database that averages material and labor pricing from hundreds of U.S. cities and includes materials, labor, and contractor overhead and profit.

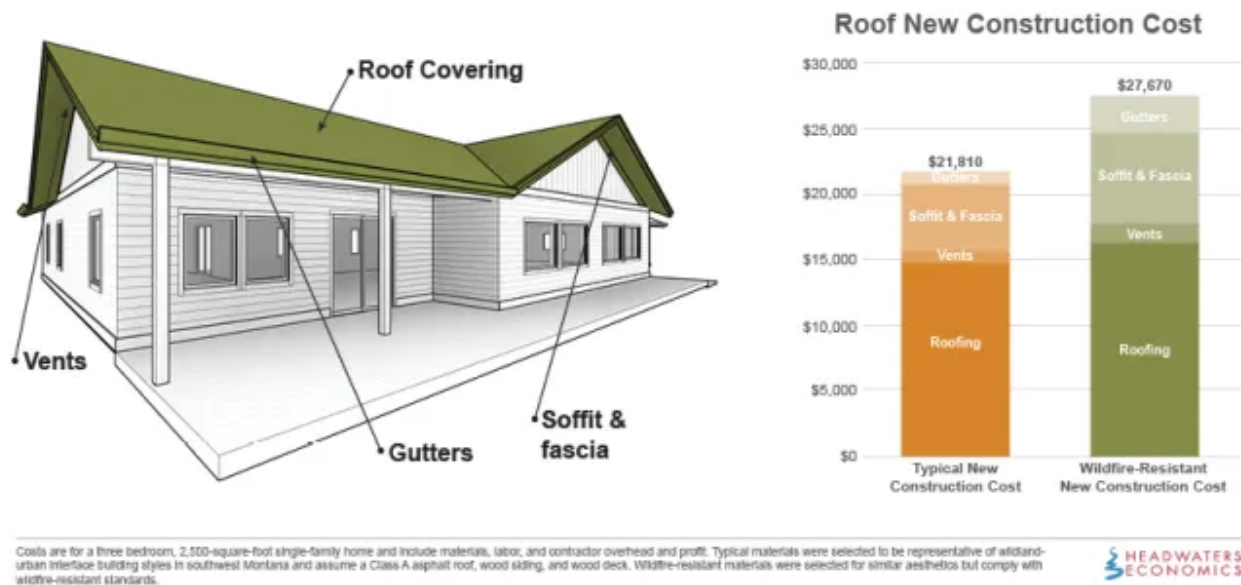
We examined costs in four vulnerable components of the home: the roof (including gutters, vents, and eaves), exterior walls (including windows and doors), decks, and near-home landscaping. Overall, the wildfire-resistant construction cost 2% less than the typical construction, with the greatest cost savings resulting from using wildfire-resistant fiber cement siding on exterior walls, in lieu of typical cedar plank siding. While cedar plank siding is typical in the wildland-urban interface of western Montana, fiber cement siding is already a common choice in many regions because of its relative affordability, durability and low maintenance needs. Wildfire-resistant changes to the roof resulted in the largest cost increase, with a 27% increase in gutters, vents, and soffits. The following sections describe the wildfire-resistant mitigations for each component.

## Roof

The roof is arguably the most vulnerable area of the home because of its large surface area. Embers can ignite vegetative debris that has accumulated on the roof surface or in gutters. Embers also can enter the attic through roof and under-eave vents. Also, unenclosed eaves and overhangs can trap embers and heat.

Wildfire-resistant modifications to roofing, vents, fascia, soffits, and gutters added \$5,860 (27%) to the cost of the typical roof, assuming both homes use Class A (fire-rated) asphalt composition shingles. Retrofitting an existing roof to be wildfire-resistant approached the cost of new construction, totaling \$22,010 for the model home. However, many of the wildfire-resistant roof materials have longer lifespan and reduced maintenance needs as compared to typical materials.

## Roof New Construction



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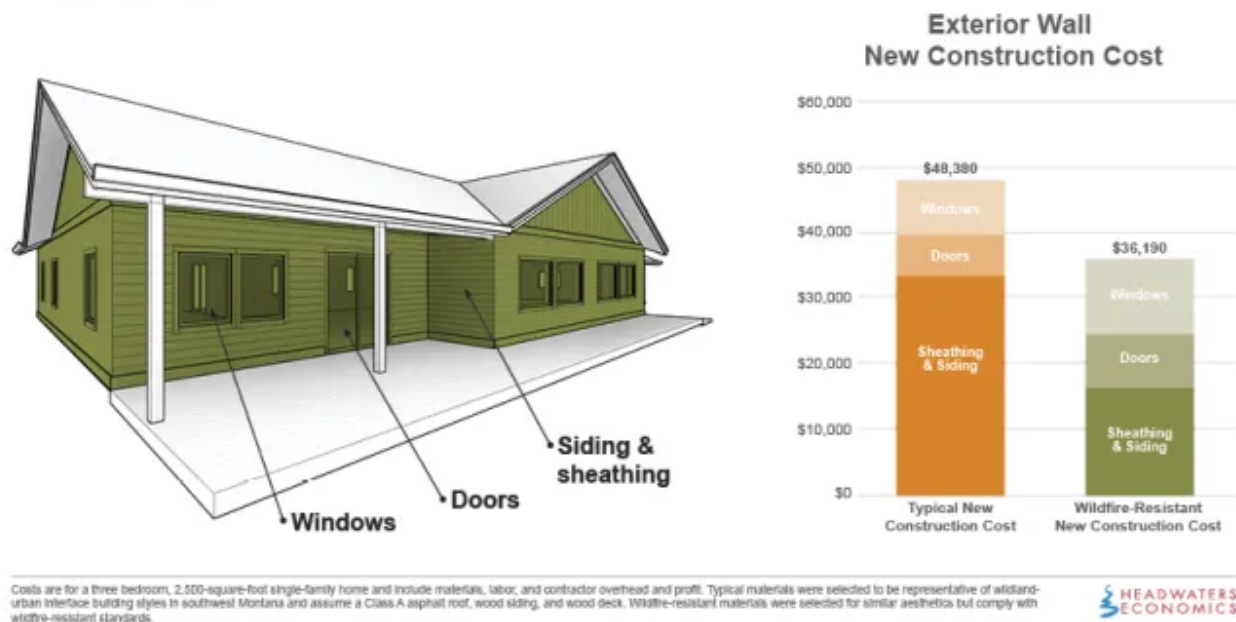
## Exterior Walls

Exterior walls are especially vulnerable from exposure to flames or prolonged exposure to radiant heat, such as from burning vegetation or a neighboring home. These exposures can potentially ignite combustible siding products. Some plastic siding products (e.g., vinyl) can also melt, exposing underlying sheathing. Wind-blown embers can accumulate in gaps or pass through openings around windows and doors. Glass in a window or door can break from radiant heat or flame contact, exposing the interior of the home. Wildfire-resistant siding and installation design features, tempered glass in windows, wildfire-resistant doors, and weather-stripping can reduce home vulnerability. The relative importance of each of these items varies depending on home-to-home spacing and location of vegetation on the property. Siting on the property relative to topography and typical wind directions can also be important factors in determining necessary external wall mitigations.

Wildfire-resistant construction for exterior walls was \$12,190 (25%) less expensive than the typical home, with the cost savings resulting from the difference in using wildfire-resistant fiber-cement siding as compared to cedar plank siding. Fiber cement siding is already a common siding option in

many regions and several styles options mimic the look of wood siding. While the change in siding reduced the cost of the wildfire-resistant home, cost increases for other exterior wall features are \$5,370 (29%) more than typical exterior wall features. Retrofitting the exterior walls (including windows and doors) on the model home totaled \$40,750. Depending on neighboring home spacing, not all retrofitting activities may be necessary, but several of these activities will have added benefits such as improved energy efficiency (e.g., multi-pane windows) and reduced maintenance.

## Exterior Wall New Construction



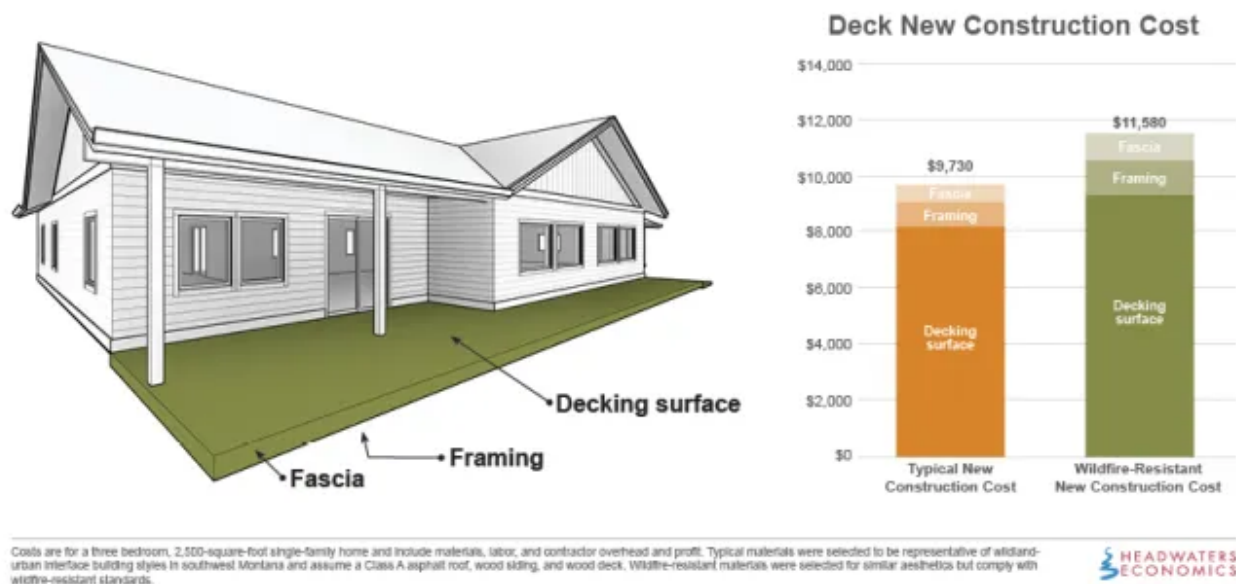
(<https://i0.wp.com/headwaterseconomics.org/wp-content/uploads/Building-Materials-Exterior-Walls-Large.jpg?ssl=1>).

## Deck

Embers can ignite vegetative debris or other combustible material stored or accumulated on top of the deck. If ignited, the burning deck could expose walls, windows, and doors to radiant heat. Embers can ignite decking materials directly when they accumulate on the surface of vulnerable decking, typically occurring in the gaps between deck boards. Decks can also ignite from below when vegetation or stored materials ignite beneath the deck. Mitigations to make a deck wildfire-resistant include using wildfire-resistant materials for walking surface (e.g., composite boards), using foil-faced bitumen tape on the top surface of the support joists, and creating a noncombustible zone

underneath the deck. The wildfire-resistant deck added \$1,850 (19%) to the cost of the typical deck. Some wildfire-resistant decking materials can have a longer lifespan and require less maintenance than typical materials.

## Deck New Construction

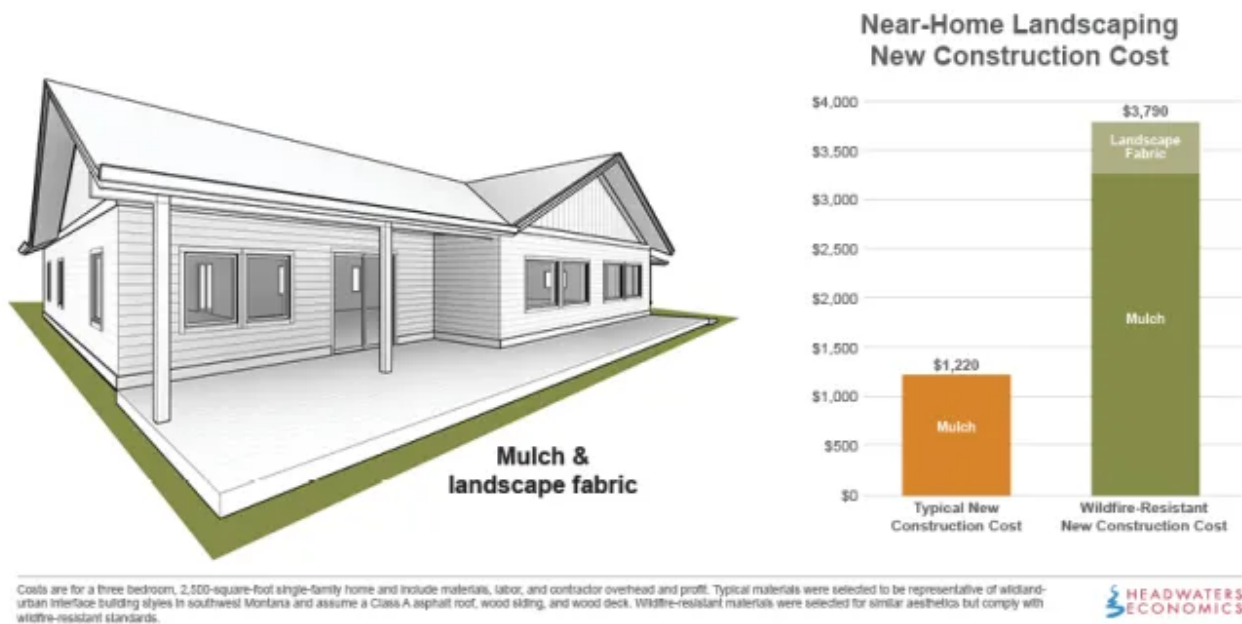


(<https://i0.wp.com/headwaterseconomics.org/wp-content/uploads/Building-Materials-Deck-Large.jpg?ssl=1>).

## Near-Home Landscaping

If ignited by wind-blown embers, burning vegetation and other combustible materials near the home can allow flames to touch the home or subject it to an extended radiant heat exposure, potentially igniting siding or breaking glass in windows. Maintaining a noncombustible zone of five feet around the entire perimeter of the house and outer edges of the deck can significantly reduce the vulnerability of the home. Mitigations include using rock instead of bark mulch on top of landscape fabric. Placing landscape fabric underneath the area can reduce the growth of weeds, thereby minimizing the maintenance needed by the homeowner. These modifications increased the cost of near-home landscaping by \$2,570 (210%). Rock has a longer lifespan than bark mulch and landscape fabric will reduce the maintenance required in the near-home landscaping area.

## Near-Home Landscaping New Construction



(<https://i0.wp.com/headwaterseconomics.org/wp-content/uploads/Building-Materials-Near-Home-Landscaping-Large.jpg?ssl=1>).

## Costs Should Not Be a Barrier to Constructing Wildfire-Resistant Homes

Laboratory research and post-fire analysis have determined that local ignitability of the home itself, largely determined by the building materials and design features, is an important factor in determining survivability during a wildfire. Existing codes and standards provide ample guidance for how to construct a wildfire-resistant home and reduce vulnerability. This study demonstrates that a new home can be constructed to such standards for approximately the same cost as a typical home, and some of these materials have added benefits such as longer lifespan and reduced maintenance.

City, county, and state governments must weigh many issues when considering new regulations, but the cost of constructing a home to meet wildfire-resistant building codes need not be a barrier. If communities continue to allow growth in wildfire-prone lands, adopting wildfire-resistant building codes may be one of the most effective tools for reducing home loss. Absent such requirements, homeowners and builders can take steps to protect the home by carefully designing and

constructing (or retrofitting) the most vulnerable components—the roof, walls, deck, and landscaping—to be wildfire-resistant. The long-term benefits may include longer lifecycle and reduced maintenance.

As recent wildfire disasters have demonstrated, the converging trends of rapid growth in the wildland-urban interface, fuel accumulation after a century of fire suppression, and a warming climate will make wildfires more costly and dangerous in years to come. Just as the cause of this problem is multipronged, there is no single solution to protecting lives and property and we must employ a suite of solutions that include land use planning, vegetation management, and emergency preparedness. Constructing homes to be wildfire-resistant is a critical and cost-effective piece of the puzzle.

**Download Full Report (<https://headwaterseconomics.org/wp-content/uploads/building-costs-codes-report.pdf>)**

In addition to the [full report \(https://headwaterseconomics.org/wp-content/uploads/building-costs-codes-report.pdf\)](https://headwaterseconomics.org/wp-content/uploads/building-costs-codes-report.pdf), you can also download:

- [Summary report \(https://headwaterseconomics.org/wp-content/uploads/building-costs-codes-summary.pdf\)](https://headwaterseconomics.org/wp-content/uploads/building-costs-codes-summary.pdf).
- [Data tables \(https://headwaterseconomics.org/wp-content/uploads/building-costs-codes-appendix.xlsx\)](https://headwaterseconomics.org/wp-content/uploads/building-costs-codes-appendix.xlsx).
- [News release \(https://headwaterseconomics.org/wp-content/uploads/building-costs-codes-release.pdf\)](https://headwaterseconomics.org/wp-content/uploads/building-costs-codes-release.pdf).

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*Prepared For*

**National Association of  
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**DECEMBER 2020**

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## ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

EA	Each
CY	Cubic Yard
HI	Home Innovation Research Labs
IBC	International Building Code
IR 1	Ignition Resistant Class 1
IR 2	Ignition Resistant Class 2
IR 3	Ignition Resistant Class 3
IRC	International Residential Code
IWUIC	International Wildfire Urban Interface Code
LF	Linear Feet
MSF	Thousand Square Feet
NAHB	National Association of Home Builders
O&P	Overhead and Profit
SF	Square Feet

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## BACKGROUND

The National Association of Home Builders (NAHB) asked Home Innovation Research Labs (HI) to study the cost impact of building a house to the 2018 ICC *International Wildland Urban Interface Code* (IWUIC 2018)<sup>1</sup>.

## METHODOLOGY

Baseline metrics were identified for two representative single-family homes, a single story and a 2-story home, built to the International Residential Code (IRC) in three different locations – Los Angeles, CA; Dallas, TX; and Denver, CO. Materials and type of construction were selected for the specific location based on market research data from HI (Appendix B).

The cost impacts in this analysis have been developed primarily with data adapted from *2020 Residential Costs with RSMeans Data*<sup>2</sup>. The costs for individual code changes are shown in Appendix A. Costs are reported at the national level and modified for selected locations by applying a location factor adjustment. Costs are reported as both total to the builder and total to consumer. The total cost to builder includes overhead and profit (designated in the tables as “w/O&P”) applied to individual component costs (i.e., materials and labor) to represent the cost charged by the sub-contractor. The total cost to consumer is based on the builder’s gross margin, reported as 18.9% of construction cost in NAHB’s *Cost of Doing Business Study, 2016 edition*<sup>3</sup>.

## Reference House Characteristics

The features of the single-story and 2-story Reference Houses are summarized in Table 1. The basis for the selection of the characteristics of the Reference Houses are provided in Appendix E.

**Table 1. Reference House Features**

<b>Reference House Features</b>	<b>1-story</b>	<b>2-story</b>
Conditioned floor area, total, SF	2,600	2,600
First floor area, SF	2,600	1,080
Second floor area, SF	NA	1,520
First floor dimensions, ft.	40 x 75	40 x 38
Second floor dimensions, ft.	NA	40 x 38
Garage dimensions, ft.	20 x 20	20 x 22
Attic	Vented	Vented
Foundation: slab-on-grade (SOG)	SOG	SOG
Slab Perimeter, LF	230	156
Ceiling height, first floor, ft.	9	9
Ceiling height, second floor, ft.	NA	8

<sup>1</sup> <https://codes.iccsafe.org/content/IWUIC2018>

<sup>2</sup> <https://www.rsmeans.com/products/books/2020-cost-data-books/2020-residential-costs-book>

<sup>3</sup> <http://eyeonhousing.org/2016/03/whats-the-average-profit-margin-of-single-family-builders/>

Walls, gross area, includes 1' rim for 2-story, SF	2070	2808
Window area, SF	360	360
Roof type (gable or hip)	Hip	Hip
Roof slope	7:12	7:12
Roof overhang at eaves/gables, ft.	1	1
Deck area, based on 20'x14' deck, SF	280	280
Roof cladding material	Asphalt shingle	Asphalt shingle
Wall cladding material	Varies	Varies
Soffit/trim cladding material	Lumber	Lumber
Window construction/material	Vinyl	Vinyl
Lot size/house setbacks, SF	11,250	11,250

Median lot size varies by region<sup>4</sup> so a suitable size within the range was selected for the reference houses.

Construction practices vary depending on location and climate zone. Table 2 shows common construction practices used for given reference houses in selected location based on HI market research data.

**Table 2. Common Construction Practices in Selected Locations**

Construction	Colorado	East TX	Southern CA
1-story, % of all homes	50%	71%	36%
Foundation	Basement	Slab	Slab
Wall Cladding	Fiber Cement	Brick	Stucco
Roofing	Asphalt Shingle	Asphalt Shingle	Clay/Cement Tile
Exterior Trim	Wood Fiber Composite	Fiber Cement	Lumber Boards

(source: Home Innovation Research Labs)

Costs were compared for IWUIC Ignition Resistant Class 1 (IR 1) construction versus the baseline practices in Table 2.

For comparison, the baseline practice for wall cladding was assumed to be wood in this study even though the most common materials used there are fiber cement, brick, and stucco. For other components addressed in the IWUIC, such as windows, doors, exterior decks, etc., non-compliant vs. compliant materials were compared to evaluate the cost difference. The range of cost impact is

<sup>4</sup> <http://eyeonhousing.org/2019/10/lot-size-remains-low-in-2018/#:~:text=The%20median%20lot%20size%20of,different%20from%20the%202017%20median.>



provided to show low and high cost impact for common practices that had more than one method of compliance.

## IWUIC Requirements

IWUIC 2018 requires a house constructed, modified, or relocated into or within wildland-urban interface areas to be in compliance with one of the three classes of ignition resistant construction: Class 1 Ignition Resistant Construction (IR 1), Class 2 Ignition Resistant Construction (IR 2), or Class 3 Ignition Resistant Construction (IR 3,) depending on whether the site conforms to the water supply and defensible space requirements for the appropriate fire hazard severity.

## Fire Hazard Severity

IWUIC 2018 classifies the fire hazard severity of locations as moderate hazard, high hazard, or extreme hazard based on the fuel type in the area. Vegetation of selected locations were studied to see if any location followed a particular fuel model. Appendix C shows fuel classification and fire hazard severity per the IWUIC 2018. The selected locations did not conform to a specific fuel model, so all three hazard severities were considered. To narrow down the study, only the cost impact for Class 1 Ignition Resistant Construction (IR 1) was analyzed and shown in the report.

## Water Supply

The water sources, both manmade and natural, are required to be equipped with an approved hydrant in order to conform to the water supply requirements of the IWUIC, along with other provisions. IWUIC 2018 requires mandatory conformance with defensible space requirements for building in extreme hazard areas that do not conform to the water supply requirements (IWUIC Table 503.1).

## Defensible Space

The IWUIC 2018 defines defensible space as “an area either natural or man-made, where material capable of allowing a fire to spread unchecked has been treated, cleared or modified to slow the rate and intensity of an advancing wildfire and to create an area for fire suppression operations to occur.”

## Fuel Modification for Reference House

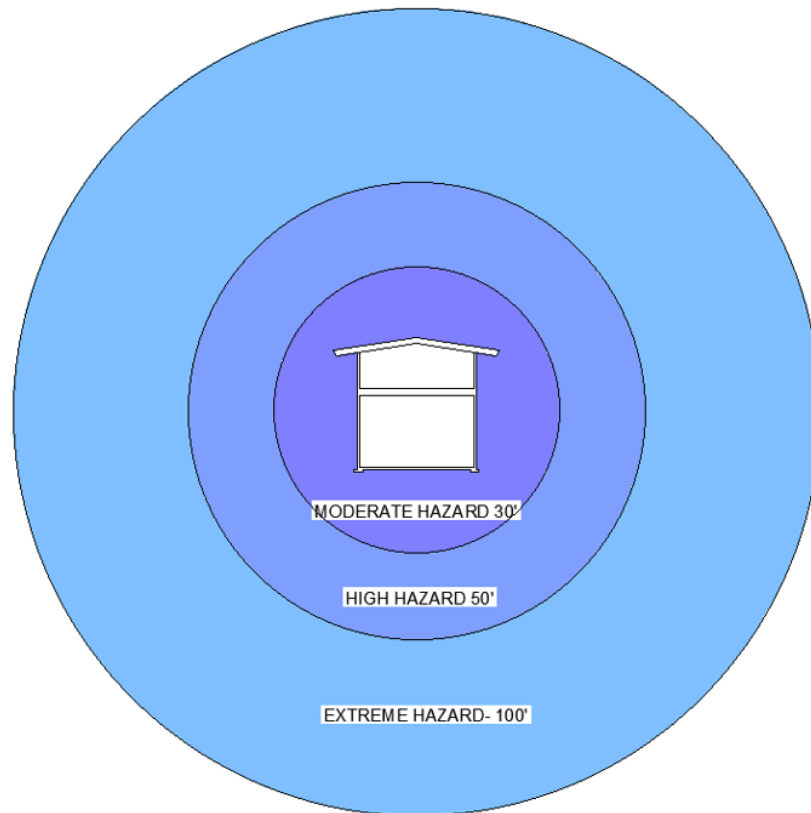
Depending on whether the building is located in a moderate, high, or extreme hazard area, homeowners are responsible for providing fuel modification over a distance of 30 feet, 50 feet, or 100 feet, as shown in Table 5 and illustrated in Image 1, for conformance with the defensible space requirements. For the purposes of this study, the cost of providing defensible space is limited up to the lot line, assuming that the reference house is on a developed lot and all the neighboring lots are complying with the defensible space requirements.

**Table 3 Fuel Modification for Defensible Space<sup>5</sup>**

<b>WILDLAND-URBAN INTERFACE AREA</b>	<b>FUEL MODIFICATION DISTANCE (feet)<sup>3</sup></b>
Moderate hazard	30
High hazard	50
Extreme hazard	100 <sup>6</sup>

*For SI = 1 foot = 304.8 mm*

*Distances can be increased to reflect site-specific analysis based on local conditions and fire protection plans.*



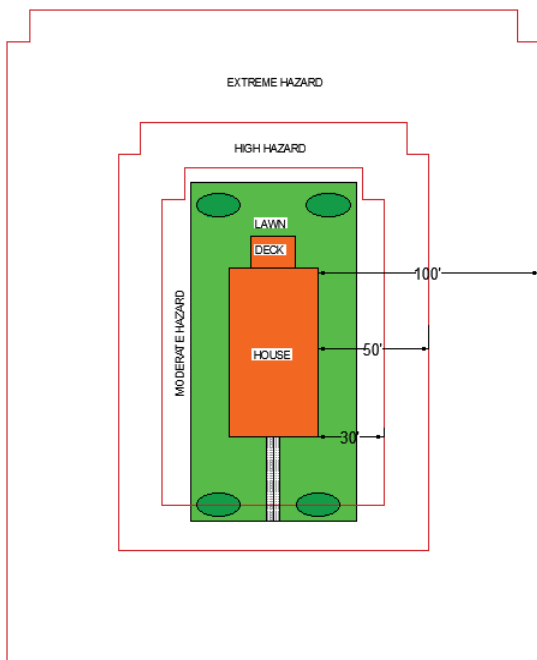
**Image 1. Fuel Modification Requirement for Defensible Space**

<sup>5</sup> IWUIC 2018, Table 603.2

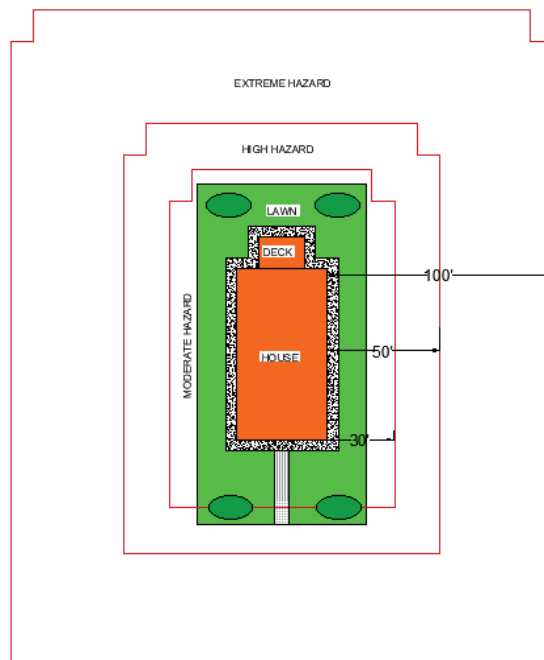
Assuming new construction on a developed lot as illustrated in Figure 1, the areas of fuel modification for the reference houses are shown in Table 6.

**Table 4 Fuel modification area**

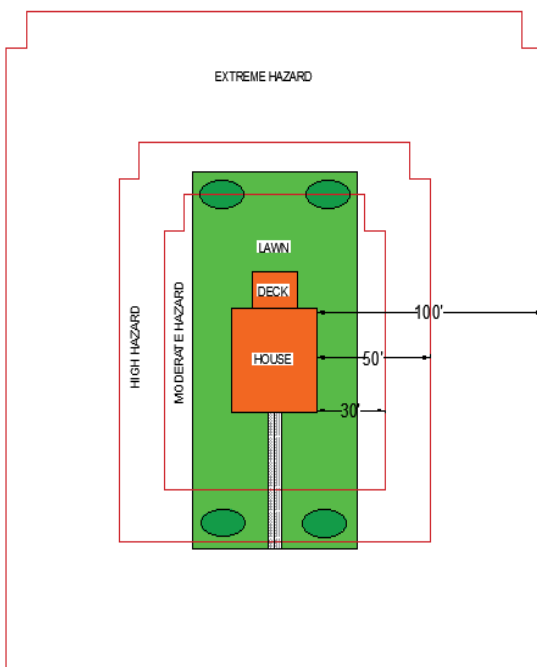
Reference house	Lot area (SF)	Area of house and deck (SF)	Area of gravel addition (SF)	Area of sidewalk (SF)	Area of lawn modification (SF)
Single story	11250	3,275	<b>1,395</b>	195	<b>6,385</b>
2 story	11250	1,791	<b>1,029</b>	285	<b>8,145</b>



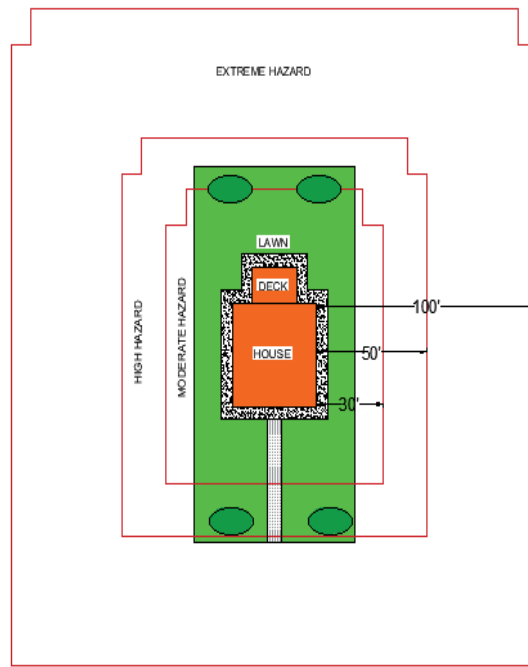
Single story house without defensible space



Single story house with defensible space



Two story house without defensible space



Two story house with defensible space

Figure 1 Fuel modification for defensible space

## Automatic Sprinkler Systems

IWUIC 2018 requires an approved automatic sprinkler system be installed in all occupancies in new buildings meeting the requirements for IR 1 construction. California is not impacted by this cost because an automatic sprinkler system is mandated for residential buildings by the local code.

## Building Components

Characteristics of a house that make it vulnerable to wildland-urban interface fires include exterior features like roof covering, exterior siding, door and window trim, the presence of an exterior deck, and the presence of trees, vegetation or other landscaping on the surrounding lot.

IWUIC 2018 requirements for IR 1 construction mandate specific practices for various exterior components of the building. Building components of the reference houses analyzed for this study include soffit and fascia, vents, downspouts and gutters, exterior wall cladding, exterior windows and exterior doors.

Cost of an automatic sprinkler, exterior deck and defensible space are provided as separate costs in Table 7 and 8 to differentiate the cost of the basic house components from the cost of additional features. The cost estimate does not include landscape maintenance costs.

## RESULTS

### Summary of Cost Impact of IWUIC Code Compliance

Tables 5 and 6 summarize the estimated cumulative impact of constructing the reference houses to the 2018 IWUIC. The cost is adjusted for selected city's location factor in each state.

**Table 5 Cost Impact Summary, Single-Story House**

Component*	Southern California (L.A, 0.99)		Colorado (Denver, 1.05)		Eastern Texas (Dallas, 0.98)	
	Low Cost	High Cost	Low Cost	High Cost	Low Cost	High Cost
Roof covering	\$0	\$0	\$0	\$0	\$0	\$0
Soffit and Fascia	\$1,839	\$1,839	\$1,950	\$1,950	\$1,820	\$1,820
Gutters and Downspouts	\$860	\$860	\$912	\$912	\$852	\$852
Exterior wall (siding)	(\$3,839)	\$21,391	(\$4,071)	\$22,688	(\$3,800)	\$21,175
Windows	\$2,509	\$2,678	\$2,661	\$2,840	\$2,483	\$2,651
Door	\$0	\$0	\$0	\$0	\$0	\$0
Vents	\$484	\$484	\$514	\$514	\$479	\$479
<b>Total impact for house components</b>	<b>\$1853</b>	<b>\$27,253</b>	<b>\$1966</b>	<b>\$28,905</b>	<b>\$1,835</b>	<b>\$26,978</b>
Exterior Deck	\$1,293	\$1,293	\$1,371	\$1,371	\$1,280	\$1,280
Defensible space	\$883	\$883	\$937	\$937	\$874	\$874
Automatic Sprinklers	NA <sup>7</sup>	NA	\$4,311	\$6,743	\$4,024	\$6,294
<b>Total</b>	<b>\$4,029</b>	<b>\$29,429</b>	<b>\$8,584</b>	<b>\$37,955</b>	<b>\$8,012</b>	<b>\$35,425</b>

**Table 6 Cost Impact Summary, Two-Story House**

Component*	Southern California		Colorado		Eastern Texas	
	Low Cost	High Cost	Low Cost	High Cost	Low Cost	High Cost
Roof covering	\$0	\$0	\$0	\$0	\$0	\$0
Soffit and Fascia	\$1,247	\$1,247	\$1,323	\$1,323	\$1,235	\$1,235
Gutters and Downspouts	\$470	\$470	\$499	\$499	\$466	\$466
Exterior wall (siding)	(\$5,628)	\$31,364	(\$5,969)	\$33,265	(\$5,571)	\$31,047
Windows	\$2,509	\$2,678	\$2,661	\$2,840	\$2,483	\$2,651
Door	\$0	\$0	\$0	\$0	\$0	\$0
Vents	\$386	\$386	\$410	\$410	\$382	\$382
<b>Total impact for house components</b>	<b>(\$1,016)</b>	<b>\$36,146</b>	<b>(\$1,077)</b>	<b>\$38,337</b>	<b>(\$1,005)</b>	<b>\$35,781</b>
Exterior Deck	\$1,293	\$1,293	\$1,371	\$1,371	\$1,280	\$1,280
Defensible space	\$1,550	\$1,550	\$1,644	\$1,644	\$1,534	\$1,534
Automatic Sprinklers	NA	NA	\$4,311	\$6,743	\$4,024	\$6,294
<b>Total</b>	<b>\$1,827</b>	<b>\$38,989</b>	<b>\$6,248</b>	<b>\$48,095</b>	<b>\$5,832</b>	<b>\$44,888</b>

<sup>7</sup> NA: Not Applicable

## APPENDIX A: COST IMPLICATION OF IWUIC COMPLIANCE

### Reference Code Section

2018 IWUIC Section 504.2 Roof Covering.

### Summary of the Code:

IR 1 construction requires roof assemblies that comply with a Class A rating. For roof coverings where the profile allows a space between the roof covering and roof decking, this section requires the space at the eave ends to be firestopped to preclude entry of flames or embers or have one layer of 72-pound mineral-surfaced, nonperforated cap sheet complying with ASTM D 3909 installed over the combustible decking.

### Cost Implication of the Code Compliance:

Compliance with this code section does not have any cost impact as the reference houses are assumed to have asphalt or clay/cement tiles that meet the Class A roofing requirement. These materials are the most common roofing materials for the three selected locations.

## Reference Code Section

2018 IWUIC Section 504.3 Protection of Eaves.

### Summary of the Code:

IR1 construction requires soffits to be protected on the exposed underside by ignition-resistant materials or by materials approved for not less than 1-hour fire-resistance-rated construction, 2-inch nominal dimension lumber, or 1-inch nominal fire-retardant-treated lumber or ¾-inch nominal fire-retardant treated plywood identified for exterior use and meeting the requirements of Section 2303.2 of the IBC. It also requires fascia to be protected on the backside by ignition resistant materials of materials approved for not less than 1-hour fire-resistant construction or 2-inch nominal dimension lumber.

### Cost Implication of the Code Compliance:

Compliance with this code section will increase the cost of construction for the given reference houses due to replacing 1" thick fascia board with 2" thick lumber and addition of fire retardant-treated soffit panels. The costs are applicable to all three locations.

**Table A 1 Cost Impact, protection of eaves, single story reference house**

Component	Unit	Material	Labor	Total	w/O&P	Quantity	Cost
Fascia board, 1" x 6" lumber	LF	0.86	1.38	2.24	3.21	(230)	(738)
Fascia board, 2" x 6" lumber	LF	0.69	2.31	3.00	4.55	230	1,047
Soffit panels, plywood, fire-retardant treated, 3/4"	SF	2.03	1.95	3.98	5.45	230	1,254
<b>Total to Builder</b>							<b>1,562</b>
<b>Total to Consumer</b>							<b>1,857</b>

**Table A 2 Cost Impact, protection of eaves, 2-story reference house**

Component	Unit	Material	Labor	Total	w/O&P	Quantity	Cost
Fascia board, 1" x 6" lumber	LF	0.86	1.38	2.24	3.21	(156)	(501)
Fascia board, 2" x 6" Lumber	LF	0.69	2.31	3.00	4.55	156	710
Soffit covering, plywood, Fire treated, 3/4"	SF	2.03	1.95	3.98	5.45	156	850
<b>Total to Builder</b>							<b>1,059</b>
<b>Total to Consumer</b>							<b>1,260</b>



## Reference Code Section

### 2018 IWUIC Section 504.4 Gutters and Downspouts

#### Summary of the Code:

IR 1 construction requires gutters and downspouts to be constructed of noncombustible material. It also requires gutters be provided with an approved means to prevent accumulation of leaves and debris in the gutter.

#### Cost Implication of the Code Compliance:

Compliance with this code section will increase the cost of construction for the given reference houses due to replacing vinyl gutters and downspouts with aluminum gutters and downspouts and providing gutter guards to cover the gutters. The costs are applicable to all three locations.

**Table A 3 Cost Impact, Gutter and Downspouts, Single Story Reference House**

Component	Unit	Material	Labor	Total	w/O&P	Quantity	Cost
Gutter, Vinyl, O.G., 5" wide	LF	1.51	2.50	4.03	5.80	(150)	(870)
Downspouts, vinyl, rectangular, 2"x3"	LF	2.17	1.50	3.67	4.87	(40)	(195)
Downspouts elbow	EA	1.00	3.14	4.14	6.30	(12)	(76)
Aluminum , stock units, 5" K type, .027" thick, plain	LF	2.85	2.51	5.36	7.30	150	1,095
Downspouts, aluminum, embossed, .020" thick, 2"x3"	LF	0.95	1.65	2.60	3.79	40	152
Gutter guard, 6" wide strip, aluminum mesh	LF	2.46	0.58	3.04	3.66	150	549
Downspouts elbow	EA	1.00	3.14	4.14	6.30	12	76
<b>Total to Builder</b>							<b>731</b>
<b>Total to Consumer</b>							<b>869</b>

**Table A 4 Cost Impact, Gutter and Downspouts, 2-Story Reference House**

Component	Unit	Material	Labor	Total	w/O&P	Quantity	Cost
Gutter, Vinyl, O.G., 5" wide	LF	1.51	2.50	4.03	5.80	(80)	(464)
Downspouts, vinyl, rectangular, 2"x3"	LF	2.17	1.50	3.67	4.87	(80)	(390)
Downspouts elbow	EA	1.00	3.14	4.14	6.30	(12)	(76)
Aluminum , stock units, 5" K type, .027" thick, plain	LF	2.85	2.51	5.36	7.30	80	584
Downspouts, aluminum, embossed, .020" thick, 2"x3"	LF	0.95	1.65	2.60	3.79	80	303
Gutter guard, 6" wide strip, aluminum mesh	LF	2.46	0.58	3.04	3.66	100	366
Downspouts elbow	EA	1.00	3.14	4.14	6.30	12	76
<b>Total to Builder</b>							<b>400</b>
<b>Total to Consumer</b>							<b>475</b>

## Reference Code Section

### 2018 IWUIC Section 504.5 Exterior Walls

#### Summary of the Code:

IR 1 construction requires the exterior walls of the buildings or structure to be constructed with materials approved for not less than 1-hour fire-resistance-rated construction on the exterior side, approved noncombustible material, heavy timber or log wall construction, fire-retardant-treated wood on the exterior side or ignition-resistant materials complying with the code on exterior side.

#### Cost Implication of the Code Compliance:

Compliance with this code section will decrease the cost of construction for the given reference houses where a more-costly material such as wood siding is replaced with a less-costly material such as fiber cement siding, but will increase the cost of construction where a less-costly material such as vinyl siding is replaced with a more costly-material such as fiber cement siding or brick veneer. The costs are not necessarily applicable to all three locations as the most common siding materials in the selected locations are either fiber cement, stucco or brick veneer which all comply with IWUIC requirement for Class 1 ignition-resistant construction. However, to provide a range of cost implications, both low and high cost impact changes are included in the report assuming a change in siding is required.

**Table A 5 Cost Impact, Siding, Single Story Reference House**  
(Lower Cost Impact: Substitute Fiber Cement Siding for Wood Siding)

Component	Unit	Material	Labor	Total	w/O&P	Quantity	Cost
Wood, cedar bevel, A grade, 1/2" x 6"	SF	4.46	0.98	5.44	6.50	(1,583)	(10,290)
Fiber cement siding, 6-1/4" exposure	SF	2.00	1.36	3.36	4.44	1,583	7,029
<b>Total to Builder</b>							<b>(3,261)</b>
<b>Total to Consumer</b>							<b>(3,877)</b>

**Table A 6 Cost Impact, Siding, Single Story Reference House**  
(Higher Cost Impact: Substitute Brick Veneer for Vinyl Siding)

Component	Unit	Material	Labor	Total	w/O&P	Quantity	Cost
Vinyl siding, .048" thick, double 4	SF	1.09	1.17	2.26	3.12	(1,583)	(4,939)
Brick veneer masonry	SF	4.52	5.80	10.32	14.60	1,583	23,112
<b>Total to Builder</b>							<b>18,173</b>
<b>Total to Consumer</b>							<b>21,608</b>

**Table A 7 Cost Impact, Siding, 2-Story Reference House**  
(Lower Cost Impact: Substitute Fiber Cement Siding for Wood Siding)

Component	Unit	Material	Labor	Total	w/O&P	Quantity	Cost
Wood, cedar bevel, A grade, 1/2" x 6"	SF	4.46	0.98	5.44	6.50	(2,321)	(15,087)
Fiber cement siding, 6-1/4" exposure	SF	2.00	1.36	3.36	4.44	2,321	10,305
<b>Total to Builder</b>							<b>(4,781)</b>
<b>Total to Consumer</b>							<b>(5,685)</b>

**Table A 8 Cost Impact, Siding, 2-Story Reference House**  
(Higher Cost Impact: Substitute Brick Veneer for Vinyl Siding)

Component	Unit	Material	Labor	Total	w/O&P	Quantity	Cost
Vinyl siding, .048" thick, double 4	SF	1.09	1.17	2.26	3.12	(2,321)	(7,242)
Brick veneer masonry	SF	4.52	5.80	10.32	14.60	2,321	33,887
<b>Total to Builder</b>							<b>26,645</b>
<b>Total to Consumer</b>							<b>31,681</b>

## Reference Code Section

2018 IWUIC Section 504.6 Underfloor enclosure

### Summary of the Code:

IR 1 construction requires underfloor areas (e.g. crawlspaces) be enclosed down to the ground with exterior walls in accordance with IWUIC Section 504.5 on exterior walls.

### Cost Implication of the Code Compliance:

Compliance with this code section has no cost impact as the reference houses have no underfloor enclosures.

## Reference Code Section

2018 IWUIC Section 504.7 Appendages and Projections

### Summary of the Code:

IR 1 construction requires unenclosed accessory structures attached to buildings with habitable spaces, and projections such as decks, to have a minimum of 1-hour fire-resistance-rated construction.

### Cost Implication of the Code Compliance:

Compliance with this code section will increase the cost of construction where a concrete patio is substituted for a non-fire-rated wood deck. A different cost impact is possible for replacing a non-fire-rated wood deck with a fire-rated wood deck, but due to the lack of pricing data for lumber that is both fire-retardant treated and preservative-treated for exterior use, only the costs for substituting a concrete patio for a non-fire-rated wood deck.

**Table A 9 Cost Impact, Exterior Deck, Single and 2-Story Reference House**

Component	Unit	Material	Labor	Total	w/O&P	Quantity	Cost
Posts, 4x6, treated	LF	2.24	2.10	4.34	5.90	(12)	(71)
Girder, double 2x10	LF	2.49	1.05	3.99	4.97	(20)	(99)
Ledger, 2x10, treated, bolted 4' o.c.	LF	1.59	1.50	3.09	4.22	(20)	(84)
Joists, 2x10 treated	LF	1.47	0.64	2.11	2.68	(210)	(563)
Decking, 2x6, treated	SF	1.66	0.90	2.56	3.32	(280)	(930)
Excavation for footing, 12" x 36" deep	CY		55.50	55.50	91.50	5	458
Gravel for footing	CY	28.93	4.89	33.82	40.00	5	200
Gravel below slab, 4" deep	SF	0.52	0.14	0.66	0.80	280	224
Concrete slab on grade, 4", 3500 psi	CY	147.45	51.00	198.45	246.00	4	984
Thickened slab edge, reinforced 8" x 8"	LF	6.72	2.31	9.03	11.20	48	538
Concrete stair	LF	6.72	20.50	27.22	41.00	6	246
Concrete slab finishing	SF		0.43	0.43	0.70	280	196
<b>Total to Builder</b>							<b>1,098</b>
<b>Total to Consumer</b>							<b>1,306</b>

## Reference Code Section

### 2018 IWUIC Section 504.8 Exterior Glazing

#### Summary of the Code:

IR 1 construction requires exterior windows, window walls and glazed doors, windows within exterior doors and skylights to be tempered glass, multilayered glazed panels, glass block or have a fire protection rating of not less than 20 minutes.

#### Cost Implication of the Code Compliance:

Compliance with this code section will increase the cost of construction where vinyl windows are replaced with metal-clad wood windows. There is a higher cost impact for replacing plain glass wood windows with tempered glass metal clad wood windows.

**Table A 10 Cost Impact, Window, Single and 2-Story Reference House**  
(Lower Cost Impact: Substitute Vinyl with Metal Clad Wood Window)

Component	Unit	Material	Labor	Total	w/O&P	Quantity	Cost
Vinyl, double hung, 3040	SF	20.58	2.67	23.25	27.08	(360)	(9,749)
Metal clad wood, double hung, 3050	SF	26.33	2.40	28.73	33.00	360	11,880
<b>Total to Builder</b>							<b>2,131</b>
<b>Total to Consumer</b>							<b>2,534</b>

**Table A 11 Cost Impact, Window, Single and 2-Story Reference House**  
(Higher Cost Impact: Substitute Plain Glass Vinyl Window with Tempered Glass Metal Clad Wood Window)

Component	Unit	Material	Labor	Total	w/O&P	Quantity	Cost
Vinyl, double hung, 3040	SF	20.58	2.67	23.25	27.08	(360)	(9,749)
Metal clad wood, double hung, 3050	SF	26.33	2.40	28.73	33.00	360	11,880
Float glass, 3/16" plain	SF	7.10				(360)	(2,556)
Float glass, 3/16" tempered, clear	SF	7.50				360	2,700
<b>Total to Builder</b>							<b>2,275</b>
<b>Total to Consumer</b>							<b>2,705</b>

## Reference Code Section

2018 IWUIC Section 504.9 Exterior Doors

### Summary of the Code:

IR 1 construction requires the exterior doors to be approved noncombustible construction, solid core wood not less than 1 ¾ inches thick or have a fire protection rating of not less than 20 minutes.

### Cost Implication of the Code Compliance:

Compliance with this code section does not have any cost impact as the reference houses have solid wood core 1 ¾ inches thick exterior doors that are already compliant with the IWUIC.

## Reference Code Section

### 2018 IWUIC Section 504.10 Vents

#### Summary of the Code:

IR 1 construction requires attic ventilation openings, foundation or underfloor vents, or other ventilation openings in vertical exterior walls and vents through roofs to not exceed 144 square inches each. It also requires such vents to be covered with noncombustible corrosion-resistant mesh with openings not to exceed ¼ inch or be designed and approved to prevent flame or ember penetration into the structure. Further, vents are not permitted in the soffit areas.

#### Cost Implication of the Code Compliance:

Compliance with this code section will increase the cost of construction for the reference houses. The cost analysis is based on replacing soffit and ridge vents with gable wall louvers and static roof vents<sup>8</sup> located close to the ridge. The total required vent area is calculated per the IRC 2018, and the quantity of gable vents and roof vents is determined based on the 144 square inch limit requirement per vent. Note that no deduction is taken for soffit vents; it is assumed that non-perforated soffit material (same cost) will still be installed.

**Table A 12 Cost Impact, Vents, Single Story Reference House**

Component	Unit	Material	Labor	Total	w/O&P	Quantity	Cost
Gable wall louver, aluminum 12"x12"	EA	17.85	7.60	25.45	32.00	4	128
Roof vent, aluminum 12"x12"	EA	27.00	10.30	37.30	48.00	14	672
Ridge vent	LF	2.54	1.55	4.09	5.55	(70)	(389)
<b>Total to Builder</b>							<b>412</b>
<b>Total to Consumer</b>							<b>489</b>

**Table A 13 Cost Impact, Vents, 2-Story Reference House**

Component	Unit	Material	Labor	Total	w/O&P	Quantity	Cost
Gable wall louver, aluminum 12"x12"	EA	17.85	7.60	25.45	32.00	6	192
Roof vent, aluminum 12"x12"	EA	27.00	10.30	37.30	48.00	7	336
Ridge vent	LF	2.54	1.55	4.09	5.55	(36)	(200)
<b>Total to Builder</b>							<b>328</b>
<b>Total to Consumer</b>							<b>390</b>

<sup>8</sup> Example static roof vents: <https://www.tamtech.com/product/static-roof-vent-large-capacity-round-vent-vx25-series/>



## Reference Code Section

2018 IWUIC Section 504.8 Detached accessory structures

### Summary of the Code:

IR 1 construction requires detached accessory structures located less than 50 feet from a building containing habitable space to have exterior walls constructed with materials approved for not less than 1-hour fire-resistance-rated construction, heavy timber, log wall construction, or constructed with approved noncombustible materials or fire-retardant-treated wood on the exterior side.

### Cost Implication of the Code Compliance:

Compliance with this code section does not have any cost impact as the lots for the reference houses do not have any detached structures within 50 feet of habitable space.

## Reference Code Section

2018 IWUIC Section 603.2 Fuel modification (Defensible space)

### Summary of the Code:

IR 1 construction requires fuel modification up to 30', 50' or 100' around a building or structure for moderate hazard, high hazard or extreme hazard areas respectively to create a defensible space.

### Cost Implication of the Code Compliance:

Compliance with this code section will increase the cost of construction where a 5-foot-wide strip of gravel is added for ground covering around the boundary of the reference house, standard shrubs are replaced with fire resistant shrubs and standard turf grass is replaced with drought tolerant grass for the lawn. The IWUIC does not specify fuel types requiring modification so external references were studied for this purpose.<sup>9 10</sup>

**Table A 14 Cost Impact, Defensible Space, Single Story Reference House**

Component	Unit	Material	Labor	Total	w/O&P	Quantity	Cost
Ground cover, pea gravel	Ton	11.80	24.50	36.30	53.00	13.95	739
Shrub, Russian olive, 3' - 4'	EA	26.00	13.40	47.95	60.50	(4.00)	(242)
Shrub, viburnum, 3' - 4'	EA	27.00	25.00	68.05	88.50	4.00	354
Sodding, bluegrass sod on level ground	MSF	335.00	82.50	430.65	520.00	(7.78)	(4,046)
Sodding, pallet of Zoysia	MSF	530.00	82.50	625.65	733.59	6.39	4,684
<b>Total to Builder</b>							<b>750</b>
<b>Total to Consumer</b>							<b>892</b>

**Table A 15 Cost Impact, Defensible Space, 2-Story Reference House**

Component	Unit	Material	Labor	Total	w/O&P	Quantity	Cost
Ground cover, pea gravel	Ton	11.80	24.50	36.30	53.00	10.29	545
Shrub, Russian olive, 3' - 4'	EA	26.00	13.40	47.95	60.50	(4.00)	(242)
Shrub, viburnum, 3' - 4'	EA	27.00	25.00	68.05	88.50	4.00	354
Sodding, bluegrass sod on level ground	MSF	335.00	82.50	430.65	520.00	(9.17)	(4,770)
Sodding, pallet of Zoysia	MSF	530.00	82.50	625.65	733.59	8.15	5,975
<b>Total to Builder</b>							<b>1,317</b>
<b>Total to Consumer</b>							<b>1,565</b>

<sup>9</sup> [https://ibhs.org/wp-content/uploads/wpmembers/files/Near-Building\\_Noncombustible\\_Zone\\_Report\\_IBHS.pdf](https://ibhs.org/wp-content/uploads/wpmembers/files/Near-Building_Noncombustible_Zone_Report_IBHS.pdf)

<sup>10</sup> [https://www.fs.fed.us/rm/pubs\\_other/rmrs\\_2004\\_barkeley\\_y001.pdf](https://www.fs.fed.us/rm/pubs_other/rmrs_2004_barkeley_y001.pdf)

## Reference Code Section

2018 IWUIC Section 602 Automatic sprinkler system

### Summary of the Code:

IR 1 construction requires approved automatic sprinkler system to be installed in all occupancies in new buildings.

### Cost Implication of the Code Compliance:

Compliance with this code section will increase the cost of construction where automatic fire sprinkler systems are not already mandated by the local code. The Home Fire Sprinkler Cost Assessment- 2013<sup>11</sup> report by The Fire Protection Research Foundation showed that the maximum cost for residential sprinkler system was \$2.47 (\$/sprinkled SF) because of the additional cost associated with different piping materials and permitting and fees for sprinkler system. This rate is used to calculate the high cost impact for the reference houses using a sprinkled area of 2600 SF. This cost is applicable to all selected location except Los Angeles, CA because California has a state-wide mandated requirement for automatic sprinkler system in residential houses.

**Table A 16 Cost Impact, Automatic Sprinkler System, Single and 2-Sotry Reference House**  
(Lower Cost Impact: Addition of Automatic Sprinkler System)

Component	Unit	Material	Labor	Total	w/O&P	Quantity	Cost
Flow alarm	EA	112.00	12.45	124.45	144.00	1	144
Flow switch (valve supervisory switch)	EA	265.00	20.00	285.00	325.00	1	325
Sprinkler head, fast response glass bulb, 135°F to 155°F	EA	34.00	20.00	54.00	70.50	10	705
Sprinkler head escutcheons, standard, brass tone, 1"	EA	3.56	8.10	11.66	17.15	10	172
CPVC fire suppression pipe, 1"	LF	2.26	1.71	3.97	5.30	200	1,060
CPVC fire suppression tee, 1"	EA	5.10	21.50	26.20	40.50	12	486
CPVC fire suppression 90 elbow, 1"	EA	4.12	14.30	18.42	28.00	10	280
CPVC fire suppression cap, 1"	EA	1.55	7.20	8.75	13.50	4	54
CPVC fire suppression coupling, 1"	EA	2.39	14.30	16.69	26.00	2	52
CPVC fire suppression adapter, metal thread, 1"x1/2"	EA	5.25	7.20	12.45	17.55	10	176
<b>Total to Builder</b>							<b>3,453</b>
<b>Total to Consumer</b>							<b>4,106</b>

<sup>11</sup> <https://www.nfpa.org/-/media/Files/Fire-Sprinkler-Initiative/HomeFireSprinklerCostAssessment2013.pdf>

## APPENDIX B: CONSTRUCTION PRACTICES IN SELECTED LOCATIONS

Table B 1 Common Construction Practices in Selected Locations

Component	Colorado	East TX	South CA
Percent 1-story	50	71	36
<b>Foundations</b>			
Basement	68	11	16
Crawlspace	6	3	13
Slab	23	78	71
<b>Roofing Material (Top 4)</b>			
Asphalt Shingles	85	92	33
Clay/Cement Tiles	9	2	38
Aluminum/Steel	3	4	2
Single ply/built-up	3	2	17
<b>Roof Pitch</b>			
Average Roof Pitch */12	6	7.4	4.8
<b>Wall Cladding (Top 4)</b>			
Fiber Cement	23	27	
Engineered Wood	17	9	10
EIFS	10		6
Stucco	12	8	37
Brick		30	7
Vinyl		11	
Stone			15
<b>Exterior Trim Material (Top 4)</b>			
Wood fiber composite	37	20	12
Lumber boards	12	18	49
Fiber Cement	18	40	8
Aluminum	13	9	
Stucco			19
<b>Exterior Decking Material</b>			
Treated lumber	9	32	14
Cedar or Redwood	7	13	26
Composite or Plastic	79	47	54
<b>Windows</b>			
Wood	18	17	41
Aluminum	1	5	7
Vinyl	77	66	49
Composite/Fiberglass	4	12	3

## APPENDIX C: LOCATION ADJUSTMENT FACTORS

Location factors for various cities in California, Colorado and Texas from *2020 Residential Costs with RSMeans Data* are shown in the following tables.

**Table C 1 Location Factors, California Cities**

SN	CALIFORNIA CITIES	LOCATION FACTORS
1	Los Angeles	0.99
2	Inglewood	0.97
3	Long Beach	0.95
4	Pasadena	0.94
5	Van Nuys	0.99
6	Alhambra	1
7	San Diego	0.98
8	Palm Springs	0.95
9	San Bernardino	0.97
10	Riverside	0.98
11	Santa Ana	0.99
12	Anaheim	0.97
13	Oxnard	0.98
14	Santa Barbara	0.97
15	Bakersfield	0.98
16	San Luis Obispo	1
17	Mojave	0.99
18	Fresno	0.99
19	Salinas	0.99
20	San Francisco	1.03
21	Sacramento	0.97
22	Palo Alto	0.98
23	San Mateo	1.03
24	Vallejo	0.96
25	Oakland	1.02
26	Berkeley	1.06
27	Richmond	1.07
28	San Rafael	1.03
29	Santa Cruz	1.05
30	San Jose	1.04
31	Stockton	1
32	Modesto	0.99
33	Santa Rosa	1

<b>34</b>	Eureka	1.06
<b>35</b>	Marysville	1.02
<b>36</b>	Redding	1.07
<b>37</b>	Susanville	1.07

**Table C 2 Location Factors, Colorado Cities**

<b>SN</b>	<b>COLORADO CITIES</b>	<b>LOCATION FACTORS</b>
<b>1</b>	Denver	1.05
<b>2</b>	Boulder	1.04
<b>3</b>	Golden	1.01
<b>4</b>	Fort Collins	1.03
<b>5</b>	Greeley	1.01
<b>6</b>	Fort Morgan	1.05
<b>7</b>	Colorado Springs	1
<b>8</b>	Pueblo	1
<b>9</b>	Alamosa	0.99
<b>10</b>	Salida	1.01
<b>11</b>	Durango	1.05
<b>12</b>	Montrose	0.97
<b>13</b>	Grand Junction	1.08
<b>14</b>	Glenwood Springs	1

**Table C 3 Location Factors, Texas Cities**

<b>SN</b>	<b>TEXAS CITIES</b>	<b>LOCATION FACTORS</b>
<b>1</b>	McKinney	0.94
<b>2</b>	Waxahachie	0.94
<b>3</b>	Dallas	0.98
<b>4</b>	Greenville	0.94
<b>5</b>	Texarkana	0.96
<b>6</b>	Longview	0.93
<b>7</b>	Tyler	0.95
<b>8</b>	Palestine	0.9
<b>9</b>	Lufkin	0.94
<b>10</b>	Fort Worth	0.98
<b>11</b>	Denton	1.01
<b>12</b>	Wichita Falls	1
<b>13</b>	Eastland	0.98

<b>14</b>	Temple	0.98
<b>15</b>	Waco	0.99
<b>16</b>	Brownwood	0.95
<b>17</b>	San Angelo	0.95
<b>18</b>	Houston	0.99
<b>19</b>	Huntsville	0.96
<b>20</b>	Wharton	0.96
<b>21</b>	Galveston	0.97
<b>22</b>	Beaumont	1.03
<b>23</b>	Bryan	0.91
<b>24</b>	Victoria	0.99
<b>25</b>	Laredo	0.95
<b>26</b>	San Antonio	0.98
<b>27</b>	Corpus Christi	1.02
<b>28</b>	McAllen	1.04
<b>29</b>	Austin	0.95
<b>30</b>	Del RIO	0.97
<b>31</b>	Giddings	0.96
<b>32</b>	Amarillo	0.99
<b>33</b>	Childress	0.96
<b>34</b>	Lubbock	0.97
<b>35</b>	Abilene	0.98
<b>36</b>	Midland	1.01
<b>37</b>	El Paso	0.95

## APPENDIX D: FIRE HAZARD SEVERITY

**Table D 1 IWUIC Fire Hazard Severity (source: adapted from 2018 IWUIC Table 502.1)**

FUEL MODEL	Critical Fire Weather Frequency (days)								
	≤ 1			2 - 7			≥8		
	<div><div></div>Slope ≤ 40;<div></div>Slope 41-60;<div></div>Slope ≥61</div>								
Light fuel	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High
Medium fuel	Moderate	Moderate	High	High	High	High	Extreme	Extreme	Extreme
Heavy fuel	High	High	High	High	Extreme	Extreme	Extreme	Extreme	Extreme

IWUIC 2018 defines light fuel as vegetation consisting of herbaceous plants and round wood less than ¼ inch (6.4 mm) in diameter. Fuel models A, C, E, L, N, P, R and S described in IWUIC Appendix D are classified as light fuel. Medium fuel comprises vegetation consisting of round wood ¼ to 3 inches (6.4 mm to 76 mm) in diameter. Fuel models B, D, F, H, O, Q and T are classified under this category. Similarly, heavy fuel comprises vegetation consisting of round wood 3 to 8 inches (76 mm to 203 mm) in diameter. Fuel models G, I, J, K and U are classified as heavy fuel. Table D2 lists the various fuel models provided in Appendix D of IWUIC 2018.

**Table D 2 Fuel Model Classification (source: adapted from 2018 IWUIC)**

IWUIC Chapter 2 Definitions:	Fuel Models							
<b>Light Fuel:</b> "Vegetation consisting of herbaceous plants and round wood less than 1/4 inch (6.4 mm) in dia."	A	C	E	L	N	P	R	S
<b>Medium Fuel:</b> "Vegetation consisting of round wood 1/4 to 3 inches (6.4 mm to 76 mm) in diameter."	B	D	F	H	O	Q	T	
<b>Heavy Fuel:</b> "Vegetation consisting of round wood 3 to 8 inches (76 to 203 mm) in diameter."	G	I	J	K	U			

Table D3 provides elaborate description of various fuel models and is an excerpt from National Fire Danger Rating System, 1978, U.S. Department of Agricultural Forest Service, General Technical Report INT-39<sup>12</sup> that has been provided for information in Appendix D of 2018 IWUIC.

<sup>12</sup> [https://www.fs.fed.us/rm/pubs\\_int/int\\_gtr169.pdf](https://www.fs.fed.us/rm/pubs_int/int_gtr169.pdf)



Table D 3 Fuel Models (source: adapted from 2018 IWUIC APPENDIX D)

Fuel Model Type	IWUIC Description of Vegetation
Fuel Model A	<i>"This fuel model represents western grasslands vegetated by annual grasses and forbs. Brush or trees may be present but are very sparse, occupying less than a third of the area. Examples of types where Fuel Model A should be used are cheatgrass and medusahead. Open pinyon-juniper, sagebrush-grass, and desert shrub associations may appropriately be assigned this fuel model if the woody plants meet the density criteria. The quantity and continuity of the ground fuels vary greatly with rainfall from year to year."</i>
Fuel Model B	<i>"Mature, dense fields of brush 6 feet (1829 mm) or more in height are represented by this fuel model. One-fourth or more of the aerial fuel in such stands is dead. Foliage burns readily. Model B fuels are potentially very dangerous, fostering intense, fast-spreading fires. This model is for California mixed chaparral generally 30 years or older. The F model is more appropriate for pure chamise stands. The B model may also be used for the New Jersey pine barrens"</i>
Fuel Model C	<i>"Open pine stands typify Model C fuels. Perennial grasses and forbs are the primary ground fuel but there is enough needle litter and branchwood present to contribute significantly to the fuel loading. Some brush and shrubs may be present but they are of little consequence. Situations covered by Fuel Model C are open, longleaf, slash, ponderosa, Jeffrey and sugar pine stands. Some pinyon-juniper stands may qualify."</i>
Fuel Model D	<i>"This fuel model is specifically for the palmetto-gallberry understory-pine overstory association of the southeast coastal plains. It can also be used for the so called "low pocosins" where Fuel Model O might be too severe. This model should only be used in the Southeast, because of a high moisture of extinction."</i>
Fuel Model E	<i>"Use this model after leaf fall for hardwood and mixed hardwood-conifer types where the hardwoods dominate. This fuel is primarily hardwood leaf litter. The oak-hickory types are best represented by Fuel Model E, but E is an acceptable choice for northern hardwoods and mixed forests of the Southeast. In high winds, the fire danger may be underrated because rolling and blowing leaves are not accounted for. In summer after the trees have leafed out, Fuel Model E should be replaced by Fuel Model R."</i>
Fuel Model F	<i>"Fuel Model F is the only one of the 1972 NFDR System Fuel Models whose application has changed. Model F now represents mature closed chamise stands and oakbrush fields of Arizona, Utah and Colorado. It also applies to young, closed stands and mature, open stands of California mixed chaparral. Open stands of pinyon-juniper are represented; however, fire activity will be overrated at low wind speeds and where there is sparse ground fuels."</i>

Fuel Model G	<i>“Fuel Model G is used for dense conifer where there is a heavy accumulation of litter and downed woody material. Such stands are typically overmature and may also be suffering insect, disease, wind or ice damage-natural events that create a very heavy buildup of dead material or the forest floor. The duff and litter are deep, and much of the woody material is more than 3 inches (76 mm) in diameter. The undergrowth is variable, but shrubs are usually restricted to openings. Types meant to be represented by Fuel Model G are hemlock-Stika spruce, Coast Douglas-fir, and wind thrown or bug-killed stands of lodgepole pine and spruce.”</i>
Fuel Model H	<i>“The short-needed conifers (white pines, spruces, larches and firs) are represented by Fuel Model H. In contrast to Model G fuels, Fuel Model H describes a healthy stand with sparse undergrowth and a thin layer of ground fuels. Fires in H fuels are typically slow spreading and are dangerous only in scattered areas where the downed woody material is concentrated.”</i>
Fuel Model I	<i>“Fuel Model I was designed for clearcut conifer slash where the total loading of materials less than 6 inches (152 mm) in diameter exceeds 25 tons/acre (56.1 metric tons/ha). After settling and the fines (needles and twigs) fall from the branches, Fuel Model I will overrate the fire potential. For lighter loadings of clearcut conifer slash, use Fuel Model J, and for light thinnings and partial cuts where the slash is under a residual overstory, use Fuel Model K.”</i>
Fuel Model J	<i>“This model is complementary to Fuel Model I. It is for clearcuts and heavily thinned conifer stands where the total loading of materials less than 6 inches (152 mm) in diameter is less than 25 tons/acre (56.1 metric tons/ ha). Again, as the slash ages, the fire potential will be overrated.”</i>
Fuel Model K	<i>“Slash fuels from light thinnings and partial cuts in conifer stands are represented by Fuel Model K. Typically, the slash is scattered about under an open overstory. This model applies to hardwood slash and to southern pine clearcuts where the loading of all fuels is less than 15 tons/acre. (33.7 tons/ha).”</i>
Fuel Model L	<i>“This fuel model is meant to represent western grasslands vegetated by perennial grasses. The principal species are coarser and the loadings heavier than those in Model A fuels. Otherwise, the situations are very similar; shrubs and trees occupy less than one-third of the area. The quantity of fuel in these areas is more stable from year to year. In sagebrush areas, Fuel Model T may be more appropriate.”</i>
Fuel Model N	<i>“This fuel model was constructed specifically for the saw-grass prairies of South Florida. It may be useful in other marsh situations where the fuel is coarse and reedlike. This model assumes that one-third of the aerial portion of the plants is dead. Fast-spreading, intense fires can occur even over standing water.”</i>

Fuel Model O	<i>"The O fuel model applies to dense, brushlike fuels of Southeast. O fuels, except for a deep litter layer are almost entirely living in contrast to B fuels. The foliage burns readily, except during the active growing season. The plants are typically over 6 feet (1829 mm) tall and are often found under an open stand of pine. The high pocosins of Virginia, North and South Carolina coasts are the ideal of Fuel Model O. If the plants do not meet the 6-foot (1829 mm) criterion in those areas, Fuel Model D should be used."</i>
Fuel Model P	<i>"Closed, thrifty stands of long-needled southern pines are characteristic of P fuels. A 2- inch to 4-inch (51 to 102 mm) layer of lightly compacted needle litter is the primary fuel. Some small-diameter branchwood is present, but the density of the canopy precludes more than a scattering of shrubs and grass. Fuel Model P has the high moisture of extinction characteristic of the Southeast. The corresponding model for other long-needled pines is U."</i>
Fuel Model Q	<i>"Upland Alaskan black spruce is represented by Fuel Model Q. The stands are dense but have frequent openings filled with usually flammable shrub species. The forest floor is a deep layer of moss and lichens, but there is some needle litter and small-diameter branchwood. The branches are persistent on the trees, and ground fires easily reach into the tree crowns. This fuel model may be useful for jack pine stands in the Lake States. Ground fires are typically slow spreading, but a dangerous crowning potential exists."</i>
Fuel Model R	<i>"This model represents hardwood areas after the canopies leaf out in spring. It is provided as the off-season substitute for E. It should be used during summer in all hardwood and mixed conifer-hardwood stands where more than half of the overstory is deciduous."</i>
Fuel Model S	<i>"Alaskan or alpine tundra on relatively well-drained sites. Grass and low shrubs are often present, but principal fuel is a deep layer of lichens and moss. Fires in these fuels are not fast spreading or intense, but are difficult to extinguish."</i>
Fuel Model T	<i>"The bothersome sagebrush-grass types of the Great Basin and the Intermountain West are characteristic of T fuels. The shrubs must occupy at least one third of the site or the A or L fuel models should be used. Fuel model T might be used for immature scrub oak and desert shrub associations in the West, and the scrub oak-wire grass type in the Southeast."</i>

Fuel Model U	<p><i>“Closed stands of western long-needled pines are covered by this model. The ground fuels are primarily litter and small branchwood. Grass and shrubs are precluded by the dense canopy but occur in the occasional natural opening. Fuel Model U should be used for Ponderosa, Jeffrey, sugar pine, and red pine stands of the Lake States. Fuel model P is corresponding model for southern pine plantations.”</i></p>
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## APPENDIX E: REFERENCE HOUSE CHARACTERISTICS

The Reference Houses for this study are based on similar reference houses that were initially defined in a report by Home Innovation titled “Estimated Costs of the 2015 Code Changes”<sup>13</sup>; additional details from this report are provided below.

### Reference House Characteristics – Previous Studies

For earlier studies by Home Innovation, baseline metrics were defined for four representative single-family houses, built to the IRC, to determine the cost impact of any code changes. The Reference Houses and their site locations were initially defined in a report titled “Estimated Costs of the 2015 Code Changes” prepared by Home Innovation for NAHB. These single-family houses were selected for their similarity to new home offerings in the six metropolitan areas selected as site locations – Miami, Dallas, Los Angeles, Seattle, New York, and Chicago, and their size proximity to a national average of 2,607 SF. Features of the Reference Houses are summarized in the next section.

The four residential building designs are based on the data contained in the Census Bureau report, *Characteristics of New Single-Family Construction Completed*<sup>14</sup>. The report provides information about building foundation type and number of stories for new single-family detached construction over the previous nine-year period.

**Table E 1 New Construction Foundation Types**

Slab	54%
Crawlspace	17%
Basement	30%

**Table E 2 New Construction Number of Stories**

One-story	53%
Two-story	43%
Three-story	3%

The Census data supports defining the four reference houses as follows to encompass approximately 85% of the last decade’s new single-family construction:

- One-story on slab foundation
- Two-story on slab foundation
- One-story on basement foundation
- Two-story on basement foundation

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<sup>13</sup> Estimated Costs of the 2015 Code Changes, Home Innovation Research Labs.  
[https://www.homeinnovation.com/trends\\_and\\_reports/featured\\_reports/estimated\\_costs\\_of\\_the\\_2015\\_irc\\_code\\_changes](https://www.homeinnovation.com/trends_and_reports/featured_reports/estimated_costs_of_the_2015_irc_code_changes)

<sup>14</sup> [www.census.gov/construction/charts/completed.html](https://www.census.gov/construction/charts/completed.html)

The table below covers the locations where each type of reference house foundation would be pragmatically constructed. All these selected cities, except Chicago, lie within the top ten states for construction starts in 2013.<sup>15</sup> Chicago was selected to represent a Climate Zone 5 house.

**Table E 3 Sites for Reference Houses**

Reference House	Climate Zone	1	2	3	4
Foundation		Slab	Slab	Basement	Basement
Miami	1	X	X		
Los Angeles	3	X	X		X*
Dallas	3	X	X		X*
Seattle	4	X	X	X	X
New York	4	X	X	X	X
Chicago	5			X	X
Fairbanks	8			X	X

<sup>15</sup> [www.census.gov/construction/bps/pdf/2013statepiechart.pdf](http://www.census.gov/construction/bps/pdf/2013statepiechart.pdf)



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