DAVID Y. IGE
GOVERNOR

RODERICK K. BECKER
Comptroller

AUDREY HIDANO
Deputy Comptroller

STATE OF HAWAII
DEPARTMENT OF ACCOUNTING AND GENERAL SERVICES
STATE BUILDING CODE COUNCIL
P.O. BOX 119, HONOLULU, HAWAII 96810-0119

November 13, 2018

SUBJECT: State Building Code Adoption
Adopting the 2012 International Building Code with Amendments

The attached document is the Hawaii State Building Code as adopted on November 13, 2018 by the State Building Code Council in accordance with HRS 107-24.

No later than November 13, 2019, the design of all State building construction must comply with the attached code in accordance with HRS 107-27.

No later than November 13, 2020, each county in the State of Hawaii must amend and adopt the attached code in accordance with HRS 107-28(a).

If by November 13, 2020, a county does not amend the attached code, it shall become applicable as an interim county building code in accordance with HRS 107-28(b).

State Building Code Council

Attached: Hawaii State Building Code

State Building Code Council

HAWAII STATE BUILDING CODE

Effective Date: November 13, 2018

State Building Code Council

HAWAII STATE BUILDING CODE

Effective Date: November 13, 2018

_____

Scope.

This code sets forth minimum requirements for the construction, alteration, movement, enlargement, replacement, repair, equipment, use and occupancy, location, maintenance, removal, and demolition of every building or structure or any appurtenances connected or attached to buildings or structures.

Definitions.

In this code, unless the context otherwise requires:

"IBC" means the ICC, *International Building Code*, 2012 edition, as copyrighted by the International Code Council.

"ICC" means the International Code Council.

"Section" means a section of a chapter of the *International Building Code*.

Adoption of the *International Building Code*.

The "*International Building Code, 2012 Edition*" as copyrighted and published in 2012 by International Code Council, Incorporated, 500 New Jersey Avenue, 6th Floor, Washington, DC 20001, is adopted by reference and made a part of this code. This incorporation by reference includes all parts of the International Building Code subject to the amendments in this code. The appendices of the ICC, IBC are not adopted except as provided in this code.

Permit authorization.

Each county of the State of Hawaii may, by ordinance, require that a permit be obtained from the building official for any area regulated by this code.

AMENDMENTS TO THE 2012 ICC *INTERNATIONAL BUILDING CODE*

(1) Title and purpose.

Section 101.1 is amended to read as follows:

"101.1 Title. These regulations shall be known as the Building Code of the State of Hawaii, hereinafter referred to as "this code"."

(2) Scope.

Section 101.2 is amended to read as follows:

"101.2 Scope. The provisions of this code shall apply to the construction, alteration, movement, enlargement, replacement, repair, equipment, use and occupancy, location, maintenance, removal, and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures.

Exception: Detached one- and two-family dwellings and multiple single-family dwellings (townhouses) not more than three stories above grade plane in height with a separate means of egress and their accessory structures shall be permitted to comply with the International Residential Code, if adopted by the county jurisdiction. Prescriptive framing shall not be applicable for structures designed using exception 4 in Section 1609.1.2 Protection of Openings of this code."

(3) Appendices.

Section 101.2.1 is amended to read as follows:

"101.2.1 Appendices. Provisions in the appendices shall not apply unless specifically adopted.

Exceptions:

1. Appendix U, Hawaii Hurricane Sheltering Provisions for New Construction, shall be adopted.
2. Appendix W, Hawaii Wind Design Provisions for New Construction, shall be adopted.
3. Appendix X, Hawaii Provisions for Indigenous Hawaiian Architecture Structures, shall be adopted."

(4) Referenced codes.

Section 101.4 is amended to read as follows:

"101.4 Referenced codes. The other codes referenced elsewhere in this code shall be considered a part of this code to the prescribed extent of each such reference.

101.4.1 Conflicts with other codes. If a referenced code conflicts with another applicable law of the jurisdiction, then said applicable law shall prevail over the referenced code.

101.4.2 Plumbing Code. Wherever the term *International Plumbing Code* is used in this code, it shall mean the adopted State Plumbing Code.

101.4.3 Fire Code. Wherever the term *International Fire Code* is used in this code, it shall mean the adopted State Fire Code.

101.4.4 Energy Code. Wherever the term *International Energy Conservation Code* is used in this code, it shall mean the adopted State Energy Conservation Code.

101.4.5 Residential Code. Wherever the term *International Residential Code* is used in this code, it shall mean the adopted State Residential Code."

(5) Existing structures.
Section 102.6 is amended to read as follows:
"102.6 Existing structures. Existing structures that were constructed in accordance with prior building code requirements may continue to be used and occupied provided that the continued use does not constitute a hazard to the general safety and welfare of the occupants and the public."

(6) Department of building safety.
Section 103 is deleted in its entirety.

(7) Permits.
Section 105 is deleted in its entirety.

(8) Live loads posted.
Section 106.1 is amended to read as follows:
"106.1 Live loads posted. Where the live loads for which each floor or portion thereof of a commercial or industrial building is or has been designed to exceed 100 psf (4.80 kN/m^2), such design live loads shall be conspicuously posted by the owner in that part of each story in which they apply, using durable signs. It shall be unlawful to remove or deface such notices."

(9) Submittal documents.
Section 107 is deleted in its entirety.

(10) Temporary structures and uses.
Section 108 is deleted in its entirety.

(11) Fees.
Section 109 is deleted in its entirety.

(12) Area of rescue assistance.
The definition of area of refuge" in Section 202 is amended to read as follows:

"**AREA OF REFUGE.** An area where persons unable to use stairways can remain temporarily to await instructions or assistance during emergency evacuation. Area of rescue assistance."

(13) Structural observation defined.
The definition of "structural observation" in Section 202 is amended to read as follows:

"**STRUCTURAL OBSERVATION.** Structural observation is equivalent to "observation of construction" of the structural system, as defined in Hawaii Administrative Rules chapter 16-115, implementing Hawaii Revised Statutes chapter 464. Structural observation does not include or waive the responsibility for the inspection required by Section 110, 1705 or other sections of this code."

(14) Occupant evacuation elevators.
Section 403.6.2 is deleted in its entirety.

(15) Group R.
Section 903.2.8 is revised by adding the following exception:

"Exception: In accordance with HRS 46-19.8 Fire sprinklers; residences, until June 30, 2027 no county shall require the installation or retrofitting of automatic fire sprinklers or an automatic fire sprinkler system in:

(1) Any new or existing detached one- or two-family dwelling unit in a structure used only for residential purposes; and
(2) Nonresidential agricultural and aquacultural buildings and structures located outside an urban area;

provided that this section shall not apply to new homes that require a variance from access road or firefighting water supply requirements."

(16) Portable fire extinguishers.
Section 906 is deleted in its entirety and replaced to read as follows:

"**SECTION 906 PORTABLE FIRE EXTINGUISHERS**
906.1 General. Portable fire extinguishers shall be provided as required by the State Fire Code."

(17) Fire command center.
Section 911 is deleted in its entirety and replaced to read as follows:

"**SECTION 911 – FIRE COMMAND CENTER**

911.1 General. Where required by other sections of this code, a fire command center for fire department operations shall be provided and shall comply with the State Fire Code."

(18) Fire pumps.
Section 913 is deleted in its entirety and replaced to read as follows:

"**SECTION 913 FIRE PUMPS**

913.1 Fire Pumps. Where provided, fire pumps shall be installed in accordance with the State Fire Code."

(19) Emergency Power for illumination.
Section 1006.3 is amended by adding a new item 6 as follows:

"6. Enclosed stairways of buildings more than two stories in height."

(20) Gates.
Section 1008.2 is amended to read as follows:

"**1008.2 Gates.** Gates serving the means of egress system shall comply with the requirements of this section. Gates used as a component in a means of egress shall conform to the applicable requirements for doors.

Exceptions:

1. Horizontal sliding or swinging gates exceeding the 4-foot (1219 mm) maximum leaf width limitation are permitted in fences and walls surrounding a stadium.
2. Security gates may be permitted across corridors or passageways in school buildings if there is a readily visible durable sign on or adjacent to the gate, stating 'THIS GATE IS TO REMAIN SECURED IN THE OPEN POSITION WHENEVER THIS BUILDING IS IN USE'. The sign shall be in letters not less than one inch high on a contrasting background. The use of this exception may be revoked by the building official for due cause."

(21) Use in a means of egress.
Section 1026.2 is deleted in its entirety.

(22) Minimum Size of Glass jalousie windows.
Section 1029.2 is amended by adding a new paragraph 1029.2.2 as follows:

"**1029.2.2 Glass jalousie windows.** Glass jalousie windows complying with Section 2403.5 may be used for emergency escape or rescue windows."

(23) Chapter 11 Accessibility

Accessibility. Chapter 11 is deleted in its entirety and replaced to read as follows:

"**1101 Scope.** Buildings or portions of buildings shall be accessible to persons with disabilities in accordance with the following regulations:

1. For construction of buildings or facilities of the state and county governments, compliance with Section 103-50 HRS, administered by the Disability and Communication Access Board, State of Hawaii.
2. Department of Justice's Americans with Disabilities Act Standards for Accessible Design.
3. Housing and Urban Development recognized 'Safe Harbors' for compliance with the Fair Housing Acts design and construction requirements.
4. Other pertinent laws relating with disabilities shall be administered and enforced by agencies responsible for their enforcement.

Prior to the issuance of a building permit, the owner (or the owner's representative, professional architect, or engineer), shall submit a statement that all requirements, relating to accessibility for persons with disabilities, shall be complied with."

(24) Unvented attic spaces.

Section 1203.2.2 is added to read as follows:

"**1203.2.2 Unvented attic spaces.** The attic space shall be permitted to be unvented when the design professional determines it would be beneficial to eliminate ventilation openings to reduce salt-laden air and maintain relative humidity at 60 per cent or lower to:

1. Avoid corrosion to steel components,
2. Avoid moisture condensation in the attic space, or
3. Minimize energy consumption for air conditioning or ventilation by maintaining satisfactory space conditions in both the attic and occupied space below."

(25) Roof slope.

Section 1503.4 is amended by adding a new Section 1503.4.4 to read as follows:

"**1503.4.4 Slope.** Roofs shall be sloped a minimum of 1 unit vertical in 48 units horizontal (2 per cent slope) for drainage unless designed for water accumulation in accordance with Section 1611. Leaders, conductors and storm drains shall be sized on the basis of Figure 1611.1 and the Plumbing Code."

(26) Roof drains.

Section 1503.4 is amended by adding a new Section 1503.4.5 to read as follows:

"**1503.4.5 Roof drains.** Unless roofs are sloped to drain over the roof edges, roof drains shall be installed at each low point of the roof."

(27) Requirements for roof coverings.

Section 1507.1 is amended to read as follows:

"**1507.1 Scope.** Roof coverings shall be applied in accordance with the applicable provisions of this section and the manufacturer's installation instructions. For the purposes of Section 1507 high wind requirements for roof coverings, wherever the term V_{asd} is used, it shall be $V_{eff-asd}$, which is the effective ultimate design wind speed, $V_{eff-ult}$ multiplied by $\sqrt{0.625}$. The effective ultimate design wind speeds are given in Figure 1609.3.2 (a-f) for Risk Category II and Figure 1609.3.3 (a-f) for Risk Category III and IV.

(28) Seismic design – short period.

Table 1613.3.5(1) is amended to read as follows:

"Table 1613.3.5(1)
Seismic Design Category Based On Short-Period (0.2 second) Response Acceleration

Value of S_{DS}	Risk Category		
	I or II	III	IV
S_{DS} < 0.167g	A	A	A
0.167g ≤ S_{DS} < 0.33g	B	B	C
0.33g ≤ S_{DS} < 0. 50g	C	C	D
0.50 ≤ S_{DS} < 0.60g	C	D	D
0.60g ≤ S_{DS}	D	D	D

"

(29) Seismic design – 1-second period.

Table 1613.3.5(2) is amended to read as follows:

"Table 1613.3.5(2)
Seismic Design Category Based On 1-Second Period Response Acceleration

Value of S_{DI}	Risk Category		
	I or II	III	IV
S_{DI} < 0.067g	A	A	A
0.067g ≤ S_{DI} < 0.133g	B	B	C
0.133g ≤ S_{DI} < 0.20g	C	C	D
0.20g ≤ S_{DI} < 0.25g	C	D	D
0.25g ≤ S_{DI}	D	D	D

"

(30) Structural integrity.

Section 1615 Structural Integrity is amended by renumbering the section to section 1616 as follows:

"**1616 STRUCTURAL INTEGRITY"**
Any references to section 1615 in other parts of this code pertaining to structural integrity shall refer to section 1616 structural integrity.

(31) Tsunami Loads and Effects.
A new Section 1615 Tsunami Loads and Effects is added to read as follows:
"**SECTION 1615 TSUNAMI LOADS**
1615.1 General. The design and construction of Risk Category III and IV buildings and structures and Risk Category II buildings taller than 75 feet, where located in the Tsunami Design Zones defined in the ASCE 7 Tsunami Design Geodatabase (version 2016-1.0), shall be in accordance with Chapter 6 of ASCE 7-16.

1615.2 DEFINITIONS.
TSUNAMI DESIGN GEODATABASE. The ASCE database (version 2016-1.0) of Tsunami Design Zone maps and associated design data for the states of Alaska, California, Hawaii, Oregon, and Washington.

TSUNAMI DESIGN ZONE. An area identified on the Tsunami Design Zone map between the shoreline and the inundation limit, within which certain structures designated in Chapter 16 are designed for or protected from inundation."

(32) Special Inspections.
Section 1704.2 is amended to read as follows:
"**1704.2 Special Inspections.** Where application is made for construction as described in this section, the owner or the registered design professional in responsible charge acting as the owner's agent shall employ one or more special inspectors independent of the contractors performing the work, to provide inspections during construction on the types of work listed under Sections 1705. These inspections are in addition to the inspections specified in Section 110.

Exceptions:
1. Special inspections are not required for construction of a minor nature or as warranted by conditions in the jurisdiction as approved by the building official.
2. The employment of a special inspector shall not be required for construction work for any government agency that provides for its own inspections.
3. Special inspections are not required for building components unless the design involves the practice of professional engineering or architecture as defined by Hawaii Revised Statutes chapter 464.
4. Unless otherwise required by the building official, special inspections are not required for Group U occupancies that are accessory to a residential occupancy including, but not limited to those listed in Section 312.1.

5. Special inspections are not required for portions of structures designed and constructed in accordance with the cold-formed steel light-frame construction provisions of Section 2211.7 or the conventional light-frame construction provisions of Section 2308. For these structures, Section 1705.10 shall nevertheless apply."

(33) Special inspector qualifications.

Section 1704.2.1 is amended to read as follows:

"**1704.2.1. Special inspector qualifications.** Each special inspector shall provide written documentation to the building official demonstrating his or her competence and relevant experience or training in each type of inspection they will perform. Experience or training shall be considered relevant when the documented experience or training is related in complexity to the same type of special inspection activities for projects of similar complexity and material qualities. These qualifications are in addition to qualifications specified in other sections of this code.

The registered design professional in responsible charge and engineers of record involved in the design of the project are permitted to act as the approved agency and their personnel are permitted to act as the special inspectors for the work designed by them, with the exception of welding and high strength bolting."

(34) Statement of special inspections.

Section 1704.2.3 is amended to read as follows:

"**1704.2.3 Statement of special inspections.** The applicant shall submit a statement of special inspections in accordance with Section 107.1 as a condition for permit issuance. This statement shall be deemed to be satisfied by Section 1704.3."

(35) Report requirement.

Section 1704.2.4 is amended to read as follows:

"**1704.2.4 Report requirement.** Special inspectors shall keep records of inspections. The special inspector shall furnish inspection reports to the owner and licensed engineer or architect of record. Reports shall indicate whether the work inspected was done in conformance to approved construction documents. Discrepancies shall be brought to the immediate attention of the contractor for correction, then, if uncorrected, to the licensed engineer or architect of record and to the building official. The special inspector shall submit a final signed report to the owner and licensed engineer or architect of record, stating whether the work requiring special inspection was, to the best of the inspector's knowledge, in conformance to the approved plans and specifications and the applicable workmanship provisions of this code."

(36) Statement of special inspections.
Section 1704.3 deleted in its entirety and replaced to read as follows:

"**1704.3 Statement of special inspections.** Where special inspection or testing is required by Section 1705, the construction drawings shall include a complete list of special inspections required by this section."

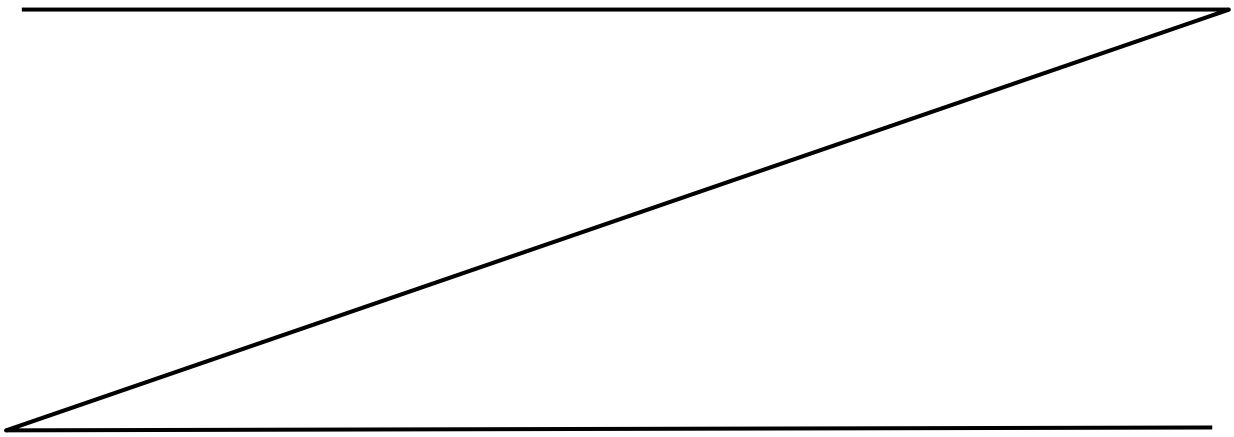
(37) Structural observations.
Section 1704.5 is deleted in its entirety and replaced to read as follows:

"**1704.5 Structural observations.** The owner shall employ a registered design professional to perform structural observations. Structural observations shall be performed in accordance with Section 464-5, Hawaii Revised Statutes, administered and enforced by the Department of Commerce and Consumer Affairs.

Prior to the final inspection required under Section 110.3.10, the licensed engineer or architect of record shall submit a written statement verifying receipt of the final special inspection reports and documenting that to the best of his/her knowledge, information and belief, there are no known unresolved code requirements that create significant public safety deficiencies."

(38) Special inspections for wind requirements.
Section 1705.10 is amended to read as follows:

"**1705.10 Special inspections for wind requirements.** Special inspections itemized in Sections 1705.10.1 through 1705.10.3, unless exempted by the exceptions to Section 1704.2, are required for buildings and structures constructed where the 3-second-gust effective ultimate design wind speed is 120 mph (53 m/sec) or greater."



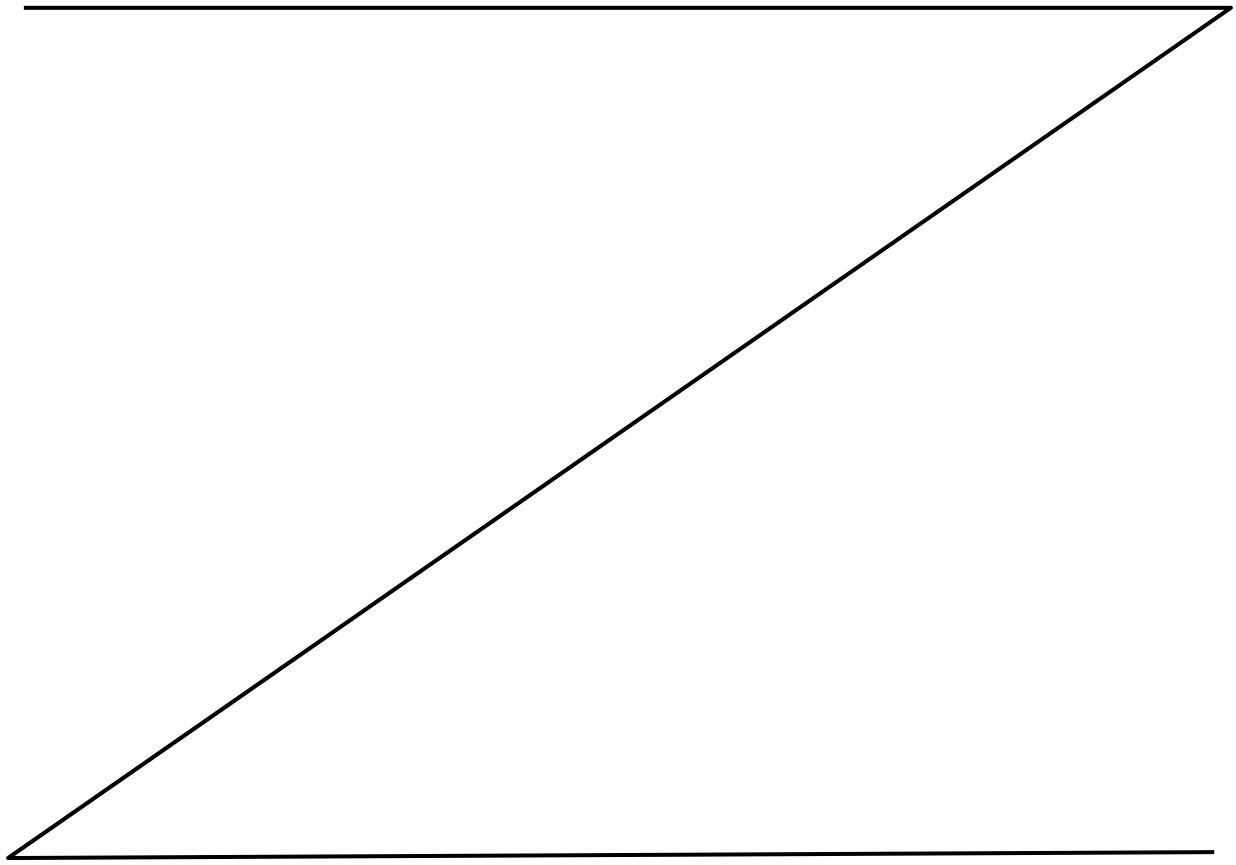
(39) Concrete Construction.

Section 1705.3 is amended to read as follows:

"**1705.3 Concrete Construction.** The special inspections and verifications for concrete construction shall be as required by this section and Table 1705.3.

Exceptions: Special Inspections shall not be required for:

1. Foundation concrete for structures permitted to be designed under the International Residential Code.
2. Concrete footings supporting buildings three stories or less in height that are fully supported on earth or rock where the structural design is adequate based on a compressive strength f'c no greater than 2,500 pounds per square inch (psi) (17.2 Mpa), regardless of the compressive strength specified in the construction documents or used in the footing construction. Periodic inspection of the reinforcing of all concrete footings shall be required.
3. Nonstructural concrete slabs supported directly on the ground.
4. Concrete patios, driveways and sidewalks, on grade.
5. Field sampling for air content of non-air-entrained concrete mixes where not required by the registered design professional."



(40) Concrete Construction.

Table 1705.3 is amended to read as follows:

"**TABLE 1705.3 REQUIRED VERIFICATION AND INSPECTION OF CONCRETE CONSTRUCTION**

VERIFICATION AND INSPECTION	CONTINUOUS	PERIODIC	REFERENCED STANDARD[a]	IBC REFERENCE
1. Inspection of reinforcing steel, including prestressing tendons, and placement.	—	X	ACI 318: 3.5, 7.1-7.7	1910.4
2. Inspection of reinforcing steel welding in accordance with Table 1705.2.2, Item 2b.	—	—	AWS D1.4 ACI 318: 3.5.2	—
3. Inspection of anchors cast in concrete where allowable loads have been increased or where strength design is used.	—	X	ACI 318: D.9.2	1908.5, 1909.1
4. Inspection of anchors post-installed in hardened concrete members[b]:				
a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads	X	—	ACI 318: D.9.2.4	—
b. Mechanical anchors and adhesive anchors not defined in 4.a.	—	X	ACI 318: D.9.2	—
5. Verifying use of required design mix.	—	X	ACI 318: Ch. 4, 5.2-5.4	1904.2, 1910.2, 1910.3
6. At the time fresh concrete is sampled to fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	X	—	ASTM C 172 ASTM C 31 ACI 318: 5.6, 5.8	1910.10
7. Inspection of concrete and shotcrete placement for proper application techniques.	X	—	ACI 318: 5.9, 5.10	1910.6, 1910.7, 1910.8
8. Inspection for maintenance of specified curing temperature and techniques.	—	X	ACI 318: 5.11-5.13	1910.9
9. Inspection of prestressed concrete:				
a.Application of prestressing forces.	X	—	ACI 318: 18.20	—
b.Grouting of bonded prestressing ten-dons in the seismic force-resisting system.	X	—	ACI 318: 18.18.4	—
10. Erection of precast concrete members.	—	X	ACI 318: Ch. 16	—
11. Verification of in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs.	—	X	ACI 318: 6.2	—
12. Inspect formwork for shape, location and dimensions of the concrete member being formed.	—	X	ACI 318: 6.1.1	—

For SI: 1 inch = 25.4 mm.

a. Where applicable, see also Section 1705.11, Special inspections for seismic resistance.

b. Specific requirements for special inspection shall be included in the research report for the anchor issued by an approved source in accordance with D.9.2 in ACI 318 or other qualification procedures. Where specific requirements are not provided, special inspection requirements shall be specified by the registered design professional and shall be approved by the building official prior to the commencement of the work."

(41) Splices.

Section 1810.3.6 is amended to read as follows:

"**1810.3.6 Splices.** Splices shall be constructed so as to provide and maintain true alignment and position of the component parts of the pier or pile during installation and subsequent thereto and shall be of adequate strength to transmit the vertical and lateral loads and moments occurring at the location of the splice during driving and under service loading.

Splices occurring in the upper 10 feet (3048 mm) of the embedded portion of the pier or pile shall be capable of resisting at allowable working stresses the moment and shear that would result from an assumed eccentricity of the pier or pile load of 3 inches (76 mm), or the pier or pile shall be braced in accordance with Section 1810.2.2 to other piers or piles that do not have splices in the upper 10 feet (3048 mm) of embedment."

(42) Anchoring to Concrete.

Section 1901.4 is added to read as follows:

"**1901.4 Anchoring to concrete.** Anchoring to concrete shall be in accordance with ACI 318 as amended in Section 1905, and applies to cast-in (headed bolts, headed studs, and hooked J- or L-bolts) anchors and post-installed expansion (torque-controlled and displacement-controlled), undercut, and adhesive anchors."

(43) Modifications to ACI 318.

Section 1905 is modified to read as follows:

"**SECTION 1905 MODIFICATIONS TO ACI 318.**

1905.1 General. The text of ACI 318 shall be modified as indicated in Sections 1905.1.1 through 1905.1.9.

1905.1.1 ACI 318, Section 2.2. Modify existing definitions and add the following definitions to ACI 318, Section 2.2.

DESIGN DISPLACEMENT. Total lateral displacement expected for the design-basis earthquake, as specified by Section 12.8.6 of ASCE 7.

DETAILED PLAIN CONCRETE STRUCTURAL WALL. A wall complying with the requirements of Chapter 22, including 22.6.7.

ORDINARY PRECAST STRUCTURAL WALL. A precast wall complying with the requirements of Chapters 1 through 18.

ORDINARY REINFORCED CONCRETE STRUCTURAL WALL. A cast-in-place wall complying with the requirements of Chapters 1 through 18.

ORDINARY STRUCTURAL PLAIN CONCRETE WALL. A wall complying with the requirements of Chapter 22, excluding 22.6.7.

SPECIAL STRUCTURAL WALL. A cast-in-place or precast wall complying with the requirements of 21.1.3 through 21.1.7, 21.9 and 21.10, as applicable, in addition to the requirements for ordinary reinforced concrete structural walls or ordinary precast structural walls, as applicable. Where ASCE 7 refers to a "special reinforced concrete structural wall", it shall be deemed to mean a "special structural wall."

1905.1.2 ACI 318, Section 21.1.1. Modify ACI 318 Sections 21.1.1.3 and 21.1.1.7 to read as follows:

21.1.1.3. Structures assigned to Seismic Design Category A shall satisfy requirements of Chapters 1 to 19 and 22; Chapter 21 does not apply. Structures assigned to Seismic Design Category B, C, D, E or F also shall satisfy 21.1.1.4 through 21.1.1.8, as applicable. Except for structural elements of plain concrete complying with Section 1905.1.8 of the International Building Code, structural elements of plain concrete are prohibited in structures assigned to Seismic Design Category C, D, E or F.

21.1.1.7. Structural systems designated as part of the seismic force-resisting system shall be restricted to those permitted by ASCE 7. Except for Seismic Design Category A, for which Chapter 21 does not apply, the following provisions shall be satisfied for each structural system designated as part of the seismic force-resisting system, regardless of the Seismic Design Category:

(a) Ordinary moment frames shall satisfy 21.2.
(b) Ordinary reinforced concrete structural walls *and ordinary precast structural walls* need not satisfy any provisions in Chapter 21.
(c) Intermediate moment frames shall satisfy 21.3.
(d) Intermediate precast *structural* walls shall satisfy 21.4.
(e) Special moment frames shall satisfy 21.5 through 21.8.
(f) Special structural walls shall satisfy 21.9.
(g) Special structural walls constructed using precast concrete shall satisfy 21.10.

All special moment frames and special structural walls shall also satisfy 21.1.3 through 21.1.7.

1905.1.3 ACI 318, Section 21.4. Modify ACI 318, Section 21.4, by adding new Section 21.4.3 and renumbering existing Section 21.4.3 to become 21.4.4. :

21.4.3. Connections that are designed to yield shall be capable of maintaining 80 per cent of their design strength at the deformation induced by the design displacement or shall use Type 2 mechanical splices.

21.4.4. Elements of the connection that are not designed to yield shall develop at least 1.5 *Sy.*

1905.1.5 ACI 318, Section 21.10. Modify ACI 318, Section 21.10.2, to read as follows:

21.10.2. Special structural walls constructed using precast concrete shall satisfy all the requirements of 21.9 for cast-in-place special structural walls in addition to Sections 21.4.2 through 21.4.4.

1905.1.6 ACI 318, Section 21.12.1.1. Modify ACI 318, Section 21.12. 1.1, to read as follows:

21.12.1.1. Foundations resisting earthquake-induced forces or transferring earthquake-induced forces between a structure and ground shall comply with the requirements of Section 21.12 and other applicable provisions of ACI 318 unless modified by Chapter 18 of the International Building Code.

1905.1.7 ACI 318, Section 22.6. Modify ACI 318, Section 22.6, by adding new Section 22.6.7 to read as follows:

22.6.7 Detailed plain concrete structural walls.

22.6.7.1. Detailed plain concrete structural walls are walls conforming to the requirements of ordinary structural plain concrete walls and 22.6.7.2.

22.6.7.2. Reinforcement shall be provided as follows:

(a) Vertical reinforcement of at least 0.20 square inch (129 mm^2) in cross-sectional area shall be provided continuously from support to support at each corner, at each side of each opening and at the ends of walls. The continuous vertical bar required beside an opening is permitted to substitute for one of the two No. 5 bars required by 22.6.6.5.

(b) Horizontal reinforcement at least 0.20 square inch (129 mm^2) in cross-sectional area shall be provided:

1. Continuously at structurally connected roof and floor levels and at the top of walls;
2. At the bottom of load-bearing walls or in the top of foundations where doweled to the wall; and
3. At a maximum spacing of 120 inches (3048 mm).

Reinforcement at the top and bottom of openings, where used in determining the maximum spacing specified in Item 3 above, shall be continuous in the wall.

1905.1.8 ACI 318, Section 22.10. Delete ACI 318, Section 22.l0, and replace with the following:

22.10. Plain concrete in structures assigned to Seismic Design Category C, D, E or F.

22.10.1. Structures assigned to Seismic Design Category C, D, E or F shall not have elements of structural plain concrete, except as follows:

(a) Structural plain concrete basement, foundation or other walls below the base are permitted in detached one- and two-family dwellings three stories or less in height constructed with stud-bearing walls. In dwellings assigned to Seismic Design Category D or E, the height of the wall shall not exceed 8 feet (2438 mm), the thickness shall not be less than 7 ½ inches (190 mm), and the wall shall retain no more than 4 feet (1219 mm) of unbalanced fill. Walls shall have reinforcement in accordance with 22.6.6.5.

(b) Isolated footings of plain concrete supporting pedestals or columns are permitted, provided the projection of the footing beyond the face of the supported member does not exceed the footing thickness.

Exception: In detached one- and two-family dwellings three stories or less in height, the projection of the footing beyond the face of the supported member is permitted to exceed the footing thickness.

(c) Plain concrete footings supporting walls are permitted, provided the footings have at least two continuous longitudinal reinforcing bars. Bars shall not be smaller than No. 4 and shall have a total area of not less than 0.002 times the gross cross-sectional area of the footing. For footings that exceed 8 inches (203 mm) in thickness, a minimum of one bar shall be provided at the top and bottom of the footing. Continuity of reinforcement shall be provided at corners and intersections.

Exceptions:

1. In Seismic Design Categories A, B and C, detached one- and two-family dwellings three stories or less in height constructed with stud-bearing walls, are permitted to have plain concrete footings without longitudinal reinforcement.
2. For foundation systems consisting of a plain concrete footing and a plain concrete stem wall, a minimum of one bar shall be provided at the top of the stem wall and at the bottom of the footing.
3. Where a slab on ground is cast monolithically with the footing, one No. 5 bar is permitted to be located at either the top of the slab or bottom of the footing.

1905.1.9 ACI 318, Section D.3.3. Modify ACI 318 Sections D.3.3.4.2, D.3.3.4.3(d) and D.3.3.5.2 to read as follows:

D.3.3.4.2. Where the tensile component of the strength-level earthquake force applied to anchors exceeds 20 per cent of the total factored anchor tensile force associated with the same load combination, anchors and their attachments shall be designed in accordance with D.3.3.4.3. The anchor design tensile strength shall be determined in accordance with D.3.3.4.4.

Exception: Anchors designed to resist wall out-of-plane forces with design strengths equal to or greater than the force determined in accordance with ASCE 7 Equation 12.11-1 or 12.14-10 shall be deemed to satisfy Section D.3.3.4.3(d).

D.3.3.4.3(d) - The anchor or group of anchors shall be designed for the maximum tension obtained from design load combinations that include E, with E increased by Ω_0. The anchor design tensile strength shall be calculated from D.3.3.4.4.

D.3.3.5.2. Where the shear component of the strength-level earthquake force applied to anchors exceeds 20 per cent of the total factored anchor shear force associated with the same load combination, anchors and their attachments shall be designed in accordance with D.3.3.5.3. The anchor design shear strength for resisting earthquake forces shall be determined in accordance with D.6.

Exceptions:

1. For the calculation of the in-plane shear strength of anchor bolts attaching wood sill plates of bearing or nonbearing walls of light-frame wood structures to foundations or foundation stem walls, the in-plane design shear strength in accordance with D.6.2 and D.6.3 need not be computed and D.3.3.5.3 shall be deemed to be satisfied provided all of the following are met:
   1.1. The allowable in-plane shear strength of the anchor is determined in accordance with AF&PA NDS Table 11E for lateral design values parallel to grain.
   1.2. The maximum anchor nominal diameter is 5/8 inches (16 mm).
   1.3. Anchor bolts are embedded into concrete a minimum of 7 inches (178 mm).

1.4. Anchor bolts are located a minimum of 1¾ inches (45 mm) from the edge of the concrete parallel to the length of the wood sill plate.
1.5. Anchor bolts are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the wood sill plate.
1.6. The sill plate is of 2-inch or 3-inch nominal thickness.

2. For the calculation of the in-plane shear strength of anchor bolts attaching cold-formed steel track of bearing or nonbearing walls of light-frame construction to foundations or foundation stem walls, the in-plane design shear strength in accordance with D.6.2 and D.6.3 need not be computed and D.3.3.5.3 shall be deemed to be satisfied provided all of the following are met:
2.1. The maximum anchor nominal diameter is 5/8 inches (16 mm).
2.2. Anchors are embedded into concrete a minimum of 7 inches (178 mm).
2.3. Anchors are located a minimum of 1 ¾ inches (45 mm) from the edge of the concrete parallel to the length of the track.
2.4. Anchors are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the track.
2.5. The track is 33 to 68 mil designation thickness.
Allowable in-plane shear strength of exempt anchors, parallel to the edge of concrete shall be permitted to be determined in accordance with AISI S100 Section E3.3.1.

3. In light-frame construction, bearing or non-bearing walls, shear strength of concrete anchors less than or equal to 1 inch (25 mm) in diameter of sill plate or track to foundation or foundation stem wall need not satisfy D.3.3.5.3(a) through (c) when the design strength of the anchors is determined in accordance with D.6.2.1(c).”

(44) Anchorage to Concrete-Strength Design.
Section 1909 is deleted in its entirety.

(45) Concrete Masonry Unit Strength.

Table 2105.2.2.1.2 Compressive Strength of Concrete Masonry is amended to read as follows:

"TABLE 2105.2.2.1.2
COMPRESSIVE STRENGTH OF CONCRETE MASONRY

NET AREA COMPRESSIVE STRENGTH OF CONCRETE MASONRY UNITS (psi)		NET AREA COMPRESSIVE STRENGTH OF MASONRY (psi)[a]
Type M or S Mortar	Type N mortar	
---	1,900	1,700
1,900	2,350	1,900
2,000	2,650	2,000
2,600	3,400	2,250
3,250	4,350	2,500
3,900	---	2,750
4,500	---	3,000

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 0.00689 MPa.

a. For units less than 4 inches in height, 85 percent of the values listed."

(46) Masonry Cleanouts.

Section 2104.1.7 is added to read as follows:

"2104.1.7 Cleanouts. Cleanouts shall be provided for all grout pours over 5 feet 4 inches in height. Special provisions shall be made to keep the bottom and sides of the grout spaces, as well as the minimum total clear area required by ACI 530.1/ASCE 6/TMS 602 clean and clear prior to grouting.

Exception: Cleanouts are not required for grout pours 8 feet or less in height providing all of the following conditions are met:

1. The hollow masonry unit is 8-inch nominal width or greater.
2. The specified compressive strength of masonry, f'm, is less than or equal to 1,900 psi as determined per Table 2105.2.2.1.2;
3. Fine grout is used complying with ASTM C-476 minimum compressive strength of 3,000 psi; and
4. Special Inspection is provided."

(47) Cold-Formed Steel Prescriptive Framing

Section 2211.7 shall be amended to read as follows:

"2211.7 Prescriptive Framing. Detached one- and two-family dwellings and townhouses, less than or equal to three stories above grade plane, shall be permitted to be constructed in accordance with AISI S230 subject to the limitations therein. Prescriptive framing shall not be applicable for structures designed using exception 4 in section 1609.1.2 Protection of Openings."

(48) Wood Design Requirements

Section 2301.2 is amended to read as follows:

"**2301.2 General design requirements.** The design of structural elements or systems, constructed partially or wholly of wood or wood-based products, shall be in accordance with one of the following methods:

1. Allowable stress design in accordance with Sections 2304, 2305 and 2306.
2. Load and resistance factor design in accordance with Sections 2304, 2305 and 2307
3. Conventional light-frame construction in accordance with Sections 2304 and 2308.

   Exception: Buildings designed in accordance with the provisions of the AWC WFCM shall be deemed to meet the requirements of Section 2308. **P**rescriptive framing of detached one- and two-family dwellings and townhouses, using Section 2308 or the AWC WFCM shall be limited to heights of less than or equal to three stories above grade plane. Prescriptive framing shall not be applicable for structures designed using exception 4 in Section 1609.1.2 Protection of Openings."

(49) Preservative-treated wood.

Section 2303.1.8 is deleted in its entirety and replaced to read as follows:

"**2303.1.8 Preservative-treated wood.** Structural lumber, including plywood, posts, beams, rafters, joists, trusses, studs, plates, sills, sleepers, roof and floor sheathing, flooring and headers of new wood-frame buildings and additions shall be:

1. Treated in accordance with AWPA Standard U1 (UC1 thru UC4B) for AWPA Standardized Preservatives, all marked or branded and monitored by an approving agency. Incising is not required, providing that the retention and penetration requirements of these standards are met.
2. For SBX disodium octaborate tetrahydrate (DOT), retention shall be not less than 0.28 pcf B_2O_3 (0.42 = pcf DOT) for exposure to Formosan termites. All such lumber shall be protected from direct weather exposure as directed in AWPA UC1 and UC2.
3. For structural glued-laminated members made up of dimensional lumber, engineered wood products, or structural composite lumber, pressure treated in accordance with AWPA U1 (UC1 thru UC4B) or by Light Oil Solvent Preservative (LOSP) treatment standard as approved by the building official. Water based treatment processes as listed in paragraphs 1 and 2 are not allowed to be used on these products unless specified by a structural engineer for use with reduced load values and permitted by the product manufacturer.

4. For structural composite wood products, treated by non-pressure processes in accordance with AWPA Standard U1 (UC1, UC2 and UC3A) or approved by the building official.

2303.1.8.1 Treatment. Wood treatment shall include the following:
1. A quality control and inspection program which meets or exceeds the current requirements of AWPA Standards M2-01 and M3-03;
2. Inspection and testing for the treatment standards as adopted by this code shall be by an independent agency approved by the building official, accredited by the American Lumber Standards Committee (ALSC) and contracted by the treating company;
3. Field protection of all cut surfaces with a preservative, which shall be applied in accordance with AWPA Standard M-4-02 or in accordance with the approved preservative manufacturer's ICC-Evaluation Services report requirements.

2303.1.8.2 Labeling. Labeling shall be applied to all structural lumber 2 inches or greater nominal thickness, with the following information provided on each piece as a permanent ink stamp on one face or on a durable tag permanently fastened to ends with the following information:
1. Name of treating facility;
2. Type of preservative;
3. AWPA use category;
4. Quality mark of third party inspection agency;
5. Retention minimum requirements; and
6. Year of treatment.

All lumber less than 2 inches in nominal thickness, shall be identified per bundle by means of a label consisting of the above requirements. Labels measuring no less than 6 inches by 8 inches shall be placed on the lower left corner of the strapped bundle.

2303.1.8.3 Moisture content of treated wood. When wood pressure treated with a water-borne preservative is used in enclosed locations where drying in service cannot readily occur, such wood shall be at a moisture content of 19 percent or less before being covered with insulation, interior wall finish, floor covering or other material."

(50) Protection against decay and termites.
Section 2304.11 is deleted in its entirety and replaced to read as follows:

"2304.11 Protection against decay and termites.

2304.11.1 General. Where required by this section, protection from decay and termites shall be provided by the use of naturally durable or preservative-treated wood.

2304.11.2 Wood used above ground. Structural lumber installed above ground shall be preservative-treated wood in accordance with Section 2303.1.8.

2304.11.2.1 Soil treatment and termite barriers. Where structural lumber of wood frame buildings or structures are supported directly on the ground by a concrete slab, or concrete and/or masonry

foundation, Formosan subterranean termite protection shall be provided by either chemically treating the soil beneath and adjacent to the building or structure by a Hawaii licensed pest control operator, or stainless steel termite barrier, or other termite protection measures approved by the building official.

All soil treatment, stainless steel termite barrier, and termite protection measures shall be installed according to manufacturer's recommendations for control of Formosan subterranean termites, with chemical barriers applied at the maximum label rates.

2304.11.3 Wood in ground contact. Wood supporting permanent buildings and structures, which is in direct soil contact or is embedded in concrete or masonry in direct contact with earth shall be treated to the appropriate commodity specification of AWPA Standard U1.

Wood in direct soil contact but not supporting any permanent buildings or structures shall be treated to the appropriate commodity specification of AWPA Standard U1 for ground contact.

2304.11.4 Retaining walls. Wood in retaining or crib wall shall be treated to AWPA Standard U1.

2304.11.5 Wood and earth separation. Where wood is used with less than 6-inch vertical separation from earth (finish grade), the wood shall be treated for ground-contact use.

Where planter boxes are installed adjacent to wood frame walls, a 2-inch-wide (51 mm) air space shall be provided between the planter and the wall. Flashings shall be installed when the air space is less than 6 inches (152
mm) in width. Where flashing is used, provisions shall be made to permit circulation of air in the air space. The wood-frame wall shall be provided with an exterior wall covering conforming to the provisions of section 2304.6.

2304.11.6 Under-floor clearance for access and inspection. Minimum clearance between the bottom of floor joists or bottom of floors without joists and the ground beneath shall be 24 inches; the minimum clearance between the bottom of girders and the ground beneath shall be 18 inches.

Exception: Open slat wood decks shall have ground clearance of at least 6 inches for any wood member.

Accessible under-floor areas shall be provided with a minimum 18 inch-by 24 inch access opening, effectively screened or covered. Pipes, ducts and other construction shall not interfere with the accessibility to or within under-floor areas.

2304.11.7 Wood used in retaining walls and cribs. Wood installed in retaining or crib walls shall be preservative treated in accordance with AWPA U1 (Commodity Specifications A or F) for soil and fresh water use.

2304.11.8 Weather exposure. All portions of timbers (over 5-inch nominal width) and glued-laminated timbers that form structural supports of a building or other structure shall be protected by a roof, eave, overhangs, flashings, or similar coverings.

All wood or wood composite panels, in weather-exposed applications, shall be of exterior type.

2304.11.9 Water splash. Where wood-frame walls and partitions are covered on the interior with plaster, tile or similar materials and are subject to water splash, the framing shall be protected with approved waterproof paper conforming to Section 1404.2.

2304.11.10 Pipe and other penetrations. Insulations around plumbing pipes shall not pass through ground floor slabs. Openings around pipes or similar penetrations in a concrete or masonry slab, which is in direct contact with earth, shall be filled with non-shrink grout, BTB, or other approved physical barrier."

(51) Conventional Light-Frame Construction.

Section 2308.1 is amended to read as follows:

"**2308.1 General.** The requirements of this section are intended for conventional light-frame construction. Other methods are permitted to be used, provided a satisfactory design is submitted showing compliance with other provisions of this code. Interior nonload-bearing partitions, ceilings and curtain walls of conventional light-frame construction are not subject to the limitations of this section. Alternatively, compliance with AF&PA WFCM shall be permitted subject to the limitations therein and the limitations of this code. Detached one- and two-family dwellings (townhouses) not more than three stories above grade plane in height with a separate means of egress and their accessory structures shall be permitted to comply with the International Residential Code.

2308.1.1 Portions exceeding limitations of conventional construction. When portions of a building of otherwise conventional construction exceed the limits of Section 208.2, these portions and the supporting load path shall be designed in accordance with accepted engineering practices and the provisions of this code. For the purposes of this section, the term "portions" shall mean parts of buildings containing volume and area such as a room or series of rooms."

(52) Elevators and Conveying Systems.

Section 3001.2 Referenced standards is amended to add a new section 3001.2.1 to read as follows:

"**3001.2.1 The Administrative Rules of the Department of Labor and Industrial Relations, Division of Occupational Safety and Health, Title 12, Subtitle 8, Part 11 Elevator and related systems.**"

(53) Public swimming pools.

Section 3109.3 is amended to read as follows:

"**3109.3 Public swimming pools.** Public swimming pools shall be completely enclosed by a fence at least 4 feet (1290 mm) in height or a screen enclosure. Openings in the fence shall not permit the passage of a 4-inch-diameter (102 mm) sphere. The fence or screen enclosure shall be equipped with self-closing and self-latching gates.

Exception: Swimming, dipping, or wading pools located on the premises of a hotel are not required to be enclosed."

(54) Existing Concrete Structures.

Section 3401.6 Alternative compliance is amended to read as follows:

"**3401.6 Alternative compliance.**

1) Work performed in accordance with the International Existing Building Code shall be deemed to comply with the provisions of this chapter.
2) Work performed in accordance with the 2016 version of the American Concrete Institute Committee 562, "Code Requirements for Assessment, Repair, and Rehabilitation of Existing Concrete Structures" shall be deemed to comply with this chapter when used as a supplement to the requirements of this chapter or the International Existing Building Code. Wherever the term International Existing Building Code (IEBC) is used in ACI 562-16, it shall mean International Existing Building Code or Chapter 34 of the International Building Code."

(55) Glass Replacement.

Section 3407.1 is amended to read as follows:

"**3407.1 Conformance.** The installation or replacement of glass shall be as required by Chapter 24 for new installations."

(56) Compliance with other codes.

Section 3412.3.2 is amended to read as follows:

"**3412.3.2 Compliance with other codes.** Buildings that are evaluated in accordance with this section shall comply with the State Fire Code."

(57) Appendix U – Hawaii hurricane sheltering provisions for new construction.

Appendix U is added to read as follows:

"APPENDIX U

Hawaii Hurricane Sheltering Provisions for New Construction

Section U101 Community storm shelters.

Section 423 is deleted and replaced to read as follows:

SECTION 423 COMMUNITY STORM SHELTERS

423.1 General. In addition to other applicable requirements in this code, community storm shelters and the following specific Risk Category IV buildings shall be constructed in accordance with ICC-500:

1. Designated earthquake, hurricane or other emergency shelters.
2. Designated emergency preparedness, communication, and operation centers and other facilities required for emergency response.

423.1.1 Scope. This section applies to the construction of storm shelters constructed as separate detached buildings or constructed as safe rooms within buildings for the purpose of providing safe refuge from storms that produce high winds, such as hurricanes. Such structures shall be designated to be hurricane shelters.

423.2 Definitions. The following words and terms shall, for the purposes of this chapter and as used elsewhere in this code, have the meanings shown herein.

COMMUNITY STORM SHELTER. A building, structure, or portion thereof, constructed in accordance with ICC/NSSA 500 Standard on the Design and Construction of Storm Shelters and designated for use during a severe wind storm event such as a hurricane.

Section U102 Hawaii residential safe room.

Chapter 4 is amended by adding Section 425 to read as follows:

SECTION 425 HAWAII RESIDENTIAL SAFE ROOM

425.1 Performance-based design criteria. The residential safe room shall meet the minimum performance specifications of Sections 425.1.1 through 425.10.

425.1.1 Intent and scope. The intent of the residential safe room is to temporarily provide an enhanced protection area, fully enclosed within a dwelling or within an accessory structure to a residence, which is designed and constructed to withstand the wind pressures, windborne debris impacts, and other requirements of this section.

425.1.2 Alternative standards.

1. **Manufactured safe room designs subject to approval.** A manufactured safe room or safe room kit may be substituted if documentation is submitted and approved by the building official. The safe room shall be engineered, tested, and manufactured to meet or exceed the criteria of this section.
2. **FEMA in-residence shelter designs permitted.** It shall be permissible to build FEMA In-Residence Shelters of up to 64 square feet of floor area with walls up to 8 feet long that are built in accordance with construction details of FEMA 320.

425.2 Site criteria. Residential safe rooms shall not be constructed within areas subject to stream flooding, coastal flooding or dam failure inundation within any of the following areas:

1. FEMA Special Flood Hazard Areas (SFHA) subject to rainfall runoff flooding or stream or flash flooding;
2. Coastal zones "V" or "A" identified in the Flood Insurance Rate Map (FIRM) issued by FEMA for floodplain management purposes, in which the flood hazard are tides, storm surge, waves, tsunamis, or a combination of these hazards;
3. Areas subject to dam failure inundation as determined by the Department of Land and Natural Resources.

425.3 Size of safe room. The safe room shall be designed to provide a minimum of 15 square feet per person in a room which does not need to exceed 120 square feet (11 m^2) of floor area.

425.4 Provisions for exiting. The safe room shall be equipped with an inward-swinging interior door and an impact-protected operable window or exterior door suitable for a means of alternative exiting in an emergency.

425.5 Design for dead, live, wind, rain, and impact loads.

425.5.1 Structural integrity criteria.

1. The residential safe room shall be built with a complete structural system and a complete load path for vertical and lateral loads caused by gravity and wind.
2. The building that the residential safe room is in shall be assumed to be destroyed by the storm and shall not be taken as offering any protective shielding to the safe room enclosure.
3. The ceiling structure and wall shall be capable of supporting a superimposed debris load of the full weight of any building floors and roof above, but not less than 125 psf.
4. The residential safe room enclosure shall be capable of simultaneously resisting lateral and uplift wind pressures corresponding to a 145 mph 3-second peak gust ultimate design wind speed, determined in accordance with ASCE – 7, Minimum Design Loads for Buildings and Other Structures. The site exposure factor shall be based on exposure C or the exposure shown in Figure 1609.4 , whichever is the greater. The values for the gust factor and the directionality factor shall be taken as 0.85. Topographic wind amplification caused by mountainous terrain shall be considered in accordance with the building code. Internal pressure shall be determined in accordance with ASCE – 7.
5. The residential safe room shall be anchored to a foundation system capable of resisting the above loading conditions.

425.5.2 Windborne debris impact protection of building enclosure elements. The entire enclosure of the safe room, including all walls, ceilings, and openings, fixed or operable windows, and all entry doors into the safe room, shall meet or exceed Level D requirements of ASTM E 1996 (Table 422.5-1), or be an approved assembly listed in Section 425.5.4. Any wall or ceiling penetration greater than 4 square inches shall be considered an opening.

Exception: Electrical outlet boxes and interior lighting switches not penetrating more than 2.5-inches into the interior

wall surface and a plumbing piping or conduit not greater than 1.5-inch in diameter shall be exempted from this requirement.

425.5.3 Cyclic pressure loading of glazing and protective systems. Impact protective systems shall meet the ASTM E 1996 cyclic pressure requirement for the loading given in Table 425.5-1.

Table 425.5-1
Windborne Debris Protection and Cyclic Pressure Criteria for Residential Safe Rooms

ASTM E 1996 Missile Level Rating	Debris Missile Size	Debris Impact Speed	Enclosure Wall Ceiling, and Floor Cyclic Air Pressure Testing - maximum inward and maximum outward pressures
D	2 x 4 weighing 9.0 lb. +/- 0.25 lb., and with min. length 8 ft. +/- 4-inch	50 ft./sec. or at least 34 mph	35 psf inward 45 psf outward

425.5.4 Approved Debris Impact Resistant Wall Assemblies. The following methods of wall assembly construction shall be deemed to comply with Section 425.5.2:

1. ¾-inch plywood on wood studs spaced at 16 inches on-center with #8 X 3 inch wood screws at 6 inches on-center.
2. ¾-inch plywood attached to double studs spaced at 16 inches on-center with #8 X 3 inch wood screws at 6 inches on-center.
3. 8-1/4 inch cementitious lap siding over 22 gage sheet metal attached to 350S-162-33 studs spaced at 24 inches on-center.
4. 8-1/4 inch cementitious lap siding attached to 350S-162-33 studs spaced at 24 inches on-center studs with interior ¾-inch interior plywood sheathing.
5. 8-1/4 inch cementitious lap siding attached to 350S-162-33 studs spaced at 24 inches on-center with ½-inch interior 22 gage sheet metal composite gypsum wallboard.
6. 8-1/4 inch cementitious lap siding attached to 2 inch X 4 inch wood studs spaced at 16 inches on-center with ½-inch interior 22 gage sheet metal composite gypsum wallboard.
7. 8-1/4 inch cementitious lap siding attached to 2 inch X 4 inch wood studs spaced at 16 inches on-center with 22 gage sheet metal and ½-inch interior gypsum wallboard.
8. Cementitious lap siding attached to 5/8-inch structural plywood on 2 inch X 4 inch wood studs spaced at 16 inches on-center.
9. Cementitious-panel siding attached to 5/8-inch structural plywood on 2 inch X 4 inch or 362S-137-43 steel studs spaced at 16 inches on-center.
10. EFS with ½-inch dens-glass gold exterior sheathing on 362S-137-43 steel studs spaced at 16 inches on-center and ½-inch interior gypsum wallboard.
11. 24 gage steel sheet (50 ksi) on girts.
12. Concrete with a thickness of 4 inches with reinforcing.
13. Concrete masonry units with a thickness of 6 inches with partial grouting and reinforcing spaced at 24 inches on-center.
14. Concrete masonry units with a thickness of 8 inches with partial grouting and reinforcing spaced at 24 inches on-center.

15. Interior or exterior wall with laterally braced 2 inch x 4 inch wood studs with sheathing on either side of 22 gage sheet metal.

Sheathing shall be attached to studs with fasteners at 6 inches (152 mm) on center for edge and field fastening.

425.6 Ventilation. The residential safe room shall be naturally ventilated to allow the enclosure to have approximately one air change every two hours. This requirement may be satisfied by 12 square inches of venting per occupant. There shall be at least two operable vents. The vents shall be protected by a cowling or other device that shall be impact tested to comply with ASTM E 1996-14 Level D. Alternatively, the room shall be evaluated to determine if the openings are of sufficient area to constitute an open or partially enclosed condition as defined in ASCE 7.

425.7 Communications. The residential safe room shall be equipped with a phone line and telephone that does not rely on a separate electrical power outlet. Alternatively, a wireless telephone shall be permitted to rely on an Uninterruptible Power Supply (UPS) battery device.

425.8 Construction documents. Construction documents for the residential safe room shall be directly prepared by a Hawaii licensed professional structural engineer.

425.9 Special inspection. The construction or installation of the residential safe room shall be verified for conformance to the drawings in accordance with the appropriate requirements of Chapter 17.

425.10 Notification. The owner of the safe room shall notify the state department of defense and county civil defense agency of the property's tax map key or global positioning system coordinates.

Section U103 State- and County-owned public high occupancy buildings - design criteria for enhanced hurricane protection areas.
Chapter 4 is amended by adding Section 426 to read as follows:

SECTION 426 STATE- AND COUNTY-OWNED PUBLIC HIGH OCCUPANCY BUILDINGS - DESIGN CRITERIA FOR ENHANCED HURRICANE PROTECTION AREAS

426.1 Intent. The purpose of this section is to establish minimum life safety design criteria for enhanced hurricane protection areas in high occupancy state- and county-owned buildings occupied during hurricanes of up to Saffir Simpson Category 3.

426.2 Scope. This section shall apply to state- and county-owned buildings which are of Risk Category III and IV defined by Table 1604.5 and of the following specific occupancies:

1. Enclosed and partially enclosed structures whose primary occupancy is public assembly with an occupant load greater than 300.
2. Health care facilities with an occupant load of 50 or more resident patients, but not having surgery or emergency treatment facilities.
3. Any other state- and county-owned enclosed or partially enclosed building with an occupant load greater than 5,000.

4. Hospitals and other health care facilities having surgery or emergency treatment facilities.

   Exception: Facilities located within flood zone V and flood zone A that are designated by the owner to be evacuated during hurricane warnings declared by the National Weather Service, shall not be subject to these requirements.

426.3 Site criteria.

426.3.1 Flood zones. Comply with ASCE 24-14, Flood Resistant Design and Construction, based on provisions for Risk Category III.

1. Floor slab on grade shall be 1.5 foot above the base flood elevation of the county's flood hazard map, or a higher elevation as determined by a modeling methodology that predicts the maximum envelope and depth of inundation including the combined effects of storm surge and wave actions with respect to a Category 3 hurricane, nor less than the flood elevation associated with a 500-year mean recurrence interval.
2. Locate outside of V and Coastal A flood zones unless justified by site-specific analysis or designed for vertical evacuation in accordance with a method approved by the building official. When a building within a V or Coastal A flood zone is approved, the bottom of the lowest structural framing member of any elevated first floor space shall be 2 feet above the base flood elevation of the county's flood hazard map, or at higher elevation as determined by a modeling methodology that predicts the maximum envelope and depth of inundation including the combined effects of storm surge and wave actions with respect to a Category 3 hurricane, nor less than the flood elevation associated with a 500-year mean recurrence interval.

426.3.2 Emergency vehicle access. Provide at least one route for emergency vehicle access. The portion of the emergency route within the site shall be above the 100-year flood elevation.

426.3.3 Landscaping and utility laydown impact hazards. Landscaping around the building shall be designed to provide standoff separation sufficient to maintain emergency vehicle access in the event of mature tree blowdown. Trees shall not interfere with the functioning of overhead or underground utility lines, nor cause laydown or falling impact hazard to the building envelope or utility lines.

426.3.4 Adjacent buildings. The building shall not be located within 1,000 feet of any hazardous material facilities defined by Table 1604.5. Unanchored light-framed portable structures shall be not permitted within 300 feet of the building, unless the windborne debris hazard of the portable structure uplift is mitigated.

426.4 Enhanced hurricane protection area program requirements.

426.4.1 Applicable net area. At least 50 per cent of the net square feet of a facility shall be constructed to qualify as an enhanced hurricane protection area. The net floor area shall be determined by subtracting from the gross square feet the floor area of excluded spaces, exterior walls, columns, fixed or movable objects, equipment or other features that under probable conditions cannot be removed or stored during use as a storm shelter.

426.4.2 Excluded spaces. Spaces such as mechanical rooms, electrical rooms, storage rooms, attic and crawl spaces, shall not be considered as net floor area permitted to be occupied during a hurricane.

426.4.3 Occupancy capacity. The occupancy capacity shall be determined by dividing the net area of the enhanced hurricane protection area by 15 square feet net floor area per person.

426.4.4 Toilets and hand washing facilities. Toilet and hand washing facilities shall be located and accessible from within the perimeter of the enhanced hurricane protection area.

426.4.5 Accessibility. Where the refuge occupancy accommodates more than 50 persons, provide an ADA-accessible route to a shelter area at each facility with a minimum of 1 wheelchair space for every 200 enhanced hurricane protection area occupants determined in accordance with Section 426.4.3.

426.5 Design wind, rain, and impact loads.

426.5.1 Structural design criteria. The building main wind force resisting system and structural components shall be designed per ASCE 7 for a 145 mph minimum peak 3-second gust ultimate design wind speed. Topographic and directionality factors shall be the site-specific values determined per Appendix W. Design for interior pressure shall be based on the largest opening in any exterior facade or roof surface.

426.5.2 Windborne debris missile impact for building enclosure elements. Exterior glazing and glazed openings, louvers, roof openings and doors shall be provided with windborne debris impact resistance or protection systems conforming to ASTM E1996-14 Level D, i.e., 9 lb. 2 X 4 @ 50 fps (34 mph).

426.5.3 Cyclic pressure loading of impact resistive glazing or windborne impact protective systems. Resistance to the calculated maximum inward and outward pressure shall be designed to conform to ASTM E1996-14.

426.5.4 Windows. All unprotected window assemblies and their anchoring systems shall be designed and installed to meet the wind load and missile impact criteria of this section.

426.5.5 Window protective systems. Windows may be provided with permanent or deployable protective systems, provided the protective system is designed and installed to meet the wind load and missile impact criteria and completely covers the window assembly and anchoring system.

426.5.6 Doors. All exterior and interior doors subject to possible wind exposure or missile impact shall have doors, frames, anchoring devices, and vision panels designed and installed to resist the wind load and missile impact criteria or such doors, frames, anchoring devices, and vision panels shall be provided with impact protective systems designed and installed to resist the wind load and missile impact criteria of this section.

426.5.7 Exterior envelope. The building enclosure, including walls, roofs, glazed openings, louvers and doors, shall not be perforated or penetrated by windborne debris, as determined by compliance with ASTM E1996-14 Level D.

426.5.8 Parapets. Parapets shall satisfy the wind load and missile impact criteria of the exterior envelope.

426.5.9 Roofs

426.5.9.1 Roof openings. Roof openings (e.g., HVAC fans, ducts, skylights) shall be provided with protection for the wind load and missile impact criteria of Sections 426.5.2 and 426.5.3.

426.5.9.2 High wind roof coverings. Roof coverings shall be specified and designed according to the latest ASTM Standards for high wind uplift forces and Section 1507, whichever is the greater.

426.5.9.3 Roof drainage. Roofs shall have adequate slope, drains and overflow drains or scuppers sized to accommodate 100-year hourly rainfall rates in accordance with Section 1611.1, but not less than 2-inches per hour for 6 continuous hours.

426.6 Ventilation

426.6.1 Mechanical ventilation. Mechanical ventilation as required in accordance with the International Mechanical Code. Air intakes and exhausts shall be designed and installed to meet the wind load and missile impact criteria of Sections 426.5.2 and 426.5.3.

426.6.2 HVAC equipment anchorage. HVAC equipment mounted on roofs and anchoring systems shall be designed and installed to meet the wind load criteria. Roof openings for roof-mounted HVAC equipment shall have a 12-inch-high curb designed to prevent the entry of rain water.

426.7 Standby electrical system capability. Provide a standby emergency electrical power system per Chapter 27 and NFPA 70 Article 700 Emergency Systems and Article 701 Legally Required Standby Systems, which shall have the capability of being connected to an emergency generator or other temporary power source. The emergency system capabilities shall include:

1. An emergency lighting system;
2. Illuminated exit signs;
3. Fire protection systems, fire alarm systems and fire sprinkler systems; and
4. Minimum mechanical ventilation for health/safety purposes.

426.7.1 Emergency generator. When emergency generators are pre-installed, the facility housing the generator, permanent or portable, shall be an enclosed area designed to protect the generators from wind and missile impact.

Generators hardened by the manufacturer to withstand the area’s design wind and missile impact criteria shall be exempt from the enclosed area criteria requirement.

426.8 Quality assurance

426.8.1 Information on construction documents. Construction documents shall include design criteria, the occupancy capacity of the enhanced hurricane protective area, and Project Specifications shall include opening protection devices. Floor plans shall indicate all enhanced hurricane protection area portions of the facility and exiting routes there from. The latitude and longitude coordinates of the building shall be recorded on the construction documents.

426.8.2 Special inspection. In addition to the requirements of Chapter 17, special inspections shall include at least the following systems and components:

1. Roof cladding and roof framing connections;
2. Wall connections to roof and floor diaphragms and framing;
3. Roof and floor diaphragm systems, including collectors, drag struts and boundary elements;
4. Vertical windforce-resisting systems, including braced frames, moment frames and shear walls;
5. Windforce-resisting system connections to the foundation; and
6. Fabrication and installation of systems or components required to meet the impact-resistance requirements of Section 1609.1.2.

   Exception: Fabrication of manufactured systems or components that have a label indicating compliance with the wind-load and impact-resistance requirements of this code.

426.8.3 Quality assurance plan. A construction quality assurance program shall be included in the construction documents and shall include:

1. The materials, systems, components, and work required to have special inspection or testing by the building official or by the registered design professional responsible for each portion of the work;
2. The type and extent of each special inspection;
3. The type and extent of each test;
4. Additional requirements for special inspection or testing for seismic or wind resistance; and
5. For each type of special inspection, identification as to whether it will be continuous special inspection or periodic special inspection.

426.8.4 Peer review. Construction documents shall be independently reviewed by a Hawaii-licensed structural engineer. A written opinion report of compliance shall be submitted to State Civil Defense, the building official, and the owner.

426.9 Maintenance. The building shall be periodically inspected every three years and maintained by the owner to ensure structural integrity and compliance with this section. A report of inspection shall be furnished to the State Civil Defense.

426.10 Compliance re-certification when altered, deteriorated, or damaged. Alterations shall be reviewed by a Hawaii-licensed structural engineer to determine whether any alterations would cause a violation of this section. Deterioration or damage to any component of the building shall require an evaluation by a Hawaii-licensed structural engineer to determine repairs necessary to maintain compliance with this section."

(58) Appendix W – Hawaii wind design provisions for new construction. Appendix W is added to read as follows:

"APPENDIX W

Hawaii Wind Design Provisions for New Construction

W101 Revisions to chapter 2 and chapter 16.
Wind design shall be in accordance with Chapter 2 and Chapter 16 as amended by Sections W101.1 through W101.14.

W101.1 Windborne Debris Region defined.
The definition of "Windborne Debris Region" in Section 202 is amended to read as follows:

"WIND-BORNE DEBRIS REGION. Areas in Hawaii where the effective ultimate design wind speed is 130 mph (63 m/s) or greater.

For Risk Category II buildings and structures and Risk Category III buildings and structures, except health care facilities, the wind-borne debris region shall be based on Fig. 1609.3.2.2(a-f). For Risk Category IV buildings and structures and Risk Category III health care facilities, the windborne debris region shall be based on Fig. 1609.3.2.3(a-f)."

W101.2 Revisions to section 1603.1.
Section 1603.1 is amended to read as follows:

1603.1 General. Construction documents shall show the size, section, and relative locations of structural members with floor levels, column centers and offsets dimensioned. The design loads and other information pertinent to the structural design required by Sections 1603.1.1 through 1603.1.9 shall be indicated on the construction documents.

Exception: Construction documents for buildings constructed in accordance with the conventional light-frame construction provisions of Section 2308 shall indicate the following structural design information:

1. Floor and roof live loads.
2. Ground snow load, P_g.
3. Risk Category.
4. Wind exposure.
5. Ultimate design wind speed (3-second gust) V_{ult} , and effective design wind speed $V_{eff-asd}$ (3-second gust), miles per hour (mph)(km/hr) .
6. Design spectral response acceleration parameters, S_{DS} and S_{D1}
7. Seismic design category and site class.
8. The design load-bearing values of soils.
9. Flood design data, if located in flood hazard areas established in Section 1612.3.

W101.3 Revisions to section 1603.1.4.
Section 1603.1.4 is amended to read as follows:

1603.1.4 Wind design data. The following information related to wind loads shall be shown, regardless of whether wind loads govern the design of the lateral-force-resisting system of the building:

1. Ultimate design wind speed (3-second gust) V_{ult} , and effective design wind speed $V_{eff-asd}$ (3-second gust), miles per hour (mph)(km/hr) .
2. Building Risk Category.
3. Wind exposure, if more than one wind exposure is utilized, the wind exposure for each applicable wind direction shall be indicated.
4. The applicable internal pressure coefficient.
5. Components and cladding. The design wind pressures in terms of psf (kN/m²) used for the design of exterior components, and cladding not specifically designed by the registered design professional.

W101.4 Revisions to section 1609.1.1.

Section 1609.1.1 is amended to read as follows:

1609.1.1 Determination of wind loads. Wind loads on every building or structure shall be determined in accordance with Chapters 26 to 30 of ASCE 7. Minimum values for Directionality Factor, K_d, Velocity Pressure Exposure Coefficient, K_z, and Topographic Factor, K_{zt}, shall be determined in accordance with Section 1609. The type of opening protection required, the ultimate design wind speed, V_{ult}, and the exposure category for a site is permitted to be determined in accordance with Section 1609 or ASCE 7. Wind shall be assumed to come from any horizontal direction and wind pressures shall be assumed to act normal to the surface considered.

Exceptions:

1. Subject to the limitations of Section 1609.1.1.1, the provisions of ICC 600 shall be permitted for applicable Group R-2 and R-3 buildings.
2. Subject to the limitations of Section 1609.1.1.1, residential structures using the provisions of the AWC WFCM.
3. Subject to the limitations of Section 1609.1.1.1, residential structures using the provisions of AISI S230.
4. Designs using NAAMM FP 1001.
5. Designs using TIA-222 for antenna-supporting structures and antennas, provided the effect of topography is included in accordance with Section 1609.3.3 Topographic effects.
6. Wind tunnel tests in accordance with Chapter 31 of ASCE 7, subject to the limitations in Section 1609.1.1.2.

The wind speeds in Figures 1609A, 1609B and 1609C are ultimate design wind speeds, V_{ult}. Values of effective nominal design wind speeds, $V_{eff-asd}$, determined in accordance with Sections 1609.3.1 and 1609.3.2, shall be used when the standards referenced in Exceptions 1 through 4 are used.

1609.1.1.1 Applicability. The provisions of ICC 600 are applicable only to buildings located within Exposure B or C as defined in Section 1609.4. The prescriptive provisions of ICC 600, AWC WFCM, or AISI S230 shall not be permitted for either of the following cases:

1. Structures which are more than three stories above grade plane in height.

2. Structures designed using exception 4 in Section 1609.1.2 Protection of Openings.

W101.5 Revisions to section 1609.1.2.

Section 1609.1.2 is amended to read as follows:

1609.1.2 Protection of openings. In wind-borne debris regions, glazing in buildings shall be impact-resistant or protected with an impact-resistant covering meeting the requirements of an approved impact-resistant standard or ASTM E 1996 and ASTM E 1886 referenced herein as follows:

1. Glazed openings located within 30 feet (9144 mm) of grade shall meet the requirements of the Large Missile Test of ASTM E 1996-14.
2. Glazed openings located more than 30 feet (9144 mm) above grade shall meet the provisions of the Small Missile Test of ASTM E 1996-14.
3. Glazing in Risk Category III buildings defined by Table 1604.5 of the following occupancies shall be provided with windborne debris protection:
   1. Covered structures whose primary occupancy is public assembly with an occupant load greater than 300.
   2. Health care facilities with an occupant load of 50 or more resident patients, but not having surgery or emergency treatment facilities.
   3. Any other public building with an occupant load greater than 5,000.

Exceptions:

1. Wood structural panels with a minimum thickness of 7/16 inch (11 mm) and a maximum panel span of 8 feet (2438 mm) shall be permitted for opening protection in one- and two-story buildings classified as Group R-3 or R-4 occupancy. Panels shall be precut so that they shall be attached to the framing surrounding the opening containing the product with the glazed opening. Panels shall be predrilled as required for the anchorage method and shall be secured with the attachment hardware provided. Attachments shall be designed to resist the components and cladding loads determined in accordance with the provisions of ASCE 7, with corrosion-resistant attachment hardware provided and anchors permanently installed on the building. Attachment in accordance with Table 1609.1.2 with corrosion-resistant attachment hardware provided and anchors permanently installed on the building is permitted for buildings with a mean roof height of 33 feet (10 058 mm) or less where effective ultimate design wind speeds, $V_{eff-ult}$ do not exceed 175 mph (78 m/s).
2. Glazing in Risk Category I buildings as defined in Section 1604.5, including greenhouses that are occupied for growing plants on a production or research basis, without public access shall be permitted to be unprotected.
3. Glazing in Risk Category II, III or IV buildings located over 60 feet (18 288 mm) above the ground and over 30 feet (9144

mm) above aggregate surface roofs located within 1,500 feet (458 m) of the building shall be permitted to be unprotected.

4. Risk Category II buildings shall be permitted to be designed with unprotected openings subject to the following requirements:
   a) For each direction of wind, determination of enclosure classification shall be based on the assumption that all unprotected glazing on windward walls are openings while glazing on the remaining walls and roof are intact and are not assumed to be openings.
   b) Partially enclosed and open occupancy R-3 buildings without wind-borne debris protection shall also include a residential safe room in accordance with Section 425, Hawaii residential safe room, or alternatively provide an equivalently sized room structurally protected by construction complying with Section 425.5.

1609.1.2.1 Louvers. Louvers protecting intake and exhaust ventilation ducts not assumed to be open that are located within 30 ft (9144 mm) of grade shall meet requirements of an approved impact-resisting standard or the Large Missile Test of ASTM E 1996-14.

1609.1.2.2 Garage doors. Garage door glazed opening protection for wind-borne debris shall meet the requirements of an approved impact-resisting standard or ANSI/DASMA 115.

Table 1609.1.2
Wind-Borne Debris Protection Fastening Schedule
For Wood Structural Panels [a,b,c,d]

Fastener Type	Fastener Spacing		
	Panel span ≤ 4 feet	Panel span > 4 feet and ≤ 6 feet	Panel span > 6 feet and ≤ 8 feet
No. 8 Wood screw based anchor with 2 inch embedment length	16”	10”	8”
No. 10 Wood screw based anchor with 2-inch embedment length	16”	12”	9”
¼-inch lag screw based anchor with 2-inch embedment length	16”	16”	16”

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 0.454 kg,
1 mile per hour = 1.609 km/h.

a. This table is based on a 175 mph effective ultimate design wind speed and a mean roof height of 45 feet.
b. Fasteners shall be installed at opposing ends of the wood structural panel. Fasteners shall be located a minimum of 1 inch from the edge of the panel.
c. Anchors shall penetrate through the exterior wall covering with an embedment length of 2 inches minimum into the building frame. Fasteners shall be located a minimum of 2-1/2 inches from the edge of concrete block or concrete.
d. Where panels are attached to masonry or masonry/stucco, they shall be attached utilizing vibration-resistant anchors having a minimum withdrawal capacity of 1,500 pounds.

W101.6 Revisions to Section 1609.3.
Section 1609.3 is amended to read as follows:

1609.3 Ultimate design wind speed and topographic and directionality factors. The ultimate design wind speed, V_{ult} in mph, for the determination of the wind loads shall be determined by Figure 1609A, 1609B and 1609C. The ultimate design wind speed V_{ult}, for use in the design of Risk Category II buildings and structures shall be obtained from Figure 1609A. The ultimate design wind speed, V_{ult}, for use in the design of Risk Category III and IV buildings and structures shall be obtained from Figure 1609B. The ultimate design wind speed, V_{ult}, for use in the design of Risk Category I buildings and structures shall be obtained from Figure 1609C.

The effective ultimate design wind speed, $V_{eff-ult}$, for the special wind regions indicated near mountainous terrain and near gorges shall be in accordance with Section 1609.3.2.

Special wind regions near mountainous terrain and valleys are accounted within the Topographic Factor defined in Section 1609.3.3. Wind speeds derived from simulation techniques shall only be used in lieu of the wind speeds given in Figure 1609 when:

(1) Approved simulation or extreme-value statistical-analysis procedures are used (the use of regional wind speed data obtained from anemometers is not permitted to define the hurricane wind speed risk in Hawaii); and

(2) The ultimate design wind speeds resulting from the study shall not be less than the resulting 700-year return period wind speed for Risk Category II and 1700-year return period wind speed for Risk Category III and IV , and 300-year return period design wind speed for Risk Category I.

W101.7 Addition of Section 1609.3.1.
Section 1609.3.1 is added to read as follows:

1609.3.1 Effective wind speed conversion. For Section 2308.10.1 and the exceptions permitted under Section 1609.1.1, and when otherwise required, the nominal design wind speed value used for determination of the wind loads, shall be the effective design wind speed, $V_{eff-asd}$, determined by multiplying the effective ultimate design wind speed values, $V_{eff-ult}$ given in Section 1609.3.2 by $\sqrt{0.625}$, in accordance with Equation 16-33.

$$V_{eff-asd} = V_{eff-ult} \sqrt{0.625} \qquad \text{(Equation 16-33)}$$

W101.8 Addition of effective ultimate design wind speed, $V_{eff-ult}$, contour maps to section 1609.3.2.
Figures 1609.3.2.1(a) through 1609.3.2.1(f), Figures 1609.3.2.2(a) through 1609.3.2.2(f), and Figures 1609.3.2.3(a) through 1609.3.2.3(f) are added as follows:

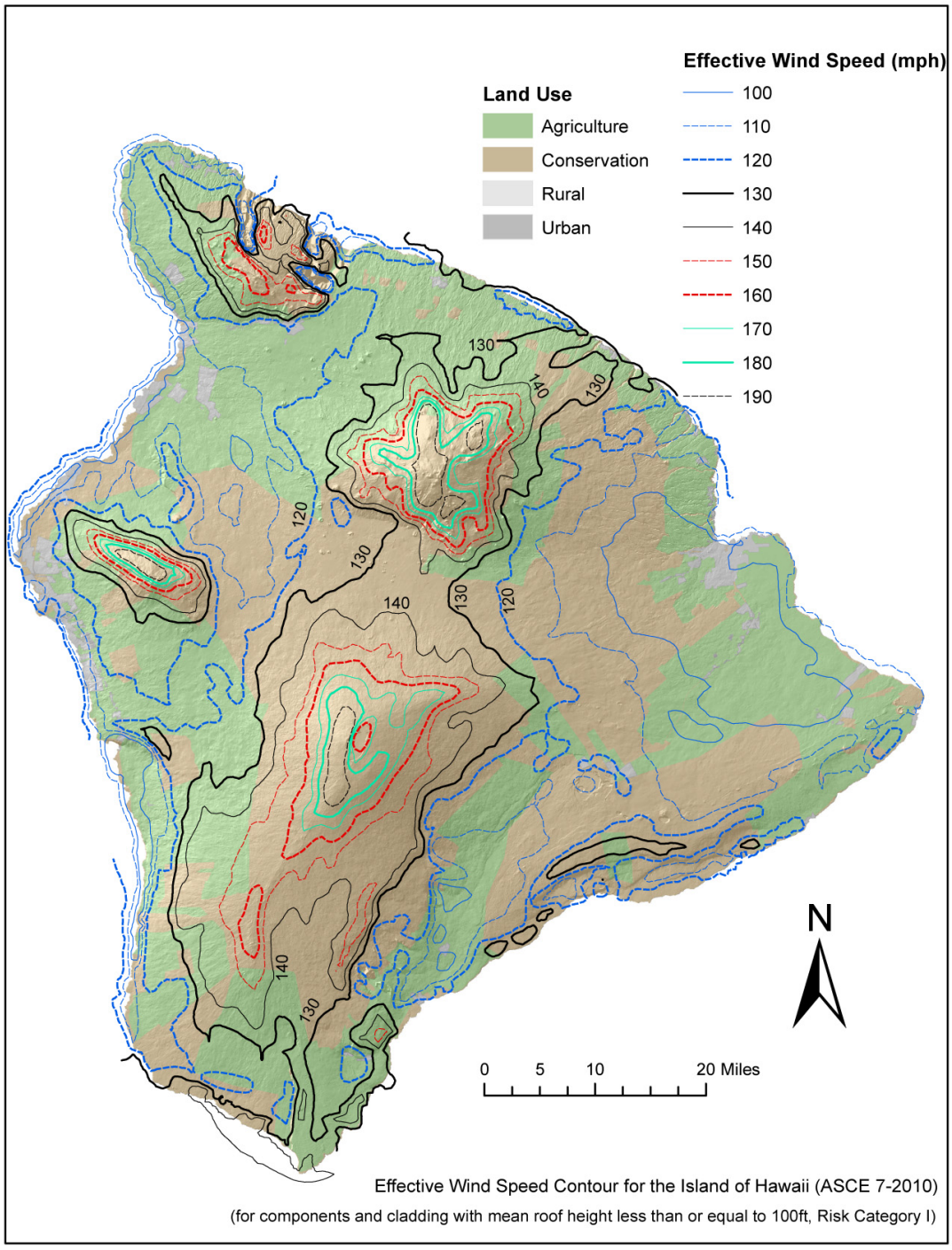


Figure 1609.3.2.1(a)
County of Hawaii Effective Ultimate Wind Speed, $V_{eff\text{-}ult}$, for Components and Cladding for Risk Category I Buildings less than 100 feet Tall

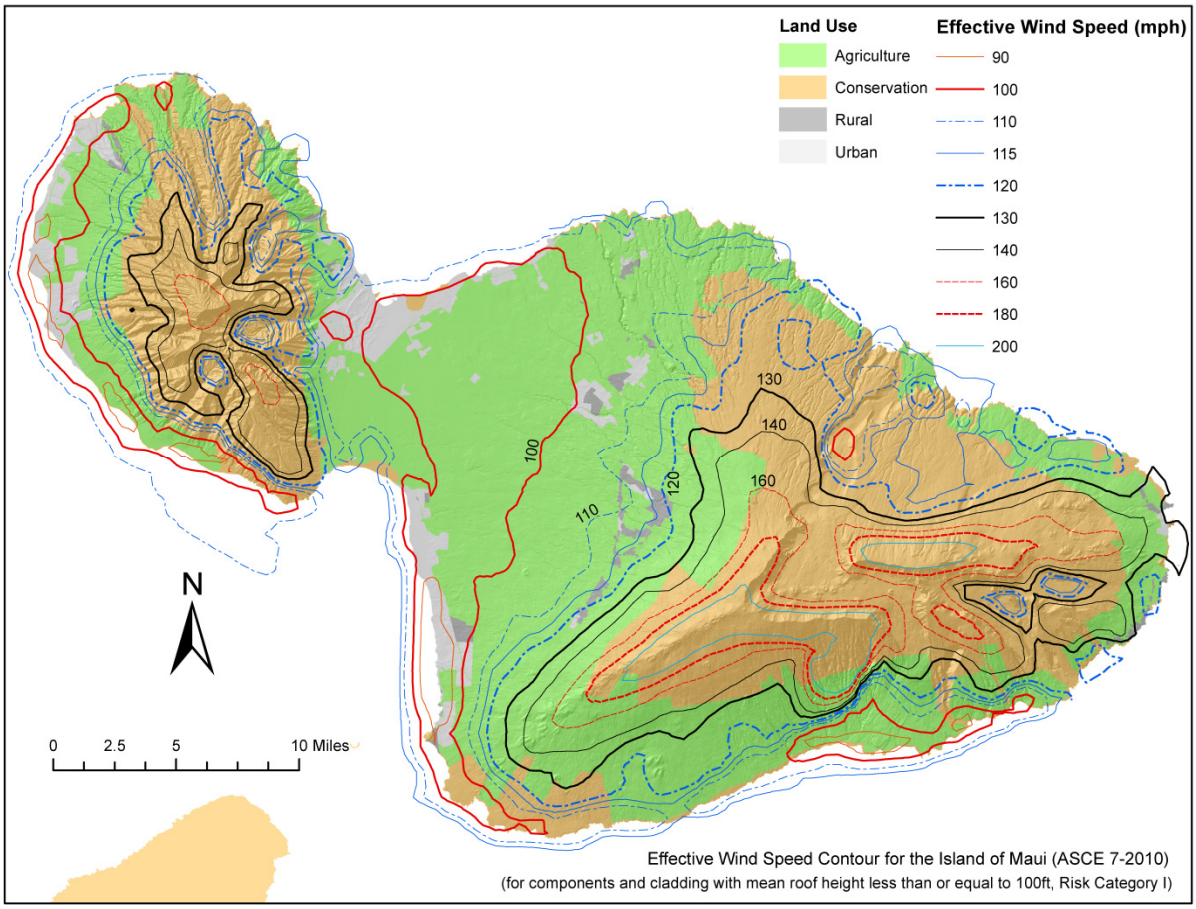


Figure 1609.3.2.1(b)
County of Maui, Island of Maui Effective Ultimate Wind Speed, $V_{eff\text{-}ult}$, for Components and Cladding for Risk Category I Buildings less than 100 feet Tall

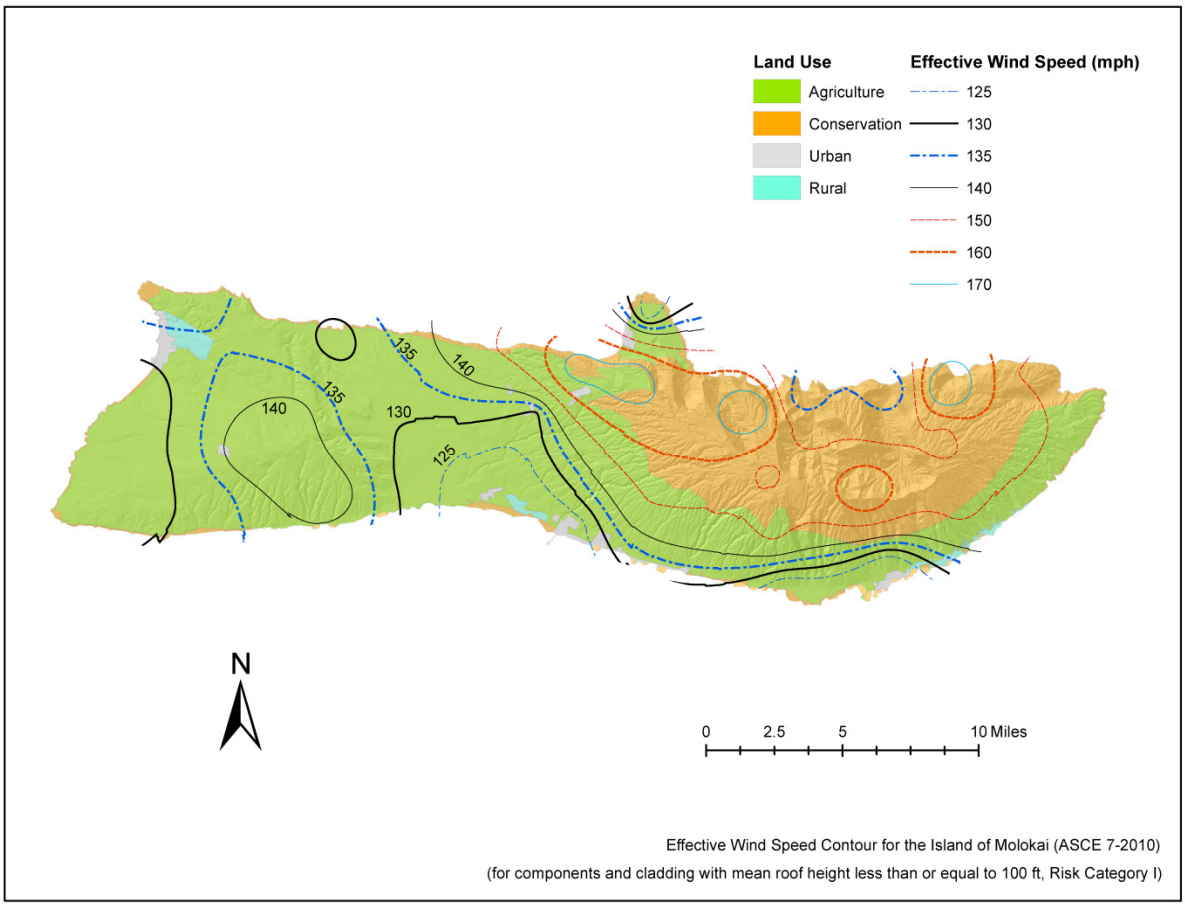
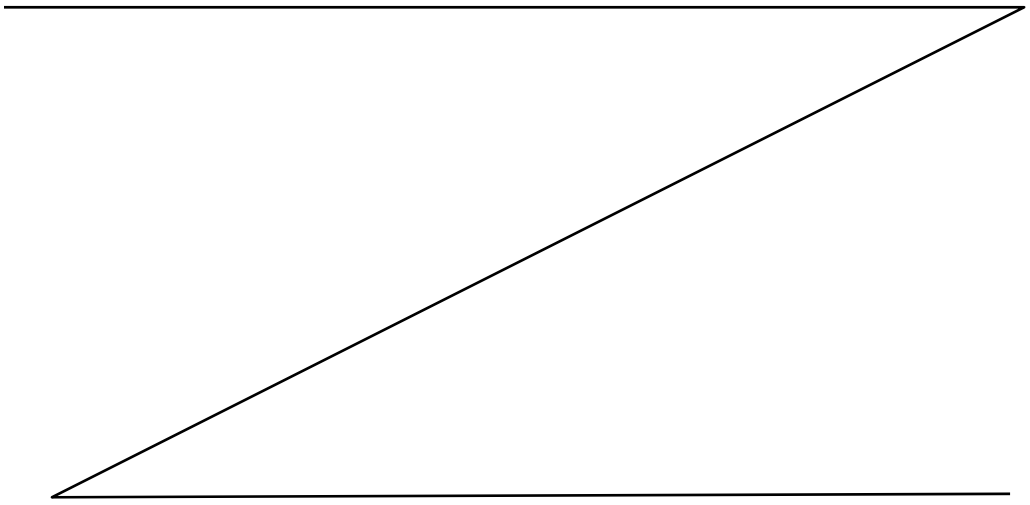


Figure 1609.3.2.1(c)
County of Maui, Island of Molokai Effective Ultimate Wind Speed, $V_{eff\text{-}ult}$, for Components and Cladding for Risk Category I Buildings less than 100 feet Tall



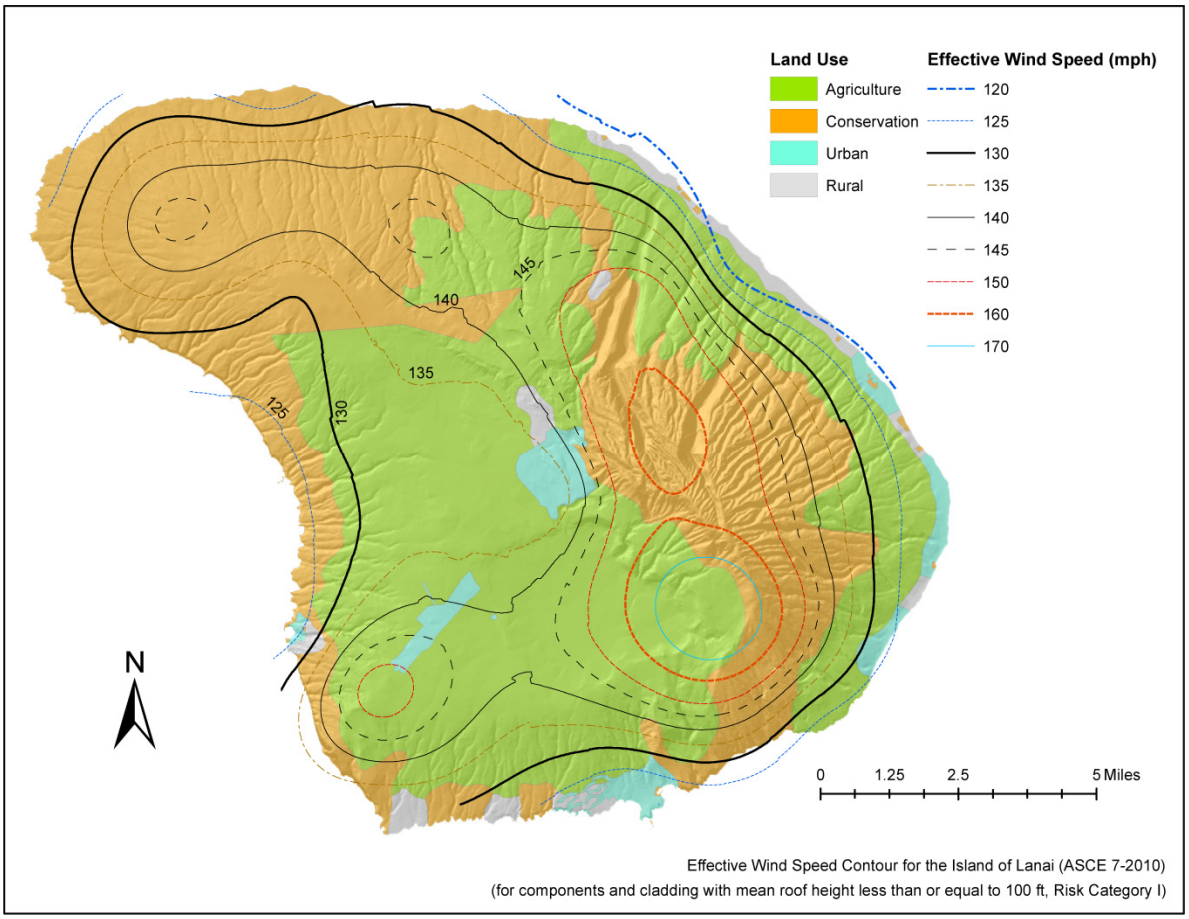


Figure 1609.3.2.1(d)
County of Maui, Island of Lanai Effective Ultimate Wind Speed, $V_{eff\text{-}ult}$, for Components and Cladding for Risk Category I Buildings less than 100 feet Tall

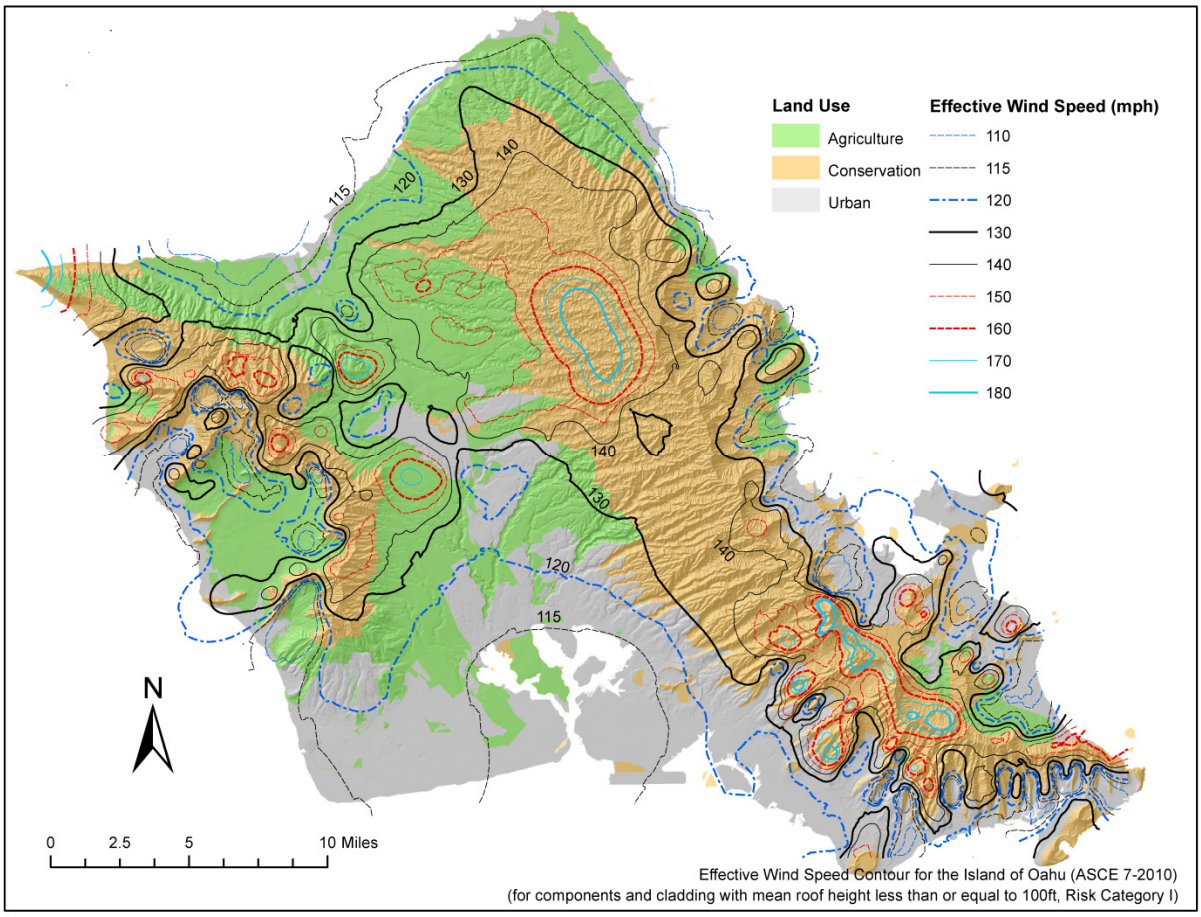


Figure 1609.3.2.1(e)
City and County of Honolulu Effective Ultimate Wind Speed, $V_{eff\text{-}ult}$, for Components and Cladding for Risk Category I Buildings less than 60 feet Tall

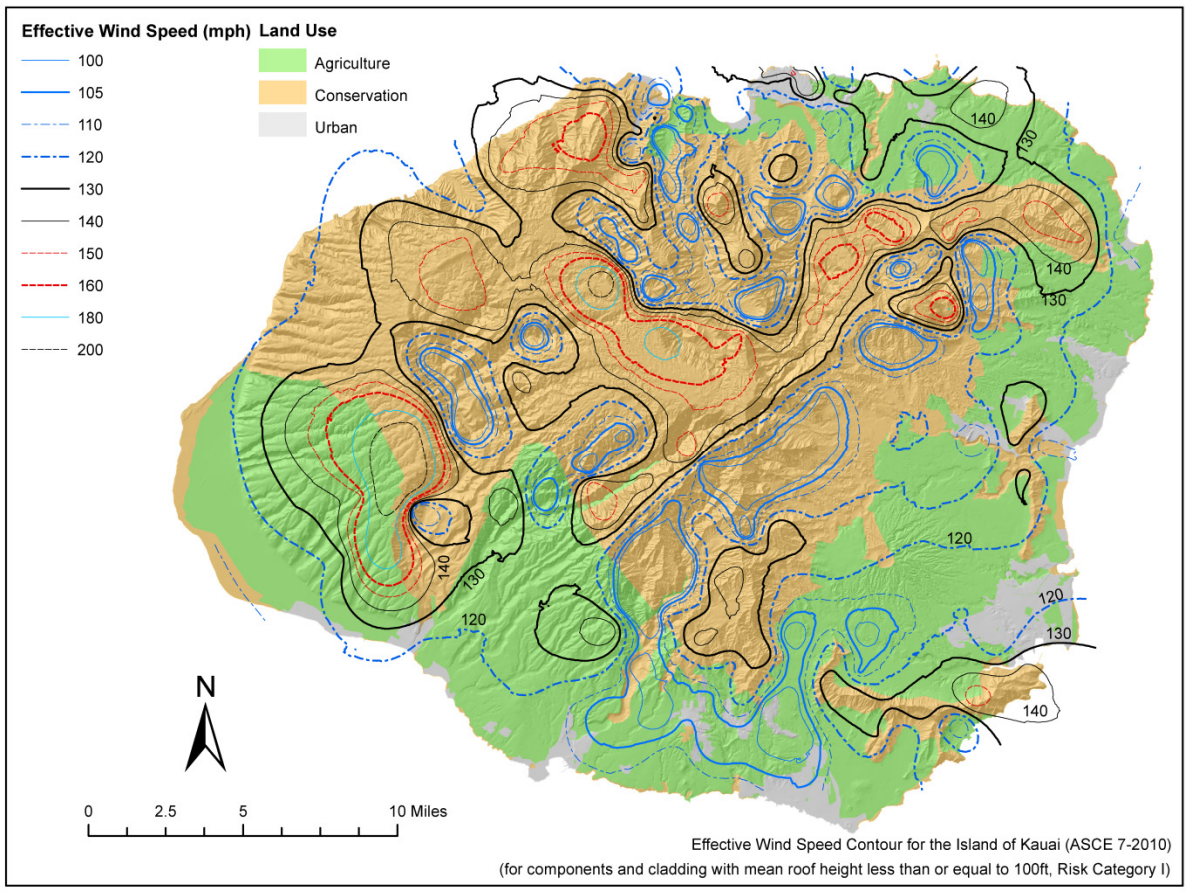


Figure 1609.3.2.1(f)
County of Kauai Effective Ultimate Wind Speed, $V_{eff\text{-}ult}$, for Components and Cladding for Risk Category I Buildings less than 100 feet Tall

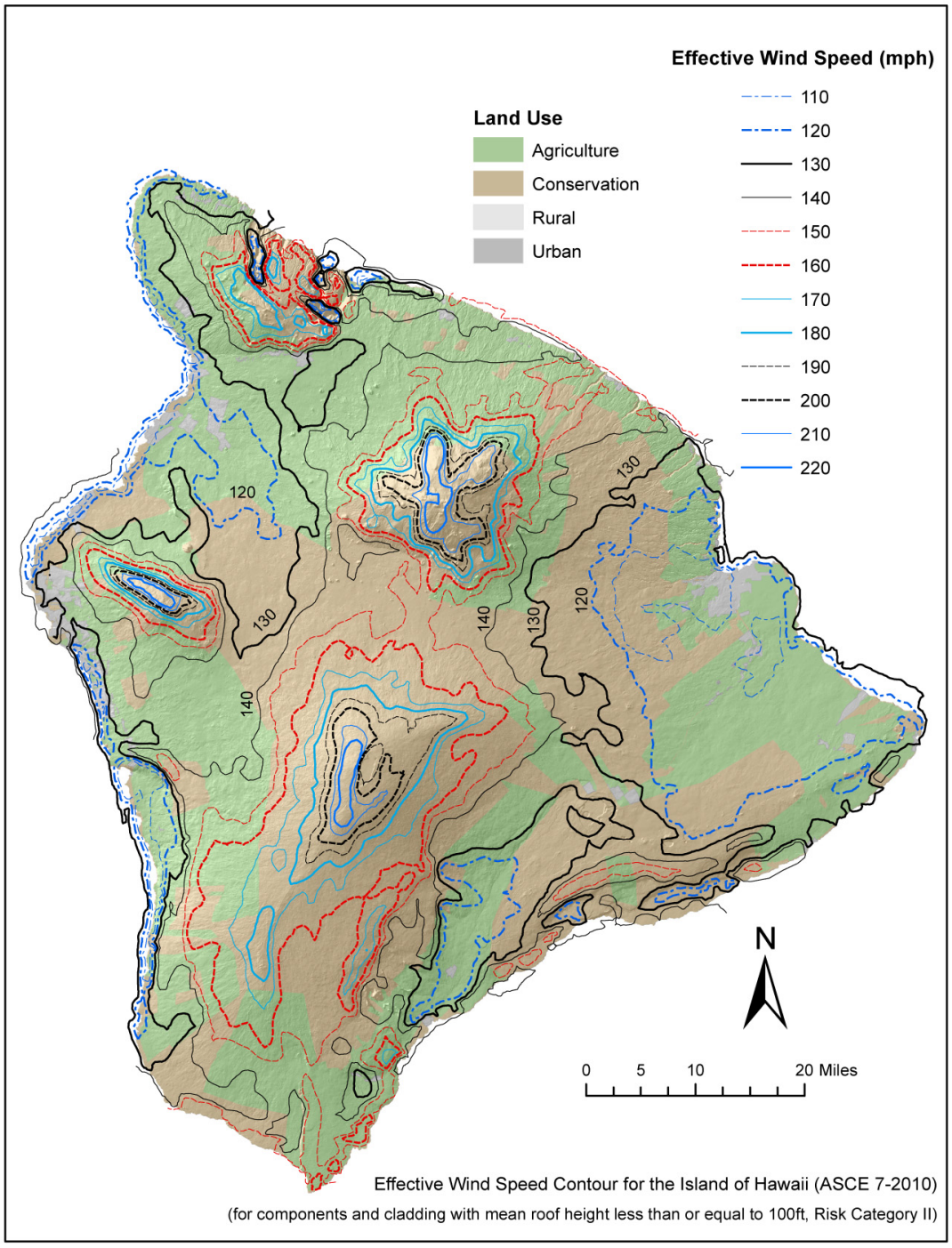


Figure 1609.3.2.2(a)
County of Hawaii Effective Ultimate Wind Speed, $V_{eff\text{-}ult}$, for Components and Cladding for Risk Category II Buildings less than 100 feet Tall

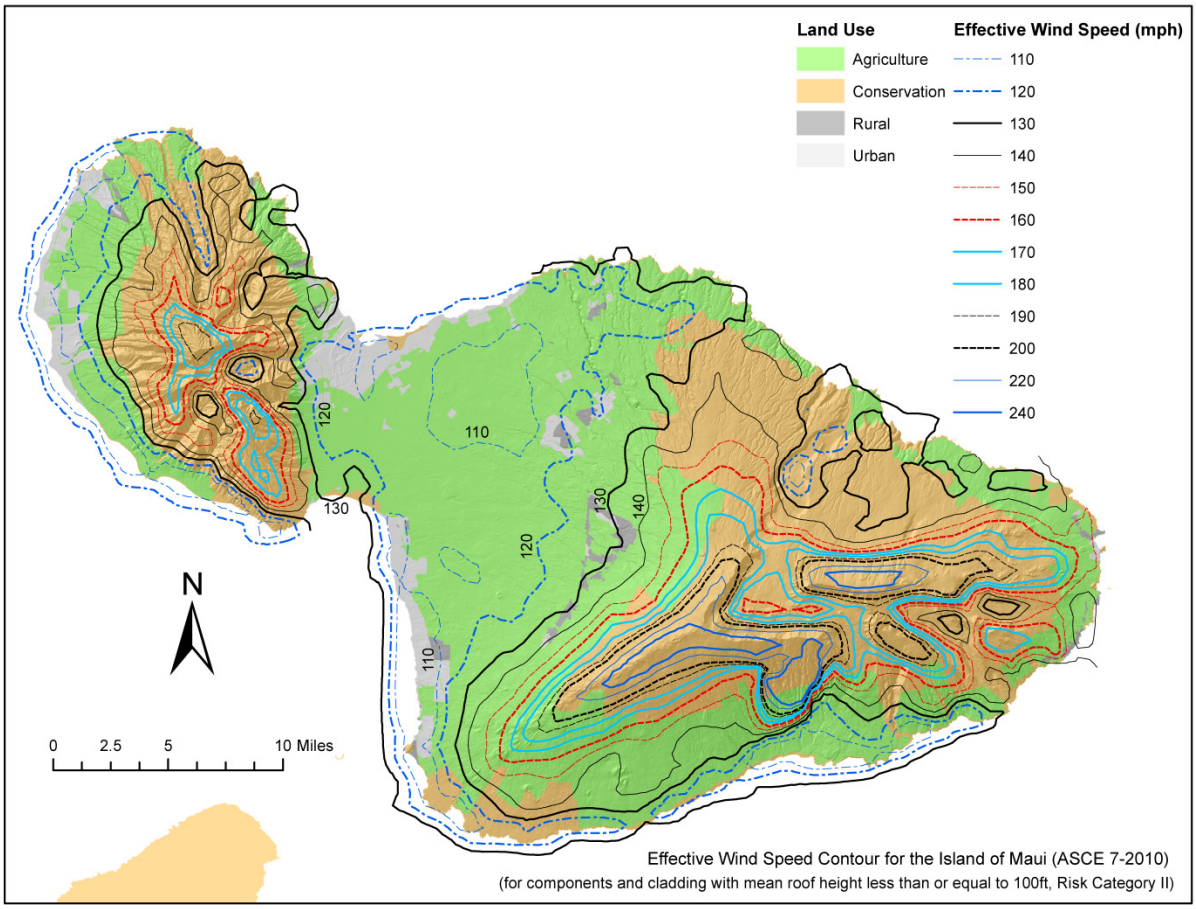


Figure 1609.3.2.1(b)
County of Maui, Island of Maui Effective Ultimate Wind Speed, $V_{eff\text{-}ult}$, for Components and Cladding for Risk Category II Buildings less than 100 feet Tall

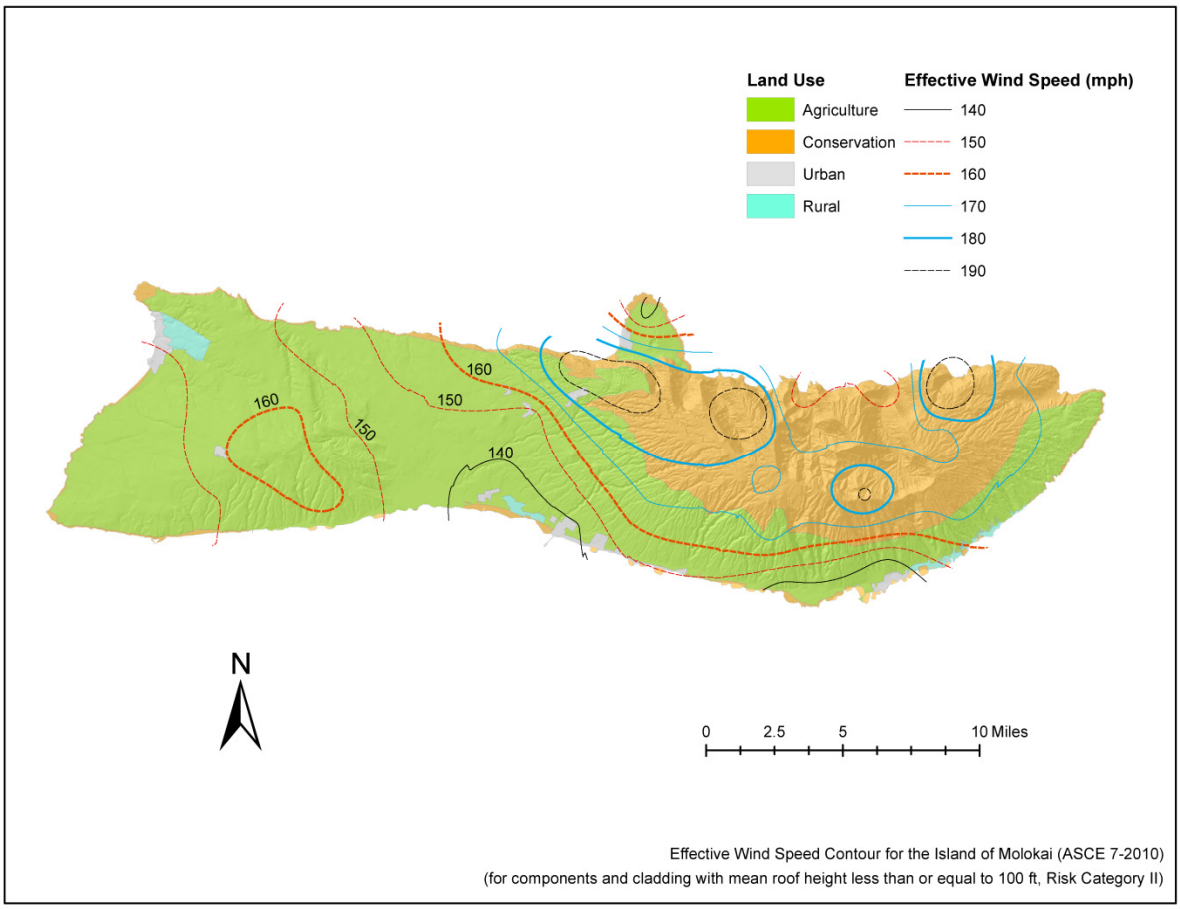


Figure 1609.3.2.2(c)
County of Maui, Island of Molokai Effective Ultimate Wind Speed, $V_{eff\text{-}ult}$, for Components and Cladding for Risk Category II Buildings less than 100 feet Tall

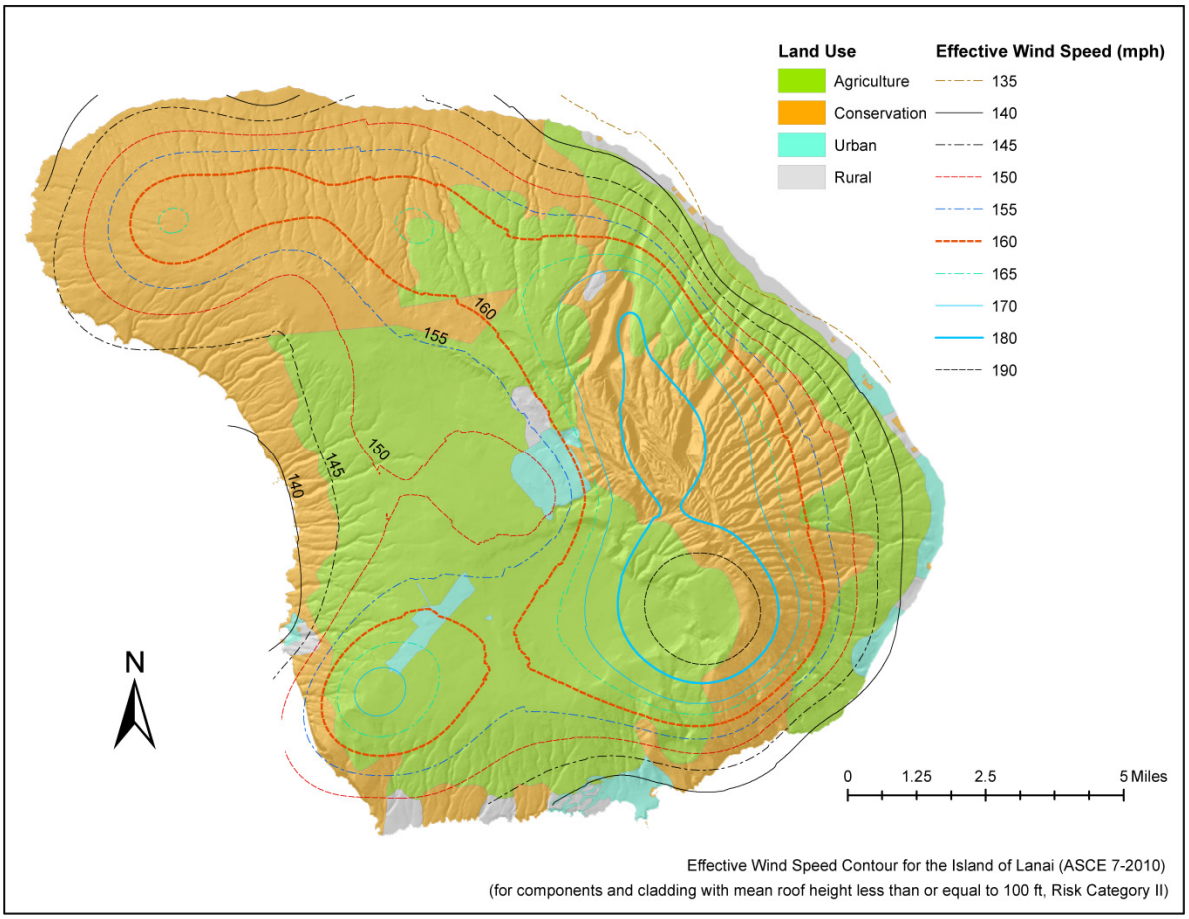
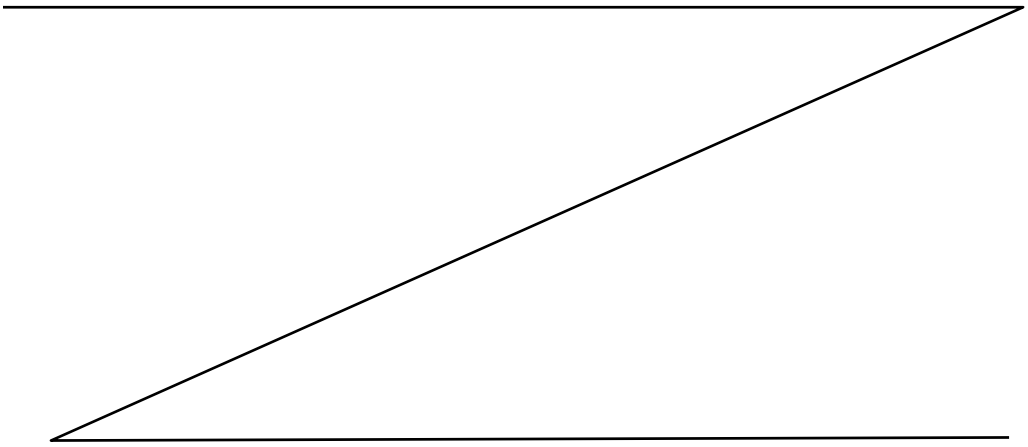


Figure 1609.3.2.2(d)
County of Maui, Island of Lanai Effective Ultimate Wind Speed, $V_{eff\text{-}ult}$, for Components and Cladding for Risk Category II Buildings less than 100 feet Tall



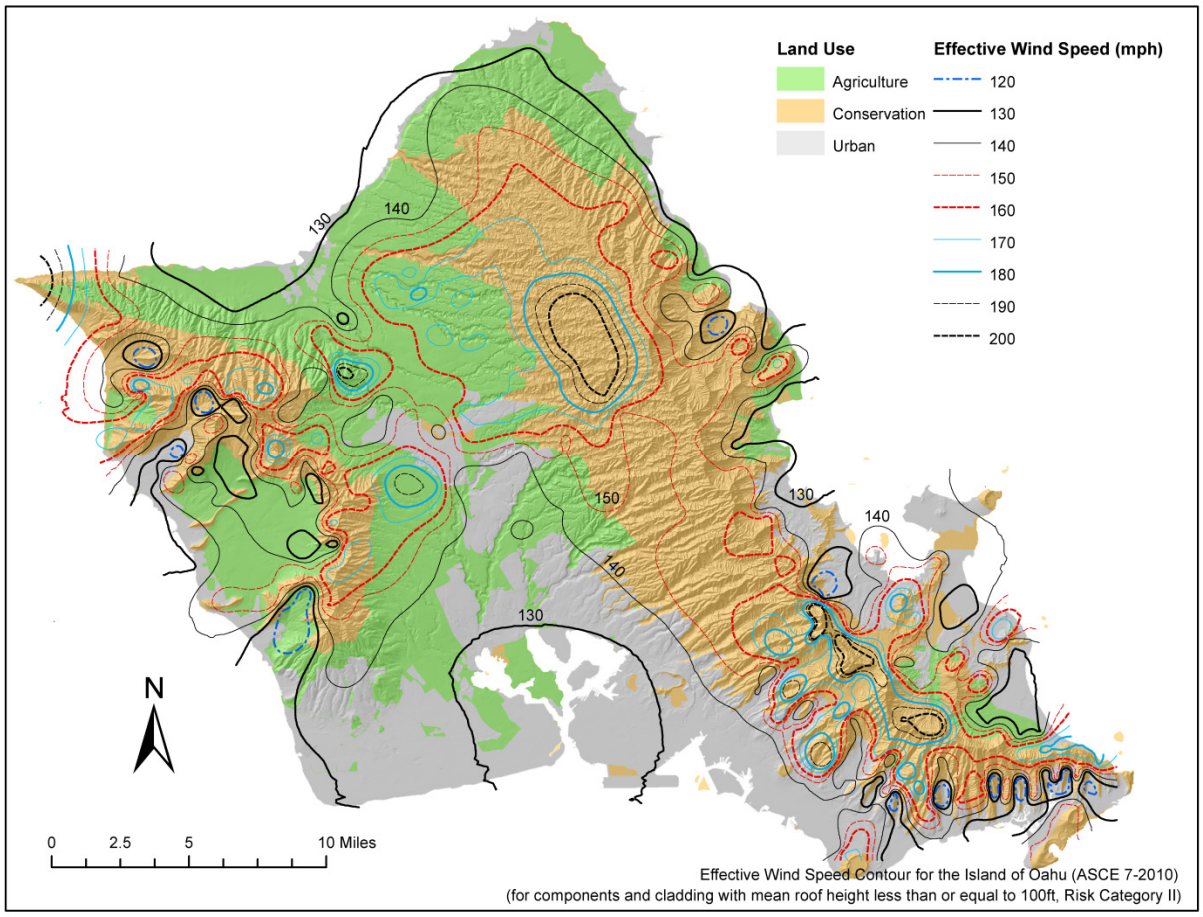


Figure 1609.3.2.2(e)
City and County of Honolulu Effective Ultimate Wind Speed, $V_{eff\text{-}ult}$, for Components and Cladding for Risk Category II Buildings less than 60 feet Tall

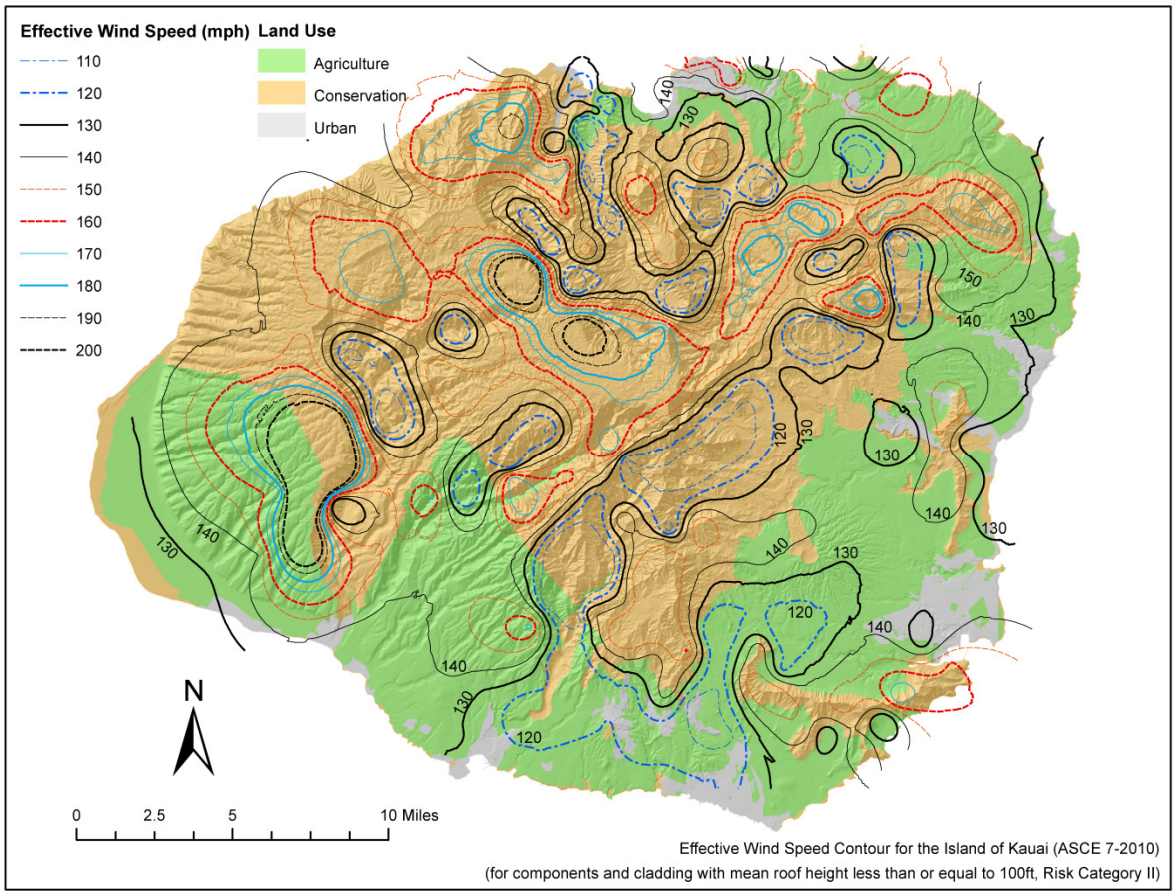
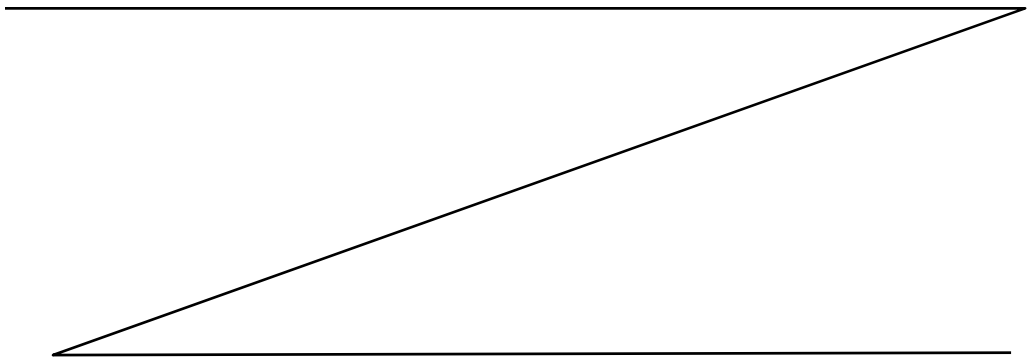


Figure 1609.3.2.2(f)
County of Kauai Effective Ultimate Wind Speed, $V_{eff\text{-}ult}$, for Components and Cladding for Risk Category II Buildings less than 100 feet Tall



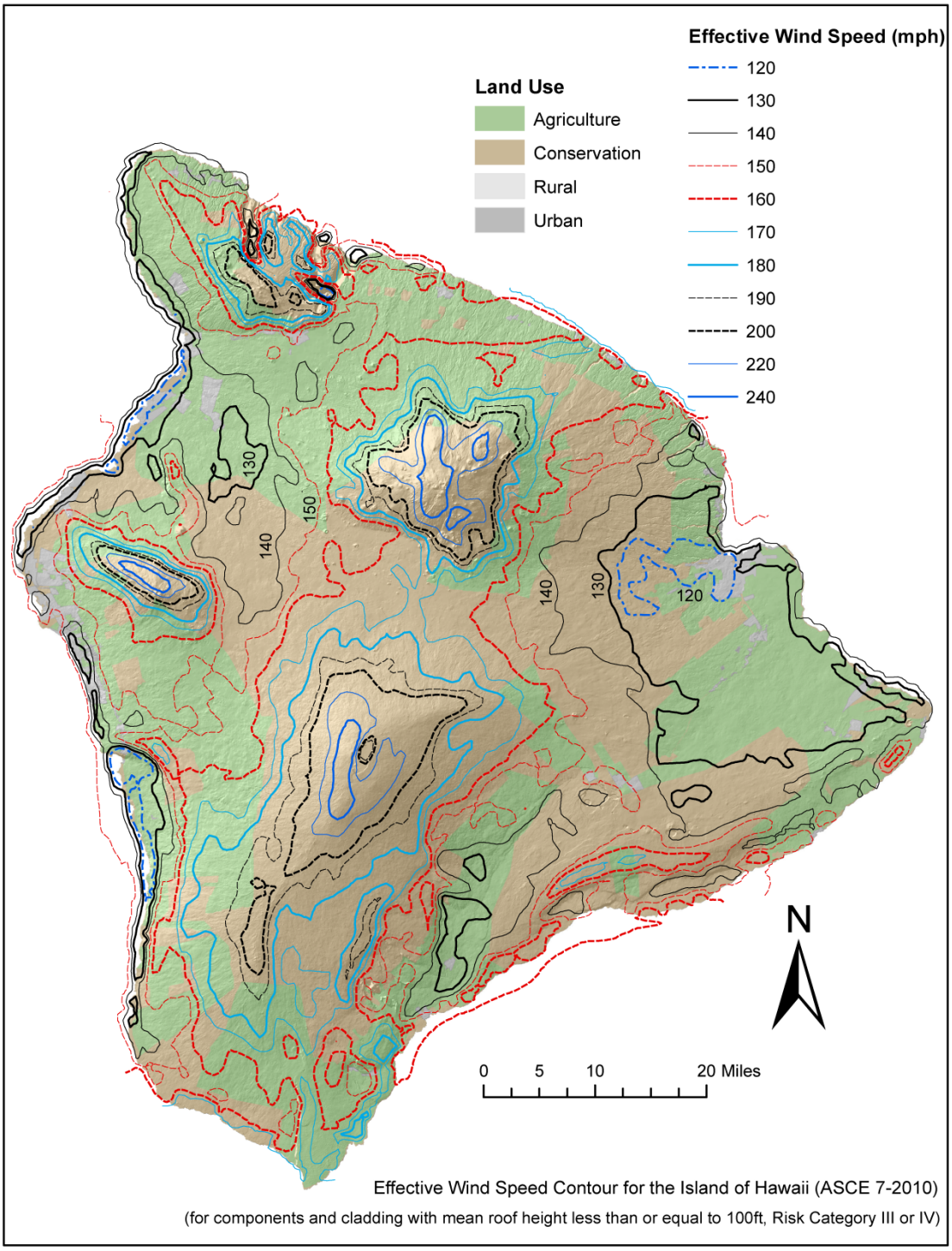


Figure 1609.3.2.3(a)
County of Hawaii Effective Ultimate Wind Speed, $V_{eff\text{-}ult}$, for Components and Cladding for Risk Category III and IV Buildings less than 100 feet Tall

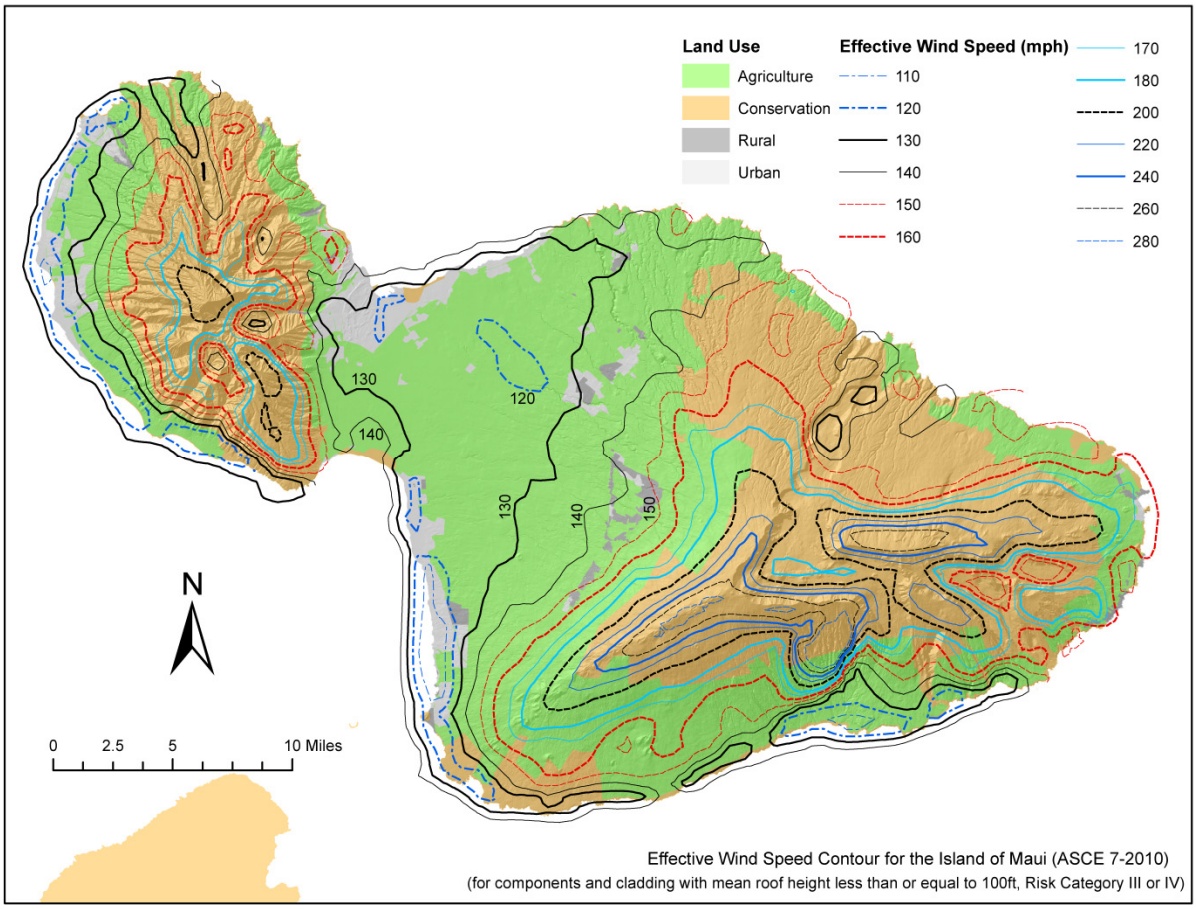


Figure 1609.3.2.3(b)
County of Maui, Island of Maui Effective Ultimate Wind Speed, $V_{eff\text{-}ult}$, for Components and Cladding for Risk Category III and IV Buildings less than 100 feet Tall

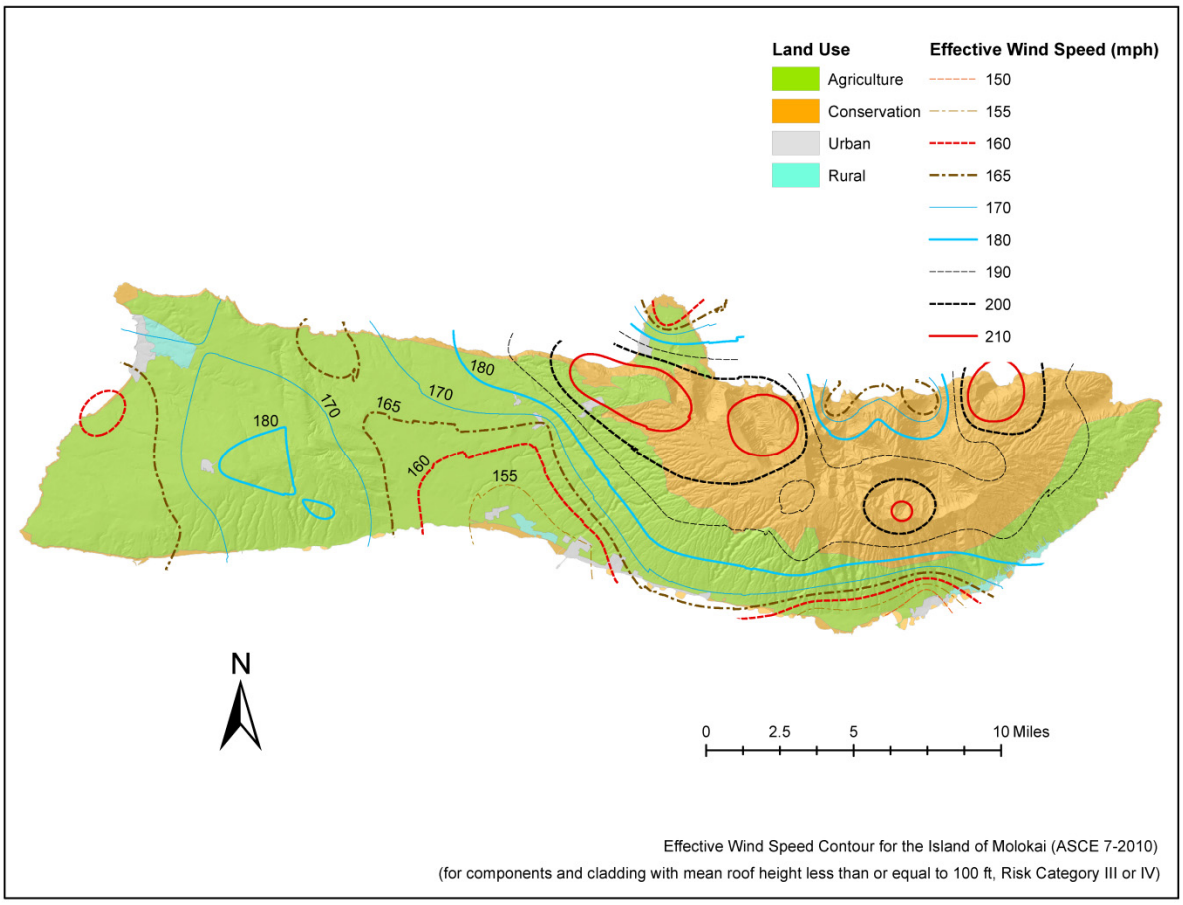


Figure 1609.3.2.3(c)
County of Maui, Island of Molokai Effective Ultimate Wind Speed, $V_{eff\text{-}ult}$, for Components and Cladding for Risk Category III and IV Buildings less than 100 feet Tall

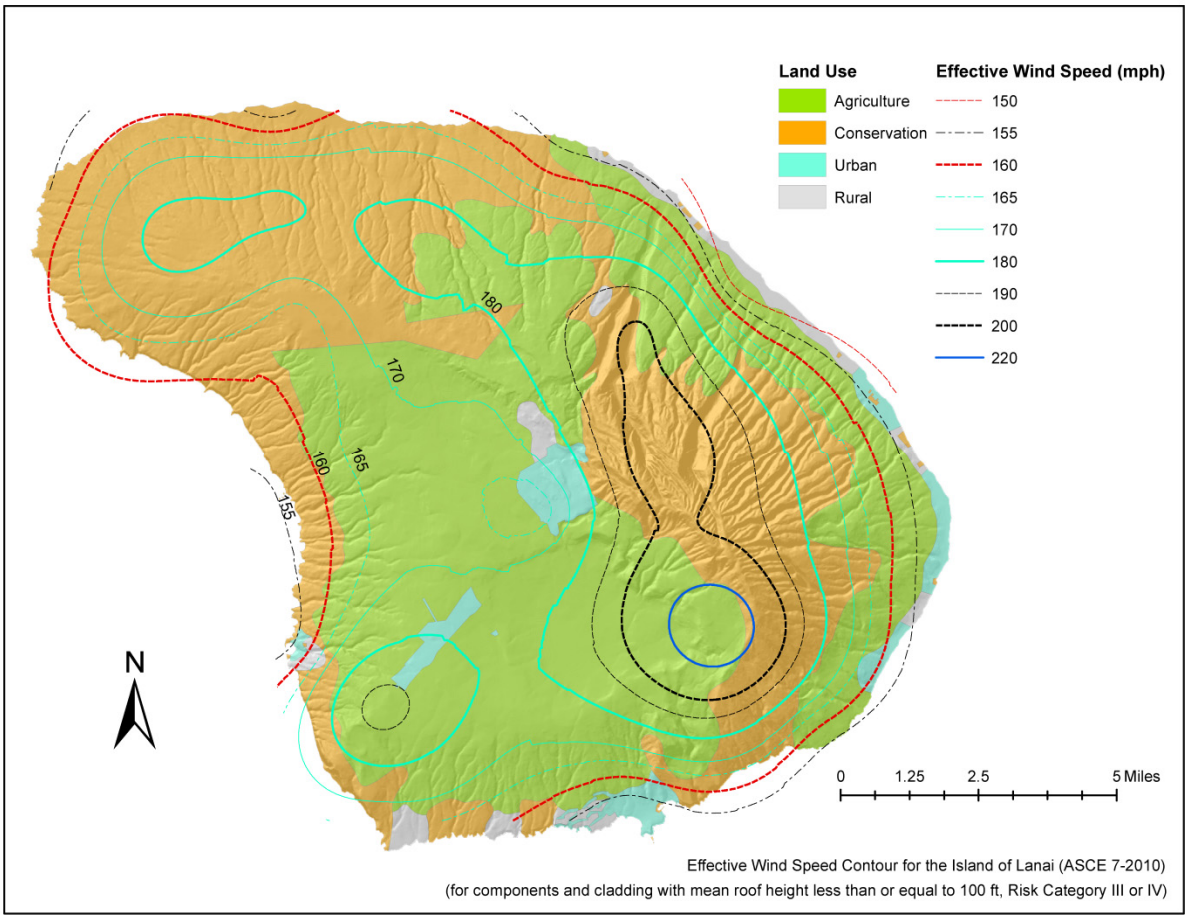
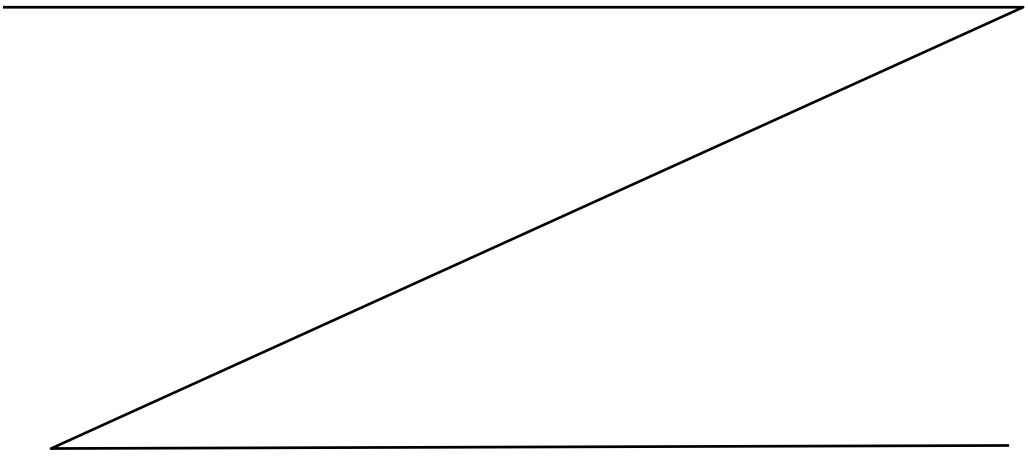


Figure 1609.3.2.3(d)
County of Maui, Island of Lanai Effective Ultimate Wind Speed, $V_{eff\text{-}ult}$, for Components and Cladding for Risk Category III and IV Buildings less than 100 feet Tall



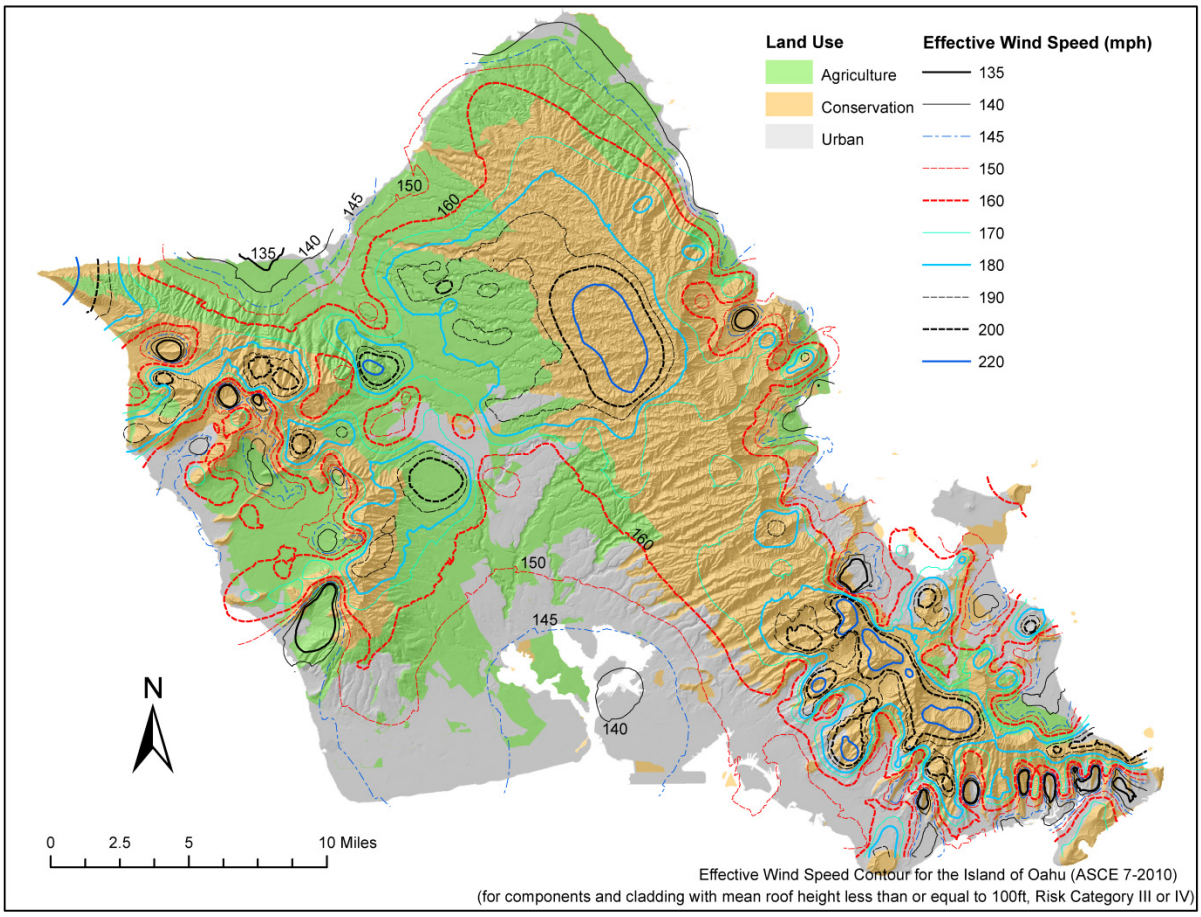


Figure 1609.3.2.3(e)
City and County of Honolulu Effective Ultimate Wind Speed, $V_{eff\text{-}ult}$, for Components and Cladding for Risk Category III and IV Buildings less than 60 feet Tall

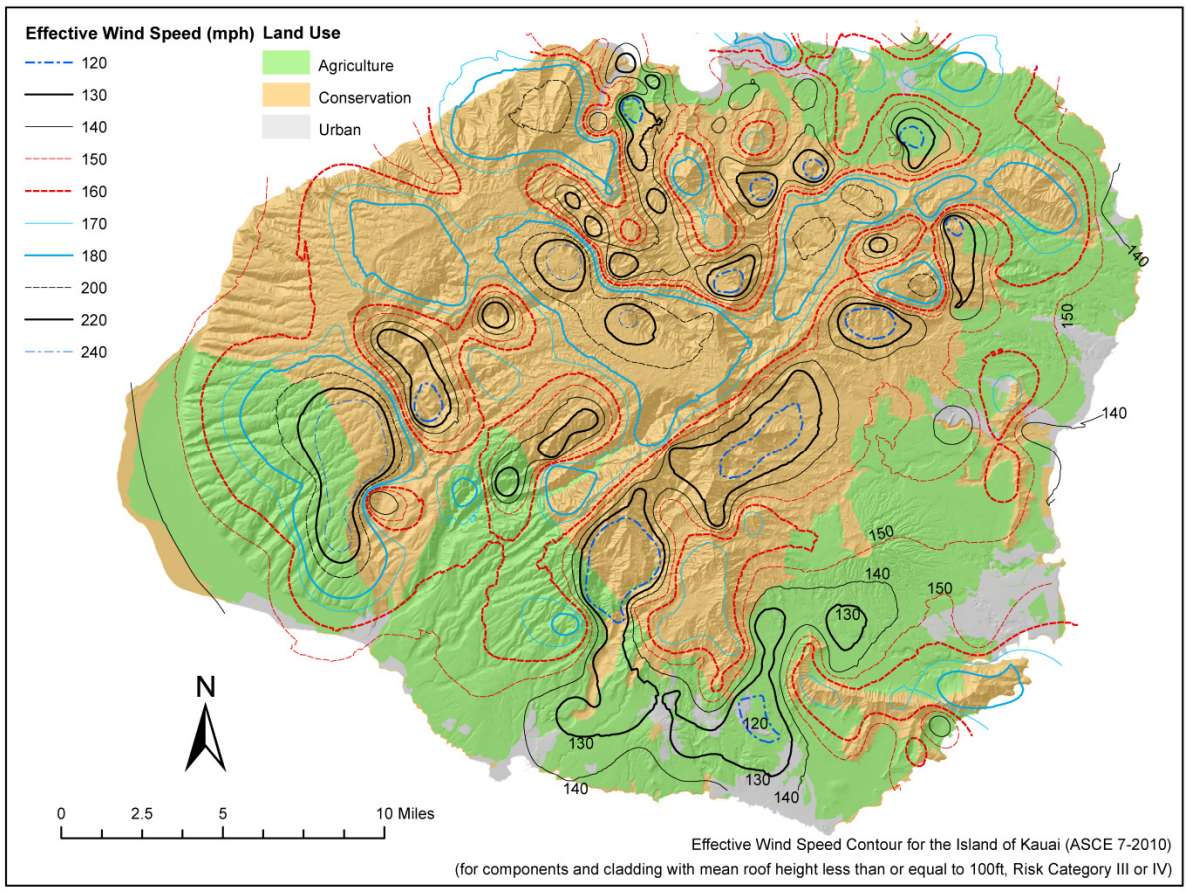
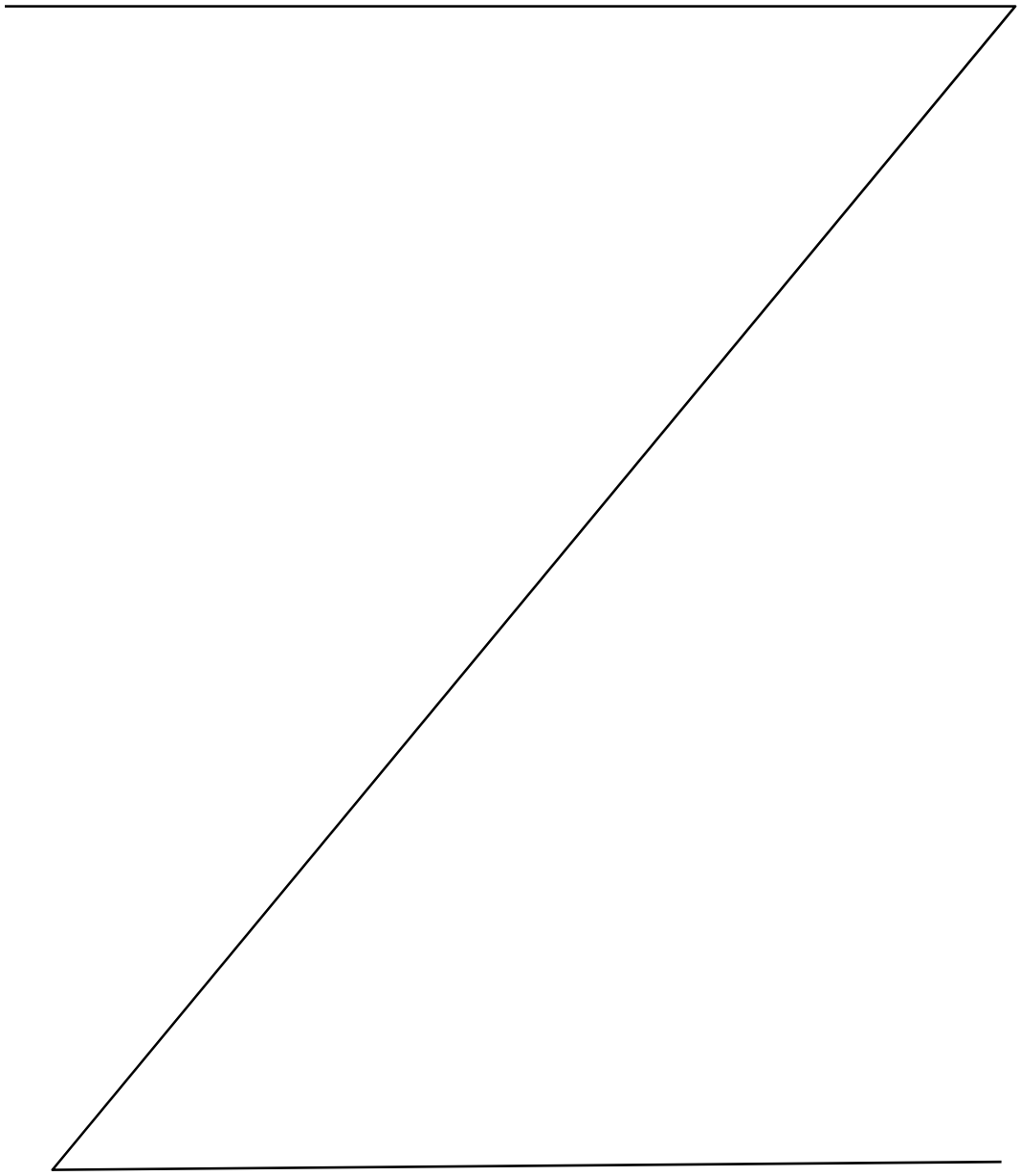


Figure 1609.3.2.3(f)
County of Kauai Effective Ultimate Wind Speed, $V_{eff\text{-}ult}$, for Components and Cladding for Risk Category III and IV Buildings less than 100 feet Tall

W101.9 Addition of section 1609.3.3.
Section 1609.3.3 is added to read as follows:

1609.3.3 Topographic effects. Wind speed-up effects caused by topography shall be included in the calculation of wind loads by using the factor K_{zt}, where K_{zt} is given in Figures 1609.3.3(a) through 1609.3.3(f).

Exception: Site-specific probabilistic analysis of directional K_{zt} based on wind-tunnel testing of topographic speed-up shall be permitted to be submitted for approval by the building official.



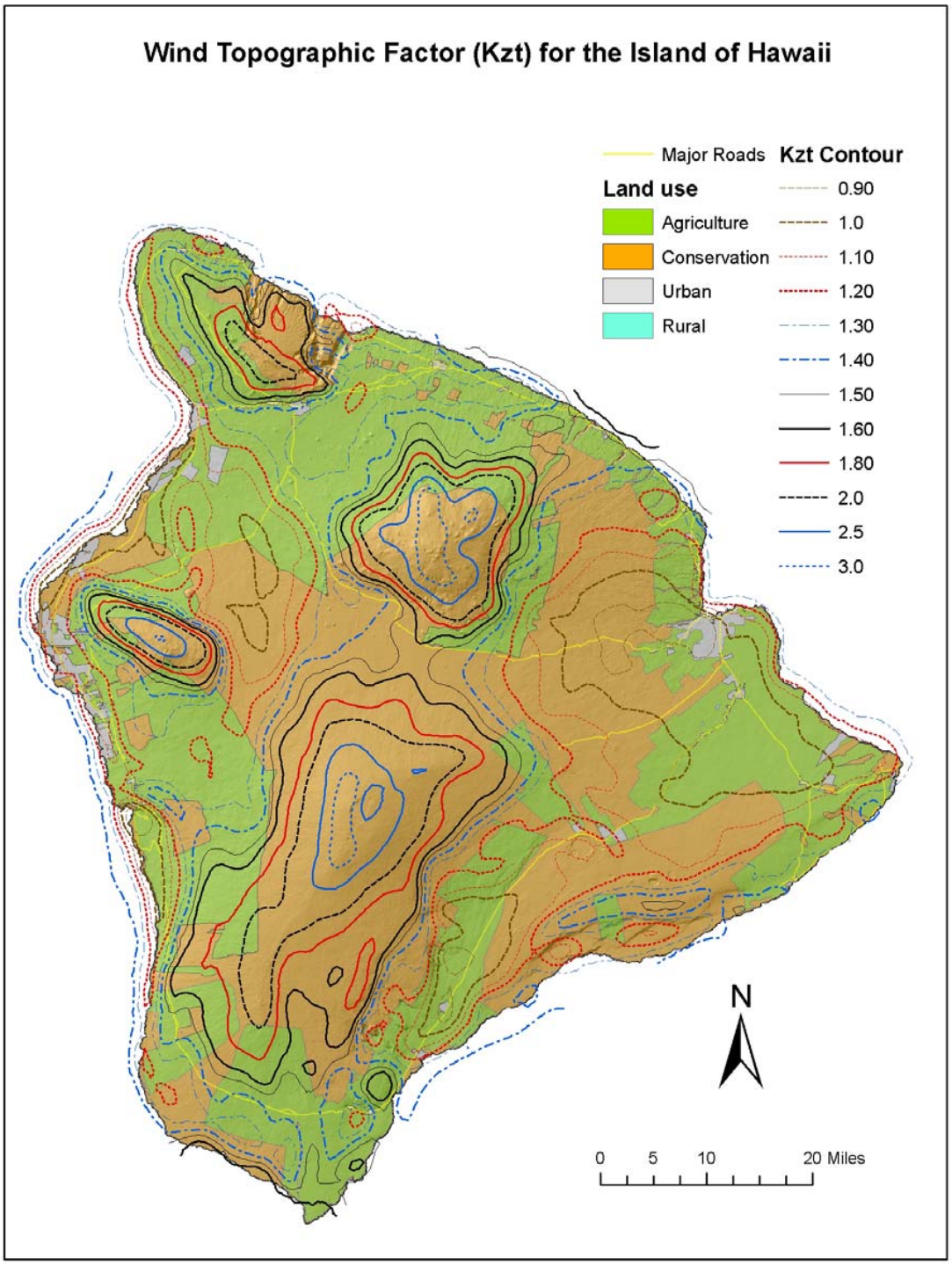


Figure 1609.3.3(a)
County of Hawaii Peak Gust Topographic Factor K_{zt}

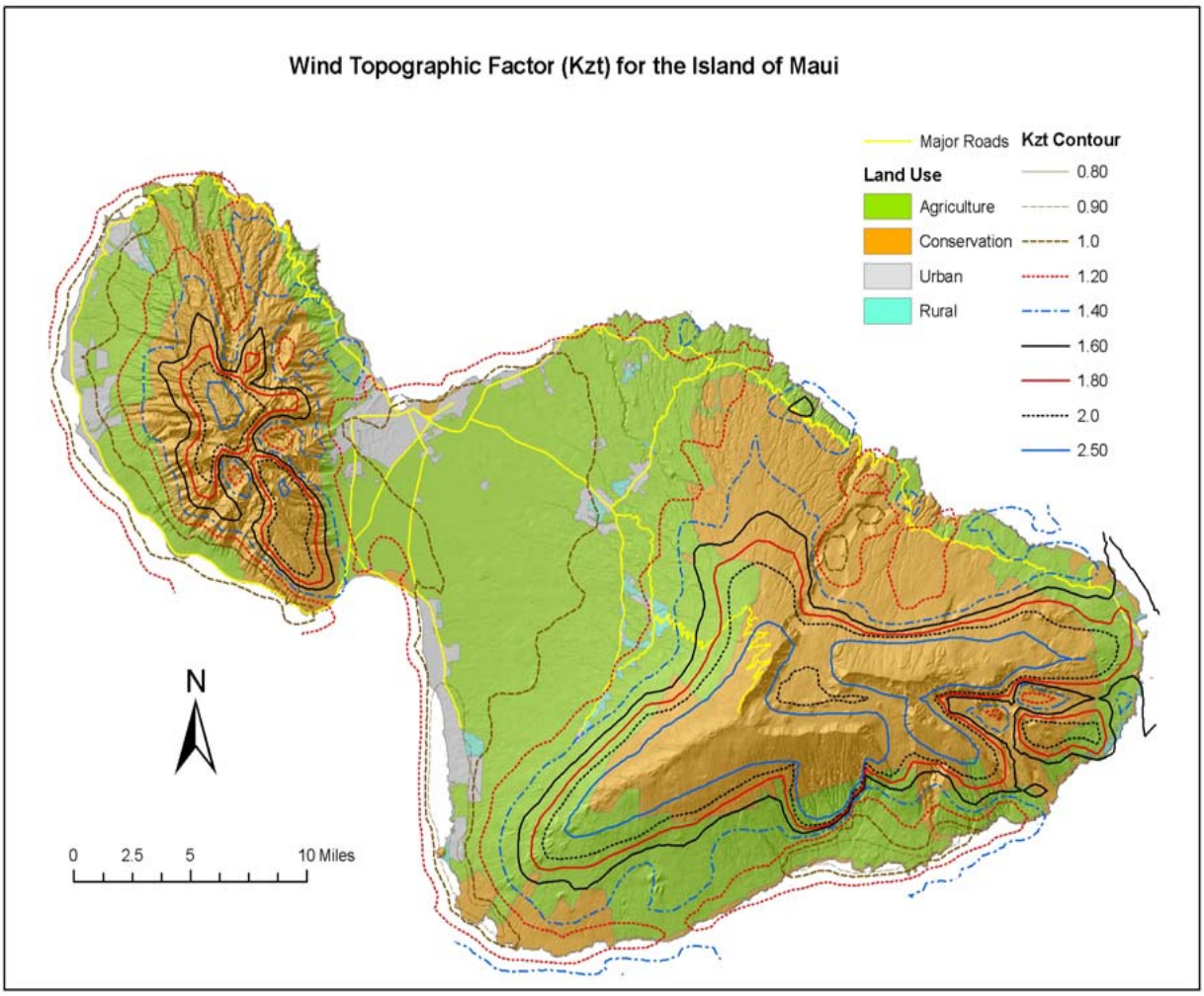


Figure 1609.3.3(b)
County of Maui, Island of Maui Peak Gust Topographic Factor K_{zt}

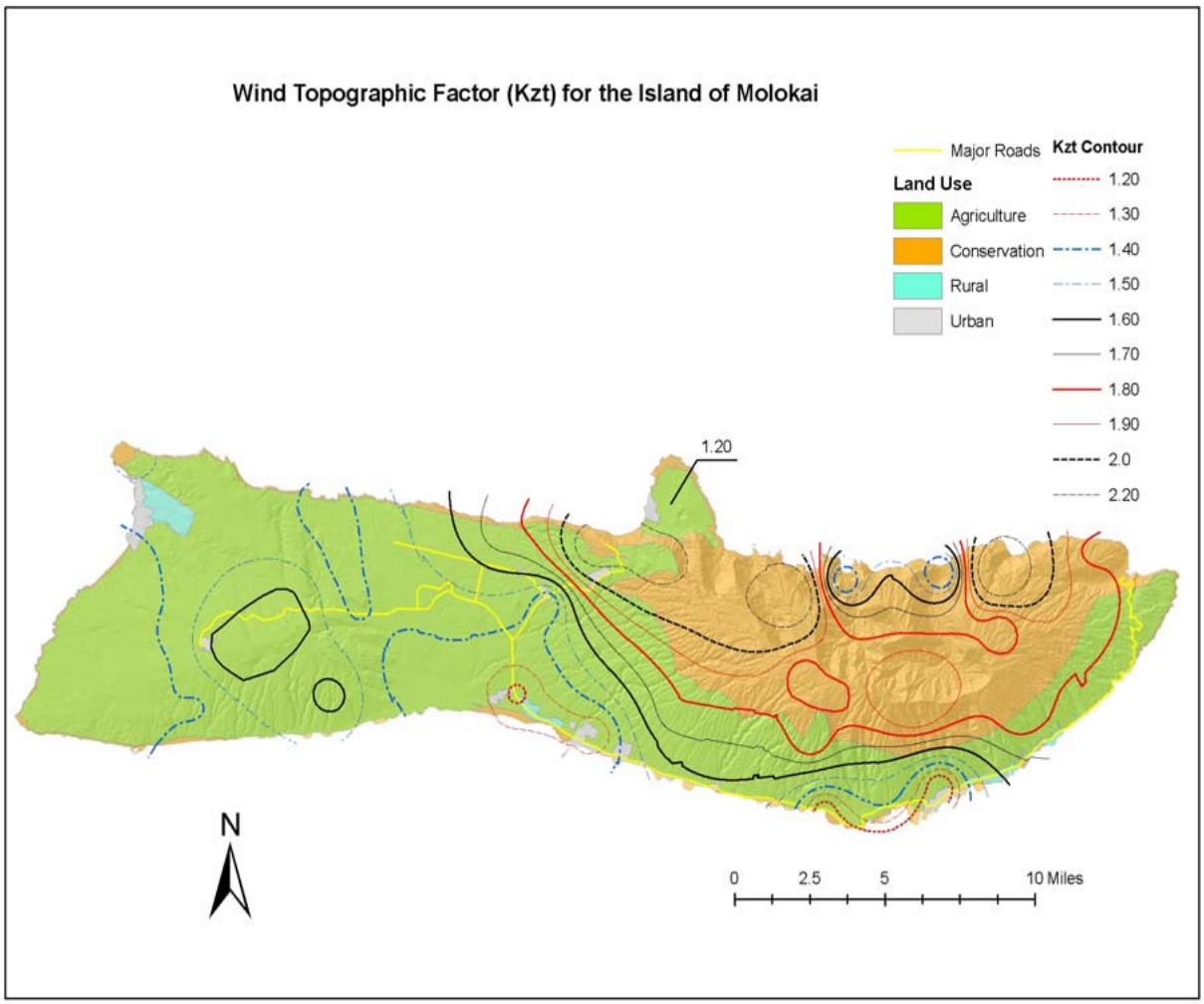


Figure 1609.3.3(c)
County of Maui, Island of Molokai Peak Gust Topographic Factor K_{zt}

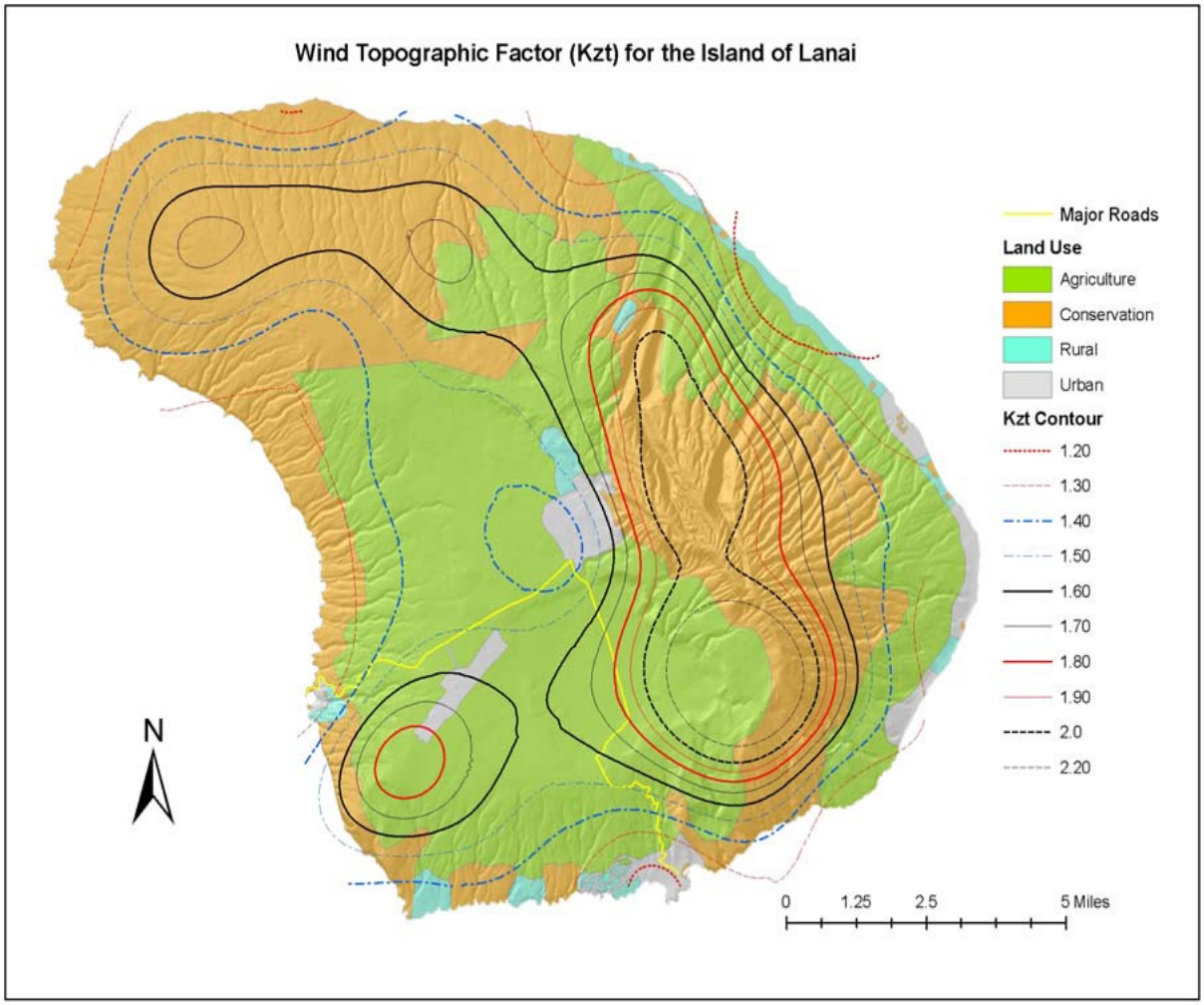


Figure 1609.3.3(d)
County of Maui, Island of Lanai Peak Gust Topographic Factor K_{zt}

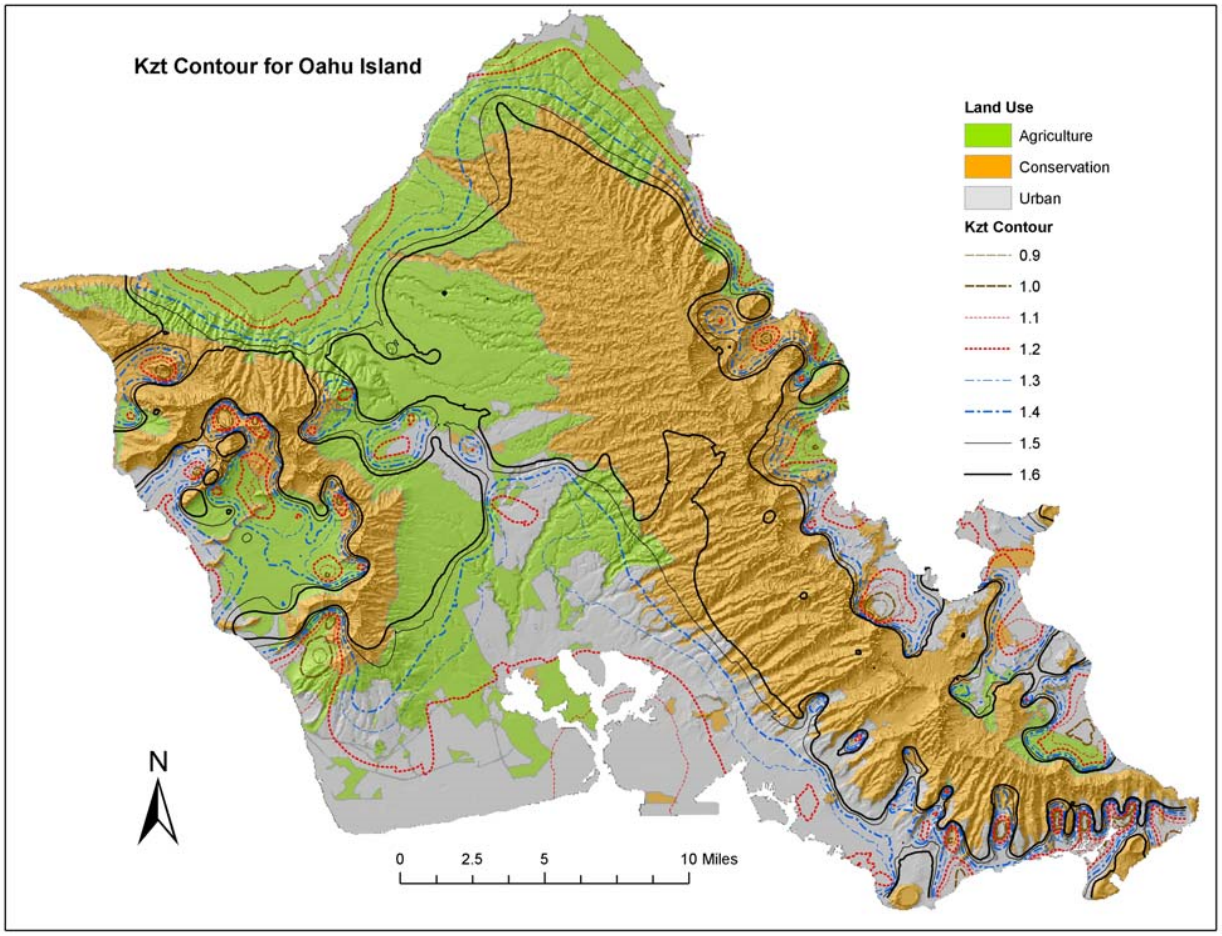


Figure 1609.3.3(e)
City and County of Honolulu Peak Topographic Factor K_{zt} for Building Heights up to 100 feet[a,b]

a. Site-specific probabilistic analysis of directional K_{zt} based on wind-tunnel testing of topographic speed-up shall be permitted to be submitted for approval by the building official. For buildings taller than 160 feet, this submittal shall include peak gust velocity profiles for all wind direction sectors.

b. At Exposure B sites with ground elevations less than 500 feet, K_{zt} values ≥1.2 shall be permitted to be reduced for building heights greater than 100 feet by multiplying K_{zt} mapped in Figure 1609.3.3(e) by the height adjustments given in the Table 1609.3.3(e)2. Interpolation is permitted.

Table 1609.3.3(e)2
Height Adjustment of Mapped K_{zt} Values at Sites with Ground Elevation Less than 500 feet

Building roof height above ground (ft)	≤100	120	140	160	180	200	220	≥240
Adjustment factor to K_{zt} ≥1.2	100%	98%	96%	94%	92%	90%	92%	94%

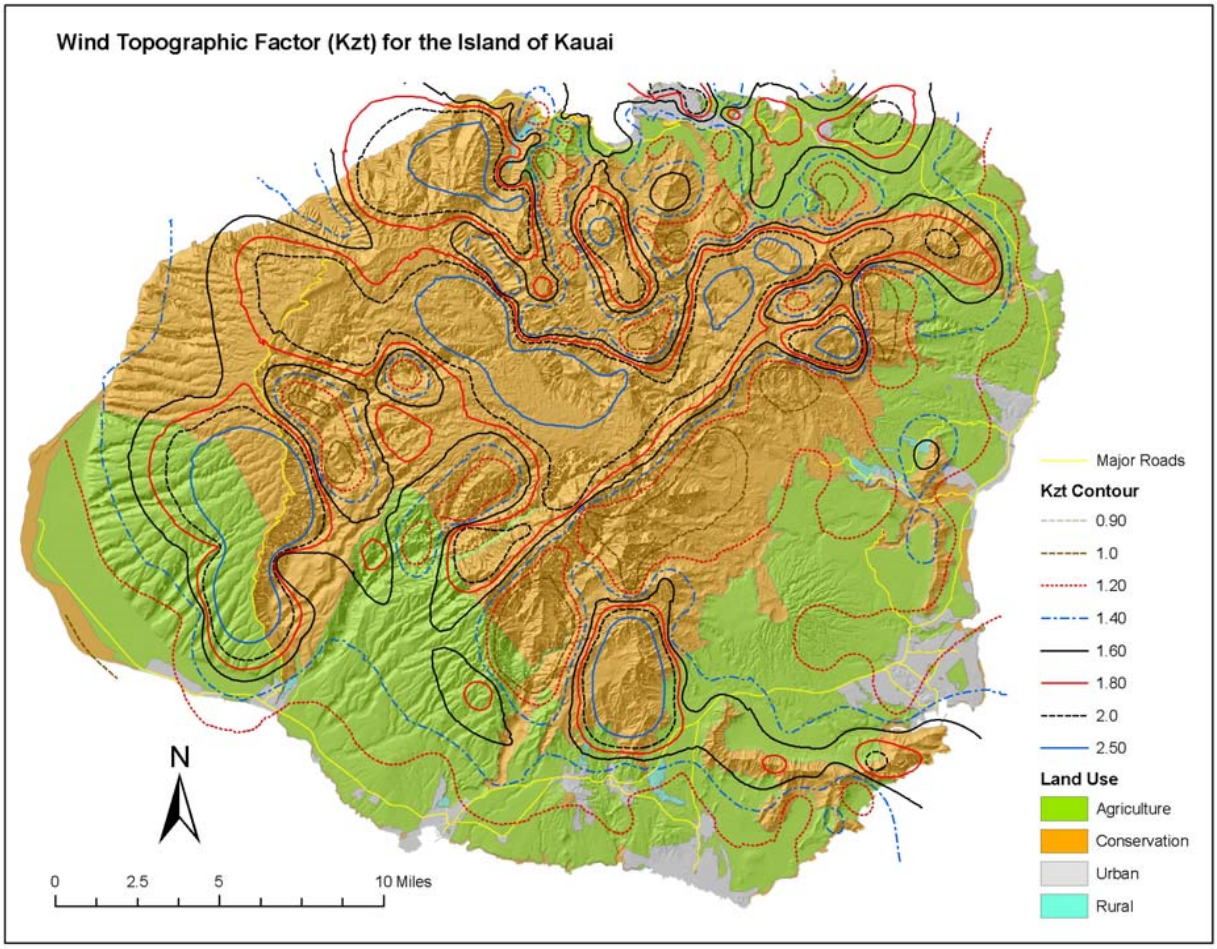


Figure 1609.3.3(f)
County of Kauai Peak Gust Topographic Factor K_{zt}

W101.10 Directionality factor.

Section 1609.3.4 is added to read as follows:

1609.3.4 Directionality factor. The wind directionality factor, K_d, shall be determined from Tables 1609.3.4(a)(1) through 1609.3.4(b)(1) through 1609.3.4(b)(3), and Figures 1609.3.4(a)(4) and 1609.3.4(b)(4).

Table 1609.3.4(a)(1)
K_d Values for Main Wind Force Resisting Systems Sited in Hawaii County [a,b]

Topographic Location on the Island of Hawaii	Main Wind Force Resisting Systems		Main Wind Force Resisting Systems with totally independent systems in each orthogonal direction		Biaxially Symmetric and Axisymmetric Structures of any Height and Arched Roof Structures
	Mean Roof Height less than or equal to 100 ft.	Mean Roof Height greater than 100 ft.	Mean Roof Height less than or equal to 100 ft.	Mean Roof Height greater than 100 ft.	
Sites in North Kohala, South Kohala, South Kona, South Hilo, and Puna Districts at an elevation not greater than 3000 ft.	0.65	0.70	0.70	0.75	0.85
All other sites	0.70	0.80	0.75	0.80	0.95

a. The values of K_d for other non-building structures indicated in ASCE-7 Table 26-4 shall be permitted.
b. Site-specific probabilistic analysis of K_d based on wind-tunnel testing of topography and peak gust velocity profile shall be permitted to be submitted for approval by the Building Official, but K_d shall have a value not less than 0.65.

Table 1609.3.4(a)(2)
K_d Values for Main Wind Force Resisting Systems Sited in Maui County [a,b]

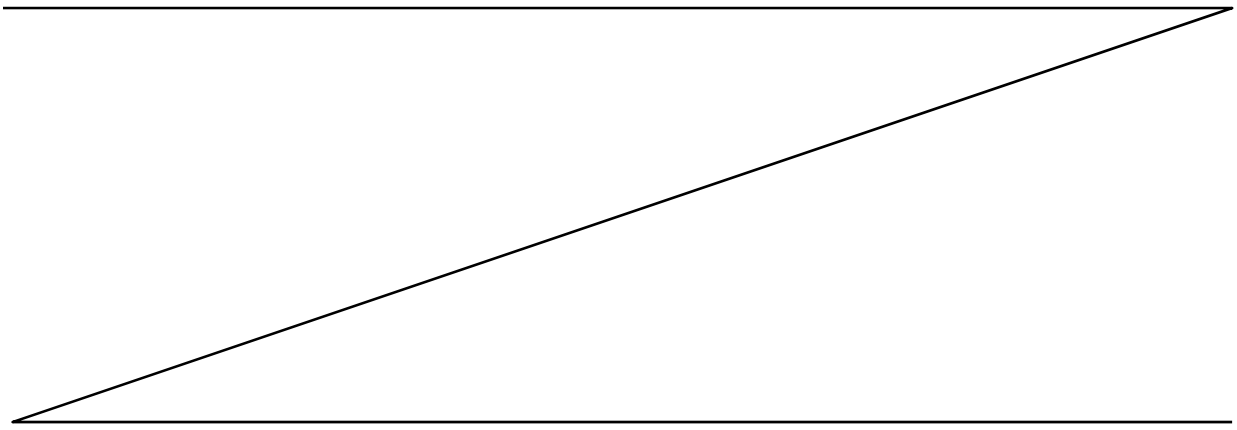
Topographic Location in the County of Maui	Main Wind Force Resisting Systems		Main Wind Force Resisting Systems with totally independent systems in each orthogonal direction		Biaxially Symmetric and Axisymmetric Structures of any Height and Arched Roof Structures
	Mean Roof Height less than or equal to 100 ft.	Mean Roof Height greater than 100 ft.	Mean Roof Height less than or equal to 100 ft.	Mean Roof Height greater than 100 ft.	
Sites on the Island of Maui at an elevation not greater than 1000 ft.	0.60	0.65	0.70	0.75	0.85
Sites on the Island of Maui at an elevation greater than 1000 ft.	0.65	.70	0.75	0.80	0.90
All other sites on the Islands of Molokai and Lanai	0.80	0.85	0.80	0.85	0.95

a. The values of K_d for other non-building structures indicated in ASCE-7 Table 26-4 shall be permitted.
b. Site-specific probabilistic analysis of K_d based on wind-tunnel testing of topography and peak gust velocity profile shall be permitted to be submitted for approval by the Building Official, but K_d shall have a value not less than 0.60.

Table 1609.3.4(a)(3)
K_d Values for Main Wind Force Resisting Systems Sited on Oahu, Hawaii[a,b]

Topographic Location on Oahu, Hawaii	Main Wind Force Resisting Systems		Main Wind Force Resisting Systems with totally independent systems in each orthogonal direction		Biaxially Symmetric and Axisymmetric Structures of any Height and Arched Roof Structures
	Mean Roof Height less than or equal to 100 ft.	Mean Roof Height greater than 100 ft.	Mean Roof Height less than or equal to 100 ft.	Mean Roof Height greater than 100 ft.	
Sites within valleys at an elevation of at least 50 ft. but not greater than 500 ft.	0.65	0.70	0.70	0.75	0.85
Central Oahu above an elevation of 500 ft, the Ewa and Kapolei plains, and coastal areas with K_{zt} (10m) not greater than 1.2	0.75	0.80	0.75	0.80	0.95
All other areas, including Hills, Hillsides, Ridges, Bluffs, and Escarpments at any elevation or height; coastal and inland areas with K_{zt} (10m) greater than 1.2	0.70	0.75	0.75	0.80	0.90

a. The values of K_d for other non-building structures indicated in ASCE-7 Table 26-4 shall be permitted.
b. Site-specific probabilistic analysis of K_d based on wind-tunnel testing of topography and peak gust velocity profile shall be permitted to be submitted for approval by the Building Official, but K_d shall have a value not less than 0.65.



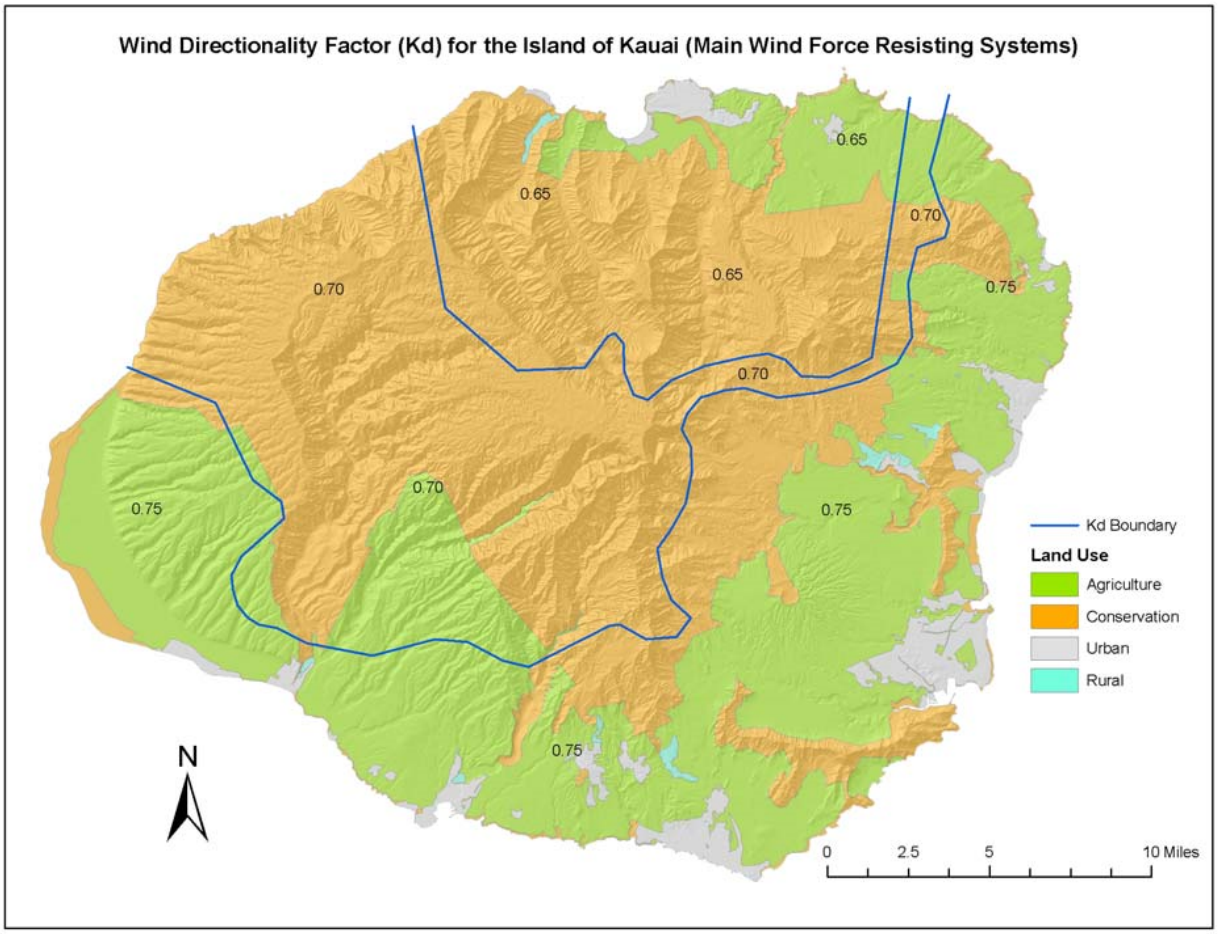


Figure 1609.3.4(a)(4)
K_d Values for Main Wind Force Resisting Systems Sited on Kauai County, Hawaii [a,b]

a. The values of K_d for other non-building structures indicated in ASCE-7 Table 26-4 shall be permitted.
b. Site-specific probabilistic analysis of K_d based on wind-tunnel testing of topography and peak gust velocity profile shall be permitted to be submitted for approval by the Building Official, but K_d shall have a value not less than 0.65.

Table 1609.3.4(b)(1)
K_d Values for Components and Cladding of Buildings Sited in Hawaii County [a,b]

Topographic Location on the Island of Hawaii	Components and Cladding		
	Mean Roof Height less than or equal to 100 ft.	Mean Roof Height greater than 100 ft.	Risk Category IV Buildings and Structures
Sites in North Kohala, South Kohala, South Kona, South Hilo, and Puna Districts at an elevation not greater than 3000 ft.	0.65	0.70	0.75
All other sites	0.75	0.80	0.85

a. The values of K_d for other non-building structures indicated in ASCE-7 Table 26-4 shall be permitted.
b. Site-specific probabilistic analysis of K_d based on wind-tunnel testing of topography and peak gust velocity profile shall be permitted to be submitted for approval by the Building Official, but in any case subject to a minimum value of 0.65.

Table 1609.3.4(b)(2)
K_d Values for Components and Cladding of Buildings Sited in Maui County [a,b]

Topographic Location on the County of Maui	Components and Cladding		
	Mean Roof Height less than or equal to 100 ft.	Mean Roof Height greater than 100 ft.	Risk Category IV Buildings and Structures
Sites on the Island of Maui at an elevation not greater than 1000 ft	0.65	0.70	0.75
Sites on the Island of Maui at an elevation greater than 1000 ft.	0.70	0.75	0.85
All other sites on the Islands of Molokai and Lanai	0.80	0.85	0.85

a. The values of K_d for other non-building structures indicated in ASCE-7 Table 26-4 shall be permitted.
b. Site-specific probabilistic analysis of K_d based on wind-tunnel testing of topography and peak gust velocity profile shall be permitted to be submitted for approval by the Building Official, but in any case subject to a minimum value of 0.65.

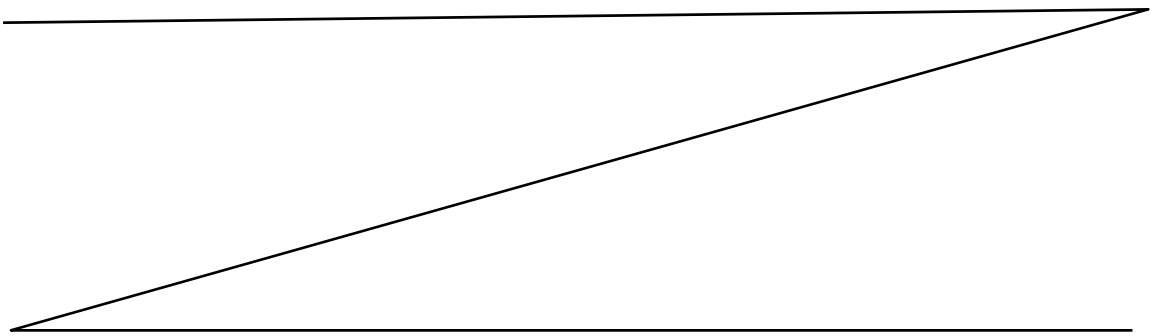
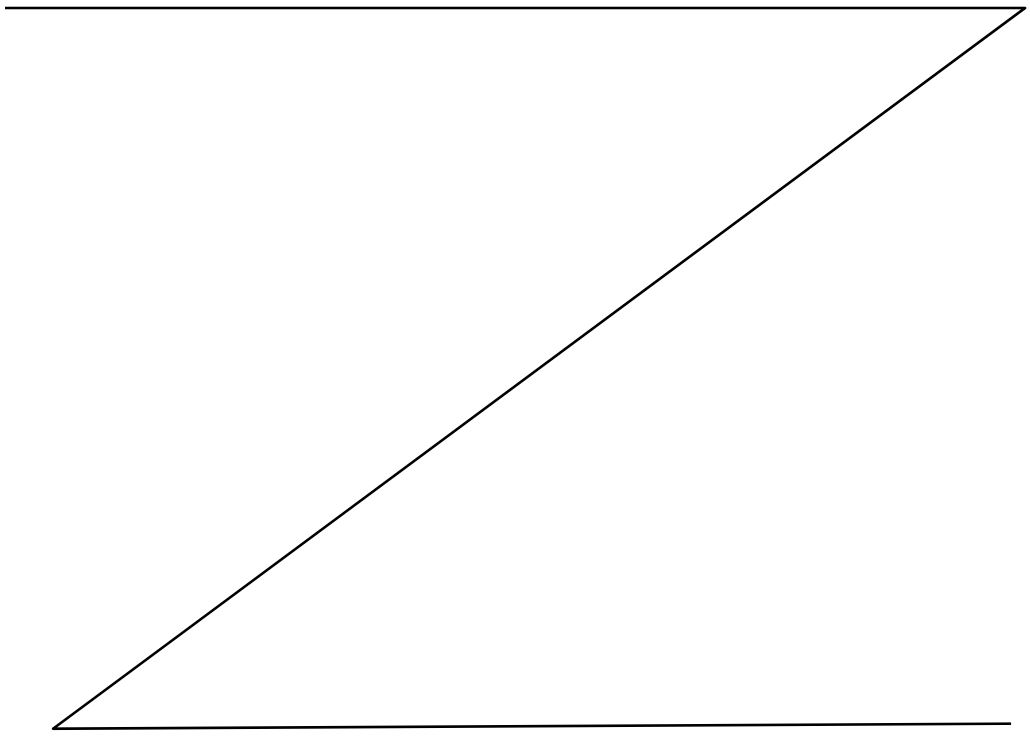


Table 1609.3.4(b)(3)
K_d Values for Components and Cladding of Buildings Sited on Oahu, Hawaii [a,b]

Topographic Location on Oahu	Components and Cladding		
	Mean Roof Height less than or equal to 100 ft.	Mean Roof Height greater than 100 ft.	Risk Category IV Buildings and Structures
Sites within valleys at an elevation of at least 50 ft. but not greater than 500 ft.	0.65	0.70	0.75
Central Oahu above an elevation of 500 ft, the Ewa and Kapolei plains, and coastal areas with K_{zt} (10m) not greater than 1.2	0.75	0.80	0.85
All other areas, including Hills, Hillsides, Ridges, Bluffs, and Escarpments at any elevation or height; coastal and inland areas with K_{zt} (10m) greater than 1.2	0.70	0.75	0.80

a. The values of K_d for other non-building structures indicated in ASCE-7 Table 26-4 shall be permitted.
b. Site-specific probabilistic analysis of K_d based on wind-tunnel testing of topography and peak gust velocity profile shall be permitted to be submitted for approval by the Building Official, but in any case subject to a minimum value of 0.65.



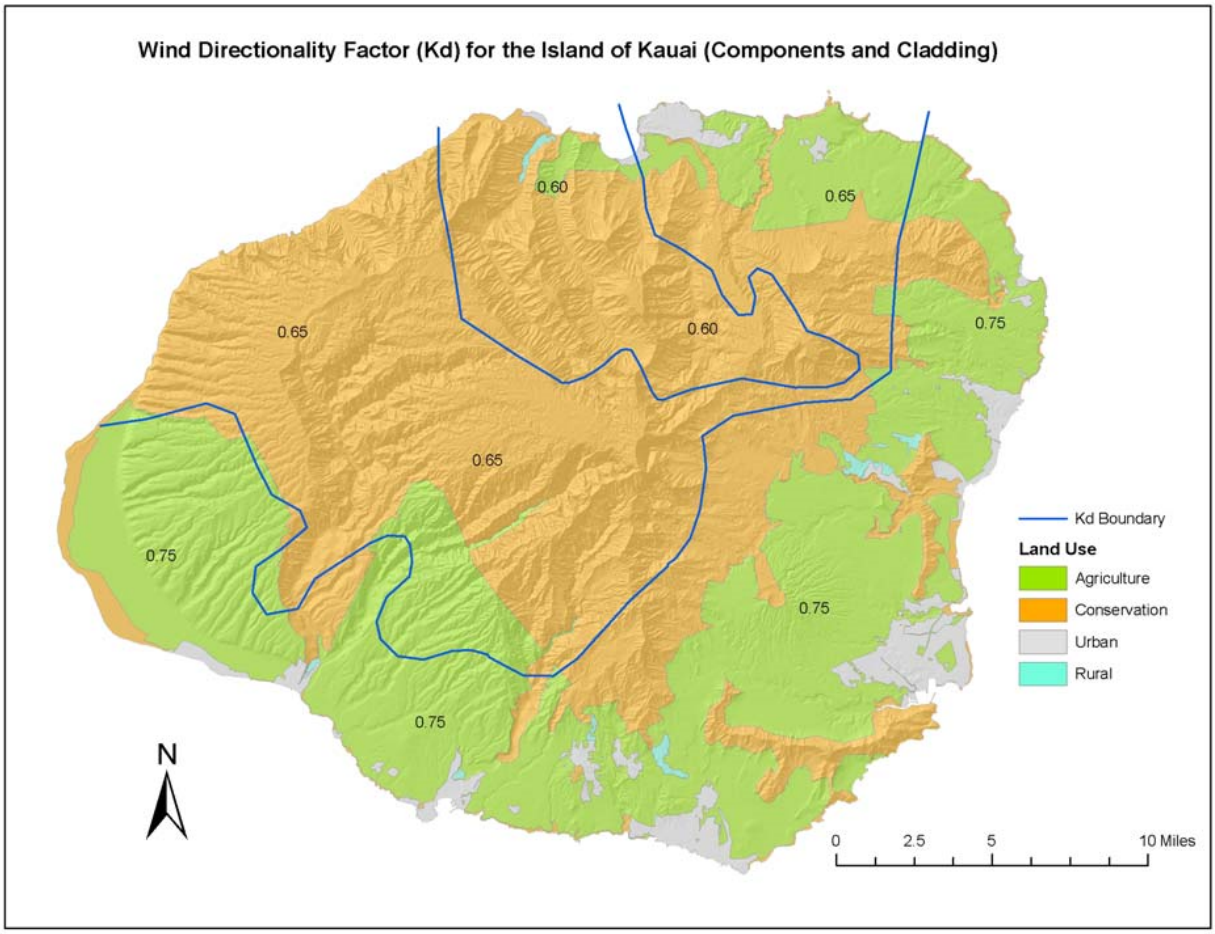


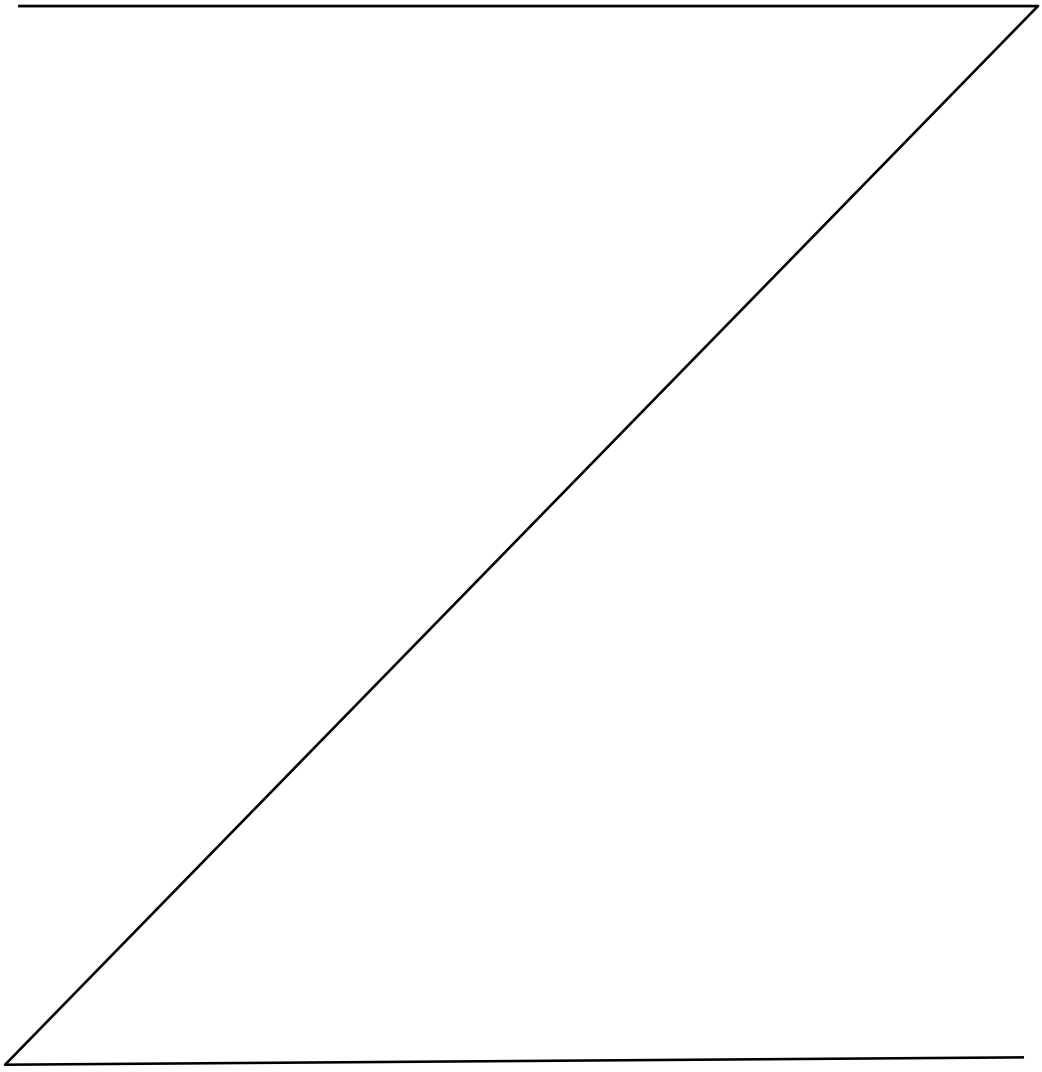
Figure 1609.3.4(b)(4)
K_d Values for Components and Cladding of Buildings Sited on Kauai County, Hawaii [a,b]

a. The values of K_d for other non-building structures indicated in ASCE-7 Table 26-4 shall be permitted.
b. Site-specific probabilistic analysis of K_d based on wind-tunnel testing of topography and peak gust velocity profile shall be permitted to be submitted for approval by the Building Official, but K_d shall have a value not less than 0.65.

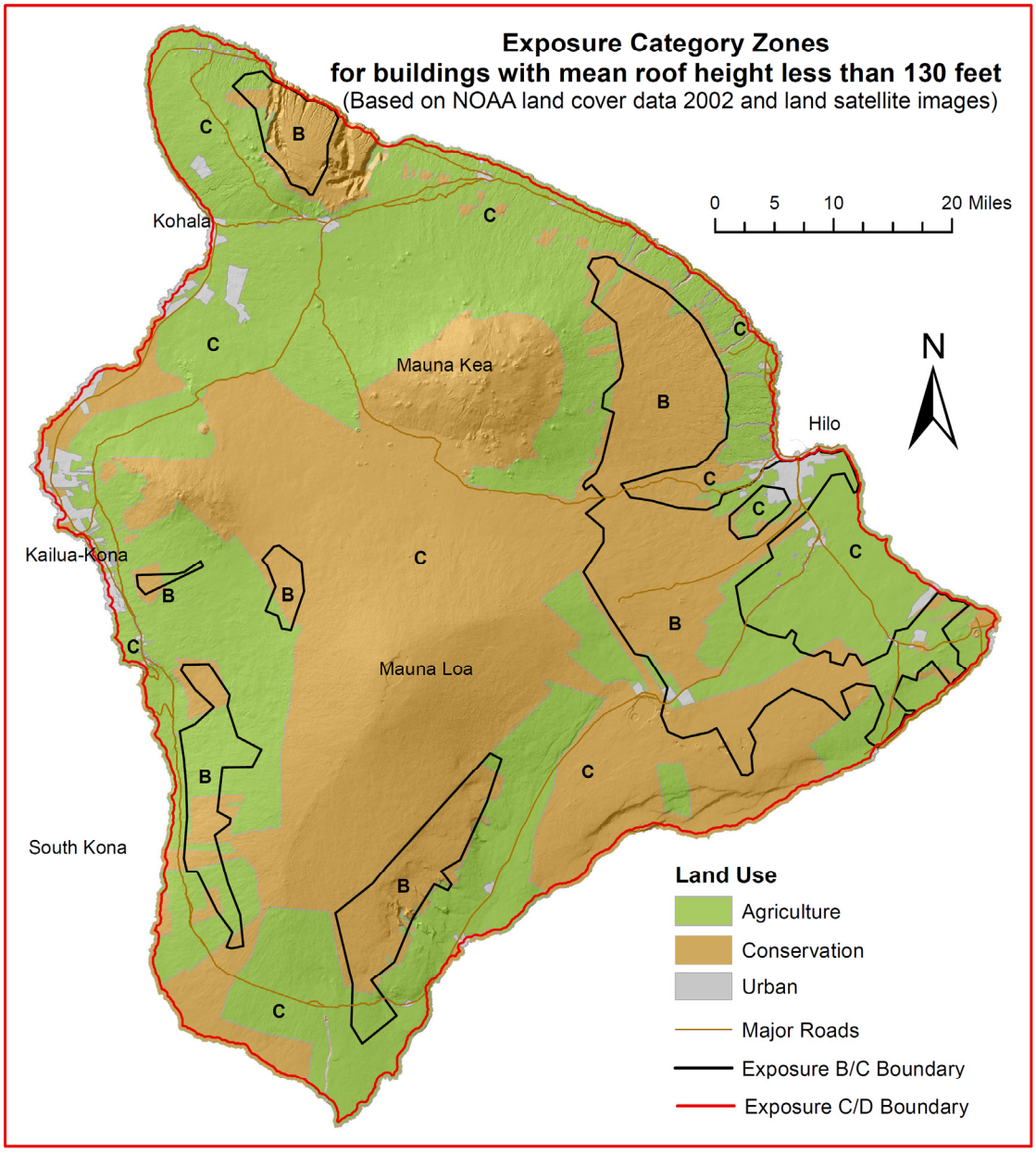
W101.11 Addition of exposure category maps.
Section 1609.4.1 is amended to read as follows:

1609.4.1 Wind directions and sectors. For each selected wind direction considered, at which the wind loads are to be evaluated, the an exposure of the building or structure shall be determined for the two upwind sectors extending 45 degrees (0.79 rad) either side of the selected wind direction. The exposures in these two sectors shall be determined in accordance with Sections 1609.4.2 and 1609.4.3 and the exposure resulting in the highest wind loads shall be used to represent winds from that direction.

Exception: Exposure categories shall be permitted to be determined using Figures 1609.4(a) through 1609.4(e).

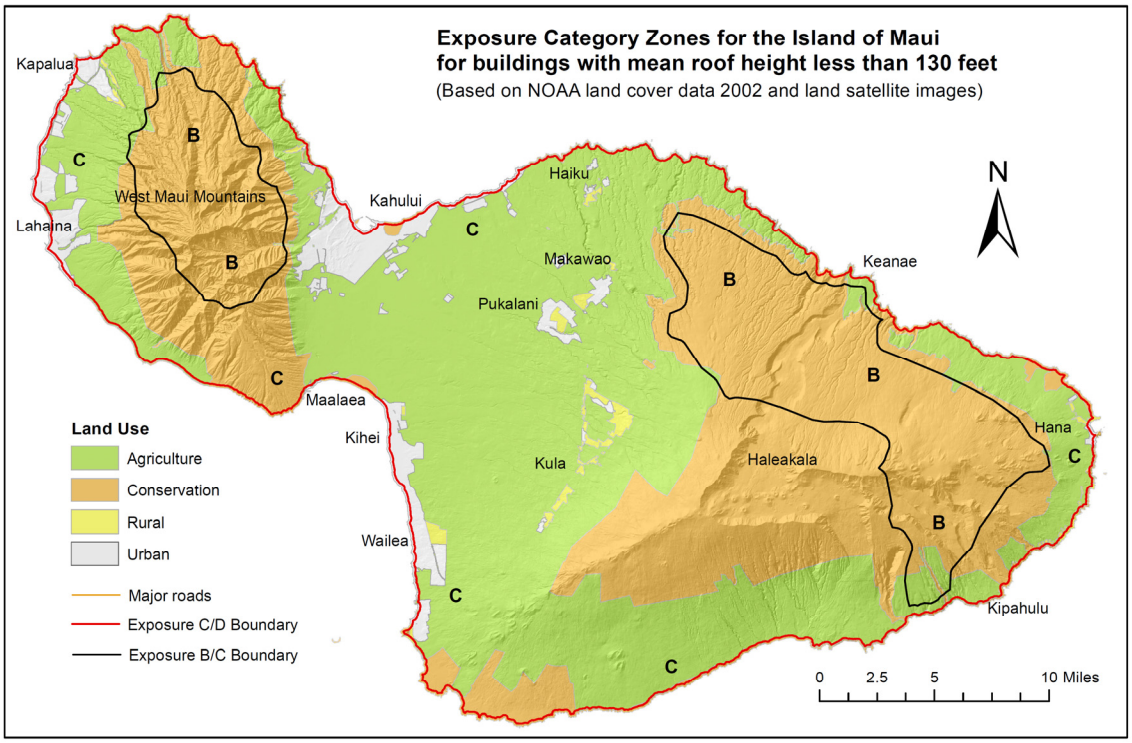


56



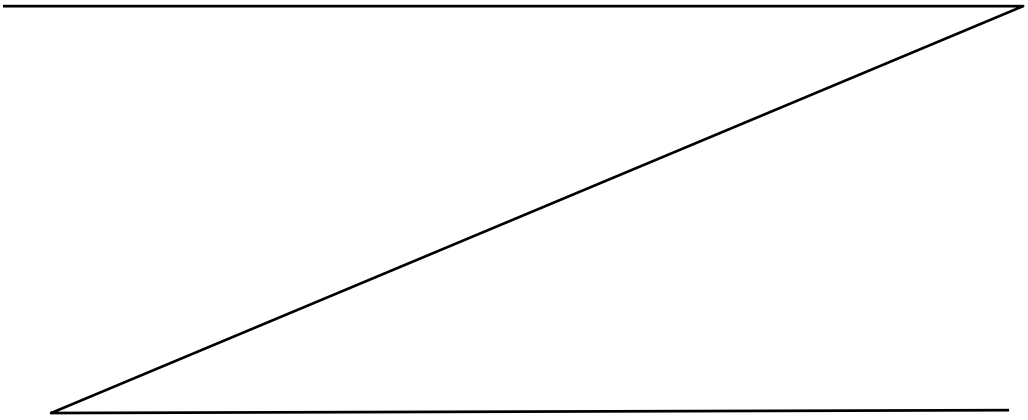
Notes:
1. Intermediate exposures, between categories B and C and between C and D, are permitted when substantiated per ASCE 7 recognized methodology.
2. Sites located within the C (coastal) zone shall be permitted to be evaluated for exposure category B for the wind directions where an adjacent B zone exists in the applicable upwind sector.
3. Sites located within 600 feet from the coastline shall be exposure category D for onshore wind directions.
4. For buildings whose height is equal to or greater than 130 ft, exposure category shall be determined per Section 1609.4.1.
5. For buildings whose mean roof height is less than or equal to 30 ft, exposure category shall be permitted to be evaluated per Section 1609.4.

Figure 1609.4 (a)
Exposure Category Zones for Hawaii County



Notes:
1. Intermediate exposures, between categories B and C and between C and D, are permitted when substantiated per ASCE 7 recognized methodology.
2. Sites located within the C (coastal) zone shall be permitted to be evaluated for exposure category B for the wind directions where an adjacent B zone exists in the applicable upwind sector.
3. Sites located within 600 feet from the coastline shall be exposure category D for onshore wind directions.
4. For buildings whose height is equal to or greater than 130 ft, exposure category shall be determined per Section 1609.4.1.
5. For buildings whose mean roof height is less than or equal to 30 ft, exposure category shall be permitted to be evaluated per Section 1609.4.

Figure 1609.4. (b)
Exposure Category Zones for Island of Maui, Maui County



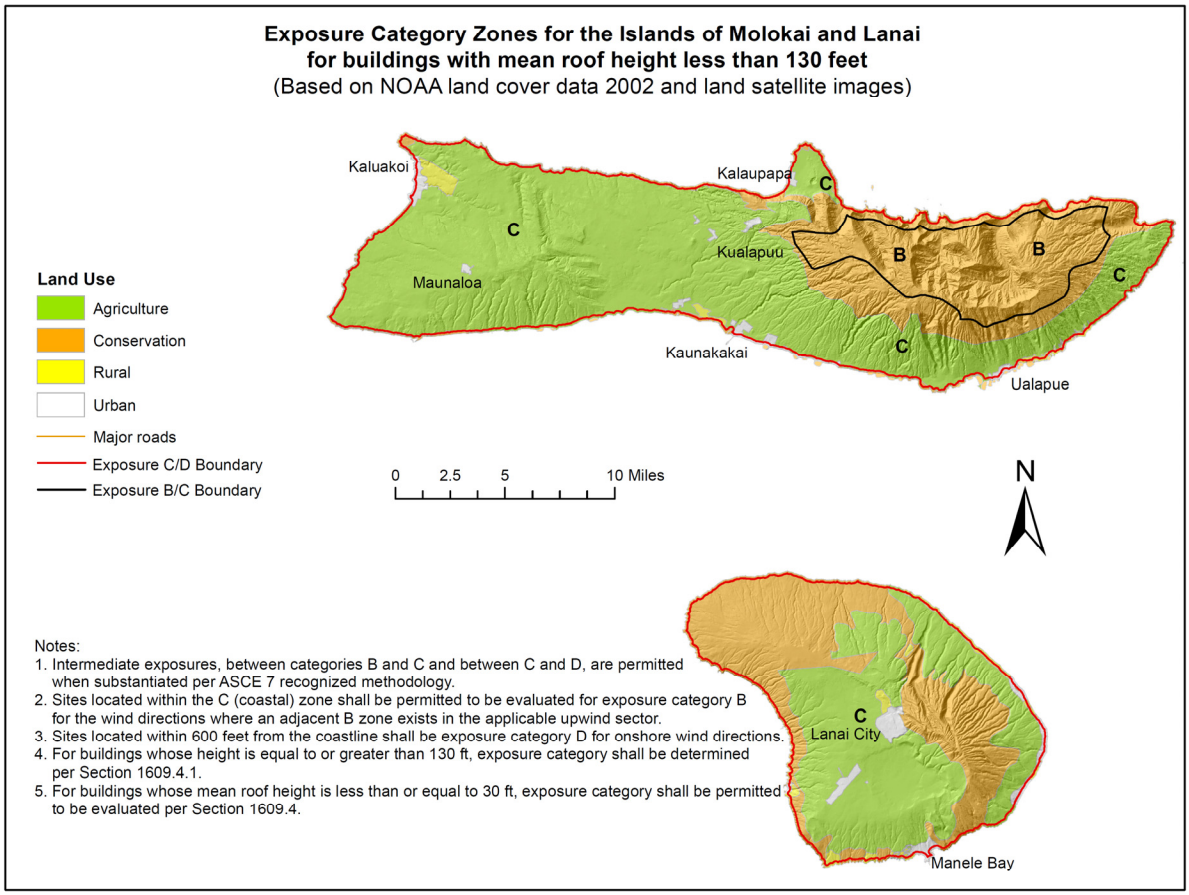
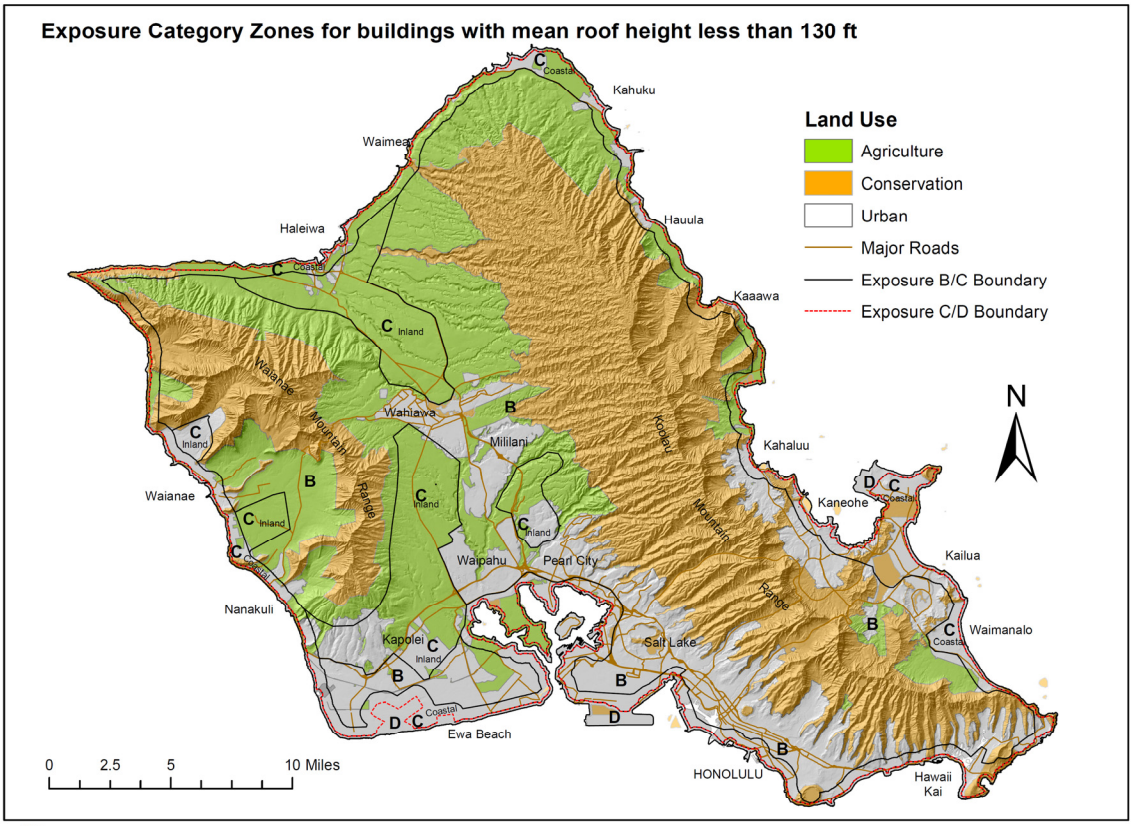
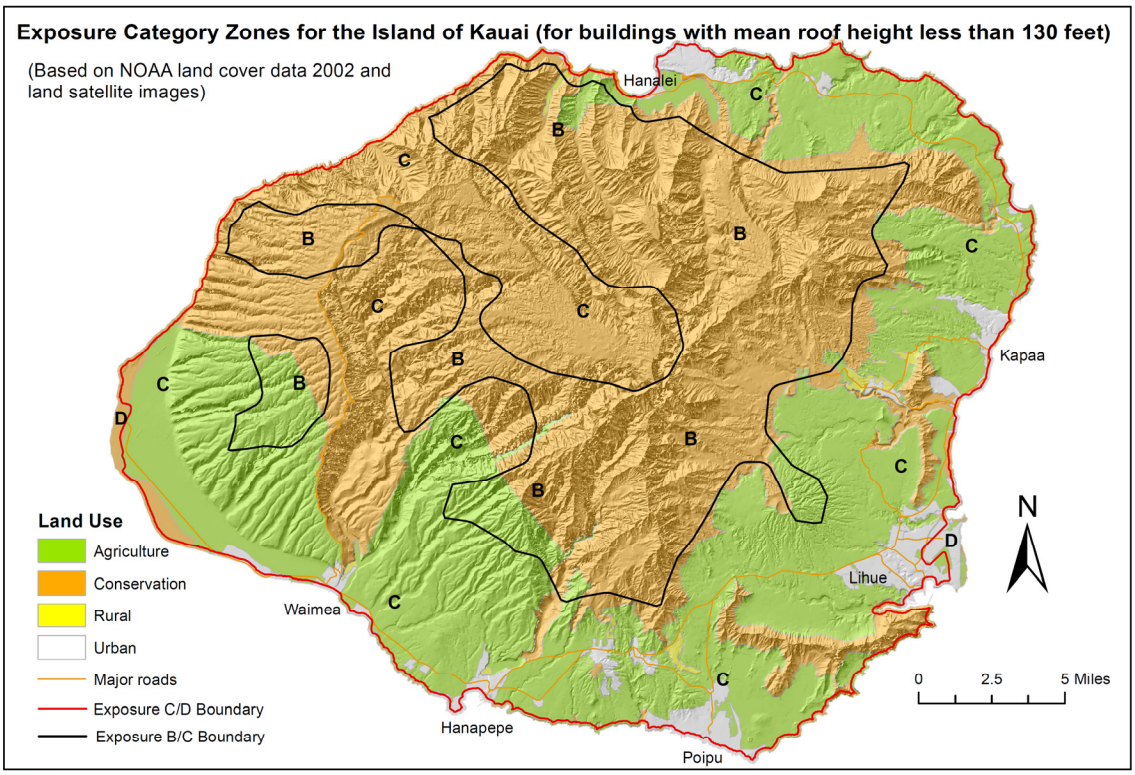


Figure 1609.4 (c)
Exposure Category Zones for Islands of Molokai and Lanai, Maui County



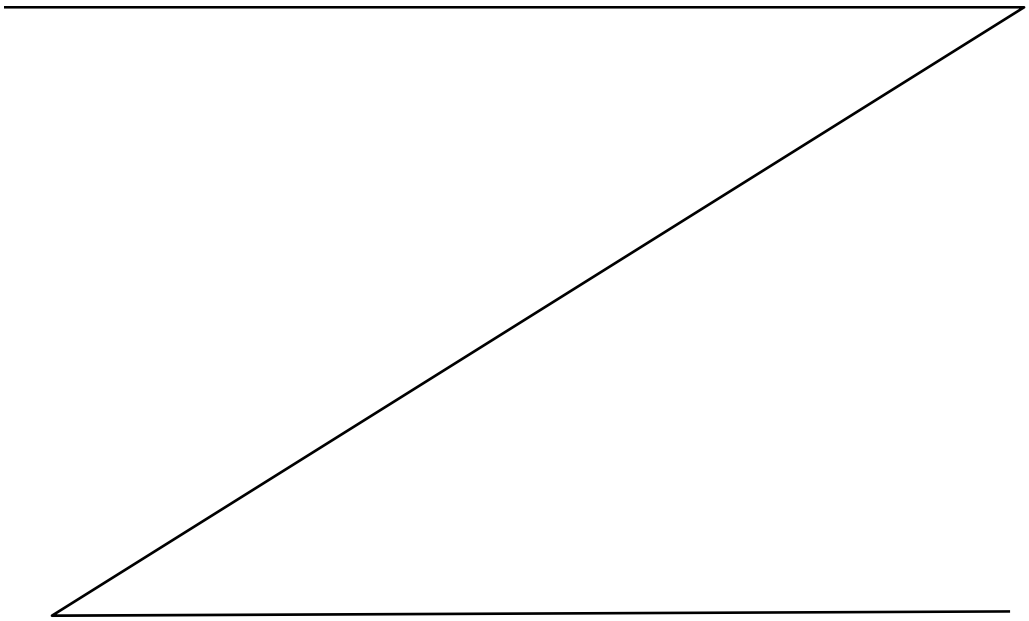
Notes:
1. Intermediate exposures, between categories B and C and between C and D, are permitted when substantiated per ASCE 7 recognized methodology.
2. Sites located within the C (coastal) zone shall be permitted to be evaluated for exposure category B for the wind directions where an adjacent B zone exists in the applicable upwind sector.
3. Sites located within 600 feet from the coastline shall be exposure category D for onshore wind directions.
4. For buildings whose height is equal to or greater than 130 ft, exposure category shall be determined per Section 1609.4.1.
5. For buildings whose mean roof height is less than or equal to 30 ft, exposure category shall be permitted to be evaluated per Section 1609.4.

Figure 1609.4 (d)
Exposure Category Zones for the City and County of Honolulu



Notes:
1. Intermediate exposures, between categories B and C and between C and D, are permitted when substantiated per ASCE 7 recognized methodology.
2. Sites located within the C (coastal) zone shall be permitted to be evaluated for exposure category B for the wind directions where an adjacent B zone exists in the applicable upwind sector.
3. Sites located within 600 feet from the coastline shall be exposure category D for onshore wind directions.
4. For buildings whose height is equal to or greater than 130 ft, exposure category shall be determined per Section 1609.4.1.
5. For buildings whose mean roof height is less than or equal to 30 ft, exposure category shall be permitted to be evaluated per Section 1609.4.

Figure 1609.4 (e)
Exposure Category Zones for Kauai County



W101.12 Addition of Section 1609.5.4 Roof-mounted panels for buildings.

Section 1609.5.4 is added to read as follows:

1609.5.4 Roof-mounted solar collectors for buildings. The design wind force for roof-mounted solar collector panels located on buildings shall be determined based on the location and height of the panel system and the configuration of the roof, in accordance with Sections 1609.5.4.1 through 1609.5.4.6.

In addition to all the other applicable provisions of this Code, the roof itself shall be designed for both of the following:

1. The case where solar collectors are present. Wind loads acting on solar collectors in accordance with this section shall be applied simultaneously with roof wind loads specified in other sections acting on areas of the roof not covered by the plan projection of solar collectors. For this case, unless otherwise noted, roof wind loads specified in other sections need not be applied on areas of the roof covered by the plan projection of solar collectors.
2. Cases where the solar arrays have been removed or are absent.

The following variables are defined for use in determining the design wind force applied to rooftop solar collectors/panels:

A = the area of the solar panel element.

d_1 = horizontal distance measured from the edge of one panel to the building edge or to an adjacent array. The distance is perpendicular to the panel edge ignoring any rooftop equipment. See Figures 1609.5-1 or 1609.5-3, in ft.

d_2 = horizontal distance measured from the edge of one panel to the nearest edge in the next row of panels. See Figure 1609.5-1 or 1609.5-3, in ft.

F = the design wind force normal to each panel determined in accordance with Section 1609.5.4

h_1 = height of a solar panel above the roof at the lower edge of the panel *measured perpendicular to the surface of the roof*, See Figures 1609.5-1 or 1609.5-3, in ft.

h_2 = height of a solar panel above the roof at the upper edge of the panel *measured perpendicular to the surface of the roof*, See Figures 1609.5-1 or 1609.5-3, in ft.

L_p = panel chord dimension, in ft, for use with rooftop solar collectors as shown in Figures 1609.5-1 or 1609.5-3.

θ = Angle of the roof surface, in degrees. See Figures 1609.5-1 or 1609.5-3.

ω = Angle that the solar panel makes with the roof surface, in degrees. See Figures 1609.5-1 or 1609.5-3.

1609.5.4.1 Roof-mounted panels mounted flush or within 10 inches (254 mm) of the roof surface and not located on a roof overhang. The design wind force determined in accordance with this section shall apply to rooftop solar collectors meeting the following conditions:

1. Rooftop solar collectors are located on enclosed or partially enclosed buildings of any height.

2. Panels are parallel to the roof surface, within a tolerance of 2°.
3. The maximum height above the roof surface, h_2, shall not exceed 10 inches (254 mm).
4. A minimum gap of 0.25 inches (6.4 mm) shall be provided between all panels.
5. The spacing of gaps between panels shall not exceed 6.7 ft (2.04 m).
6. The array shall be located at least $2h_2$ from the nearest roof edge, gable ridge, or hip ridge.

The design wind force for rooftop solar collectors shall be determined by Equation 1609-1:

$F = q_h GC_p \gamma_E \gamma_a A$ (lb) (N) **(Equation 1609-1)**

Where:

q_h = velocity pressure at the mean roof height.

GC_p = external pressure coefficient for Components and Cladding of roofs with respective roof zoning for the corresponding location on the roof, with the effective wind area, A, equal to that of the solar panel

γ_E = solar array edge factor for use with rooftop solar collectors.

γ_E = 1.5 for panels that are exposed and those within a distance 1.5(L_p) from the end of a row at an exposed edge of the array; γ_E = 1.0 elsewhere, as illustrated by the example array configuration shown in Figure 1609.5-3.

A panel is defined as exposed if d_1 to the roof edge > 0.5h and one of the following applies:
1. d_1 to the adjacent array > 4 ft (1.22m)
2. d_2 to the next adjacent panel > 4 ft (1.22m)

γ_a = solar collector pressure equalization factor, from Figure 1609.5-2.

Alternatively, it shall be permitted to determine the normal design wind force in accordance with Equation 1609-2:

$F = 40\ A\ (V_{eff\text{-}ult}/105)^2$ (lbs) **(Equation 1609-2)**

Where:

$V_{eff\text{-}ult}$ = the Effective Ultimate Design Wind Speed as determined from Figures 1609.3.2.1(a) through 1609.3.2.1(f), Figures 1609.3.2.2(a) through 1609.3.2.2(f), or Figures 1609.3.2.3(a) through 1609.3.2.3(f).

The force F shall be permitted to be applied to the centroid of the calculated pressure.

1609.5.4.2 Rooftop solar collectors for buildings of all heights with flat roofs or gable or hip roofs with slopes less than 7.° The design wind force determined in accordance with this section shall apply to rooftop solar collectors meeting the following conditions:

1. Rooftop solar collectors are located on enclosed or partially enclosed buildings of any height.
2. Flat, gable, or hip roofs with slopes, $\theta \leq 7°$.
3. Panels installation shall conform to the following limitations:
   $L_p \leq 6.7$ ft (2.04 m)
   $\omega \leq 35°$
   $h_1 \leq 2$ ft (0.61 m)
   $h_2 \leq 4$ ft (1.22 m)
4. A minimum gap of 0.25 inches (6.4 mm) shall be provided between all panels.
5. The spacing of gaps between panels shall not exceed 6.7 ft (2.04 m).
6. The minimum horizontal clear distance between the panels and the edge of the roof shall be the larger of $2(h_2 - h_{pt})$ and 4 ft.

The design wind force for rooftop solar collectors shall be determined by Eq. 1609-3:

$$F = q_h GC_{rn} A \quad (\text{lb/ft}^2) \quad (\text{N/m}^2) \qquad \textbf{(Equation 1609-3)}$$

where

$$GC_{rn} = \gamma_p \gamma_c \gamma_E \ (GC_{rn})_{nom} \qquad \textbf{(Equation 1609-4)}$$

Where:

$(GC_{rn})_{nom}$ = nominal net pressure coefficient from Figure 1609.5-3.

$\gamma_p = min\left(1.2,\ 0.9 + \frac{h_{pt}}{h}\right)$ = parapet height factor.

h_{pt} = mean parapet height above the adjacent roof surface (ft).

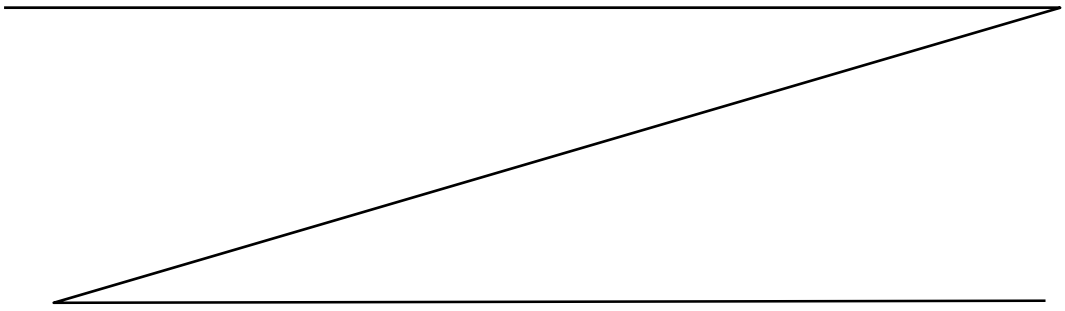
$\gamma_c = max\left(0.6 + 0.06L_p\ ,\ 0.8\right)$

γ_E = 1.5 for panels that are exposed and those within a distance $1.5(L_p)$ from the end of a row at an exposed edge of the array; γ_E = 1.0 elsewhere, as illustrated by the example array configuration shown in Figure 1609.5-3.

A panel is defined as exposed if d_1 to the roof edge > 0.5h and one of the following applies:

1. d_1 to the adjacent array > max ($4h_2$, 4 ft(1.22m))
2. d_2 to the next adjacent panel > max ($4h_2$, 4 ft (1.22m))

The force F shall be permitted to be applied to the centroid of the calculated pressure.



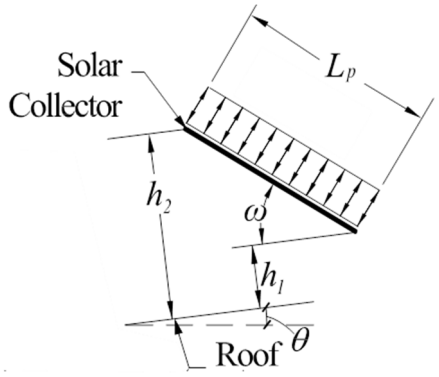


Figure 1609.5-1 Solar Collector Dimensions.

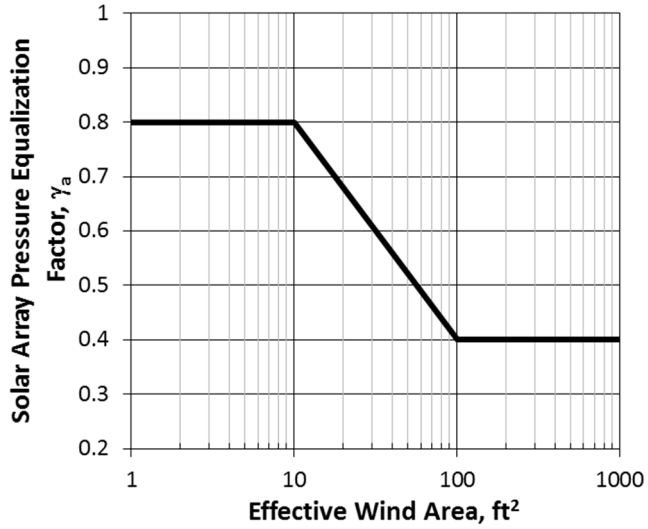
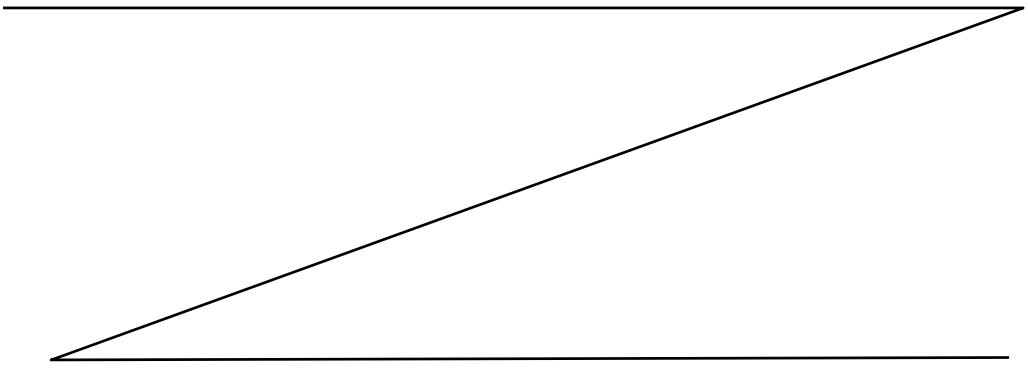
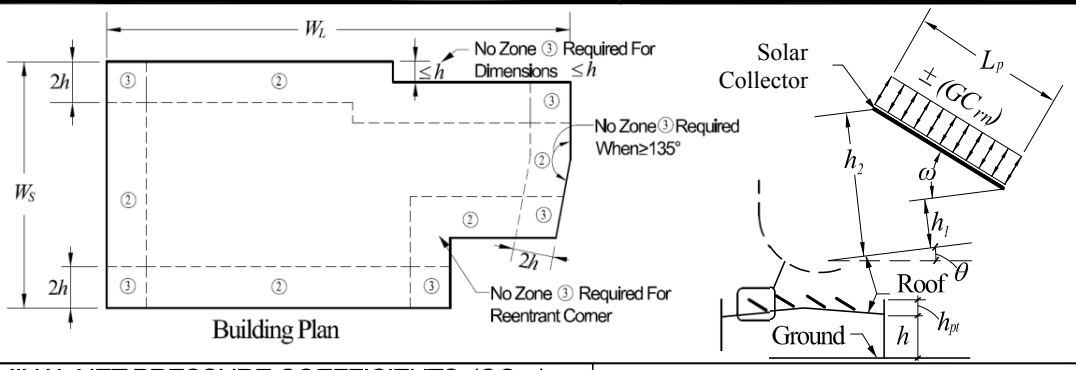


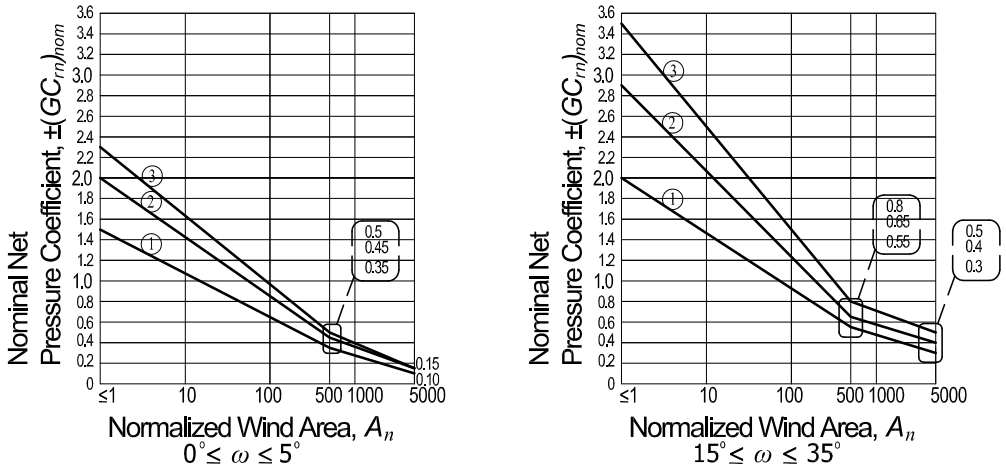
Figure 1609.5-2 Solar Collector Pressure Equalization Factor, γ_a, for enclosed and partially enclosed buildings of all heights.



Design Wind Loads	all heights
Figure 29.5-4 Rooftop Solar Collectors	Roofs $\theta \le 7^\circ$
Enclosed, Partially Enclosed Buildings	



NOMINAL NET PRESSURE COEFFICIENTS $(GC_{rn})_{nom}$



ARRAY EDGE FACTORS (γ_E)

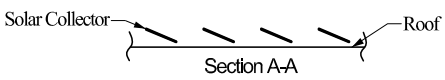
EXAMPLE PLAN

Where: 1) $d_1 > 0.5h$ and $d_1 > \max(4h_2, 4\text{ft})$
2) $d_2 < \max(4h_2, 4\text{ft})$

LEGEND:

Non Exposed Solar Collectors (γ_E=1.0)

Exposed Solar Collectors (γ_E=1.5)



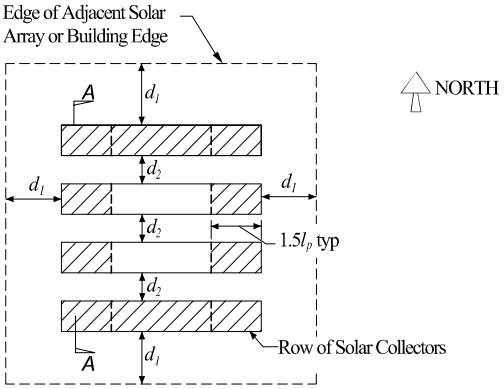


Figure 1609.5-3 ROOFTOP SOLAR COLLECTORS FOR BUILDINGS OF ALL HEIGHTS WITH FLATROOFS OR GABLE OR HIP ROOFS WITH SLOPES LESS THAN 7° (SEE NOTES 1-3 BELOW)

Notes for Figure 1609.5-3:

1. (GC_{rn}) acts towards (+) and away (-) from the top surface of the panels.
2. Linear interpolation shall be permitted for ω between 5° and 15°.
3. Notation:

$A_n = \left(\frac{1000}{[max(L_b,15)]^2}\right) A$.

An = normalized wind area for rooftop solar collectors

L_b = $min(0.4\,(h\,W_L)^{0.5}, h, W_s)$, in ft.

W_L = width of a building on its longest side in Figure 1609.5-3, in ft.

W_S = width of a building on its shortest side in Figure 1609.5-2, in ft.

1609.5.4.3 Roof-mounted panels for all other conditions. The normal force on roof-mounted panels not regulated by Section 1609.5.4.1 or 1609.5.4.2 shall be determined by Equation 1609-5:

$F = q_h (GC_p) C_N A$ (lb) (N) **(Equation 1609-5)**

Where:

C_N = pressure coefficients for monoslope free roofs from ASCE 7-10 Table 30.8-1 considering each elevated panel as a free roof surface in clear wind flow. The angle θ used for the determination of C_N shall be measured as the angle of the panel with respect to the plane of the roof (ω in Figure 1609.5-1). Values of C_N for forces on the panel may be taken as the Zone 1 coefficients.

Exception: Zone 2 coefficients for C_N shall be used where the panel angle , ω, is greater than 7.5 degrees; panels are located a distance less than or equal to twice the roof height measured from a roof corner; and the parapet is greater than 24 inches (610 mm) in height above the roof.

GC_p = the component and cladding external pressure coefficient for roofs for the roof zone corresponding to the location of the solar panel, and the effective wind area shall be that of the solar panel. The minimum magnitude of negative pressure values of GC_p in Zone 1 shall be taken as -1.0.

A = the total area of the solar panel element.

Alternatively, it shall be permitted to determine the normal force in accordance with Equation 1609-6:

$F = 100\ A\ (V_{eff\text{-}ult}/105)^2$ (lbs) **(Equation 1609-6)**

Where:

$V_{eff\text{-}ult}$ = the Effective Ultimate Design Wind Speed as determined from Figures 1609.3.2.1(a) through 1609.3.2.1(f), Figures 1609.3.2.2(a) through 1609.3.2.2(f), and Figures 1609.3.2.3(a) through 1609.3.2.3(f).

When located in roof zone 2 or 3 as defined in ASCE 7, the force F shall be applied with an eccentricity equal to a third of the solar panel width.

1609.5.4.3.1 Additive panel wind loads. The load on the panel shall be applied as point load anchorage reactions additive to the resultant of the pressure determined acting on the portion of the roof underlying the panel.

1609.5.4.4 Ballasted panels. Panels that are ballasted for uplift resistance and tilted at an angle α of 10 degrees or more from a horizontal plane shall be designed to resist the force determined by Equation 1609-7:

$$F_{ballast} \geq F\left(\frac{\mu\cos\beta + \sin\beta}{\mu\cos\alpha - \sin\alpha}\right) \quad \text{(lb) (N)} \quad \textbf{(Equation 1609-7)}$$

Where:

F = the normal force on each panel determined in accordance with Section 1609.5.4

α = the angle of the roof plane with respect to horizontal.

β = the angle of tilt of the panel with respect to the roof plane.

μ = the static friction coefficient between the panel base and its bearing surface.

Alternatively, to resist uplift and sliding, ballasted panels that are tilted at an angle of less than 10 degrees from a horizontal plane shall each be ballasted to resist a force equal to 2 times the normal force on each panel determined in Sections 1609.5.4.1 or 1609.5.4.2. Ballasted panels that are tilted at an angle between 10 degrees to 25 degrees from a horizontal plane shall each be ballasted to resist a force equal to 8 times the normal force on each panel determined in Sections 1609.5.4.1 or 1609.5.4.2.

1609.5.4.5 Permeability. A reduction of load on the panels for permeability of the panel system shall not be permitted unless demonstrated by approved wind-tunnel testing or recognized documentation for the type of panel system being considered. Testing or documentation shall replicate the panel separation spacing and height above the roof.

1609.5.4.6 Shielding. A reduction of load on the panels for shielding provided by the roof or other obstruction shall not be permitted unless demonstrated by approved wind-tunnel testing or recognized documentation for the type of panel system being considered. Testing or documentation shall replicate the panel separation spacing and height above the roof.

W101.13 Revisions to Section 1609.6.2.

Section 1609.6.2 is amended to read as follows:

1609.6.2 Symbols and notations. Coefficients and variables used in the alternative all-heights method equations are as follows:

C_{net} = Net-pressure coefficient based on Kd[(G)(Cp) – (GCpi)], in accordance with Table 1609.6.2; determined using G = Gust effect factor for rigid structures in accordance with ASCE 7 Section 26.9 and Kd = Wind directionality factor in accordance with ASCE 7 Table 26-6.

P_{net} = Design wind pressure to be used in determination of wind loads on buildings or other structures or their components and cladding, in psf (kN/m^2).

W101.14 Revisions to Section 1609.6.3.
Section 1609.6.3 is amended to read as follows:

1609.6.3 Design equations. When using the alternative all-heights method, the MWFRS, and components and cladding of every structure shall be designed to resist the effects of wind pressures on the building envelope in accordance with Equation 16-35.

$P_{net} = 0.00256V_{ult}^2K_zC_{net}K_{zt}(K_d/0.85)$ **(Equation 16-35)**

Design wind forces for the MWFRS shall not be less than 16 psf (0.77 kN/m^2) multiplied by the area of the structure projected on a plane normal to the assumed wind direction (see ASCE 7 Section 27.4.7 for criteria). Design net wind pressure for components and cladding shall not be less than 16 psf (0.77 kN/m^2) acting in either direction normal to the surface.

W101.15 Revisions to Section 1609.6.4.2.
Section 1609.6.4.2 is amended to read as follows:

1609.6.4.2 Determination of K_z, K_{zt} and K_d. Velocity pressure exposure coefficient, K_z, shall be determined in accordance with ASCE 7 Section 27.3.1. The topographic factor, K_{zt}, shall be determined in accordance with Section 1609.3.3. The wind directionality factor, K_d, shall be determined in accordance with Section 1609.3.4.

1. For the windward side of a structure, K_{zt} and K_z shall be based on height z.
2. For leeward and sidewalls, and for windward and leeward roofs, K_z shall be based on mean roof height h, and K_{zt} shall be based on height z.

W102 Revisions to Chapter 23.
Wood construction shall be in accordance with Chapter 23 as amended by Sections W102.1 through W102.5.

W102.1 Revisions to Section 2304.6.1.
Section 2304.6.1 is amended to read as follows:

2304.6.1 Wood structural panel sheathing. Where wood structural panel sheathing is used as the exposed finish on the exterior of outside walls, it shall have an exterior exposure durability classification. Where wood structural panel sheathing is used elsewhere, but not as the exposed finish, it shall be of a type manufactured with exterior glue (Exposure 1 or Exterior). Wood structural panel wall sheathing or siding used as structural sheathing shall be capable of resisting wind pressures in accordance with Section 1609. Maximum effective wind speeds for wood structural panel sheathing used to resist wind pressures shall be in accordance with Table 2304.6.1 for enclosed buildings with a mean roof height not greater than 30 feet (9144 mm).

W102.2 Revisions to Table 2304.6.1.
Table 2304.6.1 is amended to read as follows:

TABLE 2304.6.1
MAXIMUM EFFECTIVE WIND SPEED (mph) (3-SECOND GUST) PERMITTED FOR WOOD STRUCTURAL PANEL WALL SHEATHING USED TO RESIST WIND PRESSURES[a,b,c]

MINIMUM NAIL		MINIMUM WOOD STRUCTURAL PANEL SPAN RATING	MINIMUM NOMINAL PANEL THICKNESS (inches)	MAXIMUM WALL STUD SPACING (inches)	PANEL NAIL SPACING		$V_{eff-asd}$ MAXIMUM EFFECTIVE WIND SPEED (MPH)		
Size	Penetration (inches)				Edges (inches o.c.)	Field (inches o.c.)	Wind exposure category		
							B	C	D
6d common (2.0" × 0.113")	1.5	24/0	3/8	16	6	12	110	90	85
		24/16	7/16	16	6	12	110	100	90
						6	150	125	110
8d common (2.5" × 0.131")	1.75	24/16	7/16	16	6	12	130	110	105
						6	150	125	110
				24	6	12	110	90	85
						6	110	90	85

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.
a. Panel strength axis shall be parallel or perpendicular to supports. Three-ply plywood sheathing with studs spaced more than 16 inches on center shall be applied with panel strength axis perpendicular to supports.
b. The table is based on wind pressures acting toward and away from building surfaces in accordance with Chapter 27 of ASCE 7. Lateral requirements shall be in accordance with Section 2305 or 2308.
c. Wood structural panels with span ratings of wall-16 or wall-24 shall be permitted as an alternative to panels with a 24/0 span rating. Plywood siding rated 16 o.c. or 24 o.c. shall be permitted as an alternative to panels with a 24/16 span rating. Wall-16 and plywood siding 16 o.c. shall be used with studs spaced a maximum of 16 inches o.c.

W102.3 Revisions to Section 2308.2.1.
Section 2308.2.1 is amended to read as follows:

2308.2.1 Effective nominal design wind speed greater than 100 mph. Where the Effective Nominal Design Wind Speed $V_{eff-asd}$ exceeds 100 mph, the provisions of the AF&PA WFCM, AISI S230 or ICC 600 are permitted to be used.

W102.4 Addition of Section 2308.9.4.3.
Section 2308.9.4.3 is added to read as follows:

2308.9.4.3 Pre-engineered bracing of post and pier foundations. For conventional light-framed single family residences two stories or less above grade, bracing of elevated wood post and pier foundation systems shall be permitted to be pre-engineered designs for braces or shear walls constructed in accordance with FEMA Hazard Mitigation Grant Program DR-1664-HI drawings, *Structural Seismic Retrofits for Hawaii Single Family Residences with Post and Pier Foundations, May 2009.*

W102.5 Revisions to Table 2308.10.1.
Table 2308.10.1 is amended to read as follows:

Table 2308.10.1
Required Rating of Approved Uplift Connectors (pounds)[a,b,c,d,e,f,g,h,i]

Effective Nominal Design Wind Speed,	Roof Span (feet)							Overhangs (pounds/ft)[d]
$V_{eff\text{-}asd}$, 3-sec gust	12	20	24	28	32	36	40	
85	-72	-120	-144	-168	-192	-216	-240	-38.55
90	-91	-152	-182	-213	-243	-274	-304	-43.22
100	-131	-218	-262	-305	-349	-392	-436	-53.36
110	-175	-292	-350	-409	-467	-526	-584	-64.56
120	-240	-400	-480	-560	-640	-720	-800	-76.83
130	-304	-506	-607	-708	-810	-911	-1012	-90.17

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 1.61 km/hr, 1 pound = 0.454 Kg, 1 pound/foot = 14.5939 N/m.

a. The uplift connection requirements are based on a 30-foot mean roof height located in Exposure B. For Exposure C and for other mean roof heights, multiply the above loads by the adjustment coefficients below.

Exposure	Mean Roof Height (feet)									
	15	20	25	30	35	40	45	50	55	60
B	1.00	1.00	1.00	1.00	1.05	1.09	1.12	1.16	1.19	1.22
C	1.21	1.29	1.35	1.40	1.45	1.49	1.53	1.56	1.59	1.62
D	1.47	1.55	1.61	1.66	1.70	1.74	1.78	1.81	1.84	1.87

For SI: 1 inch – 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 1.61 km/hr, 1 pound = 0.454 Kg, 1 pound/foot = 14.5939 N/m.

b. The uplift connection requirements are based on the framing being spaced 24 inches on center. Multiply by 0.67 for framing spaced 16 inches on center and multiply by 0.5 for framing spaced 12 inches on center.
c. The uplift connection requirements include an allowance for 10 pounds of dead load.
d. The uplift connection requirements do not account for the effects of overhangs. The magnitude of the above loads shall be increased by adding the overhang loads found in the table. The overhang loads are also based on framing spaced 24 inches on center. The overhang loads given shall be multiplied by the overhang projection and added to the roof uplift value in the table.
e. The uplift connection requirements are based upon wind loading on end zones as defined in Chapter 30, Figure 30.5-1, of ASCE 7. Connection loads for connections located a distance of 20 percent of the least horizontal dimensions of the building from the corner of the building are permitted to be reduced by multiplying the table connection value by 0.7 and multiplying the overhang load by 0.8.
f. For wall-to-wall and wall-to-foundation connections, the capacity of the uplift connector is permitted to be reduced by 100 pounds for each full wall above. (For example, if a 500-pound rated connector is used on the roof framing, a 400-pound rated connector is permitted at the next floor level down.)
g. Interpolation is permitted for intermediate values of basic wind speeds and roof spans.
h. The rated capacity of approved tie-down devices is permitted to include up to a 60-percent increase for wind effects where allowed by material specifications.
i. $V_{eff\text{-}asd}$ is determined from Figure 1609.3.2.1 and Sections 1609.3.1 and 1609.3.2”

(59) Appendix X – Hawaii provisions for indigenous Hawaiian architecture structures.
Appendix X is added to read as follows:

"APPENDIX X

Hawaii Provisions for Indigenous Hawaiian Architecture Structures

Section X101 General.

X101.1 Scope. The provisions of this appendix shall apply exclusively to Indigenous Hawaiian Architecture Structures. The purpose of these provisions is to acknowledge and establish procedures for designing and constructing indigenous Hawaiian architecture structures.

X101.2 Publications incorporated by reference. The following publications are incorporated by reference and made a part of these provisions. Where there is a conflict between Appendix X and the referenced documents, Appendix X shall prevail.

1. "Hawaiian Thatched House" (1971), by Russell A. Apple, published by the United States Department of the Interior,
2. "Hale Construction Standards" (2000), by Francis Sinenci and Bill Sides,
3. "The Hawaiian Grass House in Bishop Museum" (1988), by Catherine C. Summers, and
4. "Arts and Crafts of Hawaii", Section II, Houses (1957) by Te Rangi Hiroa (Peter H. Buck)

X101.3 Definitions. See Chapter 2 for general definitions. As used in this appendix:

CERTIFIED HALE BUILDER. A person who has obtained a certificate of completion for satisfactorily completing a course in Hawaiian hale construction from the University of Hawaii, or any of its community colleges, or as approved by the Building Official.

GROUP OF STRUCTURES. A group of indigenous Hawaiian architecture structures that are in close proximity to each other and have an aggregate floor area of 1,800 square feet or less.

HALE or INDIGENOUS HAWAIIAN ARCHITECTURE STRUCTURE. A structure that is consistent with the design, construction methods and uses of structures built by Hawaiians in the 1800's, which uses natural materials found in the Hawaiian islands, and complies with this appendix and references.

SEPARATION. The clear distance between two structures.

SETBACK. The clear distance between a structure and a property line.

Section X201 Material requirements.

X201.1 Hale materials. Hale shall be constructed using only materials grown and harvested in the State of Hawaii.

X201.2 Wood framing material. The wood members for the hale, such as posts and rafters, shall be, but not limited to hardwoods of unmilled, straight sections of trunks or branches of the following species:

1. Casaurina equisitafolia (ironwood).
2. Prosopis-allid (kiawe).
3. Eucalyptus robusta (eucalyptus).
4. Psidium cattleianum (strawberry guava).
5. Metrosideros polymorpha (ohia).
6. Rizophora mangle (mangrove).

Exception: Ardisia elliptica (inkberry) may be used only for roof purlins as an alternative to specified woods listed in Items 1 through 6.

X201.3 Roofing and siding. Thatched roofing and siding materials for the hale may be any grass or leaf material grown and harvested in the State of Hawaii, to include but not be limited to pili, kualohia, pueo, kawelu, sugarcane leaves, and ti leaves.

X201.4 Cord. Natural or synthetic cord used for lashing structural members of the hale shall be 400 pound test. Cord used for tying floating purlins and thatched materials shall be 100 pound test. All cord used on the hale shall be shades of green, tan, brown or black.

X201.5 Metal prohibited. Metal shall not be used for the construction of the hale.

Section X202 Size and location.

X202.1 Height and size limitation. Hale shall be one-story, detached structure not exceeding 1,800 square feet. Hale shall not exceed the size indicated in Table X202.1.

Table X202.1
Maximum Size of Hale (feet)

Hale halawai	Hale ku`ai	Hale noa	Hale wa`a
30 X 60	14 X 20	14 X 24	30 X 60

X202.2 Zoning requirements. Hale shall comply with minimum yard requirements in the zoning codes.

X202.3 Minimum separation. The minimum separation between a hale and another structure shall be at least 10 feet for a one-story structure; 15 feet for a two-story structure; or a distance equal to the height of the hale, whichever is more. The minimum separation between two hale shall be at least 10 feet or a distance equal to the height of the taller hale.

X202.4 Hale Noa. Hale noa structures may only be constructed on property where a separate residence exists on the property.

Section X203 Allowable and prohibited uses.

X203.1 Allowable uses. To the extent permitted by other applicable law, allowable uses for hale structures shall be in accordance with Table X203.1.

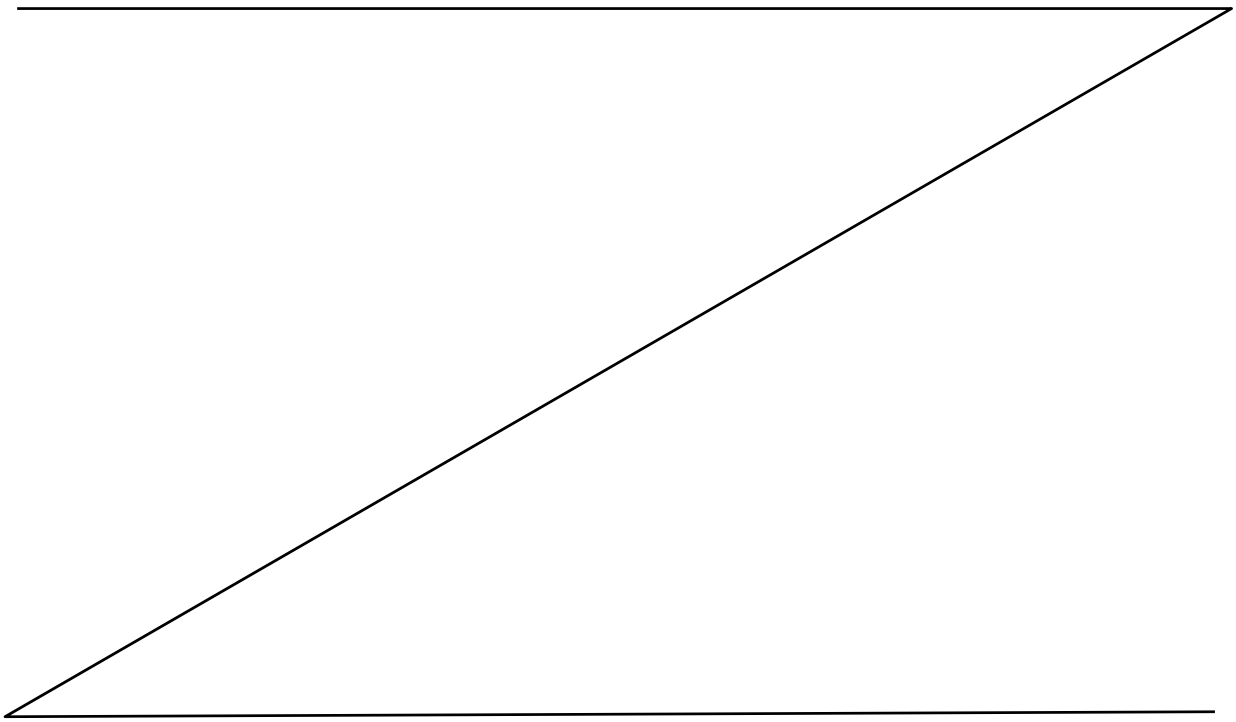
Table X203.1
Allowable Use for Each Hale Type

Use	Hale halawai	Hale ku`ai	Hale noa	Hale wa`a
Eating (ai)	Allowed	Allowed	Not permitted	Allowed
Assembling (halawai)	Allowed	Allowed	Not permitted	Allowed
Sleeping (moe)	Not permitted	Not permitted	Allowed	Not permitted
Retailing (e.g., fruits) (ku`ai)	Allowed	Allowed	Not permitted	Allowed
Storage (papa`a)	Not permitted	Allowed	Not permitted	Allowed

X203.2 Prohibited uses and activities. The following uses and activities shall be prohibited from occurring within or near the hale:

1. Cooking.
2. Open flames.
3. Generators.
4. Extension cords.
5. Electrical switches, fixtures, or outlets.
6. Plumbing faucets, fixtures, or drains.
7. Power tools.
8. No screen, mesh, plastic or any other similar material shall be attached to the hale.
9. Hale shall not be used as a food establishment as defined in the administrative rules adopted by the state department of health.

X203.3 Maintenance. The hale shall be maintained by the owner to ensure structural integrity. Repairs for maintenance of the hale shall not require additional building permits.



Section X301 Fire protection.

X301.1 Fire protection classifications. Fire protection for Indigenous Hawaiian architecture structures shall be as required in Table X301.1.

Table X301.1
Fire Protection Requirements Based on Setback

Class	Setback Requirements	Fire Protection Requirements
A	The structure (or a group of structures) is: 1. Located at least 100 feet from any existing structure on the same or neighboring properties; and 2. Located at least 100 feet from any property line, except as follows: a. If the property line abuts a public way, the 100 feet minimum setback for that property line shall be reduced by the width of the public way, b. If the property line abuts the shoreline, the minimum setback for that property line shall be the shoreline setback, or c. For any hale ku'ai in the agricultural district that is less than 200 square feet, that is completely open on three sides, and that is used as an agricultural products' stand and if the property line abuts a public way, the minimum setback for that property line shall be 15 feet.	No fire protection is required for the structure.
B	The structure (or a group of structures) that conforms to applicable zoning setback requirements but does not satisfy Class A setback requirements.	Automatic fire sprinkler system shall be installed in accordance with design standards in Section X301.2. An electrical permit is required for fire sprinklers systems.

X301.2 Automatic fire sprinklers. The design standards for automatic fire sprinklers for Class B indigenous Hawaiian architecture structures shall be in accordance with NFPA 13.

Exception: The design standards for automatic fire sprinklers for Class B indigenous Hawaiian architecture structures shall be permitted as follows:

1. 18 gallons per minute for a single head at 140 square feet maximum coverage of roof area.
2. 13 gallons per minute for each subsequent head at 140 square feet maximum coverage of roof area per head.
3. The minimum supply pressure at the base of the riser shall not be less than 40 pounds per square inch.
4. The minimum residual pressure at the highest sprinkler shall be not less than 12 pounds per square inch.
5. Sprinkler head spacing shall not exceed 14 feet.

6. Sprinkler heads shall be open type upright, pendent, or sidewall with 1/2-inch or 17/32-inch orifice and have a wax corrosion resistant coating.
7. The total number of sprinklers on a branch shall not exceed 6 heads.
8. The total number of sprinklers shall not exceed the quantity shown in Table X301.2(a).

Table X301.2(a)
Total Number of Fire Sprinklers Based on Pipe Size

Piping Size	Number of Sprinklers
1 inch diameter	2 sprinklers
1¼ inch diameter	3 sprinklers
1½ inch diameter	5 sprinklers
2 inch diameter	10 sprinklers
2½ inch diameter	30 sprinklers
3 inch diameter	60 sprinklers

9. The pipe schedule table in Item 8 shall not apply to hydraulically designed systems.
10. The water density shall not be less than 0.10 gpm per square foot.
11. The source of water may be by domestic water meters, detector check meter, underground well, storage tank, swimming pool, ponds, etc., but must meet the design requirements for adequate pressure and duration.
12. Water supply shall be sufficient to provide 30 minutes duration.
13. If domestic water meters are used as the source of water for the fire sprinklers, without a storage tank and booster pump, the maximum number of sprinklers shall not exceed the number shown in Table X301.2(b).

Table X301.2(b)
Total Number of Fire Sprinklers Based on Water Meter Size

Size of Water Meter	Number of Sprinklers
5/8 inch water meter	1 sprinkler
¾ inch water meter	2 sprinklers
1 inch water meter	3 sprinklers
1½ inch water meter	7 sprinklers
2 inch water meter	11 sprinklers
3 inch water meter	27 sprinklers

14. The piping material shall be hard drawn copper with silver solder or brazed fittings, or carbon steel with corrosion-

resistant coatings. Plastic pipes shall not be allowed, except for below grade supply pipes.

15. Fire sprinkler system shall be actuated by smoke detectors located at the highest points of the roof and spaced as recommended by the manufacturer.
16. Flow control valves shall be either hydraulically or electrically operated with a manual override switch.
17. Where the width of a roof exceeds the width allowed for one row of sprinklers, two or more rows of sprinklers shall be placed such that the entire roof area is protected.
18. Prevailing wind direction shall be considered in the placement of sprinklers.
19. Deflectors for sprinklers shall be parallel with the roof surface or tilted slightly towards the peak of the roof.
20. Fire sprinklers system shall have a local alarm activated by a smoke detector.

X301.3 Certification of water supply. For any hale that requires fire protection pursuant to Section X301.1, the applicant shall provide a certification from a licensed engineer or a licensed C-20 contractor that the water supply for the fire sprinkler system has been tested and is capable of delivering the required fire flow for 30 minutes duration.

X302 Smoke alarm. Any hale used for sleeping shall have an approved battery operated smoke alarm installed in the hale.

Section X401 Design standards.

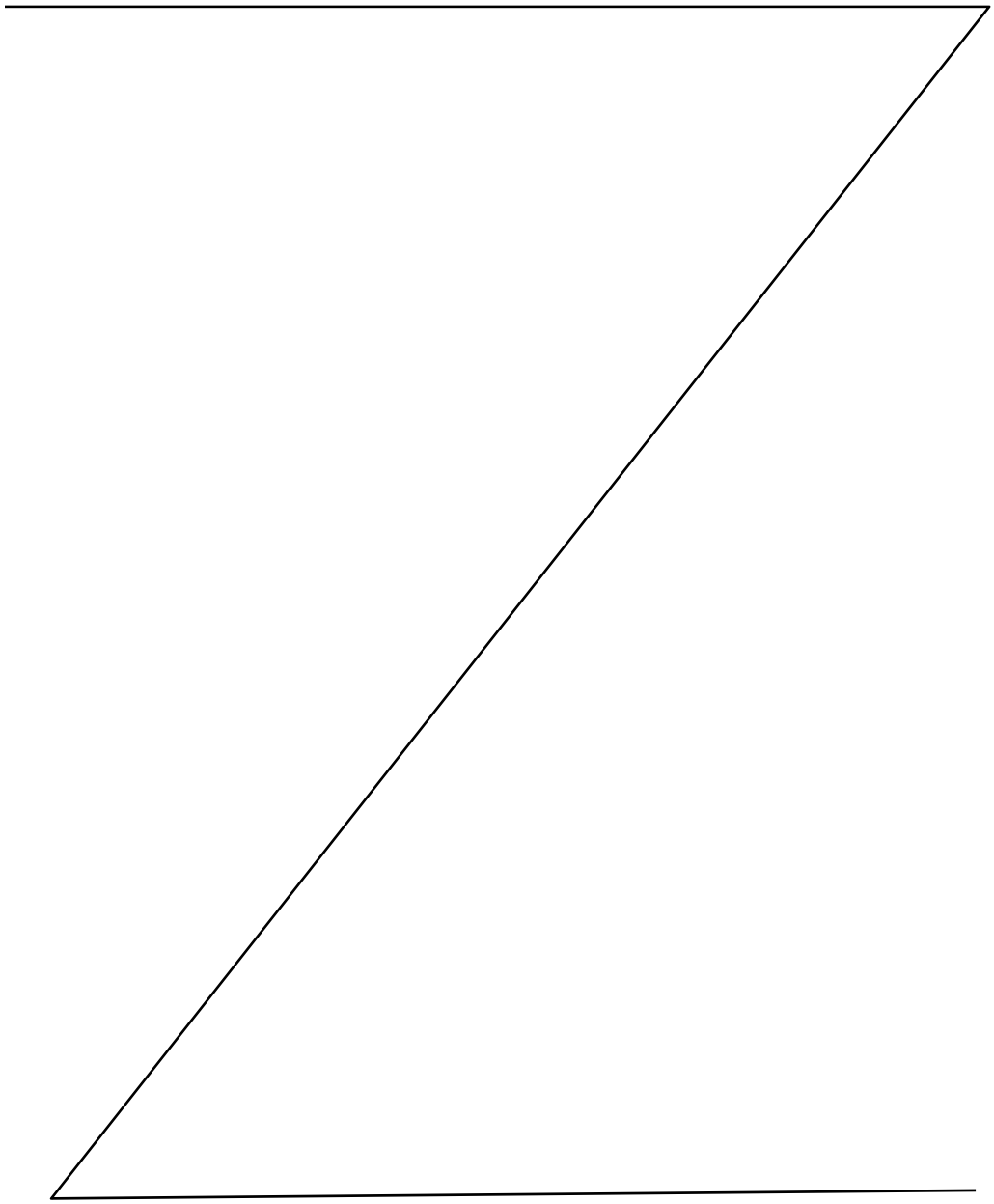
X401.1 General design standards. All types of hale shall be designed and constructed in accordance with the standards set out in this section.

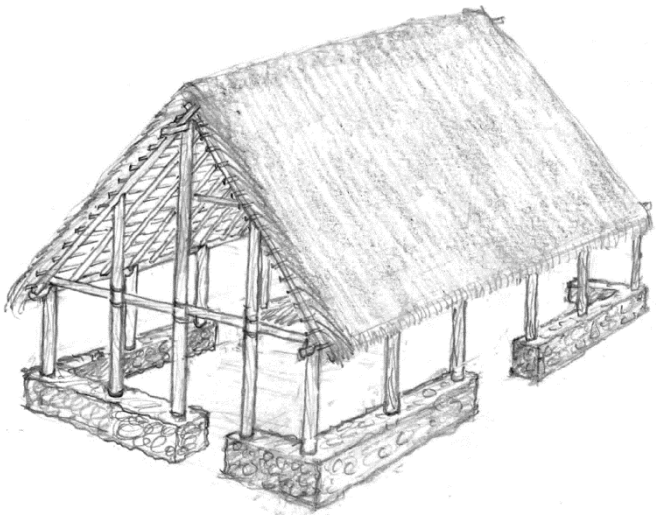
1. The minimum diameter size of all structural members shall be measured at the member's midpoint, except that the minimum diameter size of posts shall be measured at the smaller end. For structure sizes not specifically shown in the tables, the requirements in the next larger width size shall be applicable.
2. The specifications for structural members were estimated based on no wind loads. Hale shall be constructed to allow all thatching materials to separate from the structure prior to adding significant loads.
3. The mix formula for mortar specified in these rules shall be one part portland cement, four parts clean sand, and sufficient fresh water to make the mixture workable.
4. Every hale, except hale noa, shall have at least two sides completely open.
5. Lashing and thatching methods shall comply with illustrations found in "Arts and Crafts of Hawaii" or "The Hawaiian Grass House in Bishop Museum" referenced in Section X101.2.

Section X402 Allowable designs.

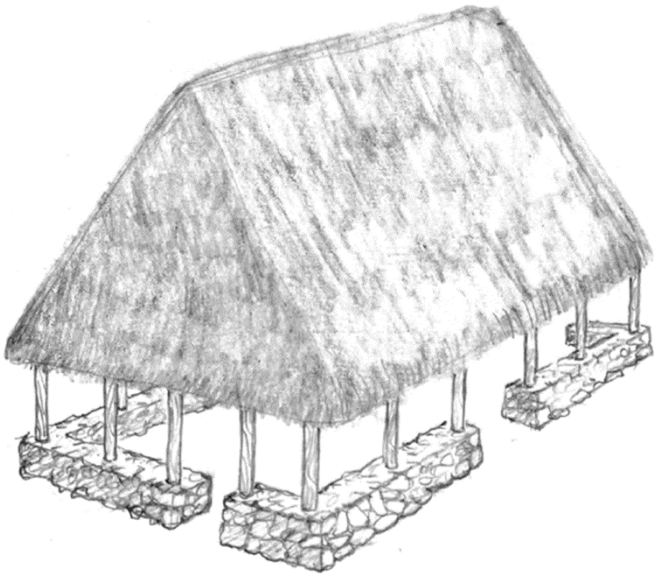
Hale shall be designed and constructed in accordance with the requirements in Sections 402.1 through 402.4.

X402.1 Hale Halawai. Each end of the Hale Halawai may be open or thatched. The ends may also be constructed with a thatched roof hip as an alternate design. Hale Halawai shall be designed in accordance with the following schematics and illustrations. Structural components for Hale Halawai shall meet the size and spacing requirements in Table X402.1(a). Foundations for Hale Halawai shall be designed in accordance with Table X402.1(b).





HALE HALAWAI
Open End Style



HALE HALAWAI
Thatched End Style

FRAMING SCHEMATIC

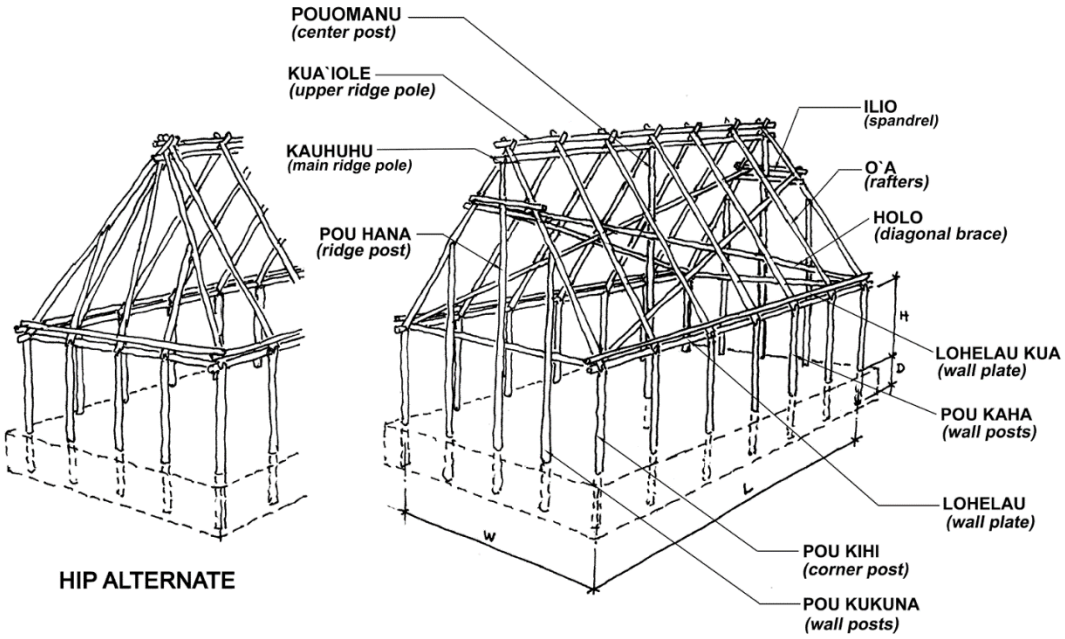
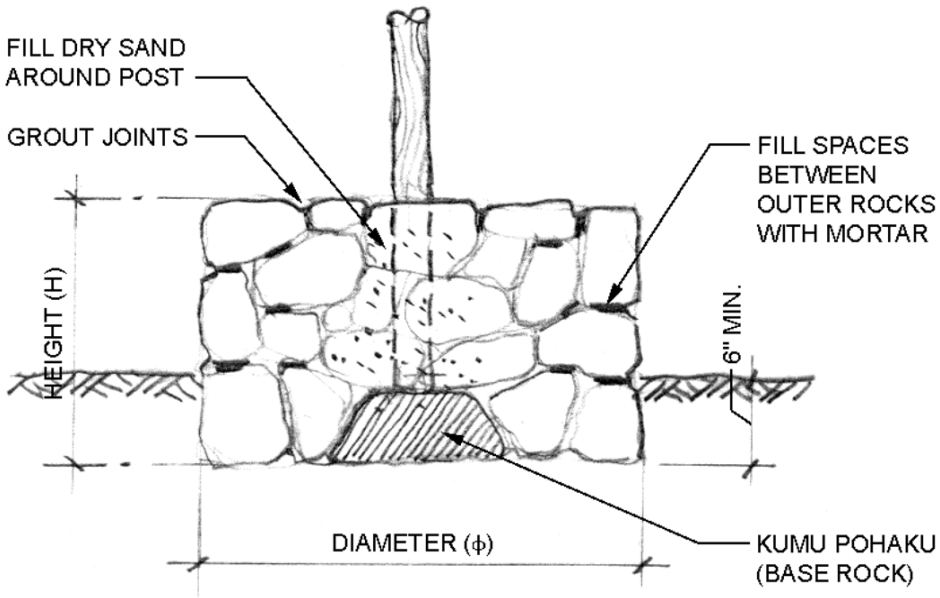
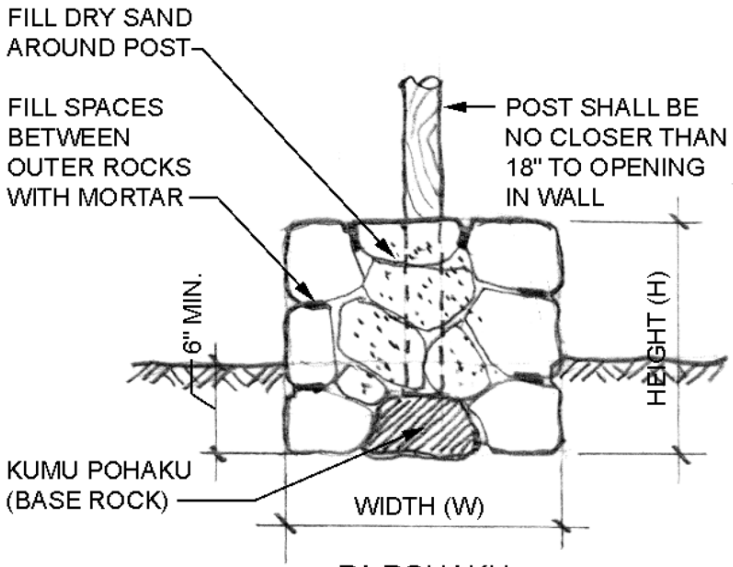


Table X402.1(a)
Size and Spacing Requirements for Structural Components used in Hale Halawai

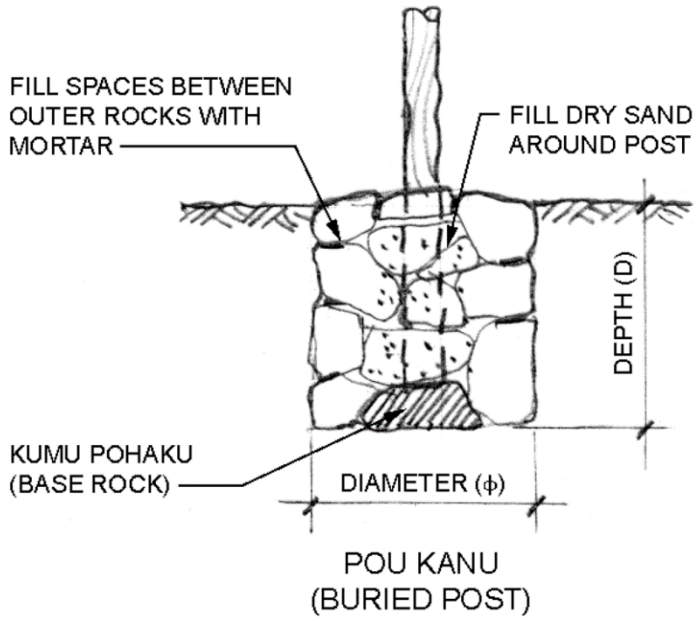
Size W x L x H	***pou kihi***	***pou kukuna*** & ***pou kaha***	***pou hana*** & ***pouomanu***	***o'a***	***kuaiole*** & ***holo***	***kauhuhu***	***lohelau***	**Maximum post spacing** (feet)	**Maximum rafter spacing** (feet)
	Minimum Diameter (inches)								
12' x 20' x 7'	4	3½	4	3½	2½	3	3	5	3
14' x 24' x 7'	4	4	4½	3½	2½	3	3½	5	3
24' x 30' x 7'	5	4½	4½	4	2½	3	3½	5	3
25' x 50' x 7'	5½	5	5½	4	2½	3	3½	5	3
30' x 60' x 7'	6	5½	6	4½	2½	3	4	5	3



KAHUA
(PEDESTAL)



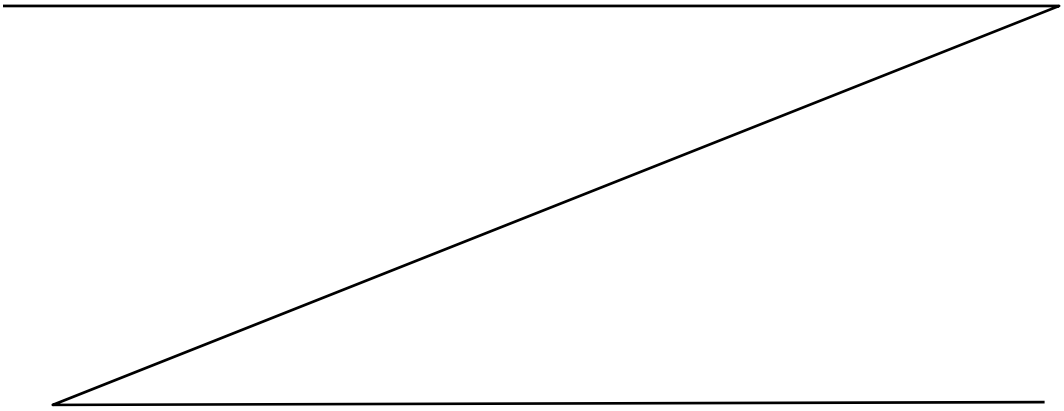
PA POHAKU
(FOUNDATION WALL)



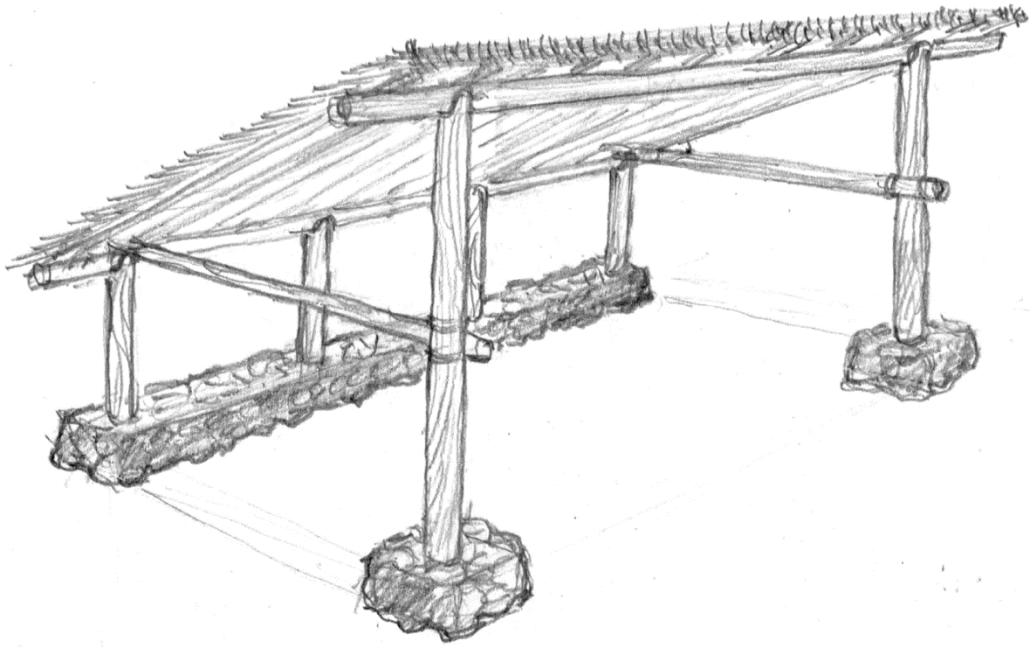
POU KANU
(BURIED POST)

Table X402.1(b)
Foundation Design for Hale Halawai

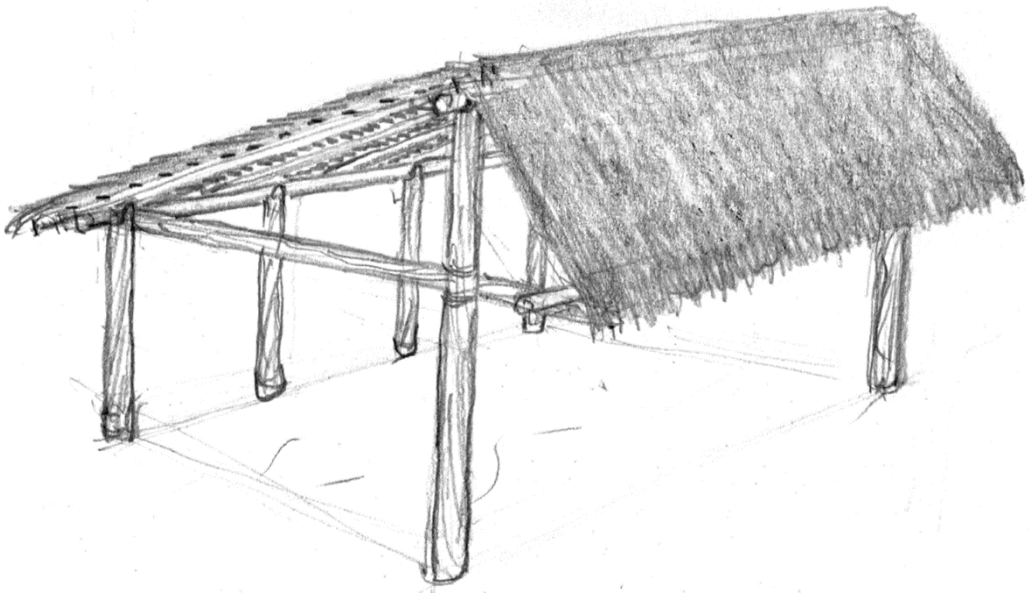
Size (W x L x H)	**Foundation Type**		
	kahua Diameter x Height	**pa pohaku** Width x Height x Length	**pou kanu** Diameter x Depth
12' x 20' x 7'	3'6"φ x 24"H	2'6"W x 2'8"H x 4'0"L	30"φ x 2'8"D
14' x 24' x 7'	3'8"φ x 24"H	2'6"W x 2'8"H x 4'0"L	30"φ x 2'9"D
24' x 30' x 7'	4'0"φ x 30"H	3'0"W x 3'0"H x 4'0"L	36"φ x 3'0"D
25' x 50' x 7'	4'0"φ x 30"H	3'0"W x 3'0"H x 4'0"L	36"φ x 3'0"D
30' x 60' x 7'	4'0"φ x 30"H	3'0"W x 3'3"H x 4'0"L	36"φ x 3'3"D



**X402.2 Hale Ku`ai.** Hale Ku`ai shall be designed in accordance with the following schematics and illustrations. Structural components for Hale Ku`ai shall meet the size and spacing requirements in Table X402.2(a). Foundations for Hale Ku`ai shall be designed in accordance with Table X402.2(b).

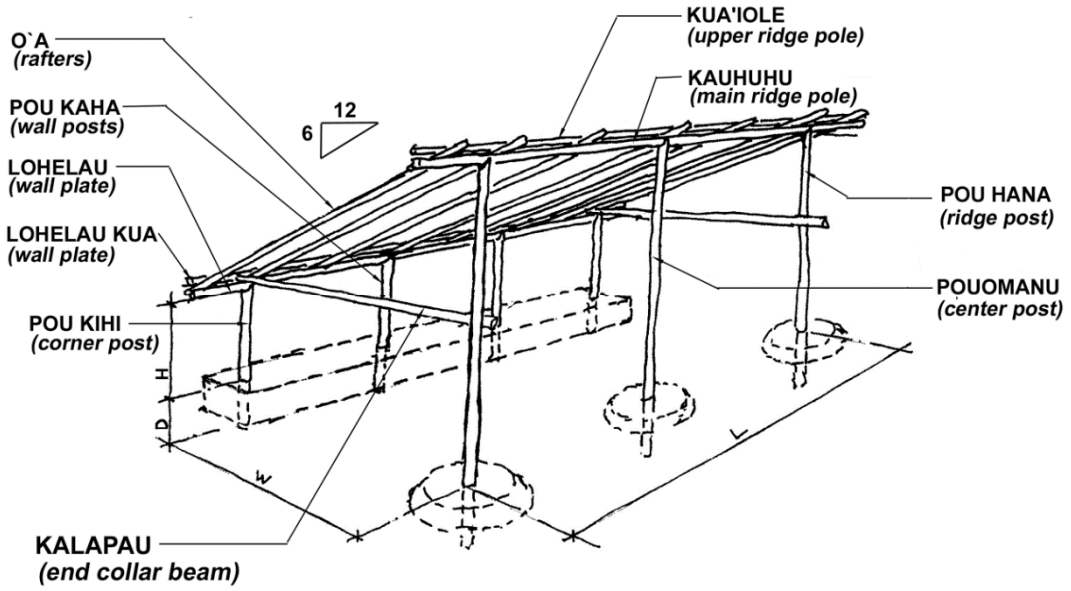


HALE KU`AI
SHED STYLE



HALE KU`AI
GABLE STYLE

FRAMING SCHEMATIC 1



FRAMING SCHEMATIC 2

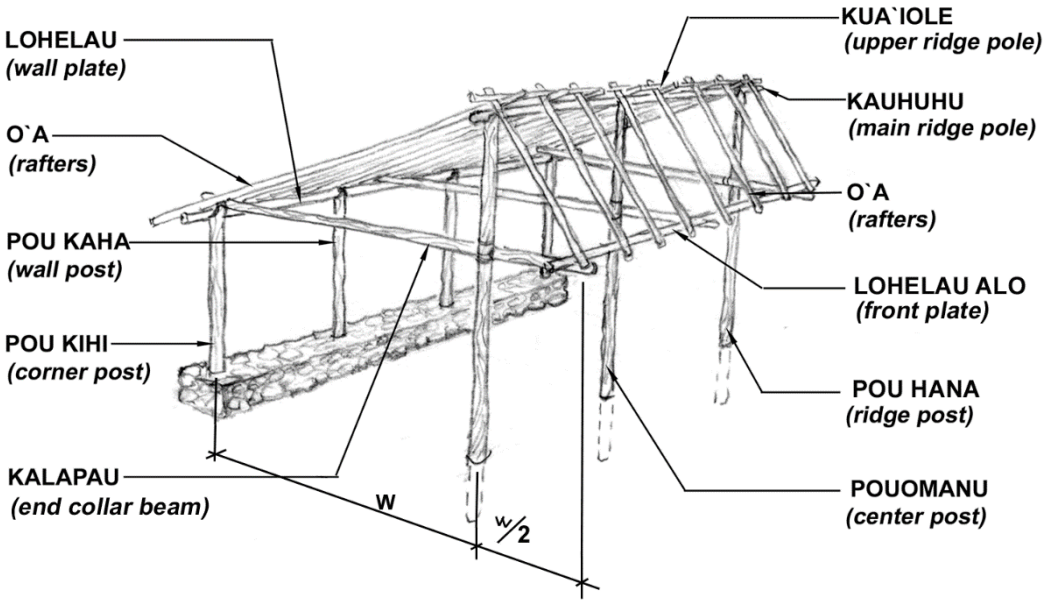
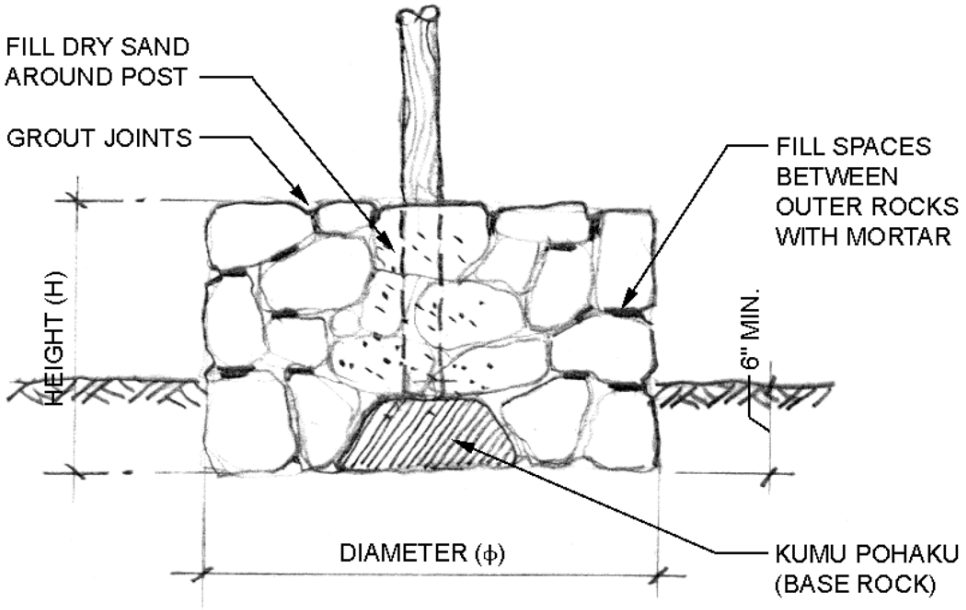


Table X402.2(a)
Size and Spacing Requirements for Structural Components used in Hale Ku`ai

Size (W x L x H)	***pou kihi***[a]	***pou kaha***[a]	***pou hana***[b]	***pouo manu***[b]	***o'a***	***kuaiole*** & ***holo***	***kauhuhu***	***lohelau***	**Maximum rafter spacing** (feet)
	Minimum Diameter (inches)								
5' x 10' x 5'	4	3	3	4	3	2	3	2	4
9' x 12' x 5'	4	3	3	4	3	2	3½	2	4
12' x 16' x 5'	4½	3½	4	4	3½	2	4	2½	4
14' x 20' x 5'	4½	3½	4	4	3½	2½	4½	2½	4

[a] The maximum post spacing for pou kihi and pou kaha is five feet.
[b] The maximum post spacing for pou hana and pouomanu is twelve feet.



KAHUA
(PEDESTAL)

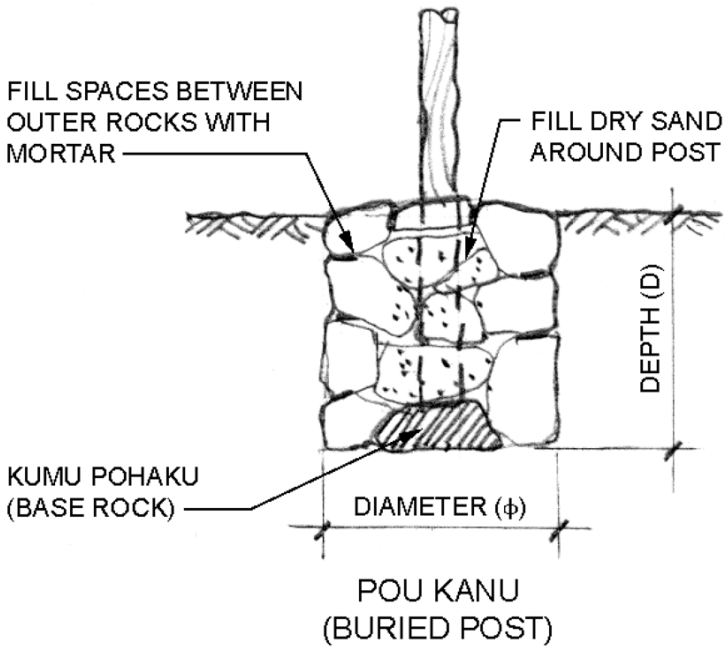
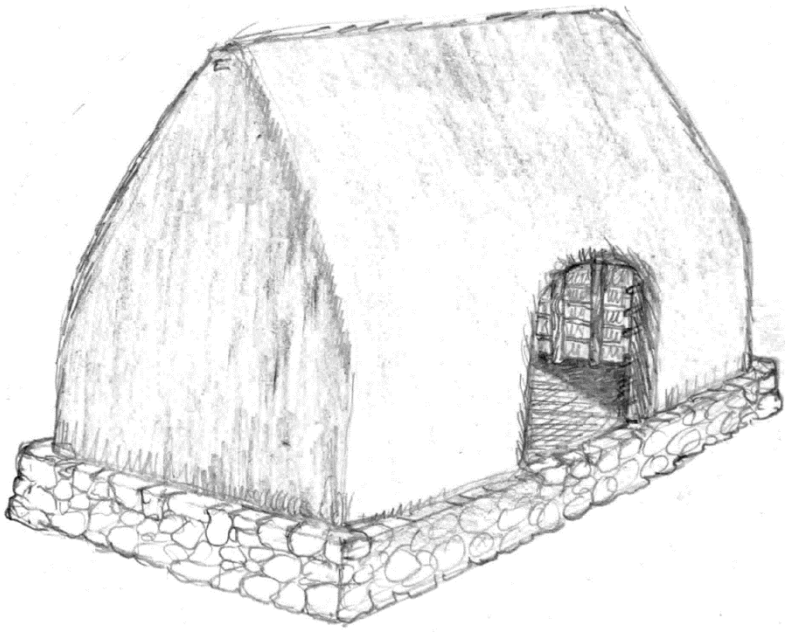


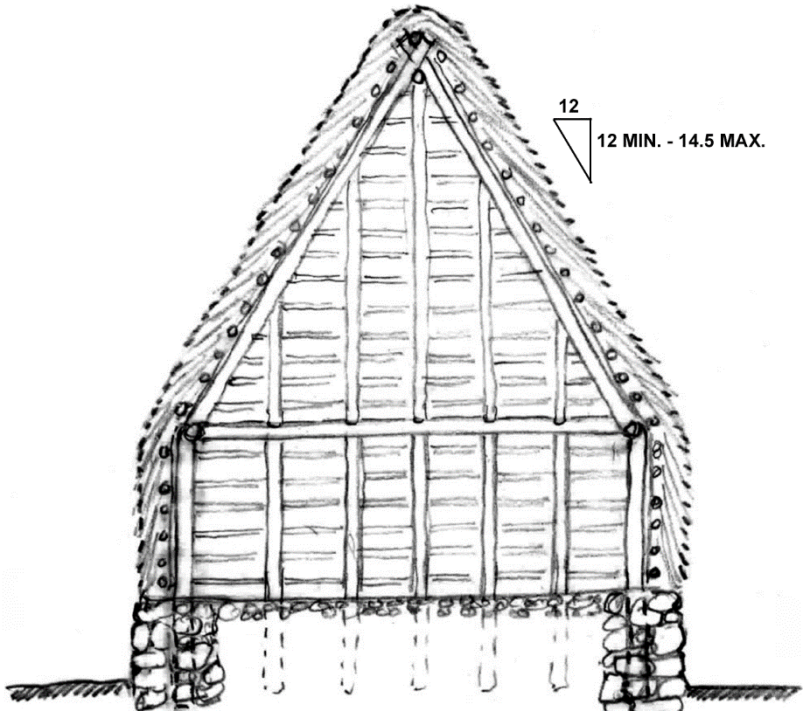
Table X402.2(b)
Foundation Design for Hale Ku`ai

Size (W x L x H)	**Foundation Type**		
	kahua Diameter x Height	**pa pohaku** Width x Height x Length	**pou kanu** Diameter x Depth
5' x 10' x 5'	3'0"φ x 24"H	2'6"W x 2'0"H x 4'0"L	30"φ x 2'6"D
9' x 12' x 5'	3'4"φ x 24"H	2'6"W x 2'0"H x 4'0"L	30"φ x 2'6"D
12' x 16' x 5'	3'6"φ x 24"H	2'6"W x 2'8"H x 4'0"L	30"φ x 2'8"D
14' x 20' x 5'	3'8"φ x 24"H	2'6"W x 2'8"H x 4'0"L	30"φ x 2'9"D

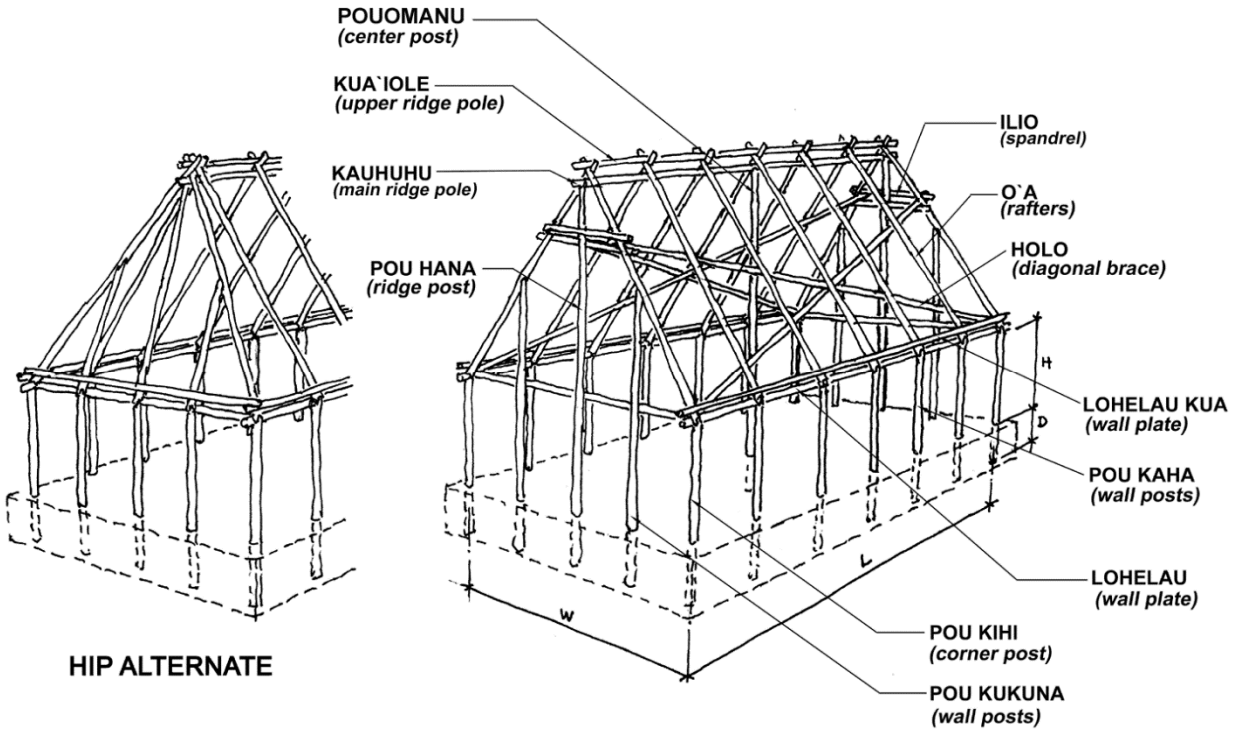
402.3 Hale Noa. Hale Noa shall have at least two openings. One opening shall be at least 3 feet wide and 5 feet high, and the other opening shall be at least 2 feet wide and 3 feet high. Hale Noa shall be designed in accordance with the following schematics and illustrations. Structural components for Hale Noa shall meet the size and spacing requirements in Table X402.3(a). Foundations for Hale Noa shall be designed in accordance with Table X402.3(b).



HALE NOA



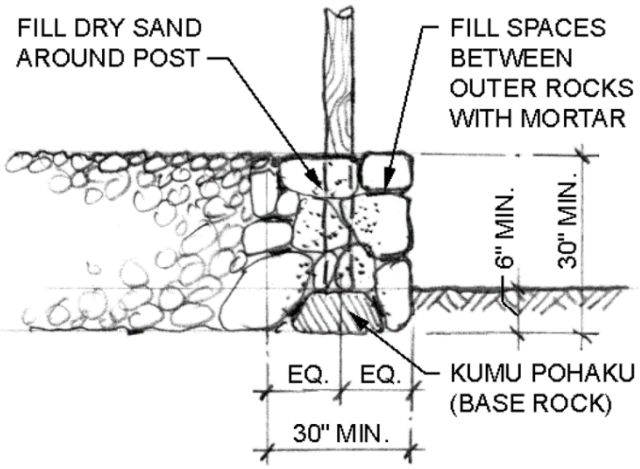
SECTION VIEW



FRAMING SCHEMATIC

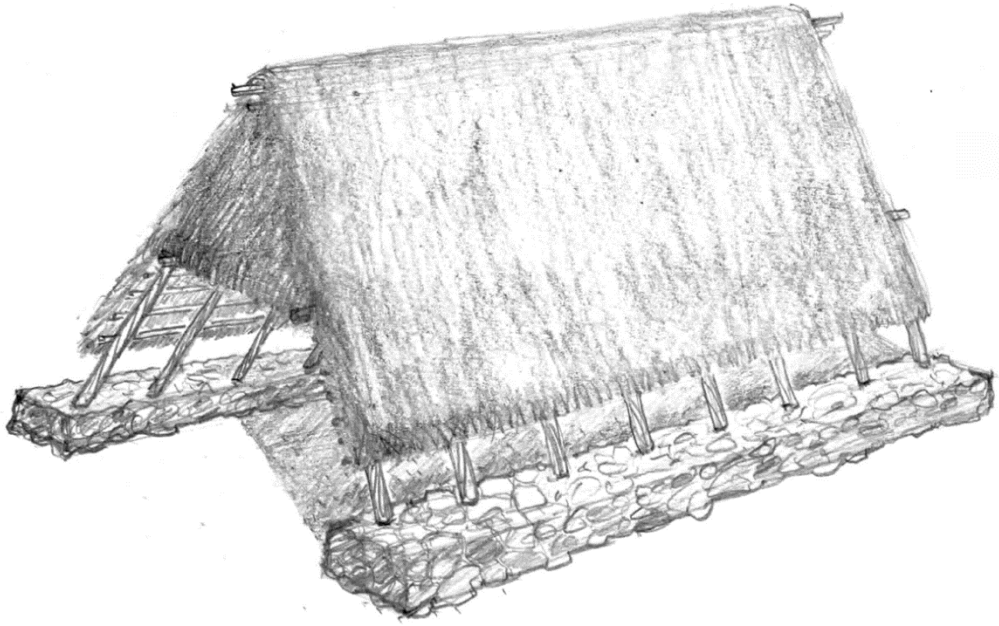
Table X402.3(a)
Size and Spacing Requirements for Structural Components used in Hale Noa

Size W x L x H	***pou kihi***	***pou kukuna*** & ***pou kaha***	***pou hana***	***pouomanu***	***o'a***	***kuaiole*** & ***holo***	***kauhuhu***	***lohelau***	**Maximum post spacing (feet)**	**Maximum rafter spacing (feet)**
	Minimum Diameter (inches)									
9' x 12' x 7'	3½	3	4	3	3	2½	3½	2½	6	4
12' x 20' x 7'	4	4½	4	3	3½	2½	3½	2½	6	4
4' x 24' x 7'	5½	4½	4	3	3½	2½	3½	3	6	4

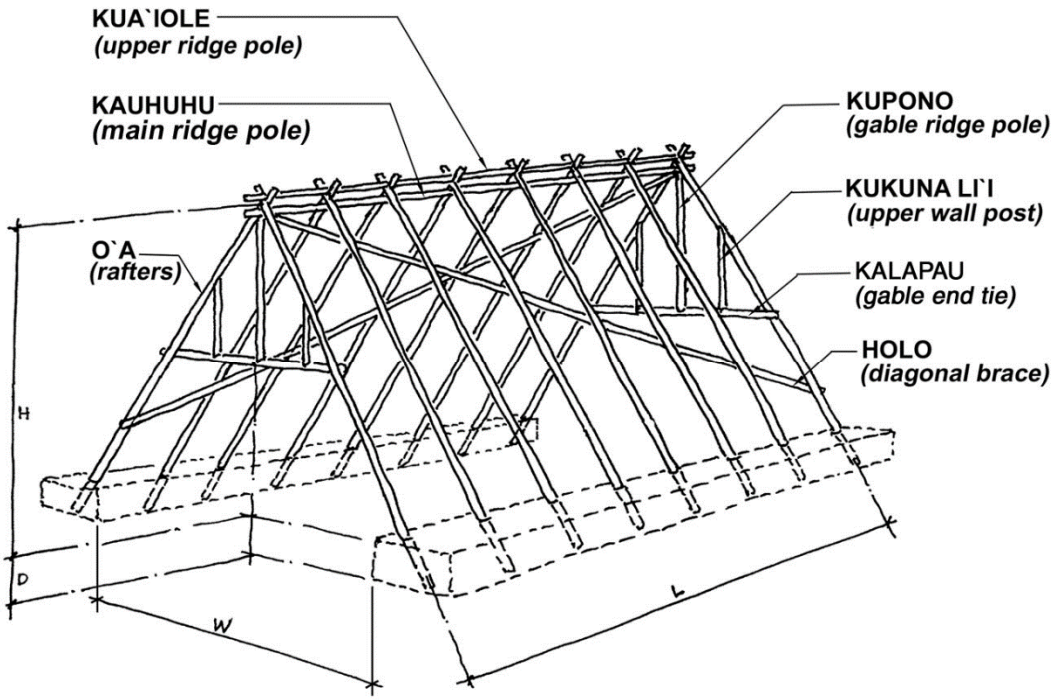


PAEPAE
(HOUSE PLATFORM)

**402.4 Hale Wa`a.** Hale Wa`a shall be designed in accordance with the following schematics and illustrations. Structural components for Hale Wa`a shall meet the size and spacing requirements in Table X402.4.



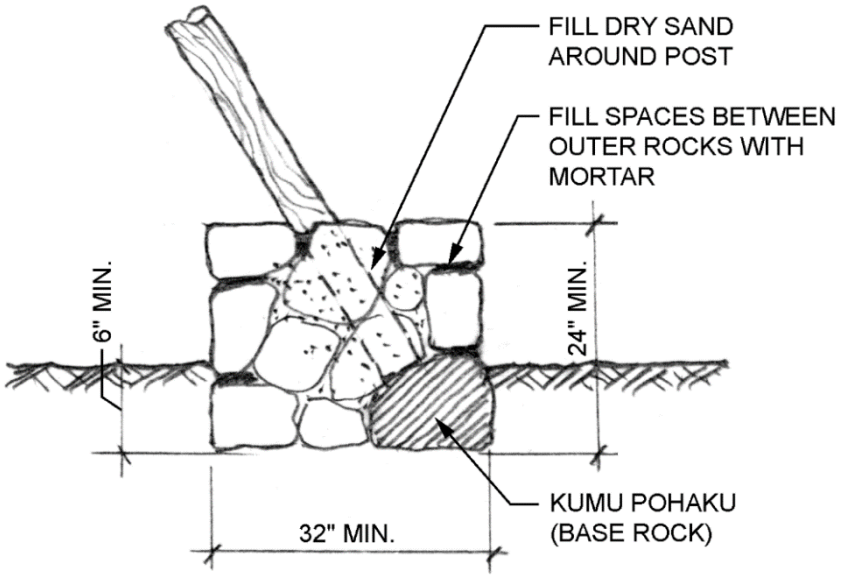
HALE WA`A



FRAMING SCHEMATIC

Table X402.4
Size and Spacing Requirements for Structural Components used in Hale *Wa`a*

Size (W x L)	***o'a***	***kuaiole*** & ***holo***	***kauhuhu***	**Spacing between Rafters**	**Minimum Ridge Height** (H)
20' x 60'	4"	3"	4"	4' to 5'	22½'
25' x 60'	5"	3"	4"	4' to 5'	27½'
30' x 60'	5½"	3"	4"	4' to 5'	27½'



PA POHAKU
(FOUNDATION WALL)

"