Field Guide for
Conducting Nonstructural Assessments

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Field Assessment Guide for Conducting Nonstructural Assessments

1. Objective

This Field Assessment Guide (Guide) is intended for use during study scoping and development of the nonstructural assessment work plan. The Guide provides recommendations for setting up and initiating a nonstructural assessment in order for the study team to be compliant with the requirements of Planning Bulletin 2016-01; Clarification of Existing Policy for USACE Participation in Nonstructural Flood Risk Management and Coastal Storm Damage Reduction Measures. The bulletin states that a nonstructural plan is required for all flood risk management studies. Nonstructural assessments inform selection of an appropriate nonstructural technique, inform cost estimates and help to identify a logical aggregation of structures. The information herein provides a systematic approach to conducting a nonstructural assessment as part of the planning process and is applicable for establishing milestones for any size assessment area.

2. Background

Within the US Army Corps of Engineers (USACE) Civil Works planning process, there are structural and nonstructural mitigation measures employed to manage flood risk. This Guide addresses the potential process for and the typical methodology in preparing for and conducting a nonstructural assessment.

Nonstructural flood risk management measures adapt to the floodplain and those inherent flood characteristics, such as depth, velocity, frequency, duration, and aerial extent of flooding, without significant alteration or modification of the natural floodplain. Hence, nonstructural flood risk management (NS-FRM) can be categorized as an array of physical or nonphysical measures utilized for mitigating existing and future flood risks and damages. The physical measures considered to be most commonly implemented are those whose adaptive characteristics can be retrofitted into existing or incorporated into new structures to mitigate for potential flood damages.

3. Nonstructural Flood Risk Management Measures

Nonstructural flood risk management can be categorized as a set of physical or nonphysical measures utilized for mitigating loss of life as well as existing and future flood damages. The physical measures are applied to individual structures to increase resiliency to flooding without adversely affecting or changing those natural characteristics of the floodplain. The nonphysical nonstructural measures are generally programmatic in nature and can be used to manage the flood risk within an entire floodplain.

3.1 Physical Nonstructural Measures

These measures are applied to individual structures either singularly or in combination with other measures in order to reduce property damages and life loss. Because of their adaptation to flood risk, wherein these measures generally cause no adverse effects to the natural floodplain, flood stage, velocity, duration, or to the environment, they support the intent of the National Flood Insurance Program as administered by the Federal Emergency Management Agency (FEMA), although not all nonstructural measures may result in a flood insurance premium reduction.

3.1.1 Acquisition. This nonstructural measure consists of acquiring the at-risk structure and land that the structure sat upon. The structure is either demolished or if in good condition is sold to others and relocated to a site external to the floodplain. Development sites for families who have had their structure acquired, if needed, can be part of a proposed project in order to provide parcels where new homes can be constructed within an established community. Keeping the displaced families within their existing community continues to support the local tax structure which could otherwise be adversely impacted by a significant number of acquisitions, and also provides the societal cohesion which many of the displaced families will be in need of. The land where the structure had been originally located is purchased, becoming deed restricted in order to prevent development from occurring in the future, and becomes available for open land management as stipulated by the NFIP.

3.1.2 Relocation. This nonstructural measure requires physically moving the existing at-risk structure away from the flood hazard area to a location which is completely outside of the floodplain. The land where the structure had been originally located is purchased, becoming deed restricted in order to prevent development from occurring in the future, and becomes available for open land management as stipulated by the NFIP. When considering relocation, it makes the most sense when structures are relocated from a high flood risk area to a location of no flood risk.

3.1.3 Elevation. This nonstructural measure should be considered for lifting an existing structure to an elevation which is at least equal to or greater than the design water surface elevation, which could be the 1% annual chance flood elevation. The final elevation should place the first floor and associated ductwork, plumbing, mechanical and electrical systems above the projected water surface elevation. In many elevation scenarios, the cost of elevating a structure an extra foot or two is less expensive than the initial foot, due to the cost incurred for mobilizing equipment. Elevation can be performed on extended foundation walls, on piers, post, columns, piles, and on fill material. Elevation is also conducive to structures having a reinforced slab on grade. If the slab is not reinforced to where it can withstand both compression and tensile forces, the technique would require separating the structure from the slab and then pouring a new reinforced slab at the appropriate elevation.

3.1.3.1 Extended Foundation. Since the foundation is the primary supporting system for a house or other structure, a perimeter of poured concrete is used as a footing from which common masonry units are extended upward to a defined height. If satisfactory, the existing footing and foundation wall may be added onto, or if necessary, a new footing and foundation may be constructed. Because the extended foundation results in an enclosed area, flood vents, for equalizing hydrostatic pressure are required to be inserted into the foundation walls. The enclosed area located under the elevated structure should not be inhabited and used for daily living activities other than storage.

3.1.3.2 Piers. An engineered pier foundation is a collection of large diameter, typically cylindrical columns, to support the superstructure of the building and to transfer the large loads to the subsurface ground below. The piers may consist of sections of galvanized or epoxy-coated steel pipe that are driven into the soil with a hydraulic ram until achieving a specified bearing strength.

3.1.3.3 Posts. A pier may also be known as a post foundation, where the engineered posts are made of wood and are driven into the subsurface ground to achieve a specified bearing strength. As with a pier, the post is used to transfer the weight of the structure to the ground.

3.1.3.3 Columns. The column is a single-point loading system, such as structural concrete or concrete blocks, supporting the weight of framed structures, where the load is spread by an engineered pad (footing) to the bearing layer of soil or rock below.

3.1.3.4 Piles. There are basically two types of cast-in-situ piles; the driven (cased or uncased) or bored. The pile is a slender column or long cylinder made of materials such as concrete or steel which are used to support the structure and transfer the load at desired depth either by end bearing or friction. A benefit to elevating a structure onto a pier, post, column, or pile is that the open space located under the structure may be used for parking or storage of materials that can be readily moved in advance of a flood event.

3.1.3.5 Fill (compacted). This elevation measure requires the placement and compaction of clean run material to a height which elevates the structure above the design water surface elevation. Since the amount and placement of fill can take a significant amount of area, this measure is typically relegated to rural settings. The fill material should be in compliance with all aspects of the National Flood Insurance Program (NFIP) and not cause adverse impacts on adjacent properties.

It is possible that the structure being assessed has an existing crawlspace or basement which would require abandoning in order to reduce future flood damages and to implement one of the elevation measures described above. Abandonment would consist of filling in the existing basement or crawlspace with clean run fill material and possibly capping with concrete. With abandonment of the basement or crawlspace, there could be the need to construct a small addition to contain utilities and mechanical equipment and to place the addition onto the side of the structure above the projected water surface elevation. If the addition cannot be constructed because of limited space within the parcel or because the owner did not want it, partial compensation for the lost space, although not mandatory, should be considered for the owner. Subgrade space does not carry the same value as above grade space.

3.1.4 Dry Flood Proofing. This nonstructural measure consists of waterproofing the structure to prevent flood waters from entering. This can be done to residential homes as well as commercial and industrial structures. This measure achieves flood risk reduction but it is not recognized by the NFIP for any flood insurance premium rate reduction if applied to a residential structure, whereas a commercial structure may achieve insurance premium reduction if dry flood proofed in compliance with the NFIP. Based on laboratory tests, a "conventional" built structure can generally be dry flood proofed up to 3- to 4-feet in elevation. A structural analysis of the exterior wall strength would be required if it was desired to achieve a higher level of protection. A sump pump and perhaps French drain system should be installed within the interior of the structure as part of the measure in order to collect any seepage coming into the structure. Closure panels are required at all openings. This measure does not work with basements or crawl spaces due to the floodwaters penetrating the structure from below. For buildings with basements and/or crawlspaces, the only way that dry flood proofing could be successful is for the first floor to become impermeable to floodwater by preventing the hydrodynamic and hydrostatic forces from penetrating the first floor from below.

3.1.5 Wet Flood Proofing. This nonstructural measure is applicable as either a stand-alone measure or as a measure combined with other measures such as elevation. As a stand-alone measure, all construction materials and finishing materials need to be water resistant and all utilities must be elevated above the design flood elevation. Wet floodproofing is applicable to large commercial and industrial structures when combined with flood warning and a flood preparedness plan. This measure is generally not applicable to large flood depths and high velocity flows.

3.2 Nonphysical Nonstructural Measures

The nonphysical nonstructural measures are generally identified as being management measures for the floodplain. These measures can address flood risk through regulation and best management practices and can be considered separately or as a combination of floodplain management and planning functions. The nonphysical measures which address flood risk can be considered separately or as a combination of floodplain management and planning functions.

3.2.1 Floodplain / Floodway Mapping. This nonphysical nonstructural measure provides the identification of flood risk, whether in the form of a map which illustrates flood boundaries, or as an inundation map illustrating the depth of flooding. This measure is a significant tool when identifying and addressing flood risk within a community.

3.2.2 Flood Warning System. This measure relies upon stream gages and rain gages for collecting hydrologic information, and computer modeling to determine the impacts of flooding for areas of potential flood risk. A flood warning system, when properly installed and calibrated, is able to identify the time available for people occupying the floodplain to safely implement temporary measures or to evacuate the area.

3.2.3 Flood Emergency Preparedness Plans. This measure encourages the development and maintenance of a flood emergency preparedness plan (FEPP) by local officials that identifies hazards, risks and vulnerabilities, and encourages the development of local mitigation. The FEPP should include the community's roles and responsibilities for responding to a flood event.

3.2.4 Evacuation Plans. This measure requires detailed hydrologic analyses for determining the rate of rise of floodwaters for various rainfall or snowmelt events. When used in conjunction with flood warning systems, this measure can provide significant reduction in life loss and flood damage reduction benefits. Evacuation planning should consider vertical evacuation as well as the traditional horizontal evacuation. This measures should only be implemented when there is signification response and action time available for floodplain occupants to evacuate. Reunification centers as well as evacuation routes should be thoughtfully planned and communicated to the public.

3.2.5 Land Use Regulations. Land use regulations are effective tools in reducing flood risk and flood damage. The principles of these tools are based in the National Flood Insurance Program (NFIP) which requires minimum standards of floodplain regulation. For communities where future growth and expansion has been identified, restrictive land use regulations may be a deterrent to life loss and property damage.

3.2.6 Zoning and Building Codes. A community may determine that certain areas are too hazardous for human habitation and restrict certain types of development from occurring. This is a long-term investment tool for alleviating flood risk. Local building codes have been established to specify the minimum standards for the construction of buildings, with some specific to flooding.

3.2.7 Risk Communication/Outreach. Through the development of and use of educational tools such as presentations, workshops, hand-outs, and pamphlets, flood risk and flood risk management measures may be communicated to government entities and floodplain occupants in an effort to reduce the consequences associated with flooding.

4. Minimum Nonstructural Study Requirements and Restrictions

In addition to Planning Bulletin 2016-01 requiring a nonstructural plan be developed and conducted for all flood risk management studies, there are additional minimal requirements governing other areas of a nonstructural study which are discussed below.

4.1 NFIP Participation

In conjunction with USACE Engineer Regulation 1105-2-100; Planning Guidance Notebook, Chapter 3-3; b; (10) (a), Communities participating in a flood damage reduction project with the Corps of Engineers are required to participate in FEMA's National Flood Insurance Program (NFIP) and to comply with the land use requirements of that program.

4.2 Single Properties

USACE cannot participate in mitigating a single private property. Nor will USACE participate in mitigation, unless single property protection is part of a larger plan for structural or nonstructural measures benefiting multiple owners collectively. USACE may consider participation in structural and nonstructural flood control measures protecting a single, non-federal, public property. Public facilities, which are separable portions of larger protection plans, must have their own distinct presentations in budget requests so that they compete for limited study and construction funds.

4.3 Cost-Sharing Nonstructural Flood Damage Reduction Projects

In accordance with Engineer Regulation 1105-2-100; Planning Guidance Notebook (Appendix E, page 128), the non-federal sponsor is responsible for 35 percent of total project costs. However, unlike structural projects, a five percent cash contribution is not required. The non-federal sponsor must provide all Lands, Easement, Rights-of-Way, Relocations and Disposal areas (LERRDs) required for the project. If credited LERRDs are less than thirty-five percent, sponsor will pay the difference in cash. If LERRDs are more than thirty-five percent, the excess is reimbursed by the federal Government.

4.4 Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R)

The nonstructural project OMRR&R is a 100% non-Federal responsibility. The non-federal sponsor is required to operate and maintain the mitigation measures, and, in the case of interests in real property acquired in conjunction with nonstructural measures, to operate and maintain the property in accordance with regulations prescribed by USACE.

5. Nonstructural Assessment Work Plan Development

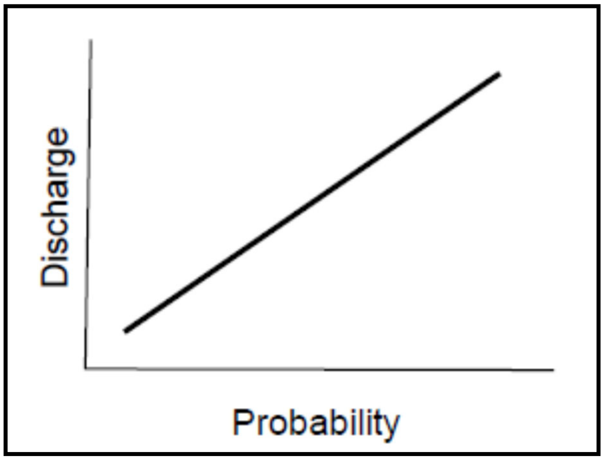
A nonstructural assessment work plan for flood risk management should consider identifying and evaluating alternatives based on completeness, effectiveness, efficiency, and acceptability. The work plan should also provide a rational framework for sound decision making when potentially evaluating multiple nonstructural measures for a single structure. There are generally six items necessary for developing a functional work plan:

- Develop study hydrology (flow of water)
- Develop study hydraulics (depth and velocity of water)
- Conduct structure inventory (structures flooded)
- Identify nonstructural measures (alternatives)
- Develop cost estimates for nonstructural implementation (optional)
- Perform economic analyses (benefit-cost ratio determination) (optional)

The last two items may be optional depending upon the level of detail scoped and funded for the work plan. Some study sponsors want the study to proceed just as far as determining the potential nonstructural measures to be considered for implementation. The remainder of this section will discuss each of these six items.

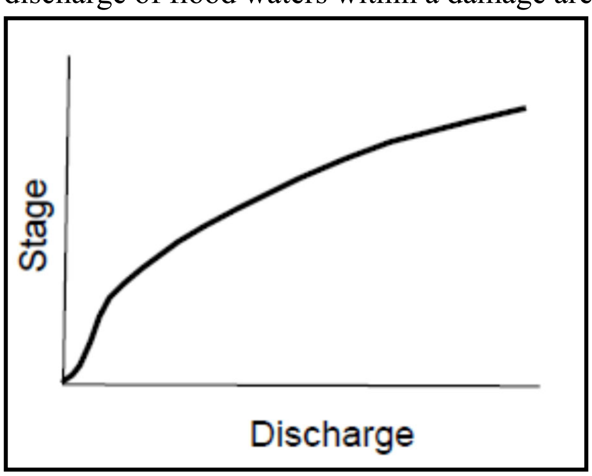
5.1 Study Hydrology

The hydrology, or discharge of flood waters, used to identify specific damage area under flood conditions is critical in establishing the potential flood damages to structures as well as the potential level of protection desired to be achieved through nonstructural mitigation. The discharge for a river is based upon the amount of runoff at a specific location. A discharge-probability curve, like the one shown here, indicates that the discharge increases (y-axis) as the probability of occurrence decreases (x-axis). A 5-year flood event would have a 5 in 100 or 20% chance of annual occurrence, while a 500-year flood would have a 1 in 500 or a 0.2% chance of annual occurrence. Most often when conducting a nonstructural assessment, structure owners and community officials are interested in protecting the structures from a 1% annual chance occurrence flood event, as that is the event to which flood insurance is tied to under the NFIP. If a structure can be protected from the 1% annual chance occurrence flood event, then the owner may be able to receive a reduction in flood insurance premiums. Considering the hydrology for a more frequent and less frequent flood event is also practical for a nonstructural assessment as this information would be beneficial in bracketing the potential level of protection to be afforded through nonstructural mitigation, and would be handy to have in the field while assessing the at-risk structures.



5.2 Study Hydraulics

Once the hydrology has been established for a damage area, the depth and velocity of flooding can be determined through a hydraulic analysis. The depth, or stage, corresponds to the hydrology, or the discharge of flood waters within a damage area. As shown here, the stage will generally increase (y-axis) as the discharge (x-axis) increases. The stage of flooding can vary along the length of a river due to the geometry of the channel and overbank areas, the amount of and type of vegetation, obstructions to the runoff, and the slope of the channel. Since the hydraulic analysis is able to convert the hydrology to a depth, typically illustrated in feet, it is relatively easy to visualize the potential impact this depth would have on a structure while conducting the field assessment. The velocity is the speed, typically provided as feet per second, which the flood waters travel at through a damage area. The availability of depth and velocity for a more frequent flood event as well as for a less frequent event provides the assessment team valuable information for determining potential mitigation measures while in the field. If one-dimensional hydraulic data is available, average stages and velocities for the study area can be used, or if two-dimensional hydraulic data is available, more site-specific stages and velocities can be used. The location of the first floor above



ground as well as windows in exterior walls, specifically the lower window sill elevation, could be compared to the available flood stages and assist in determining what frequency flood event is practical for providing protection from flooding. Likewise, the velocity of a flood event can determine if erosion will occur, or if hydrodynamic forces on the exterior of a structure may be too strong to withstand.

5.3 Identify Nonstructural Measures

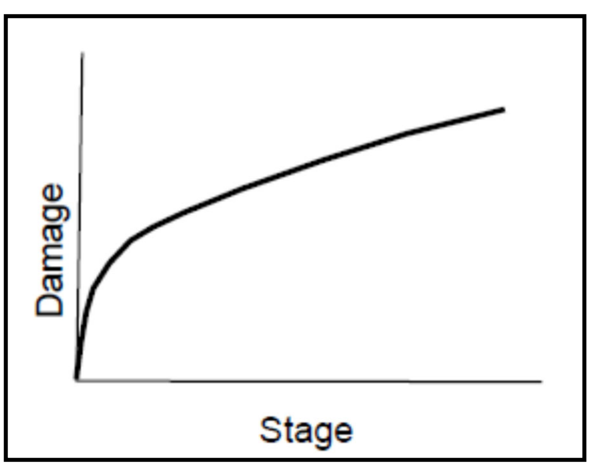
For the field assessment, all of the physical nonstructural measures described in section 3.2 should be considered for potential implementation. Some measures will readily appear as potential candidates for implementation and some will not, based upon flood characteristics, site characteristics, and structure characteristics. Converting the hydrology to a flood depth and velocity is essential in determining which nonstructural measure to pursue. Determining site characteristics like structure location (coastal beach front, coastal barrier, or riverine) and soil type (permeable or impermeable), as well as structure characteristics like foundation (slab on grade, on crawlspace, or with basement), and exterior envelope (concrete, metal, or wood), as well as condition (excellent, fair, or poor) are all important assessment parameters in identifying the most complete, effective, efficient, and acceptable nonstructural measure. Refer to the National Nonstructural Committee's (NNC) publication "Nonstructural Flood Risk Management Matrix User Guide" for a detailed description on how to identify recommended nonstructural measures for flood prone structures.

5.4 Developing Cost Estimates for Nonstructural Measures (optional)

After determining the most effective and complete nonstructural measures based upon flood characteristics, site characteristics, and structure characteristics, a cost estimate may be developed. Some study sponsors only want to receive information regarding what mitigation measures would be appropriate for implementation before moving forward with the development of cost estimates on their own. Due to regional variations in unit costs and other construction metrics, it is recommended that the study team employ the expertise of on-staff cost estimators, if detailed within the study scope, to develop cost estimates. While the cost estimate is associated with one specific structure, it may be possible to develop a range of costs for individual nonstructural techniques (elevation, flood proofing, and acquisition) given flood characteristics, site characteristics, and structure characteristics. The range of costs may then be used to extrapolate study results to structures outside of the structures assessed in the field.

5.5 Conduct Economic Analyses (optional)

In order to conduct an economic analyses to determine the potential feasibility of implementing the nonstructural measures, the detailed cost estimate of each of the measures would be required, then annualized over a 50-year project life to determine the annual cost of providing flood risk management per individual structure. If the annual benefits derived from each individual mitigation measure were to be determined by estimating the reduction in future flood damages prevented, where those benefits are proportionally weighed against the probability of future flood events and the damages which could have occurred to each individual structure from those future floods, a comparison of annual benefits and annual costs could be conducted. If the annual benefits for a structure are divided by the annual costs for that structure, a benefit to cost ratio (BCR) can be



determined. A BCR greater than 1.0 indicates that the mitigation measure has more benefits than costs and is worth further consideration for implementation. Conducting the economic analyses may be optional as it is dependent upon the development of detailed cost estimates for structures which have been assessed in the field. If more than one nonstructural measure appears to be economically feasible, recommend choosing the measure which has the highest net benefits (annual benefits – annual costs).

6. Conducting a Nonstructural Field Assessment

As stated previously, a nonstructural work plan is a requirement of all USACE Civil Works studies involving flood risk management. Since the nonstructural work plan requires existing structures to adapt to the identified flood risk, individual at-risk structures must be assessed to determine potential modifications which could be implemented for reducing their risk to flooding. The nonstructural measures most commonly used to reduce flood risk and to increase resiliency are acquisition, relocation, elevation, and flood proofing. These are known as physical nonstructural measures as implementation requires modification of the existing structure. In some instances, it may be feasible to consider a combination of nonstructural measures to minimize future flood risk.

6.1 Determining the Assessment Location and Size

The objectives of a nonstructural assessment is to determine the existing flood risks, conduct the appropriate analyses to determine the most effective, economically feasible, and environmentally acceptable measures to minimize that flood risk, identify potential residual flood risk, determine the federal interest in implementing measures, and then recommend a plan to the study sponsor. The development of a nonstructural plan has some similarities to the development of a structural plan, i.e. the baseline hydrology and hydraulics, a detailed inventory of structures, and the assessment of measures to minimize future flood risk.

6.1.1 Assessment Boundary. Unless the flood damage area within a community consists of no more than a small group of at-risk structures, it is recommended to conduct the nonstructural assessment based upon a sampling of structures rather than all structures determined to be at flood risk. Figure 1 illustrates a potential scenario for identifying the location of sample assessment structures based upon the flood damages being divided into several sub areas (A, B, and C), which could pertain to the location of structures in the right overbank area, the left overbank area, or associated with a tributary of the primary flood source. These sub areas could also be associated with geographic, political, or cultural subdivisions. If a structural assessment is being conducted, it may be beneficial to match sub areas between the structural and nonstructural assessments in order to more easily compare costs and benefits and then determine the most feasible measure, structural or nonstructural, for implementation. The planning process may result in identification of a comprehensive stand-alone nonstructural plan, a combination structural and nonstructural plan, or perhaps determine that nonstructural measures are not economically feasible and are not a part of the recommended plan.

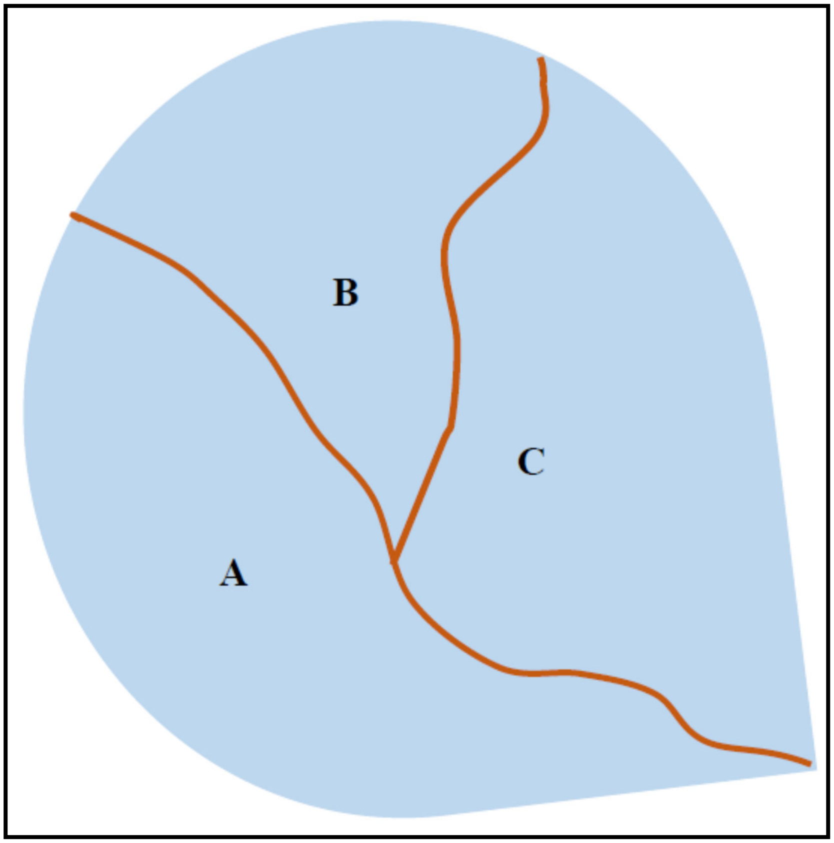


Figure 1: Assessment Area

6.1.2 Assessment Area Sampling.
All structures located within a damage area should be identified, but not necessarily assessed. Within Figure 2, there exists 17 structures as illustrated with the circles. The assessment of all 17 at-risk structures could be very time consuming and expensive, particularly if there are additional sub areas, where a smaller subset of the 17 structures may provide results which could either be extrapolated to other structures located within the sub area if the results are favorable, terminate further assessment within the sub area if the results are unfavorable, or support the need for additional assessment within the sub area in order to develop a comprehensive nonstructural work plan. It is recommended that approximately ten to twenty percent of the structures located within a sub area be assessed, unless the majority of structures represent a similar construction type, wherein a smaller percentage of structures may be selected. Within Figure 2 the assessment amounts to 4 structures, which are illustrated with solid black circles. The four structures are spaced throughout the sub area in an effort to capture the pertinent flood, site, and structure characteristics.

As the assessment area and structures to be assessed are being identified, careful evaluation of property acquisition or relocation should occur as these measures could be beneficial when evaluating existing areas where the environment has been degraded. Acquiring properties or relocating structures is a proven method of evacuating the floodplain, thereby reducing the consequences associated with flooding. Evacuation of the floodplain through acquisition and/or relocation may also result in an increase in net project benefits when considering environmental restoration or recreational opportunities. A continuing trend within urbanized areas is to champion projects which foster both restoration of the environment and inclusion of recreational opportunities.

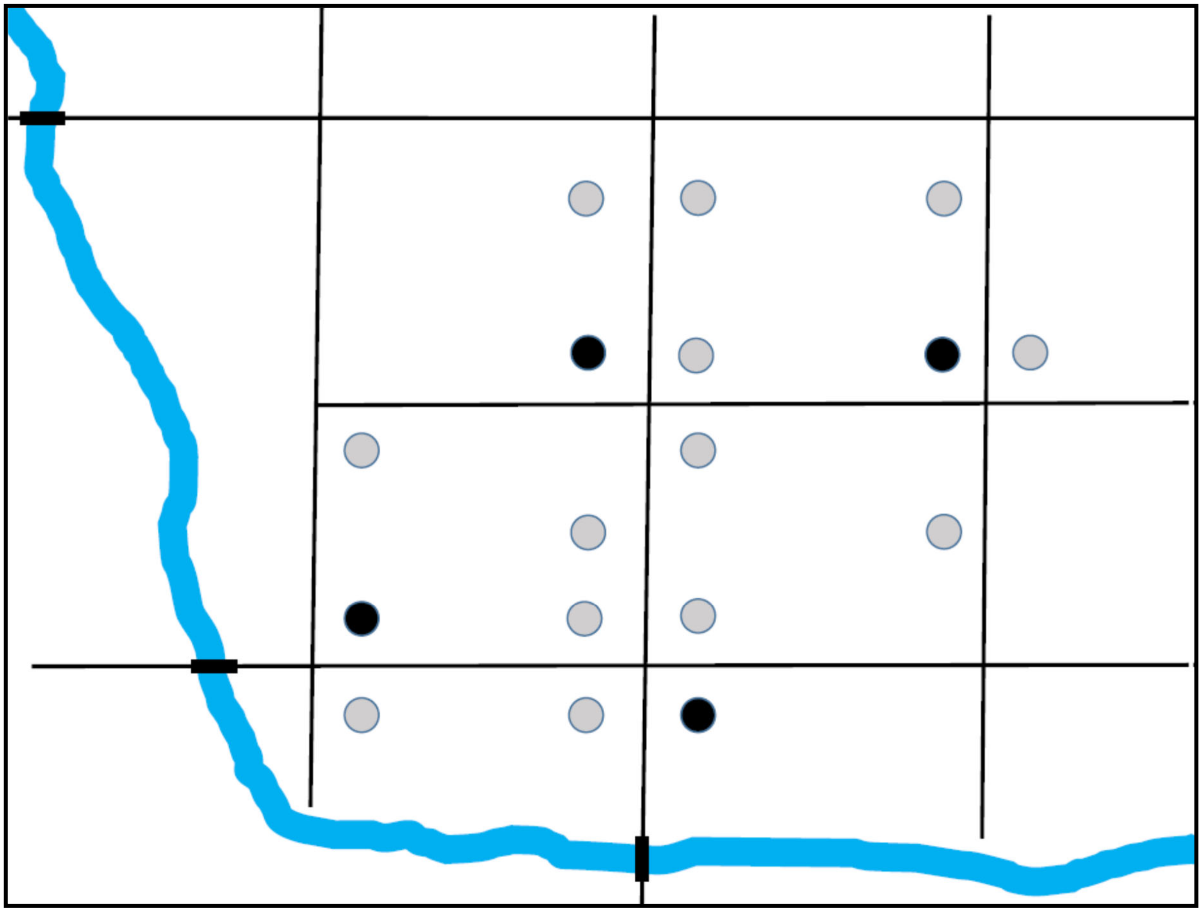


Figure 2: Sampling Sub Area Structures

The flipside of increasing net project benefits through acquisition and/or relocation is that the community's tax base could be adversely impacted by the loss of structures from the tax roll. If a family displaced through acquisition is unable to find replacement housing within the same general vicinity, the community's dollars collected from property taxes could be reduced Property tax is a real estate tax based upon the value of property, calculated by a local government, which is paid by the owner of the property. The tax is usually based on the value of the owned property, including land. If the property is removed, there is no basis for taxation. Property taxes typically provide for local road construction and maintenance, local government staff salaries, and possibly for the needs of a public school district. Municipal employees, such as police, fire fighters, and the public works department are also paid through property taxes. As the nonstructural work plan is being developed remember to communicate these potential issues thoroughly with the study sponsor.

7. Structure Inventory Attributes

While the total number of, and type of structures should be identified as part of the inventory for the entire study area, the structures being assessed are only a percentage of the overall structure count and require specific data from which informed decisions can be made.

7.1 Structure Attribute Table

Table 1 illustrates the structure attributes which are generally required for conducting an assessment of an at-risk structure. The pertinent data requirements are shown in the shaded rows of the table. After identifying which structures to assess, it may be possible to collect some of the data prior to conducting the field assessment. For instance, floor plans, elevations, dimensions, and other useful data may be available on-line from the Tax Assessor's Office.

Table 1: Structure Attribute

(Note: bold/shaded cells represent most pertinent data requirements)

Structure Data	Data Definition
Building Identification Number	Specific to Structure (geo referenced, coordinates, etc.)
Structure Address	Specific Postal Location of Structure
Critical Facility	Yes / No
Lowest Adjacent Ground Elevation	Elevation of Lowest Ground at Structure
First Floor Elevation	Elevation of Finished First Floor
Structure Category	Residential, Commercial, Industrial, Public
Structure Use	What is the Specific Use of Structure
Total Stories	Total Number of Floors Above Grade
Structure Footprint	Total Square Foot Area of At-Grade Floor
Number of Structural Corners	Total Number of Corners in Perimeter
Structure Foundation Type	Slab, Reinforced Slab, CMU, Piers, Columns, Posts, Stone
Structure Perimeter Distance	Total Length of All Exterior Sides of Structure
Exterior Wall Construction	Wood, Masonry, Brick, Metal, Stone, Concrete, Other
Structure Visual Condition	Good / Fair / Poor
Garage	Attached, Detached, None
Doorways	Number of Pedestrian Doorways
Basement	Full Basement, Half, Crawl Space, None
Structure Photos	Photograph of Four Sides of Structure
Utilities Location	Electrical, Gas, Water, Sewer, Oil, Propane, Coal, Other
Structure Value	Assessed Value of Structure
Fireplace	Yes / No
Structure Owner	Who Owns the Structure
Year Structure Built	Year Structure was Constructed (Any Historic Significance)
Water Surface Elevation	Elevation or Depth of Water at Structure (H&H activity)
Water Velocity	Erosive Potential of Flood Waters (H&H activity)

Lowest adjacent ground elevations may be available from recent Light Detection and Ranging (LiDAR) data. First floor elevations may be approximated from using the LiDAR data and estimating the height above ground from Google Maps Street View. Detailed information can be and should be obtained if measures proceed to implementation.

The nonstructural assessment becomes more effective and efficient when available data is collected in the office, prior to conducting the site assessment in the field. Communicate data needs with the study sponsor, state agencies and other federal agencies to determine what data can be made available.

8. Assessment Examples

Two examples, the first for a residential structure and the second for a commercial structure, are provided for the user to become familiar with this Field Assessment Guide. The examples discuss and illustrate the baseline information which is collected and utilized to determine potential nonstructural measures for implementation. The second example illustrates that in some situations more than one nonstructural measure may be applicable for the conditions being assessed.

8.1 Residential Structure Example

For this example, the targeted structure is a residential building located within an urbanized area. Prior to going into the field, data was researched and collected from the County Tax Assessor's Office, FEMA flood insurance studies and floodplain maps, USACE studies, and the state LiDAR dataset for lowest adjacent ground (LAG) and estimation of first floor (FFE) elevations. A right of entry was also secured to allow physical inspection of the structure in the field, and the collected information was reviewed for the presence of a basement or crawlspace. A Structure Attribute table, similar to what is shown in Table 1, was populated and is shown as Table 2. Once in the field, the assessment team considered the construction materials, depth (8.4 feet) and velocity (8.5 feet per second) of flooding on the FFE of the structure, number of entrances and windows, as well as overall condition of the structure.

The nonstructural recommendation was determined by examining available information regarding flood, site, and structure characteristics, as well as additional data gathered during the field assessment. This information was evaluated using the National Nonstructural Committee's (NNC) publication "Nonstructural Flood Risk Management Matrix User Guide" in a systematic approach to identifying a potential nonstructural measure for the structure. The nonstructural recommendation was for abandoning the basement, as it was considered to be a significant damage area, elevating the structure's first floor to above the Base Flood Elevation (BFE), and relocating utilities and appliances housed in the basement to the elevated first floor or to a utility addition constructed to the proposed first floor elevation. Table 3 illustrates the proposed elevation measure.

8.2 Commercial Structure Example

For this example, the targeted structure is a commercial building. Some data for the structure was ascertained from city officials, the state, FEMA, and USACE prior to conducting the field assessment. A Structure Attribute table was populated and formalized as Table 3. The structure is a slab on grade without a below grade feature. The BFE is at a depth of 2.0 feet onto the existing first floor elevation. As illustrated on Table 5, the availability of space surrounding the structure provides for consideration of two potential measures is identified as Option 1 and Option 2:

- Option 1. The structure could be dry flood proofed to the BFE plus one foot elevation by applying water resistant sealant to existing masonry, modifying existing windows to incorporate masonry at lower level, and incorporating flood resistant barriers for all entrances. Exterior utilities should be minimally elevated to the BFE plus an additional amount of freeboard. Anti-backflow devices should be installed on sewer pipes. An interior pump system with emergency backup power should be installed for containment and management of seepage. All inhabitants/personnel should evacuate the site in advance of a flood event.
- Option 2. A temporary flood barrier could be placed around the perimeter of the structure. The height is recommended to be to the BFE plus an additional amount of freeboard. Barriers would be required for all openings in the flood barrier. Anti-backflow devices should be installed on sewer pipes and an interior pump system with emergency backup power should be installed for containment and management of seepage through the berm or floodwall.

The most complete, effective, efficient, and acceptable measure could be determined through discussions with the property owner regarding functionality and estimating the implementation costs for both measures.

Table 2: Residential Structure Data

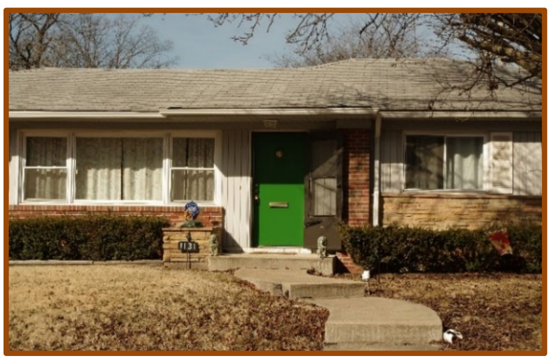
Residential Structure Inventory Attribute Sheet (NAVD88)

Building Identification Number: RES-1
Location: 1131 Wilson Avenue, Someplace, USA
Occupancy / Year Built: Single Story / Single Family Residential / 1955 Structure Condition (visual): Good
First Floor Area / Structural Corners: 1,663 Square Feet / 6
Perimeter Distance: 184 Feet
Exterior Wall Construction Wood Frame with Brick and Stone Veneer
Foundation Wall: CMU parged or Concrete
Slab/Crawlspace/Basement: Full Basement
Crawlspace/Basement Area 1,663 Square feet
Entrances / # 1st Floor Windows 2 / 9
Garage: Attached / Lower Level
Exterior Mechanical/Electrical/Fuel: AC Unit / Electric Meter / Natural Gas / Water
Fireplaces 0
Landscaping and Shrubs: Yes

FFE = First Floor Elevation LAG = Lowest Adjacent Grade LO = Lowest Opening Elevation

FFE	LAG	LO	20% / fps	10% / fps	2% / fps	1% / fps	.2% / fps
511.6	510.5	510.5	513.5 / 10.0	516.0 / 9.0	519.0 / 8.7	520.0 / 8.5	522.0 / 9.0

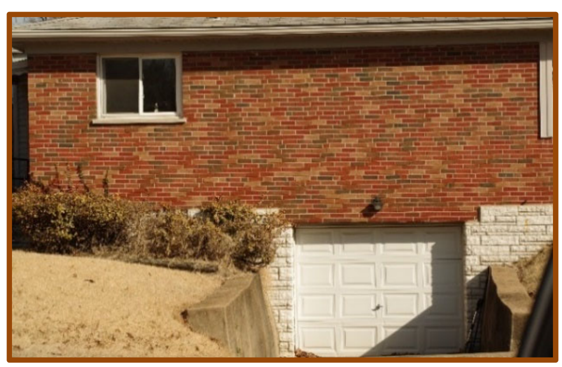
FFE	BFE	LO	FFE-LAG	FFE-BFE	LO-BFE	LAG-BFE
511.6	520.0	510.5	1.1	-8.4	-9.5	-9.5



Front View

Right Side View

Rear View

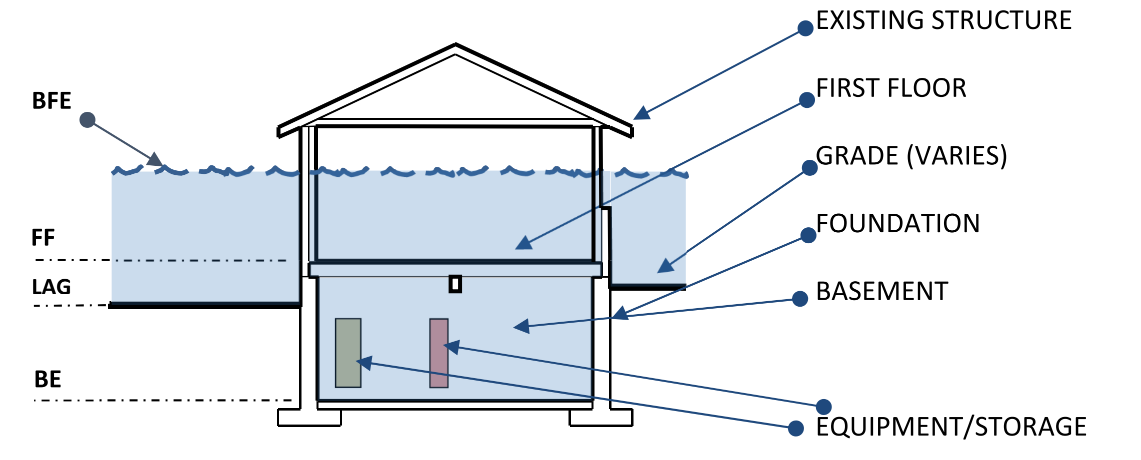


Left Side View

Table 3: Residential Structure Data Continued

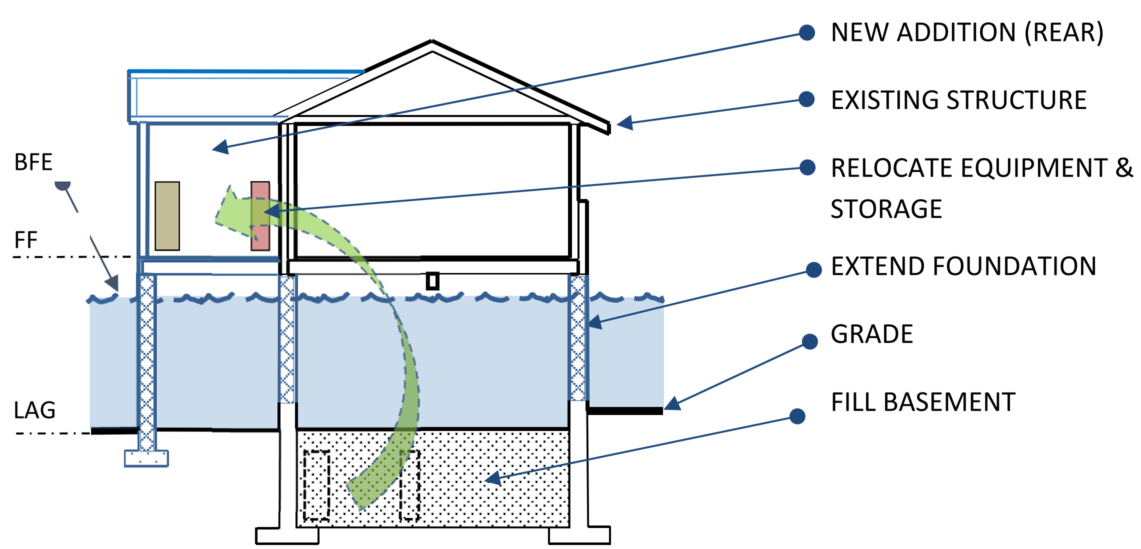
General: The structure viewed/observed from exterior. The structure is situated on a suburban site, free standing, with below grade garage. The grade around the structure varies in height below the first floor.
Building Construction: The structure is one story with full basement. The foundation walls are concrete with wood framed construction and brick/stone veneer. The garage is accessed via a steep sloping driveway with concrete retaining walls. There is small wooden addition at the rear of the structure, next to the rear entry.

Existing Structure



DIAGRAMATIC BUILDING SECTION (EXISTING)

Proposed Mitigation Measures



DIAGRAMATIC BUILDING SECTION (MITIGATED)

Recommendations:

Fracture existing basement floor to deter upheaval and flotation, and fill basement with clean, uniform material. Cap with concrete or vapor barrier.
Relocate all basement equipment (HVAC, Water Heater, Electrical Panel and storage to addition)
Elevate the entire structure and exterior mechanical equipment to above the BFE

Table 4: Commercial Structure Data

Commercial Structure Inventory Attribute Sheet

Building Identification Number:	COM-1
Location:	975 Pennsylvania Avenue, Mytown, USA
Occupancy:	Single Story / Community Center
Critical Facility	No
Structure Condition (visual):	Good
First Floor Area / Structural Corners:	11,000 Square Feet / 12
Perimeter Distance:	475 Feet
Exterior Wall Construction:	Masonry Brick/CMU and Metal framed glazed/panel wall
Foundation:	Concrete
Slab/Crawlspace/Basement:	Slab on Grade
Crawlspace/Basement Area	0
# Entrances / # 1st Floor Windows	3 single / 4 double / numerous (at grade and elevated)
Garage:	None
Exterior Mechanical/Electrical/Fuel:	AC Unit / Electric Meter / Natural Gas (all at grade)
Landscaping and Shrubs:	Yes

Structure/Flood Elevations (NAVD88):

FFE = First Floor Elevation LAG = Lowest Adjacent Grade LO = Lowest Opening Elevation

FFE	LAG	LO	20% / fps	10% / fps	2% / fps	1% / fps	.2% / fps
506.0	505.3	506.0	504.0 / 5.0	504.6 / 5.3	504.7 / 6.2	505.8 / 5.8	508.0 / 4.2

FFE	BFE	LO	FFE-LAG	FFE-BFE	LO-BFE	LAG-BFE
506.0	508.0	506.0	0.7	-2.0	-2.0	-2.7


Front View


Right Side View

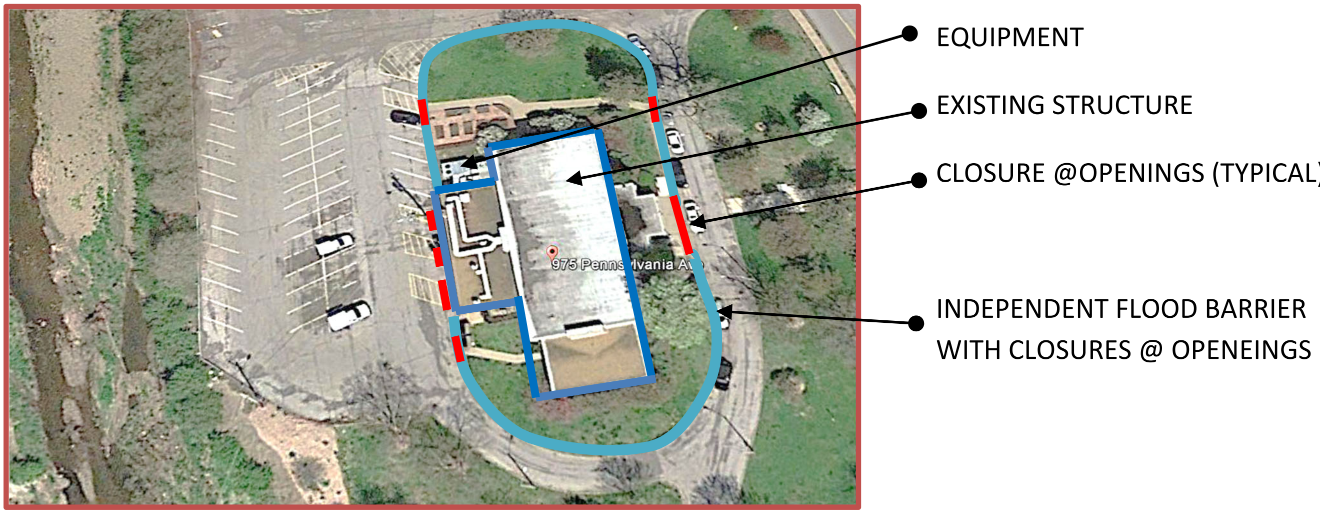

Rear View


Left Side View

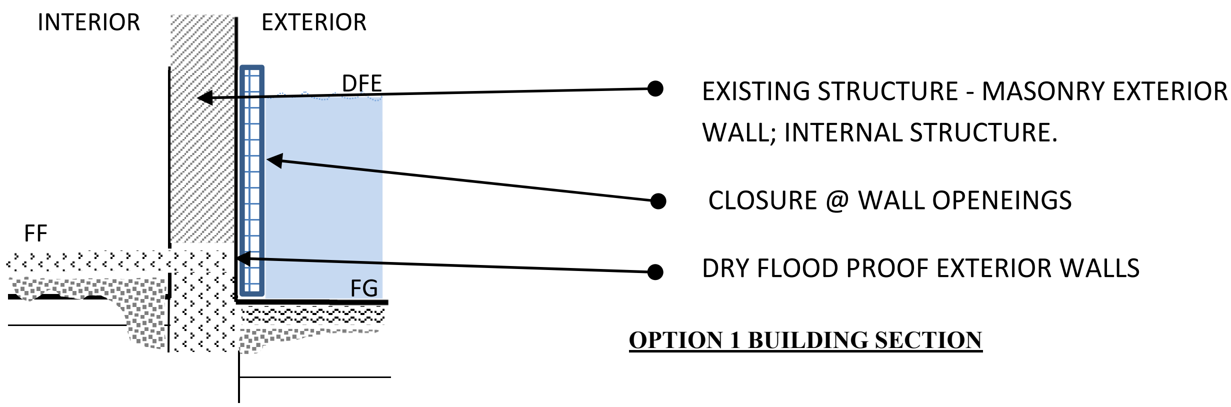
Table 5: Commercial Structure Data Continued

General: The structure viewed/observed from exterior. The structure is situated on a suburban site and free standing. Structure entry is at grade level. The grade around the structure is level and is both paved and unpaved (grass). Exterior HVAC equipment and utilities are situated close to the structure at several locations
Building Construction: The structure is one story. The foundations are concrete with slab on grade floor. Exterior walls vary -1) brick with CMU back-up; 2) metal frame with metal panel glazed in-fill.

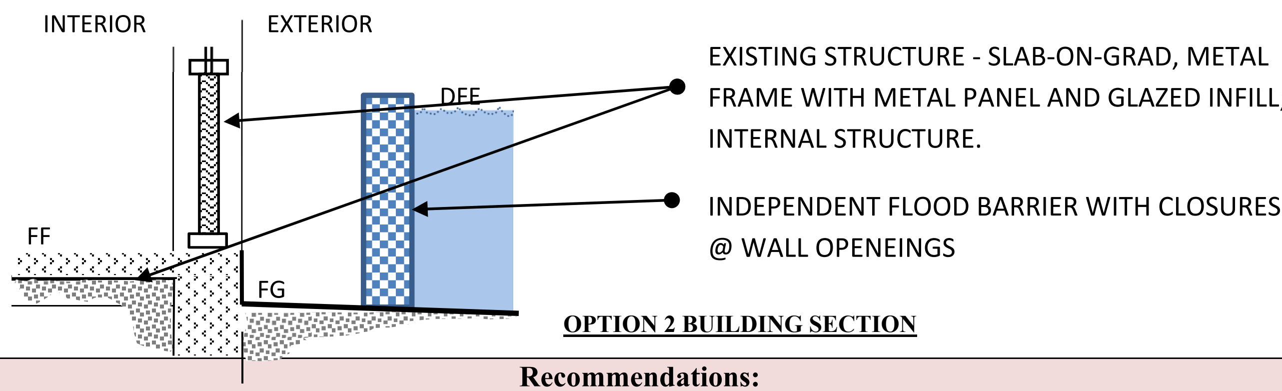
Proposed Mitigation



SITE PLAN / ARIAL VIEW



OPTION 1 BUILDING SECTION



OPTION 2 BUILDING SECTION

Recommendations:

Dry flood proof the masonry wall at the rear of the structure and provide closures at opening. Provide permanent or temporary barrier around the remainder of the structure. Provide interior and exterior pumps and emergency power. Provide back-flow preventers on building sewer and redirect roof drains.

9. Summary

Physical nonstructural measures as described in this Guide may be incorporated into at-risk structures to reduce flood damages and increase their resiliency to flooding. A nonstructural assessment work plan should be developed in order to establish an organized approach to identifying and evaluating alternatives based on completeness, effectiveness, efficiency, and acceptability. The work plan should also provide a rational framework for sound decision making when potentially evaluating multiple nonstructural measures for a single structure.

In accordance with USACE regulations, a nonstructural assessment must be equitable in terms of formulation when compared to a structural analysis. This Guide is intended for use during study scoping and development of the nonstructural assessment work plan. The Guide provides recommendations for setting up and initiating a nonstructural assessment in order for the study team to be as cost effective and efficient as possible in scoping and conducting the assessment. Numerous preparatory items can be developed in the office, prior to conducting the field assessment, from existing data located in city offices, and other state and federal agencies.

The assessment location should correspond to known damage areas and may also be determined by geographic, political, or cultural subdivisions. If a structural assessment is also being conducted as part of the study, it may be beneficial to match sub areas between the structural and nonstructural assessments in order to more easily compare costs and benefits and then determine the most feasible measure, structural or nonstructural, for implementation.

It is recommended that all structures be identified for the structure inventory, but only a sampling of structures, ten to twenty percent of the structures located within a sub area, be assessed. If the majority of structures located within a sub area represent a similar construction style, then a smaller percentage of structures may be selected for assessing with the results being extrapolated to adjacent structures.

After a field assessment has been conducted on a sampling of structures and favorable results have been determined for one or more sub areas, then discussions should commence with the study sponsor to potentially increase the number of assessed structures within the sub areas with favorable results in order to provide a comprehensive assessment of all at-risk structures.

After completion of the assessment, cost estimates may be developed for the proposed nonstructural measures. An economic analysis can then be conducted to calculate the feasibility of implementing the nonstructural measures and determining potential federal interest.