**Vulnerability FLOOD Standards**

**VF-1 Derivation of Personal Residential Structure Flood Vulnerability Functions**

1. ***Development of the personal residential structure flood vulnerability functions shall be based on two or more of the following: (1) rational structural analysis, (2) post-event site investigations, (3) technical literature, (4) expert opinion, (5) laboratory or field testing, and (6) insurance claims data. Personal residential structure flood vulnerability functions shall be supported by historical and other relevant data.***
2. ***The derivation of personal residential structure flood vulnerability functions and their associated uncertainties shall be theoretically sound and consistent with fundamental engineering principles.***
3. ***Residential building stock classification shall be representative of Florida construction for personal residential structures.***
4. ***The following flood characteristics shall be used in the derivation of personal residential structure flood vulnerability functions: depth above ground, and in coastal areas, damaging wave action.***
5. ***The following primary building characteristics shall be used or accounted for in the derivation of personal residential structure vulnerability functions: lowest floor elevation relative to ground, foundation type, construction materials, and year of construction.***

1. ***Flood vulnerability functions shall be separately derived for personal residential building structures and manufactured homes.***

Purpose: Both flood and building characteristics affect personal residential structure flood vulnerability functions. The development of personal residential structure flood vulnerability functions is to be supported by historical or other relevant data.

In coastal areas, the effects of damaging wave action must be incorporated into personal residential structure flood vulnerability functions by explicit wave modeling or by wave proxies.

The data and methods used to develop personal residential structure flood vulnerability functions, and their associated uncertainties, affect the modeled flood loss costs and flood probable maximum loss levels. Their development and documentation are essential parts of the flood model.

The adoption and enforcement of statewide and county building codes and floodplain management regulations affect the flood vulnerability functions.

Relevant Forms: GF-5, Vulnerability Flood Standards Expert Certification

VF-1, Coastal Flood with Damaging Wave Action

VF-2, Inland Flood by Flood Depth

AF-1, Zero Deductible Personal Residential Flood Loss Costs

AF-5, Logical Relationship to Flood Risk (Trade Secret Item)

**Disclosures**

1. Provide a flowchart documenting the process by which the personal residential structure flood vulnerability functions are derived and implemented.
2. Describe the assumptions, data, methods, and processes used for the development of the personal residential structure flood vulnerability functions.

3. As applicable, describe the nature and extent of actual insurance claims data used to develop the personal residential structure flood vulnerability functions. Describe in detail what is included, such as, number of policies, number of insurers, dates of loss, and number of units of dollar exposure, separated into personal residential building structures and manufactured homes.

1. Summarize post-event site investigations, including the sources, and provide a brief description of the resulting use of these data in the development or validation of personal residential structure flood vulnerability functions.
2. Describe how the personal residential structure flood vulnerability functions incorporate depth of flooding (above ground and above lowest floor) and damaging wave action (in coastal areas). For coastal areas, define the thresholds indicating the presence of damaging wave action for personal residential building structures and manufactured homes. Describe the area over which vulnerability functions for damaging wave action or wave proxies are applied.
3. State if the following flood characteristics are considered in the development of the personal residential structure flood vulnerability functions, and if so, how; if not, explain why: flood velocity, flood duration, flood-induced erosion, flood-borne debris, salinity (saltwater versus freshwater flooding), and contaminated floodwaters.
4. Describe how the personal residential structure flood vulnerability functions incorporate the following primary building characteristics: lowest floor elevation relative to ground, foundation type, primary construction materials, and year of construction.
5. State if the following building characteristics are considered in the development of the personal residential structure flood vulnerability functions, and if so, how; if not, explain why: number of stories, use of each story (e.g., habitable space, parking, storage, other), presence of basement, replacement value of building, structure value by story, square footage of living area, and other construction characteristics, as applicable.
6. Describe the process by which local construction practices, statewide and county building code, and floodplain management regulation adoption and enforcement are considered in the development of personal residential structure flood vulnerability functions.
7. Provide the total number of personal residential structure flood vulnerability functions available for use in the flood model. Describe which structure flood vulnerability functions are used for personal residential building structures, manufactured homes, condo unit owners and apartment renters.
8. Describe the assumptions, data, methods, and processes used to develop personal residential structure flood vulnerability functions when:
   1. personal residential construction types are unknown,
   2. one or more primary building characteristics are unknown, or
   3. building input characteristics are conflicting.
9. Describe similarities and differences in how the personal residential structure flood vulnerability functions are developed and applied for coastal and inland flooding.
10. Provide a completed Form VF-1, Coastal Flood with Damaging Wave Action. Provide a link to the location of the form [insert hyperlink here].
11. Provide a completed Form VF-2, Inland Flood by Flood Depth. Provide a link to the location of the form [insert hyperlink here].

**Audit**

1. All personal residential structure flood vulnerability functions will be reviewed.
2. Vulnerability functions for waves or wave proxies will be reviewed. Modeling organization thresholds for damaging wave action will be reviewed. The area over which vulnerability functions for damaging waves or wave proxies are applied will be reviewed.
3. Validation of the personal residential structure flood vulnerability functions and associated uncertainties will be reviewed.
4. Historical data in the original form will be reviewed with explanations for any changes made and descriptions of how missing or incorrect data were handled. For historical data used to develop personal residential structure flood vulnerability functions, the goodness-of-fit of the data will be reviewed. Complete reports detailing flooding conditions and damage suffered for any laboratory or field testing data used will be reviewed. A variety of different personal residential structure construction classes will be selected from the complete rational structural analyses and calculations to be reviewed. Laboratory or field tests and original post-event site investigation reports will be reviewed. Other technical literature and expert opinion summaries will be reviewed. Insurance claims data will be reviewed.
5. All papers, reports, and studies used in the continual development of the personal residential structure flood vulnerability functions must be available for review in hard copy or electronic form.
6. Multiple samples of personal residential structure flood vulnerability functions for personal residential structures and manufactured homes will be reviewed. The magnitude of logical changes among these items for given flood events and validation materials will be reviewed.
7. Justification for the personal residential structure construction classes and characteristics used will be reviewed.
8. Documentation and justification for all modifications to the personal residential structure flood vulnerability functions due to statewide and county building codes, floodplain management regulations, and their enforcement will be reviewed. If year of construction and/or geographical location of the personal residential structure is used as a surrogate for building code, floodplain management regulation, and their enforcement, complete supporting information for the number of year of construction groups used as well as the year(s) and/or geographical region(s) of construction that separates particular group(s) will be reviewed.
9. The effects on personal residential structure flood vulnerability from local and regional construction characteristics, statewide and county building codes, and floodplain management regulations will be reviewed including whether current building codes are reflected.
10. How the claim practices of insurance companies are accounted for when claims data for those insurance companies are used to develop or to verify personal residential structure flood vulnerability functions will be reviewed. Examples include the level of damage the insurer considers a loss to be a total loss, claim practices of insurers with respect to concurrent causation, or the impact of public adjusting.
11. The percentage of damage at or above which the flood model assumes a total structure loss will be reviewed.
12. Documentation and justification for the method of derivation and data on which the personal residential structure flood vulnerability functions are based will be reviewed.
13. If modeled, the treatment of water intrusion in personal residential structure flood vulnerability functions will be reviewed.
14. Form VF-1, Coastal Flood with Damaging Wave Action, will be reviewed.
15. Form VF-2, Inland Flood by Flood Depth, will be reviewed.

**VF-2 Derivation of Personal Residential Contents Flood Vulnerability Functions**

1. ***Development of the personal residential contents flood vulnerability functions shall be based on some combination of the following: (1) post-event site investigations, (2) technical literature, (3) expert opinion, (4) laboratory or field testing, and (5) insurance claims data. Contents flood vulnerability functions shall be supported by historical and other relevant data.***
2. ***The relationship between personal residential structure and contents flood vulnerability functions shall be reasonable.***

Purpose: Personal residential contents flood vulnerability functions and flood losses are affected by various flood, contents, and building characteristics. The development of personal residential contents flood vulnerability functions is to be supported by historical or other relevant data.

In coastal areas, the effects of damaging wave action must be incorporated into personal residential contents flood vulnerability functions by explicit wave modeling or by wave proxies.

The development of personal residential contents flood vulnerability functions is to be documented with respect to the methods and sources.

A reasonable representation of contents flood vulnerability is necessary in order to address policies that cover contents losses.

Relevant Forms: GF-5, Vulnerability Flood Standards Expert Certification

AF-5, Logical Relationship to Flood Risk (Trade Secret Item)

**Disclosures**

1. Provide a flowchart documenting the process by which the personal residential contents flood vulnerability functions are derived and implemented.
2. Describe the relationship between personal residential contents and personal residential structure flood vulnerability functions.
3. Describe any assumptions, data, methods, and processes used to develop and validate the personal residential contents flood vulnerability functions.
4. As applicable, describe the nature and extent of actual insurance claims data used to develop the personal residential contents flood vulnerability functions. Describe in detail what is included, such as, number of policies, number of insurers, dates of loss, and number of units of dollar exposure, separated into personal residential building structures and manufactured homes.
5. Provide the total number of personal residential contents flood vulnerability functions available for use in the flood model. Describe whether different contents flood vulnerability functions are used for personal residential building structures, manufactured homes, unit location for condo owners and apartment renters, and various building classes.
6. Describe any relationships between flood characteristics and personal residential contents flood vulnerability functions.
7. State the minimum threshold, if any, at which personal residential contents flood damage is calculated (e.g., personal residential contents damage is estimated for personal residential structure damage greater than *x* percent or flood depth greater than *y* inches). Provide documentation of assumptions and available validation data to verify the approach used.
8. Describe similarities and differences in how personal residential contents flood vulnerability functions are developed and applied for coastal and inland flooding.
9. Describe the assumptions, data, methods, and processes used to develop personal residential contents flood vulnerability functions when:
   1. personal residential construction types are unknown,
   2. one or more primary building characteristics are unknown, or
   3. building input characteristics are conflicting.

**Audit**

1. All personal residential contents flood vulnerability functions will be reviewed.

2. Validation of the personal residential contents flood vulnerability functions and associated uncertainties will be reviewed.

3. Documentation and justification of the following aspects or assumptions related to personal residential contents flood vulnerability functions will be reviewed:

a. The method of derivation and data;

b. Variability of personal residential contents flood damage by personal residential structure classification and characteristics;

c. Variability of personal residential contents flood damage by flood characteristics; and

d. Personal residential contents flood damage for various occupancies.

4. Historical data in the original form will be reviewed with explanations for any changes made and descriptions of how missing or incorrect data were handled. For historical data used to develop personal residential contents flood vulnerability functions, the goodness-of-fit of the data will be reviewed. Complete reports detailing flood conditions and damage suffered for any test data used will be reviewed. Original post-event site investigation reports will be reviewed. Other technical literature and expert opinion summaries will be reviewed. Insurance claims data will be reviewed.

5. All papers, reports, and studies used in the continual development of the personal residential contents flood vulnerability functions must be available for review in hard copy or electronic form.

**VF-3 Derivation of Personal Residential Time Element Flood Vulnerability Functions**

1. ***Development of the personal residential time element flood vulnerability functions shall be based on one or more of the following: (1) post-event site investigations, (2) technical literature, (3) expert opinion, (4) laboratory or field testing, and (5) insurance claims data.***
2. ***The relationship among personal residential structure, contents, and time element flood vulnerability functions shall be reasonable.***

Purpose: Personal residential time element flood vulnerability functions and flood losses are affected by various flood, contents and building characteristics, as well as external factors that affect the ability to repair or replace a structure. The development of personal residential time element flood vulnerability functions is to be supported by historical or other relevant data.

In coastal areas, the treatment of damaging wave action in personal residential time element flood vulnerability functions may be important.

The development of personal residential time element flood vulnerability functions is to be documented with respect to the methods and sources.

A reasonable representation of personal residential time element flood vulnerability is necessary in order to address policies that cover personal residential time element losses.

Policies can provide varying types of personal residential time element coverage and insurance policies may pay for personal residential time element claims irrespective of flood damage to the insured property.

Relevant Forms: GF-5, Vulnerability Flood Standards Expert Certification

AF-5, Logical Relationship to Risk (Trade Secret Item)

**Disclosures**

1. Provide a flowchart documenting the process by which the personal residential time element flood vulnerability functions are derived and implemented.
2. Describe the assumptions, data, methods, and processes used to develop and validate personal residential time element flood vulnerability functions.
3. Describe the relationships among personal residential structure, contents, and time element vulnerability functions.
4. As applicable, describe the nature and extent of actual insurance claims data used to develop the personal residential time element flood vulnerability functions. Describe in detail what is included, such as number of policies, number of insurers, dates of loss, and number of units of dollar exposure, separated into personal residential building structures and manufactured homes.
5. Provide the total number of personal residential time element flood vulnerability functions available for use in the flood model. Describe whether different time element flood vulnerability functions are used for personal residential building structures, manufactured homes, unit location for condo owners and apartment renters, and various building classes.
6. Describe similarities and differences in how personal residential time element flood vulnerability functions are developed and applied for coastal and inland flooding.
7. Describe whether and how personal residential structure classification and characteristics, and flood characteristics, are incorporated into the personal residential time element flood vulnerability functions.
8. Describe whether and how personal residential time element flood vulnerability functions take into consideration the damage to local and regional infrastructure, or personal residential time element vulnerability resulting from a governmental mandate associated with flood events (e.g., evacuation and re-entry mandates).
9. Describe the assumptions, data, methods, and processes used to develop personal residential time element flood vulnerability functions when:
10. personal residential construction types are unknown,
11. one or more primary building characteristics are unknown, or
12. building input characteristics are conflicting.

**Audit**

1. All personal residential time element flood vulnerability functions will be reviewed.

2. Validation of the personal residential time element flood vulnerability functions and associated uncertainties will be reviewed.

3. Documentation and justification of the following aspects or assumptions related to personal residential time element flood vulnerability functions will be reviewed:

a. The method of derivation and underlying data;

b. Variability of personal residential time element flood vulnerability by personal residential structure classification and characteristics;

c. Variability of personal residential time element flood vulnerability by flood characteristics;

d. Personal residential time element flood vulnerability for various occupancies; and

e. The methods used to estimate the time required to repair or replace the property due to flooding.

4. Historical data in the original form will be reviewed with explanations for any changes made and descriptions of how missing or incorrect data were handled. To the extent historical data are used to develop personal residential time element flood vulnerability functions, the goodness-of-fit of the data will be reviewed. Complete reports detailing flooding conditions and damage suffered for any test data used will be reviewed. Original post-event site investigation reports will be reviewed. Other technical literature and expert opinion summaries will be reviewed. Insurance claims data will be reviewed.

5. If included, the methodology and validation for determining the extent of infrastructure flood damage and governmental mandate and their effect on personal residential time element vulnerability will be reviewed.

**VF-4 Flood Mitigation Measures**

1. ***Modeling of flood mitigation measures to improve flood resistance of personal residential structures, the corresponding effects on flood vulnerability, and their associated uncertainties shall be theoretically sound and consistent with fundamental engineering principles. These measures shall include design, construction, and retrofit techniques that affect the flood resistance or flood protection of personal residential structures. The modeling organization shall justify all flood mitigation measures considered by the flood model.***

1. ***Application of flood mitigation measures that affect the performance of personal residential structures and the damage to contents shall be justified as to the impact on reducing flood damage whether done individually or in combination.***

Purpose: Flood mitigation measures are those measures undertaken at an individual building level, usually within the building footprint, and may include the following:

* Elevating the structure
* Adding flood openings to enclosure walls
* Wet and/or dry floodproofing
* Permanent elevation or protection of equipment and utilities
* Flood barriers
* Pumps.

Multiple flood mitigation measures will be considered and their combined effect on flood damage must be estimated.

Relevant Forms: GF-5, Vulnerability Flood Standards Expert Certification

VF-3, Flood Mitigation Measures, Range of Changes in Flood Damage

VF-4, Coastal Flood Mitigation Measures, Mean Coastal Flood Damage

Ratios and Coastal Flood Damage/$1,000 (Trade Secret Item)

VF-5, Inland Flood Mitigation Measures, Inland Mean Flood Damage

Ratios and Inland Flood Damage/$1,000 (Trade Secret Item)

AF-5, Logical Relationship to Flood Risk (Trade Secret Item)

**Disclosures**

1. Provide a completed Form VF-3, Flood Mitigation Measures, Range of Changes in Flood Damage. Provide a link to the location of the form [insert hyperlink here].
2. Provide a description of all flood mitigation measures used by the flood model, whether or not they are listed in Form VF-3, Flood Mitigation Measures, Range of Changes in Flood Damage.

3. Describe how personal residential time element losses are affected by performance of flood mitigation measures. Identify any assumptions.

4. Describe how personal residential structure and contents damage and their associated uncertainties are affected by flood mitigation measures. Identify any assumptions.

5. Describe how the effects of multiple flood mitigation measures are combined in the flood model and the process used to ensure that multiple flood mitigation measures are correctly combined.

6. Describe how flood mitigation measures affect the uncertainty of the vulnerability. Identify any assumptions.

**Audit**

1. Flood mitigation measures used by the flood model will be reviewed for theoretical soundness and reasonability.
2. Form VF-3, Flood Mitigation Measures, Range of Changes in Flood Damage, Form VF-4, Coastal Flood Mitigation Measures, Mean Coastal Flood Damage Ratios and Coastal Flood Damage/$1,000 (Trade Secret Item), and Form VF-5, Inland Flood Mitigation Measures, Mean Inland Flood Damage Ratios and Inland Flood Damage/$1,000 (Trade Secret Item), will be reviewed.
3. Implementation of flood mitigation measures will be reviewed as well as the effect of individual flood mitigation measures on flood damage. Any variation in the change over the range of flood depths above ground for individual flood mitigation measures will be reviewed. Historical data, technical literature, expert opinion, or insurance claims data used to support the assumptions and implementation of flood mitigation measures will be reviewed. How flood mitigation measures affect the uncertainty of the vulnerability will be reviewed.
4. Implementation of multiple flood mitigation measures will be reviewed. The combined effects of these flood mitigation measures on flood damage will be reviewed. Any variation in the change over the range of flood depths above ground for multiple flood mitigation measures will be reviewed.

**Form VF-1: Coastal Flood with Damaging Wave Action**

Purpose: This form provides an illustration of the aggregate damage/exposure ratios by flood depth and by construction type for a specific set of reference structures subject to coastal flooding with damaging wave action.

1. Sample personal residential exposure data for 8 reference structures as defined below and 26 flood depths (0-25 feet at 1-foot increments) are provided in the file named “*VFEventFormsInput17.xlsx*.”

Model the sample personal residential exposure data provided in the file versus the flood depths and provide the damage ratios summarized by flood depth and construction type. Estimated Damage for each individual flood depth is the sum of ground up loss to all reference structures in the flood depth range, excluding demand surge.

Personal residential contents, appurtenant structures, or time element coverages are not included.

**Reference Structures**

|  |  |  |
| --- | --- | --- |
| **Wood Frame** | **Masonry** | **Manufactured Home** |
| #1  One story  Crawlspace foundation  Top of foundation wall 3 feet above grade | #4  One story  Slab foundation  Top of slab 1 foot above grade  Unreinforced masonry exterior walls | #7  Manufactured post 1994  Dry stack concrete foundation  Pier height 3 feet above grade  Tie downs  Single unit |
| #2  Two story  Slab foundation  Top of slab 1 foot above grade  5/8” diameter anchors at 48” centers for wall/slab connections | #5  Two story  Slab foundation  Top of slab 1 foot above grade  Reinforced masonry exterior walls | #8  Manufactured post 1994  Reinforced masonry pier  foundation  Pier height 6 feet above grade  Tie downs  Single unit |
| #3  Two story  Timber pile foundation  Top of pile 8 feet above grade  Wood floor system bolted to piles | #6  Two story  Concrete pile foundation  Concrete slab  Top of pile 8 feet above grade  Reinforced masonry exterior walls |  |

1. Confirm that the structures used in completing the form are identical to those in the above table for the reference structures.
2. If additional assumptions are necessary to complete this form, provide the rationale for the assumptions as well as a description of how they are included.
3. Provide a plot of the flood depth versus estimated damage/subject exposure data.
4. Include Form VF-1, Coastal Flood with Damaging Wave Action, in a submission appendix.

**Form VF-1: Coastal Flood with Damaging Wave Action**

|  |  |  |
| --- | --- | --- |
| **Flood depth (feet)**  **above ground level** |  | **Estimated Damage/**  **Subject Exposure** |
| 0 |  |  |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |
| 6 |  |  |
| 7 |  |  |
| 8 |  |  |
| 9 |  |  |
| 10 |  |  |
| 11 |  |  |
| 12 |  |  |
| 13 |  |  |
| 14 |  |  |
| 15 |  |  |
| 16 |  |  |
| 17 |  |  |
| 18 |  |  |
| 19 |  |  |
| 20 |  |  |
| 21 |  |  |
| 22 |  |  |
| 23 |  |  |
| 24 |  |  |
| 25 |  |  |

**Form VF-2: Inland Flood by Flood Depth**

Purpose: This form provides an illustration of the aggregate damage/exposure ratios by flood depth and by construction type for a specific set of reference structures subject to inland (inundation) flooding.

1. Sample personal residential exposure data for 8 reference structures as defined below and 26 flood depths (0-25 feet at 1-foot increments) are provided in the file named “*VFEventFormsInput17.xlsx*.”

Model the sample personal residential exposure data provided in the file versus the flood depths and provide the damage ratios summarized by flood depth and construction type. Estimated Damage for each individual flood depth is the sum of ground up loss to all reference structures in the flood depth range, excluding demand surge.

Personal residential contents, appurtenant structures, or time element coverages are not included.

**Reference Structures**

|  |  |  |
| --- | --- | --- |
| **Wood Frame** | **Masonry** | **Manufactured Home** |
| #1  One story  Crawlspace foundation  Top of foundation wall 3 feet above grade | #4  One story  Slab foundation  Top of slab 1 foot above grade  Unreinforced masonry exterior walls | #7  Manufactured post 1994  Dry stack concrete foundation  Pier height 3 feet above grade  Tie downs  Single unit |
| #2  Two story  Slab foundation  Top of slab 1 foot above grade  5/8” diameter anchors at 48” centers for wall/slab connections | #5  Two story  Slab foundation  Top of slab 1 foot above grade  Reinforced masonry exterior walls | #8  Manufactured post 1994  Reinforced masonry pier  foundation  Pier height 6 feet above grade  Tie downs  Single unit |
| #3  Two story  Timber pile foundation  Top of pile 8 feet above grade  Wood floor system bolted to piles | #6  Two story  Concrete pile foundation  Concrete slab  Top of pile 8 feet above grade  Reinforced masonry exterior walls |  |

1. Confirm that the structures used in completing the form are identical to those in the above table for the reference structures.
2. If additional assumptions are necessary to complete this form, provide the rationale for the assumptions as well as a description of how they are included.
3. Provide a plot of the flood depth versus estimated damage/subject exposure data.
4. Include Form VF-2, Inland Flood by Flood Depth, in a submission appendix.

**Form VF-2: Inland Flood by Flood Depth**

|  |  |  |
| --- | --- | --- |
| **Flood depth (feet)**  **above ground level** |  | **Estimated Damage/**  **Subject Exposure** |
| 0 |  |  |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |
| 6 |  |  |
| 7 |  |  |
| 8 |  |  |
| 9 |  |  |
| 10 |  |  |
| 11 |  |  |
| 12 |  |  |
| 13 |  |  |
| 14 |  |  |
| 15 |  |  |
| 16 |  |  |
| 17 |  |  |
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| 22 |  |  |
| 23 |  |  |
| 24 |  |  |
| 25 |  |  |

**Form VF-3: Flood Mitigation Measures**

**Range of Changes in Flood Damage**

Purpose: This form illustrates the changes in flood damage ratios for three specific reference structures subject to individual flood mitigation measures and to combinations of flood mitigation measures.

1. Provide the change in the personal residential reference building damage ratio (not loss cost) for each individual flood mitigation measure listed in Form VF-3, Flood Mitigation Measures, Range of Changes in Flood Damage, as well as for the combination of the flood mitigation measures.
2. If additional assumptions are necessary to complete this form, provide the rationale for the assumptions as well as a detailed description of how they are included.
3. Provide this form in Excel format without truncation. The file name shall include the abbreviated name of the modeling organization, the flood standards year, and the form name. Also include Form VF-3, Flood Mitigation Measures, Range of Changes in Flood Damage, in a submission appendix.

**Reference Structures**

|  |  |
| --- | --- |
| **Wood Frame** | **Masonry** |
| One story  Crawlspace foundation  Top of foundation wall 3 feet above grade | One story  Slab foundation  Top of slab 1 foot above grade  Unreinforced masonry exterior walls |
| Two story  Timber pile foundation  Top of pile 8 feet above grade  Wood floor system bolted to piles |  |

Place the reference structures at the following locations, with latitude and longitude referenced to the World Geodetic System of 1984 (WGS84) datum, and provide the aggregated results.

Gulf of Mexico St. Johns River

Latitude: 27.9957517 Latitude: 29.3768881

Longitude: -82.8277373 Longitude: -81.6190223

1. Provide the ground elevation used from the flood model elevation database for both reference points.

**Form VF-3: Flood Mitigation Measures**

**Range of Changes in Flood Damage**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **INDIVIDUAL  MITIGATION MEASURES** | | **PERCENTAGE CHANGES IN DAMAGE**  **((REFERENCE DAMAGE RATIO - MITIGATED DAMAGE RATIO) / REFERENCE DAMAGE RATIO) \* 100** | | | | | | | | | |
| **TWO-STORY WOOD FRAME STRUCTURE** | | | | | **MASONRY STRUCTURE** | | | | |
| **FLOOD DEPTH (FT) ABOVE GROUND** | | | | | **FLOOD DEPTH (FT) ABOVE GROUND** | | | | |
| **7** | **9** | **11** | **13** | **15** | **1** | **3** | **5** | **7** | **9** |
|  | REFERENCE STRUCTURE | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |
| ELEVATE STRUCTURE | Elevate Floor 1 Foot |  |  |  |  |  | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |
| Elevate Floor 2 Feet |  |  |  |  |  | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |
| Elevate Floor 3 Feet |  |  |  |  |  | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |
| UTILITY EQUIPMENT | Elevate or Protect 1 Foot |  |  |  |  |  |  |  |  |  |  |
| Elevate or Protect 2 Feet |  |  |  |  |  |  |  |  |  |  |
| Elevate or Protect 3 Feet |  |  |  |  |  |  |  |  |  |  |
| FLOODPROOFING | Wet 1 Foot |  |  |  |  |  |  |  |  |  |  |
| Wet 2 Feet |  |  |  |  |  |  |  |  |  |  |
| Wet 3 Feet |  |  |  |  |  |  |  |  |  |  |
| Dry 1 Foot | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |  |  |  |  |  |
| Dry 2 Feet | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |  |  |  |  |  |
| Dry 3 Feet | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |  |  |  |  |  |
| FLOOD OPENINGS |  | **ONE-STORY WOOD FRAME STRUCTURE** | | | | |  | | | | |
| **FLOOD DEPTH (FT) ABOVE GROUND** | | | | |  | | | | |
| 1 | 3 | 5 | 7 | 9 |  | | | | |
| Flood Openings in Foundation Walls |  |  |  |  |  | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |
| **MITIGATION MEASURES IN COMBINATION** | | **PERCENTAGE CHANGES IN DAMAGE**  **((REFERENCE DAMAGE RATIO - MITIGATED DAMAGE RATIO) / REFERENCE DAMAGE RATIO) \* 100** | | | | | | | | | |
| **TWO-STORY WOOD FRAME STRUCTURE** | | | | | **MASONRY STRUCTURE** | | | | |
| **FLOOD DEPTH (FT) ABOVE GROUND** | | | | | **FLOOD DEPTH (FT) ABOVE GROUND** | | | | |
| **7** | **9** | **11** | **13** | **15** | **1** | **3** | **5** | **7** | **9** |
| Elevate Utility Equipment 2 Feet Above Floor and Wet Floodproof Structure to 2 Feet | |  |  |  |  |  |  |  |  |  |  |

**Form VF-4: Coastal Flood Mitigation Measures,**

**Mean Coastal Flood Damage Ratios and**

**Coastal Flood Damage/$1,000 (Trade Secret Item)**

Purpose: This form illustrates the coastal flood damage ratios and coastal flood damage/$1,000 for three specific reference structures subject to individual flood mitigation measures and to combinations of flood mitigation measures.

1. Provide the mean damage ratio (prior to any insurance considerations) to the reference structure for each individual flood mitigation measure listed in Form VF-4, Coastal Flood Mitigation Measures, Mean Coastal Flood Damage Ratios and Coastal Flood Damage/$1,000 (Trade Secret Item), as well as the percent damage for the combination of the flood mitigation measures.
2. Provide the damage/$1,000 rounded to three decimal places, for the reference structures and for each individual flood mitigation measure listed in Form VF-4, Coastal Flood Mitigation Measures, Mean Coastal Flood Damage Ratios and Coastal Flood Damage/$1,000 (Trade Secret Item), as well as the damage/$1,000 for the combination of the flood mitigation measures.
3. If additional assumptions are necessary to complete this form, provide the rationale for the assumptions as well as a detailed description of how they are included.
4. Provide a graphical representation of the personal residential structure vulnerability functions for the reference and fully mitigated structures.

**Reference Structures**

|  |  |
| --- | --- |
| **Wood Frame** | **Masonry** |
| One story  Crawlspace foundation  Top of foundation wall 3 feet above grade | One story  Slab foundation  Top of slab 1 foot above grade  Unreinforced masonry exterior walls |
| Two story  Timber pile foundation  Top of pile 8 feet above grade  Wood floor system bolted to piles |  |

Reference and mitigated structures are fully insured personal residential building structures with a zero deductible structure only policy.

Place the reference structures at the following location, with latitude and longitude referenced to the World Geodetic System of 1984 (WGS84) datum.

Gulf of Mexico

Latitude: 27.9957517

Longitude: -82.8277373

1. Provide the ground elevation used from the flood model elevation database for the reference point.

**Form VF-4: Coastal Flood Mitigation Measures,**

**Mean Coastal Flood Damage Ratios and**

**Coastal Flood Damage/$1,000 (Trade Secret Item)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **INDIVIDUAL  MITIGATION MEASURES** | | | **MEAN DAMAGE RATIO** | | | | | | | | | | | **DAMAGE PER $1,000** | | | | | | | | | | |
| **TWO-STORY WOOD FRAME STRUCTURE** | | | | | **MASONRY STRUCTURE** | | | | | | **TWO-STORY WOOD FRAME STRUCTURE** | | | | | | **MASONRY STRUCTURE** | | | | |
| **FLOOD DEPTH (FT) ABOVE GROUND** | | | | | | | | | | | | | | | | | | | | | |
| **7** | **9** | **11** | **13** | **15** | | **1** | **3** | **5** | **7** | **9** | **7** | **9** | **11** | **13** | **15** | | **1** | **3** | **5** | **7** | **9** |
|  | | REFERENCE STRUCTURE | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |
| ELEVATE STRUCTURE | | Elevate Floor 1 Foot |  |  |  |  |  | | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |  |  |  |  |  | | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |
| Elevate Floor 2 Feet |  |  |  |  |  | | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |  |  |  |  |  | | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |
| Elevate Floor 3 Feet |  |  |  |  |  | | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |  |  |  |  |  | | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |
| UTILITY EQUIPMENT | | Elevate or Protect 1 Foot |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |
| Elevate or Protect 2 Feet |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |
| Elevate or Protect 3 Feet |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |
| FLOODPROOFING | | Wet 1 Foot |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |
| Wet 2 Feet |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |
| Wet 3 Feet |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |
| Dry 1 Foot | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | |  |  |  |  |  | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | |  |  |  |  |  |
| Dry 2 Feet | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | |  |  |  |  |  | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | |  |  |  |  |  |
| Dry 3 Feet | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | |  |  |  |  |  | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | |  |  |  |  |  |
| FLOOD OPENINGS | |  | **ONE-STORY WOOD FRAME STRUCTURE** | | | | |  | | | | | | **ONE-STORY WOOD FRAME STRUCTURE** | | | | | |  | | | | |
| **FLOOD DEPTH (FT) ABOVE GROUND** | | | | | | | | | | | | | | | | | | | | | |
| 1 | 3 | 5 | 7 | 9 | |  |  |  |  |  | 1 | 3 | 5 | 7 | 9 |  | |  |  |  |  |
| Flood Openings in Foundation Walls |  |  |  |  |  | | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |  |  |  |  |  | ⎯ | | ⎯ | ⎯ | ⎯ | ⎯ |
| **MITIGATION MEASURES IN COMBINATION** | | | **MEAN DAMAGE RATIO** | | | | | | | | | | | **DAMAGE PER $1,000** | | | | | | | | | | |
| **TWO-STORY WOOD FRAME STRUCTURE** | | | | | **MASONRY STRUCTURE** | | | | | | **TWO-STORY WOOD FRAME STRUCTURE** | | | | | | **MASONRY STRUCTURE** | | | | |
| **FLOOD DEPTH (FT) ABOVE GROUND** | | | | | | | | | | | | | | | | | | | | | |
| **7** | **9** | **11** | **13** | **15** | | **1** | **3** | **5** | **7** | **9** | **7** | **9** | **11** | **13** | **15** | **1** | | **3** | **5** | **7** | **9** |
|  | Elevate Utility Equipment 2 Feet Above Floor and Wet Floodproof Structure to 2 Feet | |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |

**Form VF-5: Inland Flood Mitigation Measures,**

**Mean Inland Flood Damage Ratios and**

**Inland Flood Damage/$1,000 (Trade Secret Item)**

Purpose: This form illustrates the inland flood damage ratios and inland flood damage/$1,000 for three specific reference structures subject to individual flood mitigation measures and to combinations of flood mitigation measures.

1. Provide the mean damage ratio (prior to any insurance considerations) to the reference structure for each individual flood mitigation measure listed in Form VF-5, Inland Flood Mitigation Measures, Mean Inland Flood Damage Ratios and Inland Flood Damage/$1,000 (Trade Secret Item), as well as the percent damage for the combination of the flood mitigation measures.
2. Provide the damage/$1,000 rounded to three decimal places, for the reference structures and for each individual flood mitigation measure listed in Form VF-5, Inland Flood Mitigation Measures, Mean Inland Flood Damage Ratios and Inland Flood Damage/$1,000 (Trade Secret Item), as well as the damage/$1,000 for the combination of the flood mitigation measures.
3. If additional assumptions are necessary to complete this form, provide the rationale for the assumptions as well as a detailed description of how they are included.
4. Provide a graphical representation of the personal residential structure vulnerability functions for the reference and fully mitigated structures.

**Reference Structures**

|  |  |
| --- | --- |
| **Wood Frame** | **Masonry** |
| One story  Crawlspace foundation  Top of foundation wall 3 feet above grade | One story  Slab foundation  Top of slab 1 foot above grade  Unreinforced masonry exterior walls |
| Two story  Timber pile foundation  Top of pile 8 feet above grade  Wood floor system bolted to piles |  |

Reference and mitigated structures are fully insured personal residential building structures with a zero deductible structure only policy.

Place the reference structures at the following location, with latitude and longitude referenced to the World Geodetic System of 1984 (WGS84) datum.

St. Johns River

Latitude: 29.3768881

Longitude: -81.6190223

1. Provide the ground elevation used from the flood model elevation database for the reference point.

**Form VF-5: Inland Flood Mitigation Measures,**

**Mean Inland Flood Damage Ratios and**

**Inland Flood Damage/$1,000 (Trade Secret Item)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **INDIVIDUAL  MITIGATION MEASURES** | | | **MEAN DAMAGE RATIO** | | | | | | | | | | | **DAMAGE PER $1,000** | | | | | | | | | | |
| **TWO-STORY WOOD FRAME STRUCTURE** | | | | | **MASONRY STRUCTURE** | | | | | | **TWO-STORY WOOD FRAME STRUCTURE** | | | | | | **MASONRY STRUCTURE** | | | | |
| **FLOOD DEPTH (FT) ABOVE GROUND** | | | | | | | | | | | | | | | | | | | | | |
| **7** | **9** | **11** | **13** | **15** | | **1** | **3** | **5** | **7** | **9** | **7** | **9** | **11** | **13** | **15** | | **1** | **3** | **5** | **7** | **9** |
|  | | REFERENCE STRUCTURE | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |
| ELEVATE STRUCTURE | | Elevate Floor 1 Foot |  |  |  |  |  | | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |  |  |  |  |  | | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |
| Elevate Floor 2 Feet |  |  |  |  |  | | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |  |  |  |  |  | | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |
| Elevate Floor 3 Feet |  |  |  |  |  | | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |  |  |  |  |  | | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |
| UTILITY EQUIPMENT | | Elevate or Protect 1 Foot |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |
| Elevate or Protect 2 Feet |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |
| Elevate or Protect 3 Feet |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |
| FLOODPROOFING | | Wet 1 Foot |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |
| Wet 2 Feet |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |
| Wet 3 Feet |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |
| Dry 1 Foot | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | |  |  |  |  |  | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | |  |  |  |  |  |
| Dry 2 Feet | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | |  |  |  |  |  | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | |  |  |  |  |  |
| Dry 3 Feet | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | |  |  |  |  |  | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ | |  |  |  |  |  |
| FLOOD OPENINGS | |  | **ONE-STORY WOOD FRAME STRUCTURE** | | | | |  | | | | | | **ONE-STORY WOOD FRAME STRUCTURE** | | | | | |  | | | | |
| **FLOOD DEPTH (FT) ABOVE GROUND** | | | | | | | | | | | | | | | | | | | | | |
| 1 | 3 | 5 | 7 | 9 | |  |  |  |  |  | 1 | 3 | 5 | 7 | 9 |  | |  |  |  |  |
| Flood Openings in Foundation Walls |  |  |  |  |  | | ⎯ | ⎯ | ⎯ | ⎯ | ⎯ |  |  |  |  |  | ⎯ | | ⎯ | ⎯ | ⎯ | ⎯ |
| **MITIGATION MEASURES IN COMBINATION** | | | **MEAN DAMAGE RATIO** | | | | | | | | | | | **DAMAGE PER $1,000** | | | | | | | | | | |
| **TWO-STORY WOOD FRAME STRUCTURE** | | | | | **MASONRY STRUCTURE** | | | | | | **TWO-STORY WOOD FRAME STRUCTURE** | | | | | | **MASONRY STRUCTURE** | | | | |
| **FLOOD DEPTH (FT) ABOVE GROUND** | | | | | | | | | | | | | | | | | | | | | |
| **7** | **9** | **11** | **13** | **15** | | **1** | **3** | **5** | **7** | **9** | **7** | **9** | **11** | **13** | **15** | **1** | | **3** | **5** | **7** | **9** |
|  | Elevate Utility Equipment 2 Feet Above Floor and Wet Floodproof Structure to 2 Feet | |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |