City of Sprague, Washington
Nonstructural Flood Mitigation Assessment

January 2020

USACE Walla Walla District in support of the Washington Silver Jackets Program

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City of Sprague, Washington
Nonstructural Flood Mitigation Study

1.0 Introduction

This reconnaissance level nonstructural assessment was conducted in support of the U.S. Army Corps of Engineers (USACE) Seattle District and the Washington Silver Jackets team by the USACE Walla Walla District. The objective of the study was to assess the opportunity for nonstructural flood risk mitigation measures (NS measures) in the City of Sprague, Washington (Sprague). All 94 structures identified within the mapped 1-percent annual chance exceedance (1% ACE) floodplain were documented and qualitatively assessed. A location map of the study area is presented in Figure 1 and Figure 2.

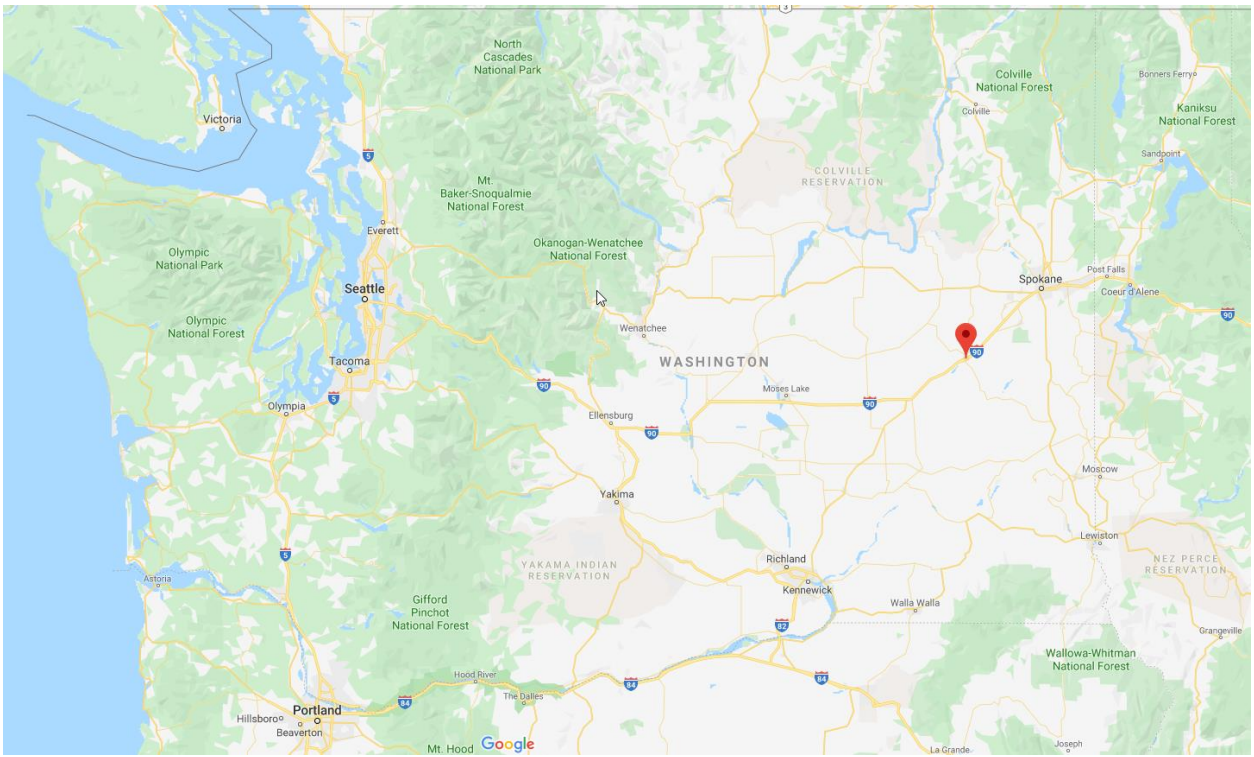

Figure 1. Sprague, Washington Vicinity Map.

In March 2017, significant rainfall on top of a melting snowpack caused significant flows in Negro Creek, which spilled over its banks and inundated homes, businesses and streets. The city mounted a significant flood fight effort with pumps and sandbags which helped to mitigate the impacts of flooding. However, damages still occurred throughout Sprague. The consequences of flooding will be very similar in future events in the absence of action taken in the floodplain.

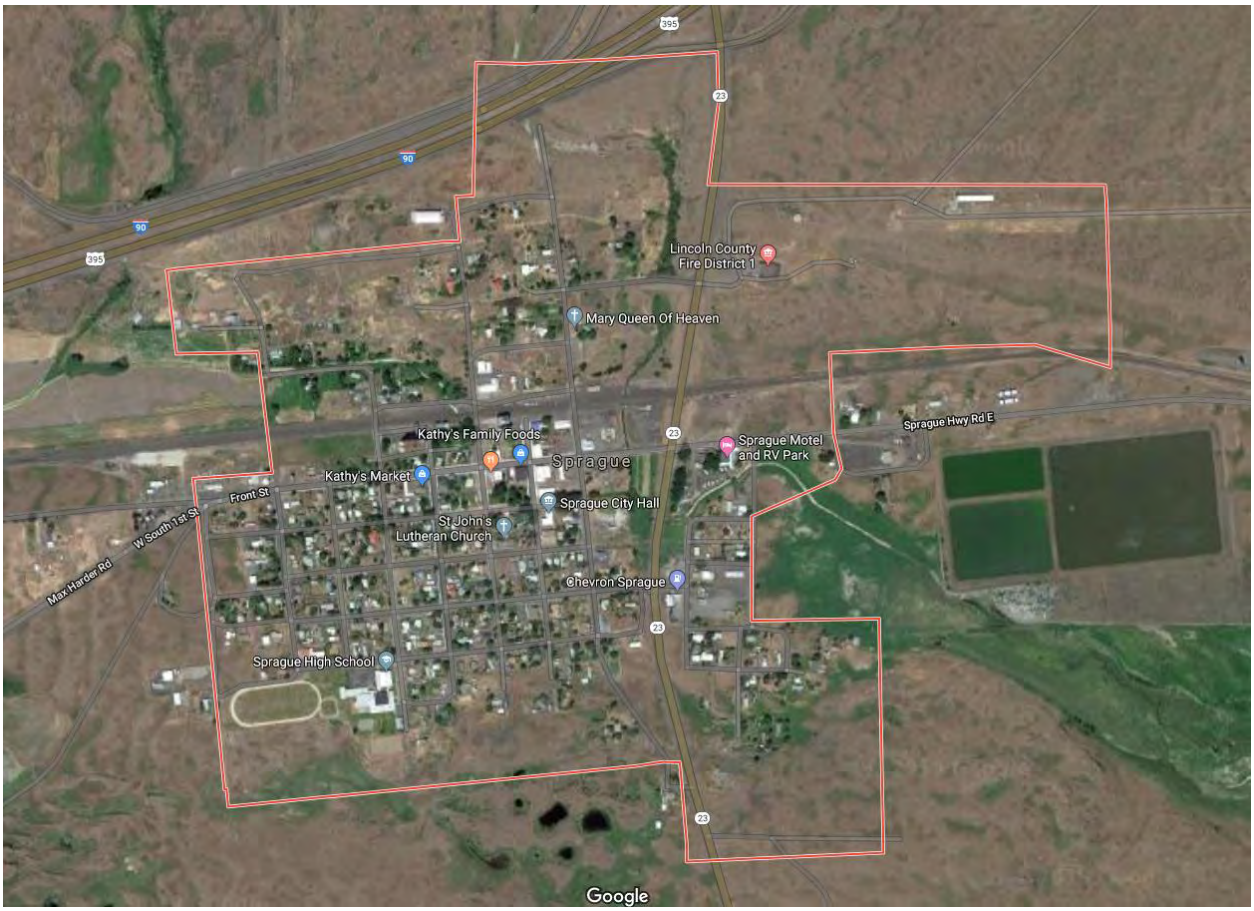

Figure 2. City of Sprague, Washington.

1.1 Floodplain and Flooding Characteristics

The primary flooding source in Sprague is from Negro Creek, which flows from east to west through the community and into Sprague Lake. Part of the flow path through town is underground. There is a substantial backwater effect from Sprague Lake downstream, causing extended periods of inundation.

The Negro Creek basin is characterized by relatively flat slopes and significant overbank storage, meaning that when floods occur, they will spread out fairly extensively in the basin. The overbank storage also provides attenuation for flood waters. The watershed lies over a fractured basalt formation, with significant exchange between surface water and groundwater.

Flooding in the Negro Creek drainage can occur from snowmelt, rain on snow, or prolonged widespread rain events in the basin. During large flood events, flood waters tend to arrive and recede slowly, often arriving in Sprague several days after whatever the source event may be. The Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) for Lincoln County, Washington, states that due to the amount of overbank storage and attenuation provided, quick moving large precipitation events like thunderstorms tend to result in minimal flooding in Sprague. Larger, more widespread sources of flooding like long rain events or rain-on-snow events tend to cause the worst flooding.

Sprague has experienced significant floods in 1918, May 1948, March 1954, January 1978, February and March of 1997, and as recently as March of 2017. Floodwaters typically have little velocity and carry little debris, so inundation is the primary damage driver.

1.2 Executive Order 11988 on Floodplain Management (EO 11988)

Executive Order 11988 (EO 11988) was issued by President Jimmy Carter on May 24, 1977. The order states "in order to avoid to the extent possible the long- and short-term impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative, it is hereby ordered that each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, floodplains in carrying out its responsibilities…". The NS measures assessment in this report was conducted in compliance with EO 11988, meaning any NS measures that are incorporated into alternatives recommended for implementation support the vision of EO 11988.

1.3 Addressing Flood Risk in Sprague

Flooding in and around Sprague requires the response and recovery efforts of local government, residents, and outside volunteers, as well as Lincoln County, state and federal agencies. When flooding occurs, the drain on human and financial resources is significant. Damage to residential, commercial and public facilities adversely impacts the entire community.

Whether hydrologic conditions remain the same or increase in the future, all structures located within the vicinity of the assessment area are at risk of flooding. This assessment focuses on at-risk structures and contains the qualitative technical assessment used for investigating the incorporation of NS measures within the assessment area. Without the incorporation of nonstructural mitigation or other structural measures such as levees, floodwalls, and channel modifications, these structures are at risk of being damaged or destroyed from flooding occurring in the future.

While NS measures are specific to the individual structure being investigated, when many measures are combined for mitigation of flood damages, the cumulative effect is to incorporate a full range of NS measures which are economically feasible, socially acceptable, environmentally adequate, and will reduce the cumulative risk of flooding for the community. Each individual structure assessed may require a different nonstructural technique. This assessment relies on data collected in the field for implementation and thus cannot be conclusive as to the ultimate feasibility of the alternative. Because of the limited nature of this investigation, this assessment was conducted as reconnaissance level detail and would require additional analyses to determine economic feasibility for implementation.

NS measures require different implementation methods than typical large-scale structural measures (for example, levees or floodwalls). Since each structure is owned and typically occupied, nonstructural implementation agreements must be entered into with each individual owner. NS measures are proven methods and techniques specifically directed at reducing flood risk and flood damages in floodplains. Numerous structures across the nation are subject to reduced risk and damage or no risk and no damage due to implementation of NS measures. These measures can be very effective for both short and long term flood risk and flood damage reduction and can be very cost effective when compared to other types of flood risk management (levee systems, detention, and channel modification) measures.

The ability of NS measures to be implemented in very small increments, with each increment producing flood risk reduction benefits, is an important characteristic of this form of flood risk management. Also

important is the ability to implement measures over intermediate and long periods such that layering of measures, each one providing a higher degree of risk reduction, is possible and given both Federal and non-Federal funding constraints, may be probable.

2.0 The Nonstructural Assessment

This nonstructural assessment is meant to provide a qualitative assessment of all of the residential and commercial structures within the mapped 1-percent annual chance of exceedence (1% ACE) floodplain on the FEMA Flood Insurance Rate Map (FIRM) for Sprague. Outbuildings were typically not considered in the analysis.

2.1 Nonstructural Assessment Objectives

For a nonstructural assessment, each structure must be investigated for purposes of determining what type of NS measure is most appropriate for that particular structure given structure construction, structure and site conditions, location within the floodplain, and local flood characteristics (velocities, stages, and duration). The target flood for nonstructural flood proofing was the 1% ACE flood event. Basic structure information was collected in the field from public property and combined with other information obtained by USACE – Walla Walla and Seattle Districts with additional assistance from the community.

This assessment aims to provide a determination of the appropriate nonstructural technique for each structure. Due to the qualitative nature of field data collection, it was not possible to assess certain aspects of each structure that should be evaluated to determine if the NS measures considered would be appropriate for a given structure. In particular, a structure has to be in relatively good condition, meaning it has to be structurally sound in order to withstand elevation, relocation, or flood proofing. If a given structure is in poor condition, then only filling in the basement/crawlspace, if one exists, could be considered.

Filling in the basement/crawlspace includes relocating utilities, mechanical equipment (furnace, water heater, water softener, and appliances), electrical panels and circuits, as well as some storage to a new location above the Base Flood Elevation (BFE), which is the water surface elevation associated with the 1% ACE flood event. These measures were considered because they would both reduce future flood damages to the structure and reduce flood insurance premiums for the owner, which start at the lowest habitable elevation.

For dry flood proofing, the depth of flooding has to be limited to between three to four feet above ground elevation and the walls of the structure have to be of such structural integrity as to being able to withstand the lateral forces applied by the floodwaters.

Relocation is provided as an alternative to elevation for some structures. Typically, relocation is recommended where the depth of flooding is determined to be greater than 12-feet. In the case of Sprague, it may be feasible and desirable to relocate manufactured homes in an economic manner to remove them from the floodplain, rather than continue to face the threat of flooding.

The assessment of the project area indicated that there are a significant number of at-risk structures. While most of the commercial structures appear to have been constructed at ground or street level elevation, the residential structures vary in the first floor height off of the ground depending upon the style of the structure and whether a crawlspace or basement were contained within the structure. The

size of structures also varied greatly from manufactured home to single story to multi-story for residential structures and from individual stand-alone to multi-bay commercial structures. Many of the commercial structures were constructed as slab-on-grade, with walls being constructed of masonry, metal, and wood.

2.2 Description of Nonstructural Structure Dataset

For this assessment, information was collected for every structure located within the mapped 1% ACE floodplain on the FEMA FIRM for Sprague. A total of 94 structures were assessed. USACE Walla Walla District personnel collected data and photographs in the field from public rights-of-way in late July of 2019. Additional information was gathered from Sprague records provided, aerial and street level imagery in Google Earth, and property information from Zillow.

The work began by digitizing the FEMA FIRM in the office and compiling information about Sprague, the floodplain, and the flood history of the area. USACE Walla Walla District personnel then performed a site visit to Sprague to photographically document conditions of each structure from public rights-of-way, gathering data about each structure (construction type, foundation, basements, mechanical equipment), and making a field estimate of potential flooding at each structure based on the Base Flood Elevation (the mapped 1% ACE flood elevation). The data was returned to the office, where assessments of each structure were made with both potential permanent nonstructural measures and also potential temporary protective measures. The caveats and cautions that were mentioned in the previous section apply to all of the recommendations.

Each structure was assessed using a similar format. The assessments and recommendations focused on mitigating structures utilizing elevation, dry flood proofing, wet flood proofing, and/or relocation/acquisition. The NS measures presented in this report are stand-alone mitigation techniques for individual structures or combination techniques to provide the most effective level of flood risk reduction.

The following assumptions were incorporated into the assessment because of the reconnaissance nature of the assessment:

1. Basement utilities, equipment, and storage are proposed to be relocated to an existing space or an addition to the existing structure and above the mitigation flood elevation. A more detailed investigation would be required to determine the specific area to accommodate these items on an individual structure basis.
2. Field observations were made as complete as possible, but there may be inaccurate or missing data in the assessment that could affect the appropriate recommendation for each structure.
3. Dry flood proofing was limited to four feet in height based upon typical best practice. Some structures may not have sufficient structural strength or integrity to handle four feet of dry flood proofing, and each structure will need to be analyzed in more detail prior to the application of any NS measure.
4. If the flood elevation is greater than the first floor elevation and a basement/crawlspace exists, the first floor cannot be dry flood proofed without eliminating the basement/crawlspace.

The assessment conducted was reconnaissance level in detail. If mitigation may occur on any individual structure, additional detailed data would be required. For the current level of assessment, the data is

sufficient to identify potential NS measures, which could be effective in reducing future flood risk, life loss, and property damage.

3.0 Permanent Nonstructural Flood Risk Mitigation Measures

Nonstructural measures are used to reduce overall flood risk, decrease flood damages, and to potentially eliminate life-loss, while increasing the overall resilience of a community to the effects of flooding. NS measures reduce flood risk by modifying the characteristics of vulnerable structures that are subject to flooding. NS measures do not modify the characteristics of floods, nor should they encourage development or further development in a floodplain that is inconsistent with reducing flood risk. Instead, they modify the characteristics of structures or communities in the floodplain to make them more resistant to flooding. In essence, the purpose of NS measures is to reduce the impacts of flooding such that a community can be inundated during a flood event and survive it with a minimum of damage overall.

NS measures contrast with structural measures in that structural measures are meant to modify the characteristics of a flood. Examples of structural measures might include dams, which can change the timing, duration, or magnitude of a flood; levees, which may exclude flood waters from a portion of a floodplain; or even ring levees, which may exclude water from specific areas of a floodplain, such as critical facilities like power plants or utilities. While structural measures may decrease the frequency of flooding at a specific location, or protect a location from some specific level of flooding, they may actually increase flood risk overall if consequences of larger flood events are allowed to increase through additional floodplain development.

There are a number of NS measures that may be applicable to Sprague, which are as follows:

- Elevate existing structures in the floodplain to raise the finished floor above anticipated flood levels;
- Relocate at-risk structures with willing owners from the floodplain to a flood-free location;
- Acquire lands in the floodplain from willing sellers where structures have been relocated or removed and enforce deed restrictions to prevent any future uses that would be subject to flood risk;
- Acquire lands in the floodplain from willing sellers that is an existing open space and prevent future development that would be subject to flood risk;
- Acquire structures in the floodplain from willing sellers, demolish them, and enforce deed restrictions on the land to prevent future development that would be subject to flood risk;
- Dry floodproof structures (exclude all water from a structure through waterproofing);
- Wet floodproof structures (retrofit existing structures with water resistant materials to allow water to enter a structure with minimal damage);
- Develop public alert flood warning systems;
- Develop and implement emergency flood preparedness plans;
- Develop and implement a floodplain management plan;
- Develop evacuation procedures for flood-prone areas; and
- Employ educational and outreach programs aimed at reducing flood risk.

Each of the above NS measures can be applied as a single measure or combined with other NS measures or even structural measures to reduce or eliminate flood risk.

While all of these NS measures may be applicable and useful to all structures in Sprague, not all of them can be applied in a manner compliant with the National Flood Insurance Program (NFIP). Serious consideration should be given to the trade-offs between NFIP compliance, overall structure protection, and the safety and practicability in applying some of these NS measures to certain buildings. These NS measures will be discussed in more detail in a section below.

3.1 Common Nonstructural Flood Risk Mitigation Measures

There are a number of common NS measures that are commonly used for reducing flood risk and increasing community resilience to flooding, both in rural and urban areas. Some measures may be more applicable than others based on the specific structure characteristics and the nature of the flood risk at each specific location. Some of the NS measures may not be applicable at all, or may not lead to a solution that is compliant with the NFIP.

3.3.1 Elevation of a Structure. This NS measure entails the lifting of either the entire structure or the habitable portion of a structure to an elevation above a specific flood elevation, as shown in Figure 3. This measure is generally applicable to the entire study area, because no structure would be required to be lifted more than 12 feet above the adjacent grade. If a structure has a developed basement, and that basement could not continue to be a developed space post-elevation, the property owner would need to be compensated for the loss/removal of the basement. Typically, below grade space is valued less than above grade space. Velocity and hydrodynamic forces would need to be considered as part of a stable design of an elevated structure. All mechanical utilities would need to be elevated above the specified flood elevation. The space under an elevated structure could be used for storage or car parking, but not living space, in order to maintain NFIP compliance.

3.3.2 Relocation of a Structure. This NS measure involves physically moving a structure that is subject to a significant flood risk to an area outside of the floodplain. This measure also requires both the acquisition of new property to place the moved structure on, and acquisition of the existing flood-prone property to prevent future development that would incur flood risk. This measure provides a high level of flood risk mitigation as at-risk structures are moved to a location with no flood risk. Development of relocation sites where structures could be moved to allows a community to achieve both flood risk reduction and maintaining a community tax base, maintaining neighborhood cohesion, and maintaining cultural or historic values that exist in a community. This measure can be applicable across the study area.

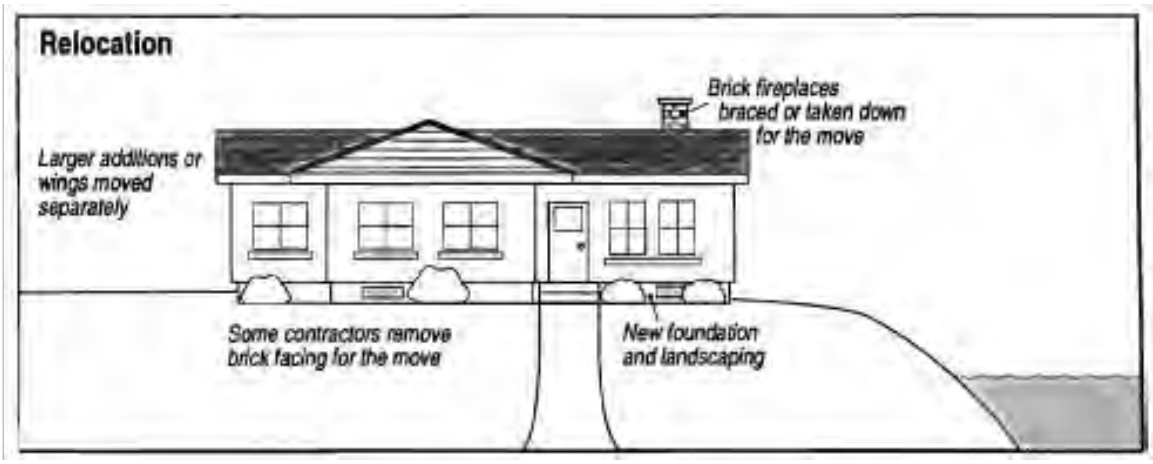

Figure 3. Relocation of a Structure (Diagrammatic Detail)

3.3.3 Removal of a Basement. In the case where a basement exists below the specified flood elevation, it is possible to move and replace all storage, utilities, mechanical equipment, electrical panels and circuits and fill the basement. If a structure's above-grade living space is already above the specified flood elevation, the basement can be filled without further elevating or modifying the rest of the structure, save for the required work to relocate storage space and all utilities and mechanical equipment. Building an addition onto the existing above-grade structure is possible to compensate for the loss of habitable basement space to the owner and to incorporate any mechanical equipment or utilities. It should be noted that if a property has an NFIP policy, an addition could trigger the substantial improvement clause, which may require additional modifications or upgrades to the structure to bring it fully into compliance with the NFIP. If an addition is not desired or cannot be accomplished on the existing property, partial compensation to the property owner for the lost basement space would be negotiable. Typically, basement space is not valued the same as above-ground finished space.

3.3.4 Acquisition with Demolition/Salvage of a Structure. This NS measure consists of purchasing an at-risk structure and the associated real property from a willing owner. The structure is either demolished or the structure is then sold to another party and relocated out of a floodplain. In some instances, communities are finding that some materials (wiring, plumbing, fixtures, etc.) can be salvaged instead of being landfilled to reduce waste. Redevelopment sites can be a consideration as part of project development in order to have locations where a community can construct new homes and businesses.

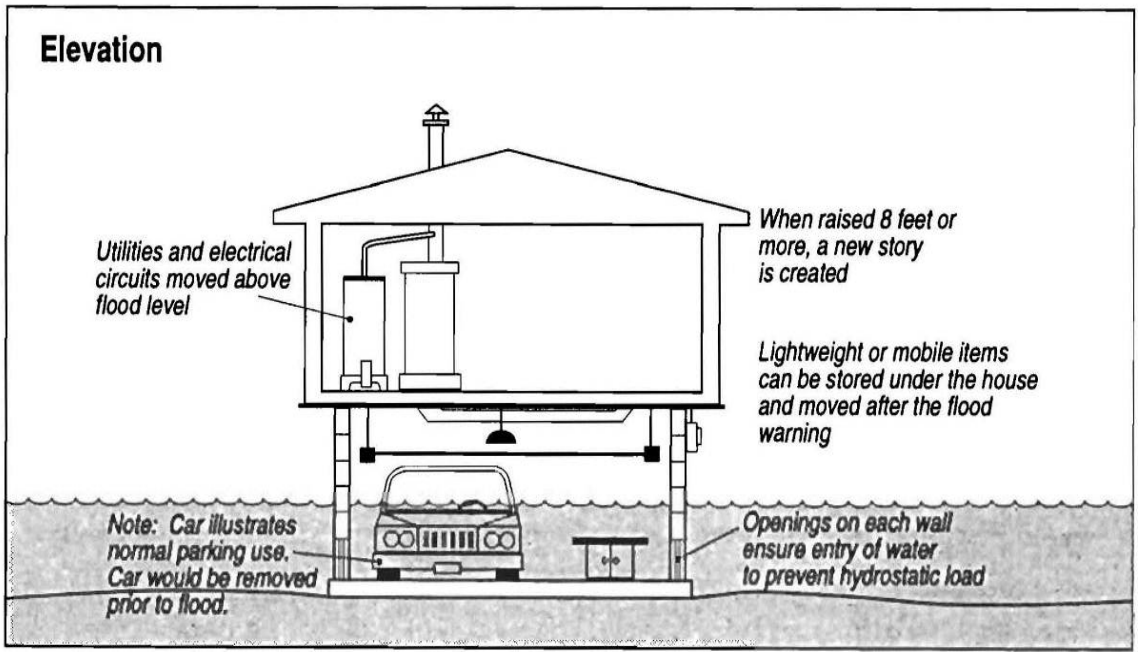

Figure 4. Elevation of a Structure (Diagrammatic Section).

3.3.5 Dry Floodproofing. Dry floodproofing is essentially waterproofing a structure, as shown in Figure 4. This NS measure is generally an acceptable approach to commercial structures, and can be applied to residential structures as well, but with some caution. While dry floodproofing achieves substantial flood risk reduction for all structures, it is not recognized by the NFIP for flood insurance premium rate reduction on residential structures. In addition, dry floodproofing a residential structure may lead to a false sense of security for a building's occupants, and may lead to belief that evacuating a structure that is or will be surrounded by flood waters is not necessary. This may lead to increase life-safety risk during a flood, as emergency services or later evacuation may not be possible for those who choose to stay in a floodproofed structure.

A general rule of thumb for the application of dry floodproofing to a structure is that it may be floodproofed up to between 3 and 4 feet on the exterior walls before hydrostatic and/or hydrodynamic forces may overcome the structural integrity of a building. A structural analysis of wall strength would be required in order determine the actual height that dry floodproofing may be effective. Additional features, such as a sump pump, a French drain system, and a one-way check valve on sewer connections may be required to account for seepage, interior drainage, and sewer backup. Closure panels would be required for all openings on the structure. Dry floodproofing does not work on structures with basements or crawl spaces due to the potential for water entry under the finished space during a long-duration flood. Filling and sealing of basements or crawl spaces may be required, or complex and expensive cut-off walls may be integrated into the design, in order to completely exclude water from the protected area and prevent the structural failure of the basement or crawl space (which would lead the failure of the overall structure).

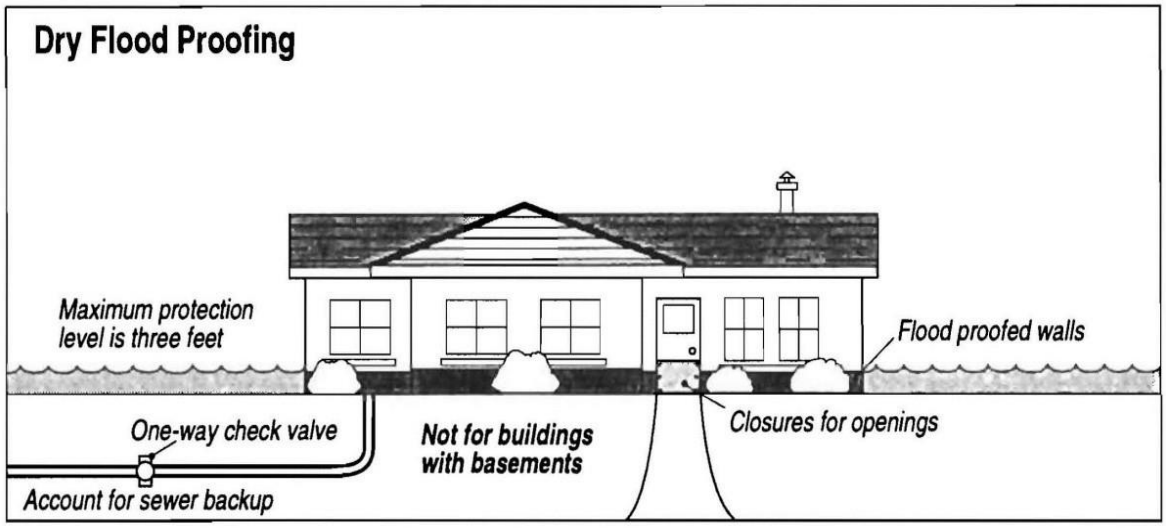

Figure 5. Dry Flood Proofing (Diagrammatic Detail).

3.3.6 Wet Floodproofing. Wet floodproofing is essentially making a structure resilient to flooding through the use of waterproof building materials up to the specified flood height, as shown in Figure 5. In wet floodproofing, water is allowed to enter and interact with a structure without damage. This NS measure can be a stand-alone measure, or combined with other measures such as elevation or dry floodproofing. All utilities and mechanical equipment must be elevated above the design flood elevation. Generally, wet floodproofing is not applicable to residential structures. It may, however, be able to provide commercial and industrial structures with a level of protection as long as the contents can be managed in such a way as to not be damaged during a flood. This measure is generally not applicable to large flood depths or high velocity flows due to the potential structure failure of walls.

Figure 6. Wet Flood Proofing (Diagrammatic Detail).

3.3.7 Berms, Levees, and Floodwalls. Although these items are structural in nature, and if considered for implementation by USACE, require standard USACE structural design criteria, they can sometimes be applied to individual structures without adversely impacting the floodplain by increasing stages, velocities, or durations. These measures are intended to reduce the frequency of flooding but not eliminate floodplain management and flood insurance requirements. An example is shown in Figure 6.

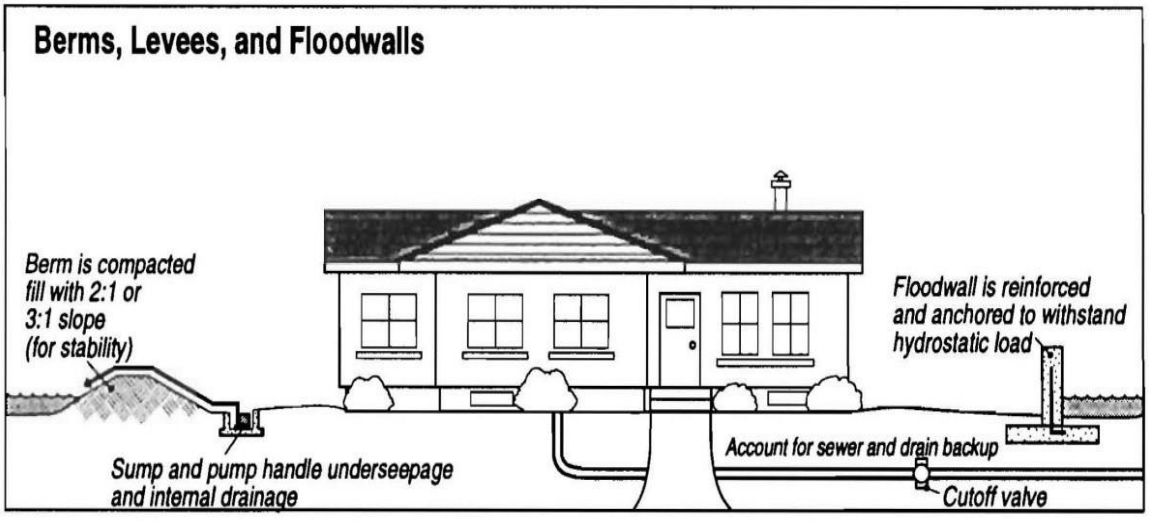

Figure 7. Berms, Levees, and Floodwalls (Diagrammatic Detail).

3.3.8 Land Acquisition.

Land acquisition as a stand-alone measure applies to current open ground with minimal or no development. This measure can be in the form of either fee title or permanent easement with fee title. The purpose of land acquisition is to reserve open land for future flood conveyance. Lands acquired can be converted to new uses such as ecosystem restoration, parks, trails, or other recreational features. Conversion of previously developed lands to open space can also be accomplished in conjunction with the removal or relocation of any existing structures. Any infrastructure present on the lands, including roads, sidewalks, and power can potentially be removed as part of this measure. Economic feasibility of a buyout or relocation project can be enhanced due to the transfer of some flood risk management costs to ecosystem restoration and by adding the benefits and costs of recreation. This is typically referred to as "new uses of the permanently evacuated floodplains."

3.3.9 Floodplain Regulation and Floodplain Management.

Floodplain regulation and floodplain management have proven to be very effective in reducing flood risk and flood damages when applied to new development. A community can develop a floodplain management plan and ordinances to direct development in a manner to reduce or avoid flood risk. It is much more difficult to apply retroactively to existing development at the time of the adoption of a management plan or new ordinances. The NFIP is a good source of minimum standards and principles for floodplain management. While the NFIP minimum standards provide some level of flood risk reduction, it is highly encouraged for a community to incorporate higher standards and more stringent building codes and zoning ordinances to meet community objectives to reduce or eliminate flood risk.

3.3.10 National Flood Insurance Program.

The NFIP contains three main components: flood insurance, flood mitigation, and floodplain regulation. Floodplain regulation and flood risk mitigation are activities that can directly affect flood risk. Flood insurance is a tool to help make impacted parties whole again after a flood disaster. Insurance does not reduce flood risk, nor do FEMA FIRMs depict a community's flood risk with total accuracy. The NFIP provides mitigation programs that can be used by communities to address and reduce their flood risk. These are the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation Grant Program (PDM), the Flood Mitigation Assistance Grant Program (FMA), and Severe Repetitive Loss Grant Program (SRL). Each of these is a cost-shared grant program. Floodplain regulation is also an effective NS measure, where a community adopts minimum floodplain management standards and participates in the NFIP.

4.0 Temporary Flood Proofing Measures

It is possible to reduce the impacts of flooding on a temporary basis, though it should be noted that permanent measures, whether structural or nonstructural, are much more reliable and effective. For the purposes of this report, this section will focus on temporary flood proofing techniques that can be employed to provide some level of protection to structures in the floodplain. It will also focus on the precautions that should be considered before implementing any particular strategy.

Effective temporary measures require significant planning ahead of an event. It is vital to understand the characteristics of flooding, such as likely depth of floodwaters, the areal extent of flooding, the potential duration of a flood, how much velocity a flood may have throughout the floodplain, and anticipated warning time of an event. Property owners and community officials alike need to consider

these flood characteristics in making decisions about which temporary measures, if any, may be effective in reducing the impacts of a flood to the community and the properties within.

Temporary flood proofing measures must be deployed every time there is a risk of flooding in order to protect structures and their contents. The most effective, efficient, and reliable way to address flood risk is through permanent measures. Temporary measures should not be considered a long-term strategy, but may be useful as a stopgap until such time as permanent measures can be implemented. Each property owner or tenant should consider the costs and risk associated with repeatedly implementing temporary flood proofing measures versus the long-term security and confidence that can come with implementing permanent measures.

4.1 Common Temporary Flood Proofing Measures

Temporary flood proofing may be effective in short-duration flood events if applied properly and completely prior to the beginning of a flood. Potential temporary measures include: 1) polyethylene sheeting hung on the structure exterior (usually to a height of 3 feet above the first floor elevation and continued on the ground surface 4 feet from the structure exterior), in combination with door and window closures, 2) clear liquid sealant applied to the structure exterior, in combination with caulking of large cracks in the exterior and placement of door and window closures, 3) sandbag berms located around all or a portion of the structure, and 4) any of the barriers certified through the National Flood Barrier Testing and Certification Program [see http://nationalfloodbarrier.org/].

A key difference between these temporary measures is that hydrostatic forces are applied to the structure walls when using the polyethylene sheeting and clear liquid sealant measures, but not with sandbag berms or the certified barriers. The condition of the structure being protected must be considered when choosing a temporary measure.

4.2 Flood Characteristics and Selecting Temporary Measures

There are a number of factors that can affect the appropriate choice of a flood proofing measure, some of which may not be known or obvious to a property owner or tenant. The characteristics of the flooding itself, including the depth, velocity, and duration of a flood, can all dictate the type of temporary measure that can be used. It should be noted that velocities will be higher near the channel, although the nature of flooding along Negro Creek through Sprague is such that depth is the larger concern. The condition of the structure being protected is also an important consideration, including the condition of the foundation, crawlspace, basement, type of construction, and type and condition of the exterior walls can affect the effectiveness of any measure implemented. Finally, the surrounding site conditions are important to consider. Soils that are permeable or impermeable, the density of landscaping, and the location of utilities and other external features may all be part of the decision of which temporary measure to use.

4.3 Implementing Temporary Measures

The use of temporary measures can be successful in reducing or even preventing flood damages when conducted correctly. The scope of this Silver Jackets study does not allow the U.S. Army Corps of Engineers to evaluate the individual structures and their sites in sufficient detail to guarantee the success of temporary flood proofing, as there are several factors that the owner or tenant must consider when implementing temporary measures:

- Because of the serious nature of flooding and because of unknowns associated with the depth, velocity, and duration of flooding, as well as the precise structural condition of each structure, it is generally considered wise to allow no temporary flood proofing measures to be placed to a height which exceeds 3 feet above the elevation of the first floor of the structure. The hydrostatic forces of the floodwaters can cause a catastrophic collapse to the walls of a structure due to the lack of lateral resistance from the structure as the flood waters rise higher against the sides of the structure. And, since the characteristics of a flood (the depth, velocity and duration) may change during a flood event, it must be noted that it is possible for failure of foundations, walls, and closure panels to occur at a flood depth of less than 3 feet. Without a proper structural analysis of individual structures by a certified professional or contractor, failure of a structure can occur due to the hydrostatic and hydrodynamic pressures caused by water pooling up against or running into a structure. It is the highest recommendation of the team of engineers preparing this report that after the flood proofing measures have been implemented, all persons evacuate the structure to a predetermined location of safety.

- Though obvious, it must be stated that a structure could be exposed to a flood event of a depth greater than for which temporary flood proofing measures have been erected.

- Preparing a structure for a flood requires significant effort, and it is impossible to accurately predict even one day in advance the depth to which flood waters from an approaching storm may rise. Therefore, the owner or tenant cannot be certain that the projected flood event will actually occur. The owner or tenant must find his own comfort level and balance the risk of not having the structure properly flood proofed, versus the risk that the effort to flood proof was not necessary.

- In order to prevent unsanitary water from backing up into the structure during a flood, the owner should ensure that his sanitary drain line is fitted with an anti-backflow device.

- Downspouts and associated drainages must be considered. If a certified barrier or sandbag berm is erected, the downspouts need to be modified so they can be directed over the barrier; this would greatly reduce the amount of water to be pumped from within the protected area. Also, there may be drain lines that carry water from the downspout that pass under the certified barrier or sandbag berm, which must be plugged to prevent flood water from flowing through the line into the protected area.

- If the exterior construction is not structurally sufficient to withstand a significant water load the force of water at a depth of three feet (or perhaps less) could collapse walls. Therefore, it is recommended that when the temporary measures include placement of polyethylene sheeting on the exterior of a structure, a thick layer of plywood (up to 1 inch) be attached to the exterior surface of the structure up to the level of protection. The plywood could be attached to wall studs using countersunk threaded anchors with bolts, and sheeting would be placed over the plywood. Again, structural evaluation by a certified professional or contractor is recommended.

4.4 Planning and Preparation of Temporary Measures

The information provided in this report section is the basis for developing temporary mitigation measures to reduce the possibility of extensive flood damages. In order for flood proofing to be successful, a thorough plan for each individual structure needs to be developed and implemented. The plans will vary from structure to structure, depending upon structure type, projected depth of flooding, the velocity of floodwaters, the time available to implement the measures, and the availability of flood proofing materials. In some instances, due to the depth of flooding or the projected velocity of the floodwaters, rather than attempt to keep floodwater out of the structure, it may be more cost effective to remove or elevate to a higher interior location, those items (business records, electronics, computers, heirlooms, artwork, etc.) which contain a high value, intrinsic or monetary, so as to avoid exceptional loss.

For individuals wishing to implement temporary flood proofing measures, a plan should be developed to ensure that the measures can be employed as quickly as possible when the threat of flooding is imminent. Locations for storage of the materials and equipment should be designated far in advance of an event. Storage can occur on- or off-site; however, if materials and equipment are maintained off-site, arrangements should be made to transport these materials and equipment to the site for implementation. Because the limited time available to install temporary measures is a critical factor in the prevention of flood damages, site preparation, maintaining the proper inventory of flood proofing materials, and having a well prepared emergency response plan are crucial to a successful outcome. Early preparation can make the difference between minimal dollar damages and a catastrophic loss. While even the best laid plans may go awry, nationwide data indicate that the owners who pay attention to the details, establish a thorough step-by-step process for implementing their temporary flood proof measures, and prepare themselves and their structures prior to the start of the flood season, fare far better than those individuals who rush against time to install temporary measures which have not been thoroughly planned out.

It is imperative that the structure owner or tenant determine the type and amount of materials required to be on hand each year through the forecasted flood season. A checklist of these items or material requirements should be prepared, including the sequence of placement of materials in order to establish the most time-effective process for implementing the temporary measures. Each year prior to the start of the flood season, the owner or tenant should review the checklist, replace missing or damaged items, and prepare to implement the entire flood proofing measure during the first signs or indication of imminent flooding. In addition, the owner and/or tenant should develop a procedure for ensuring that all employees, residents and others who may have been in the structure prior to the flood event are accounted for after evacuation. This may be accomplished by planning to contact all personnel via cell phone and/or by arranging to meet at a designated location.

Once the owner or tenant has established a temporary protection plan for the structure, it may be beneficial to test the plan for efficiency and effectiveness in order to optimize the plan. The flood fight materials and equipment should be stored in such a manner that they will not be damaged and should be monitored on a regular basis to ensure that these materials will be effective when and if needed. For instance, blue plastic can become damaged with holes from animals or normal weathering and should be replaced if any damage occurs, and plywood should be stored such that it will not rot or be damaged by termites or storage in a wet or damp environment.

While protection of the structure and of the structure contents are of high importance, during any flood event there is a possibility of extensive damage to the structure. It is worth repeating that, in order to prevent extensive loss or damage to high value items, it is recommended that the emergency response plan also consider relocating away from the structure or to a higher elevation, those items which would be difficult or impossible to replace.

Again, it is imperative that each structure owner understand that the intent of these proposed measures is to provide only temporary protection from flooding. After the temporary measures have been implemented, after the sump pump(s) has been positioned and flooding appears to be imminent, the owner and all associated persons should evacuate the premises during the flood event. There is always a possibility that catastrophic failure of a structure or loss of life could occur during a flood event.

4.4.1 Site Preparation

The type and amount of site preparation will vary with each structure. For many structures, one of the recommendations is that, in order to prevent floodwaters from entering a structure and causing damage, the site surrounding the structure be prepped to a condition which allows relatively easy and quick installation of temporary flood proofing measures. For each structure, the owner or tenant should try to achieve at least 4 feet of leveled access area around all exposed sides of the structure. The placement of polyethylene (also known as polyurethane or plastic) sheeting and/or sandbags as a preventive barrier to flooding requires a leveled surface in order to resist seepage into the protected area.

While shrubs, flowers and trees provide character and add value to a property, it is important that they be removed from within the “leveled access area” in order to establish a preventive barrier to flooding. If the owner is unable to remove landscape items, it is important that a uniform barrier of protection be established by placing polyethylene sheeting or sandbags as close to the protruding plant as possible to develop a cohesive barrier between the ground and the employed flood proofing measures. Even a small weakness in the flood proofing measure could result in catastrophic failure and damage.

In certain circumstances, it will benefit the owner to identify appurtenances such as fence posts, gates, storage sheds and utility boxes which may prevent the establishment of a waterproof barrier. These items should be removed as much as possible from the “leveled access area.” Utilities and HVAC units must be considered. Where possible, vital utilities and HVAC units should be raised in height to a reasonable level. Otherwise, provisions in the flood proofing plan need to include the protection of these utilities and units. Also, these items are usually associated with wall openings through which flood waters may enter a structure. These openings must be sealed, along with any other holes or cracks in the exterior walls and foundation.

4.4.2 Removal of Interior Flood Water

The removal of flood waters from a structure to prevent inundation of the first floor can be one of the most important and critical ways to protect a structure from flooding. The use of sump pumps is one of the best and easiest methods to accomplish this. For most of the assessed structures, the Corps’ recommendation is to install one or more sump pumps. Loss of electricity during a flood event must also be considered; therefore, it is recommended that the owner provide pumps that can be powered with a battery power supply. In most cases, the installation of these pumps is relatively simple, and in some cases, the use of multiple pumps may be necessary.

4.4.3 Materials and Equipment Required for Temporary Measures

The owner should ensure that the materials recommended for protecting the structure have been obtained prior to the start of the flood season. Materials required for implementing a preventive barrier to flooding should be stockpiled in an accessible location. Materials remaining from the previous flood season should be inspected to determine condition for reuse. Some of the more frequent materials required for implementing successful temporary flood proofing measures includes:

- Polyethylene Sheeting. This sheeting material (known commercially as visqueen, polyethylene sheeting, LDPE sheeting, or plastic sheeting) is often recommended for use when employing a temporary waterproof barrier around a structure. The sheeting should be purchased in rolls, typically 5-6 mils thick, and will be cut long enough to extend from no more than 3 feet above the first floor of the structure to, at a minimum, 4 feet out from the structure. The further the "leveled access area" and polyethylene material extend beyond the exterior wall of the structure, the longer the flow path for floodwaters to enter a structure, including the crawlspace or basement, is extended, increasing the resistance to flooding. The shorter the flow path is to a foundation, the higher the risks of complete soil saturation around a foundation, resulting in complete inundation of the crawlspace or basement. Once the floodwaters have access to the crawlspace or basement, it becomes more difficult to remove the floodwaters and to prevent or limit damages.

- Connectors for Attaching Plastic Sheeting to Structure Exterior. The type of connector needed depends upon the type of exterior surface of the structure to which the sheeting is being fastened. Hooks, whether self-tapping or through drilled anchor connection, are normally recommended for use in fastening the polyethylene sheeting to the structure. Spacing of the hooks should be such that no span is greater than 2 feet. Hooks should be placed permanently for continuous use from one flood season to the next.

- Water Resistant Tape for Plastic Sheeting. For firm cohesiveness between the plastic sheeting and the exterior structure surface or between adjacent polyethylene sheets, this type tape is recommended for use. These tapes incorporate PVC adhesives and are ideal for use in outdoor situations. Consideration should be made for vinyl coated cloth tapes for effectiveness where product performance is critical; these tapes can sustain harsh weather conditions and can be used for repairs to many surface types. It is further recommended that tapes containing water resistant properties, all-weather properties, brittle resistance, and anti-aging properties be obtained.

- Closure panels (plywood and other material). A temporary closure system consisting of 1-inch thick plywood or OSB is often recommended for flood barrier construction at doorways and windows; no closure should have a horizontal or vertical span in excess of 3 feet without incorporating additional supports. Because 1-inch paneling may be expensive, a 1-inch closure can be pre-made by using a grid of screws to connect two boards of lesser thickness. Vent openings can usually be protected with a lesser thickness. Do not use materials that are not water resistant. The closure panel should be measured, cut, and identified for the specific location in the temporary flood barrier and should be available for use from one flood season to

the next. The panels should be held in place with water resistant caulking, nails, screws and/or liquid nail. For doorways which open inwards, or for over the top of window glass, the closure panel should extend onto the exterior wall.

- Sand and Sandbags. Considered to be one of the most durable and easily employed flood-fight products on the market, sandbags are an integral component of many temporary barriers to flooding. Sandbags should be made of nylon or polyethylene. Generally, bags can be placed in a single row up to 3 bags high. Berms more than 3 bags high should be built in pyramid fashion; these berms should be as many bags wide at the base as they are bags high. Bags should be filled between half-way and two-thirds full, should not be tied and should be placed with the top of the bag tucked under the bag. After placement of each layer, the bags should be walked on to provide a better seal with adjacent bags. The bags in each course should be placed so that they cover to the maximum possible extent the joints in between the bags in the same course and also between the bags in the course below. Additional guidance on sandbagging is available from the Corps of Engineers. Sandbag closures at doorways and similar openings can work well but must be carefully sealed at the ends. The owner may prefer to use a plywood or other type closure panel.

- Caulk and Clear Sealant for Structure Exterior. If any portion of the structure to be protected consists of brick, stone, stucco, concrete, cinder block, or tile, a water resistant sealant may be recommended for use. It is best to use a clear liquid sealant which may be applied by brush, roller, or sprayer. The sealant should be applied to all porous surfaces, which have been thoroughly cleaned and dried to allow deep penetration and maximum resistance to the effects of water. The sealant should be extended above the area of proposed protection for best coverage. While at this time, no government testing programs have rated these commercial sealants, manufacturer's information indicate that commercial sealants may last up to 20 years without discoloration. In addition, if large cracks and voids in the structure exterior need to be filled; many products carried by local hardware companies are compatible with the materials on the exterior of the structures.

- Certified Temporary Flood Barriers. Preventing flood waters from entering a structure requires the use of temporary flood barriers. While there are many products marketed as flood barriers, very few have positively tested and been certified for preventing damages. The Association of State Flood Plain Managers (ASFPM) in collaboration with FM Approvals and the US Army Corps of Engineers National Nonstructural Committee (NNC) have implemented a national program of testing and certifying flood barrier products used for flood proofing and flood fighting. The purpose of this program is to provide an unbiased process of evaluating products in terms of resistance to water forces, material properties, and consistency of product manufacturing. This is accomplished by testing the product against water related forces in a laboratory setting, testing the product against material forces in a laboratory setting, and periodic inspection of the product manufacturing process for consistency of product relative to the particular product that received the original water and material testing. Upon products meeting the consistency of manufacturing criteria and meeting the established standards for the material and water testing, the certification part of the program becomes available to the product. Since the testing

part of the program is conducted in a laboratory setting, not all forces and impacts to which the product could be subjected to during an actual flood event will be tested.

Certification will also reflect, in terms of flood proofing, the suitability of the product, the performance of the product based on the product deployment literature, the durability and reliability of the product, and the consistency of the product. All products will be examined and evaluated on a model by model, type by type, plant by plant, and manufacturer by manufacturer basis. For additional information on this program and a list of certified products, visit http://nationalfloodbarrier.org/.

- Interior Drainage Pump and Power Supply. In order to prevent flood damages due to seepage of floodwaters through the temporary flood barrier or resulting from a rising water table, it may be recommended that pumps be incorporated into the protection measures. Pumps will be needed inside the structure to collect seepage. At a minimum, one pump with a capacity of at least 20 gallons per minute should be considered for installation in the structure for every 2,000 square feet of floor space. 115-volt AC powered pumps can be used provided electricity is available throughout the flood event. The owner may consider installing a permanent sump pump with sump pit, or can bring in one or more pumps for temporary use. If loss of electrical power during a flood is a concern, the owner could employ a gasoline-powered electric generator to power the AC pump, or could use one or more battery-powered sump pumps. The user will have to be aware that the battery life is limited; therefore, a spare battery should be kept on-hand. The life of the battery recommended in the battery powered back-up sump pump 10 to 14.5 hours of pump use. Because it is impossible to know how much the pump will be operating, the user will need to monitor it often and be prepared to replace the battery. If there is no basement or crawl space, the owner may elect to use a floor-type pump that can maintain the depth of water on the floor to 1/8 inch. If the structure being protected does have a basement or crawlspace, the pump needs to be placed at the lowest elevation in order to work most efficiently. In some instances the owner may consider cutting a small hole through the floor of a closet space, for concealment purposes, and lowering the pump to the lower level. For a slab on grade structure, the pump should be placed in a location upon the floor where floodwaters may begin to collect. In all cases, the owner should consider placing the pump at a location where the discharge hose is easily positioned to extend beyond the limits of the protection measures.

  The discharge side of the pump should be sized to match a common 1-inch diameter garden hose or should be equipped with an adaptor to 1 inch. If there is a sandbag berm, a pump with significant capacity will be needed to collect rainfall, seepage and rising groundwater within the area of the berm.

5.0 Citywide Flood Risk Management

Recent flooding highlighted the flood risk that exists for Sprague. When flood events occur, they are often slow to rise and slow to recede, leaving many structures in the heart of the community vulnerable to damage from inundation.

From this assessment, it appears that managing the overall flood risk in Sprague will be complicated. Implementing NS measures may be effective for some areas of the city. Those nonstructural measures will need to be combined with flood response preparedness, managing development and

redevelopment through local zoning and building codes, and flood insurance. These measures are discussed in more detail below.

5.1 Flood Preparedness Planning

Preparing for floods in Sprague should be a multifaceted effort. First, outreach and communication of the existing risk is vital in increasing awareness among residents. Increased awareness can lead to a better response time in the face of a flood event. The flooding that occurred in 2017 is still fresh in the memories of residents, so there is already some level of awareness within the community.

Second, Sprague should have and maintain a flood action plan and be prepared to respond to flood conditions. This may include developing plans for deploying a flood response, identifying roads that may be closed or areas that need to be evacuated, identifying any at-risk residents that need help getting out of their homes, and general tactics for a flood fight.

Last, stockpiling flood fight materials in an accessible location where they can be maintained in good order will allow Sprague to quickly deploy a flood fight. It may not be reasonable for Sprague to maintain its own stockpile of materials, but if a county or regional cache of materials could be developed with mutual aid agreements and maintenance agreements, the materials could be jointly acquired and then deployed as needed. The types of materials that could be stockpiled will be discussed in the next section.

5.2 Temporary Flood Fight Techniques

During the 2017 flood event in Sprague, a fairly sizeable flood fight was mounted to reduce the impacts of flooding through town. Sandbagging streets to direct the flow of water through the city around the piped portion of Negro Creek seemed to have some positive effect on the overall extent of the flooding. Pumps were used with some success as well to move water Citizens, resources from all levels of government, and even the Washington National Guard worked to place sandbags as the floodwaters rose. While the technique of channeling water through town does cut off portions of the city due to sandbag walls blocking roads, it may have some merit as a methodology to help contain floodwaters.

Given the relative success of this strategy, it may be worth considering the use of larger materials to accomplish similar results. Several common construction or material handling items can be used to create effective flood barriers. There are also proprietary flood barrier systems that can be used in place of sandbags that can be placed more quickly and reliably than sandbags.

For faster sandbagging, it may be worth considering the use of bulk bags or super sacks. These bags typically hold a cubic yard of sand and are relatively cube-like when filled. Although they will largely work like sandbags, the best results may occur when the stack is also wrapped in plastic sheeting. The bags are stackable and can be placed relatively quickly using a forklift, telehandler, excavator, loader, or even a backhoe. Filling the bags by hand would be impossible, but using a sandbag filler or even a winter sand spreader on the back of a dump truck can make the job approachable. Highway districts or the Washington Department of Transportation may have the equipment needed to fill and handle the bags, and the bags themselves are likely available from a retail construction supplier or bulk materials company.

Another option for creating a flood barrier would be to use Jersey barriers wrapped in plastic. These may also be obtained from a highway district, the Washington Department of Transportation, or

another source. They can be transported on trucks and placed with a forklift or telehandler. Wrapping them in plastic as they are placed makes them fairly effective.

HESCO barriers can also be effective in forming long flood barriers relatively quickly, as shown in Figure 7. The barriers are fabric-lined wire baskets that are linked together and filled with sand. They can be placed and filled with small equipment, including a skid steer loader. If placed correctly, they do not need to be wrapped in plastic. These are a specialty product, however, and may not be readily available locally. However, if the city, the county, or the state desired to create a stockpile of HESCO barriers that could be readily accessed, they can be purchased. The U.S. Army Corps of Engineers also has HESCO barriers in the national flood materials stockpile, which may be accessible if a Direct Assistance mission is authorized. The lead time required for the Corps to deliver materials may be slower than the speed with which a flood develops in the Negro Creek drainage, however.

Figure 8. HESCO Barriers Deployed on the Boise River, Idaho, 2017.

Low-head, high-volume pumps may also be an important part of the flood fight to dewater areas or even to help move water through town via lay flat hoses or other means. Pumps can be used to dewater areas and discharge into the “channels” created in the streets with the flood barriers as well.

The U.S. Army Corps of Engineers Walla Walla District and Seattle District have access to dewatering pumps and dewatering expertise, though the response time may vary depending on where the pumps are located and how quickly the flooding and the associated request for assistance progresses.

There are a number of proprietary flood barrier products on the market that can be effective as well. Some can even be placed directly into moving water. While the Corps cannot recommend any one particular product over another, a general list and description is included here for further research and consideration. Water filled, linked flood control tubes such as Tiger Dams, AquaDams, or other similar products can be very effective at forming a temporary flood barrier and can be filled by the ready supply of water available during a flood. Harder barrier products, such as Muscle Walls, Aqua Fence, and others can also be highly effective when deployed. The Muscle Wall branded barriers are shown in Figure 8. Some of the harder barriers are water-filled and plastic-wrapped, and some are simply deployable walls that rely on water pressure on the wet side for stability.

Figure 9. Muscle Wall Flood Barrier Deployed on the Boise River, Idaho, 2017.

The key to effectively using any of the materials or strategies listed above is planning ahead and knowing where the materials are located and how to access them. The most effective method would be for Sprague to either own the materials themselves or have cooperative agreements in place that would allow for on-demand access to the materials. It is also important to work with the National Weather Service, the Washington Silver Jackets team, and other agencies and groups to develop both an implementation plan and strategy, and to develop thresholds or triggers to know when a deployment should begin. Getting materials on the ground quickly as the conditions for flooding are developing will have the best outcome.

5.3 Future Development

Local zoning and/or building codes may be used to reduce flood risk for new construction, redevelopment, and for community flood risk management required by the NFIP. Given the significant flood risk that exists in Sprague, it is highly recommended that the city strictly enforce its ordinances related to new development or redevelopment that require compliance with the NFIP and do not allow new construction or substantial improvements to occur in a manner that would be damaged by future floods. The ordinances could also encourage the preservation and development of open space to allow floodwaters a place to go. Finally, in any future development, the city could consider daylighting Negro Creek and do so in such a way that would allow more of a flood to pass through a channel with higher conveyance than the current capped channel allows. This last potential future development would require a significant engineering study and investment.

5.4 Risk Management through Flood Insurance

Sprague participates in the NFIP, so flood insurance is available for all structures in the community, regardless of their flood zone designation. Preferred risk flood policies, which are relatively inexpensive, may be available for structures located outside of the FEMA "Zone A" designated areas shown on the effective FIRM. A digitized depth map for the 1% ACE floodplain is included in Appendix A. Flood insurance is an important component of managing flood risk in Sprague because damage from flooding seems inevitable under current conditions. Insurance can help property owners and renters recover more quickly from flood damage.

6.0 Recommendation of Nonstructural Measures

Based upon the data collected for the 94 assessed structures, as well as the potential depth and extents of flooding for the 1% ACE flood event in Sprague, recommended mitigation measures are presented in Appendix B. Elevation appeared to be the most appropriate NS measure for the majority of the residential structures assessed in this study. Dry flood proofing was the primary NS measure identified for nonresidential structures.

It was beyond the scope of this study to determine the economic feasibility of implementing any of the recommended NS measures. The Washington State Risk MAP coordinator may be able to provide support, assistance, and guidance with understanding and planning how to address specific flood risk issues.

The temporary flood proofing measures can be considered as a potential stopgap strategy as more permanent NS measures are funded and implemented in Sprague. The use of flood fighting techniques

may also present both a stopgap strategy, and potentially a more cost-effective and economically viable alternative to Sprague. Again, no economic feasibility was determined.

There are a number of federal and state programs, administered through the State of Washington that may be useful for Sprague in both the short- and long-term mitigation of flood risk. These programs are described in the following sections.

6.1 Flood Mitigation Assistance Program

The Flood Mitigation Assistance Program (FMA) is a FEMA program with cost-shared funds managed by the Washington State Emergency Management Division (EMD). The FMA program is available annually and is nationally competitive. Funds can be used for cost-effective projects that will reduce the risk of flood damage to structures that have flood insurance coverage. Funding for properties that meet the repetitive loss (RL) or severe repetitive loss (SRL) thresholds is available at a 90 percent or 100 percent federal cost share, respectively. Funding for all other grants is available at a 75 percent federal cost share. Cost-shared grants are also available for planning initiatives to update the flood hazard portion of an applicant's hazard mitigation plan. Applications to the Washington State EMD are typically due three months after the federal announcement, which generally happens in the spring of each year.

A RL property is any insurable building for which two or more claims of more than $1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period since 1978. A RL property may or may not be currently insured by the NFIP.

A SRL property is one that has either experienced four or more separate claim payments of $5,000 (building and contents) or more since 1978, or has had two or more separate claim payments (building only) where the total of the payments exceeds the current value of the property. In both cases, two of the claims have to have occurred in the last 10 years. The property does not need to have had the same owner throughout its damage history to qualify.

6.2 Pre-Disaster Mitigation Program

The Pre-Disaster Mitigation Program (PDM) is a FEMA program with cost-shared funds managed by the Washington State EMD. The PDM program is available annually and is nationally competitive. Funds can be used for hazard mitigation measures designed to reduce injuries, loss of life, and damage and destruction of property. Grants are available for mitigation planning as well as cost-effective mitigation projects. Small impoverished communities and tribes may be eligible for a 90 percent federal cost share. Applications to the Washington State EMD are typically due three months after the federal announcement, which generally happens in the spring of each year.

6.3 Washington State Floodplains by Design Program

The Washington State Floodplains by Design (FbD) program is a partnership of local, state, federal, and private organizations focused on coordinating investment in and strengthening the integrated management of floodplain areas throughout Washington State. The FbD grant program seeks to advance integrated floodplain strategies and projects that consider a broader variety of ecological functions, values, and benefits. Projects can have a higher likelihood of success when they improve ecological function, reduce flood risk, and meet other community needs because they are more likely to garner the necessary community support and public funding. Ideal projects are part of a strategy that is

tailored to the specific reach of a river which reduces the flood risk, restores ecological function, and is a net gain for other community interests.

Funds are administered by the Washington Department of Ecology under a biennial funding cycle, with proposals due in even-numbered years. Funds, when appropriated by the state legislature, become available in odd-numbered years. There is a 20 percent non-federal cost share requirement. Qualified economically distressed communities or communities that have a Median Household Income less than 80 percent of the state Median Household Income may qualify for a zero percent non-federal cost share.

To explore qualifications and potential projects, community officials should work in coordination with Washington State Department of Ecology staff. More information and contacts can be found at https://ecology.wa.gov/About-us/How-we-operate/Grants-loans/Find-a-grant-or-loan/Floodplains-by-design.

6.4 Hazard Mitigation Grant Program

The Hazard Mitigation Grant Program (HMGP) is a FEMA program with cost-shared funds managed by the Washington State EMD, and is only available after a Presidential Declaration of Major Disaster. The program funds mitigation planning and cost-effective mitigation projects designed to reduce or eliminate the effects and costs of future disaster damage. This grant program requires a non-federal cost share of up to 25% of the total project cost. The cost share requirement may be reduced in the case of Governor and Legislature approving the state paying a portion of the non-federal cost share requirement. The HMGP program is a post-disaster program, and can be applied to communities that have suffered flooding. Competition for the funding is statewide with applications typically due to the state within 12 months of the declaration date.

More information is available by contacting the Washington EMD or visiting the state website at https://mil.wa.gov/emergency-management-division/grants/hazard-mitigation-grants

6.5 FEMA Small Impoverished Community Definition

Grants awarded to small impoverished communities may receive a Federal cost share of up to 90 percent of the total grant for use in an approved project. There are specific criteria that must be met to qualify:

- The community must have a population of 3,000 or fewer people and be identified by the state as a rural community that is not a remote area within corporate boundaries of a larger city;
- The community must be economically disadvantaged, with residents having an average per capita income of 80 percent or less of the national per capita income;
- The community must have an unemployment rate that is higher than the national unemployment rate by at least one percent; and,
- The community must meet any other requirements put in place by the state.

Applicants must certify and provide documentation of community status with an appropriate subapplication to qualify for the 90 percent federal cost share rate. If the documentation and certification is not submitted, any FEMA-funded project will be considered at the 75 percent non-federal cost share rate.

More information and assistance with applications can be obtained from the Washington EMD.

7.0 Flood Insurance Premium Reductions from Nonstructural Measures

Implementation of NS measures may result in reduced flood insurance premiums under the NFIP for certain structure type. Insurance premiums for structures located within the Special Flood Hazard Area are functions of the elevation of the first floor of the structure (which may be a basement or crawlspace, if either exists) with the respect to the BFE. The lowest habitable floor elevation will dictate the premium rate for flood insurance.

For residential structures, elevation of the structure on an extended foundation wall, on fill material, piers, posts, and columns has the effect of reducing the flood insurance premium because the structure is being moved away from the flood risk. It is important to note that the flood insurance is based upon a single flood event, the 1% ACE flood event and not a range of flood events. If the residential structure is elevated to be above the 1% flood elevation, there is still a possibility that a larger, more infrequent flood event could occur. Figure 9 illustrates the potential reduction in flood insurance premium for a sample residential structure elevated on extended foundation walls.

Currently, with regards to residential structures, no other physical NS measure, other than acquisition and relocation of the structure, provides a benefit by reducing the flood insurance premium. While wet flood proofing and dry flood proofing a residential structure have the potential to reduce property damages associated with flooding, neither technique results in a reduction in insurance premiums. As of the date of this report, FEMA had been directed by Congress, under the Homeowner Flood Insurance Affordability Act of 2014 (HIFAA), to produce guidelines for structure owners regarding alternative mitigation efforts, other than structure elevation, to reduce flood risk to residential structures that cannot be elevated due to structural characteristics. This request requires alternative forms of mitigation measures to be considered in the calculation of risk premium rates.

However, for nonstructural mitigation of commercial structures, a reduction in flood insurance premium may be obtainable if the flood risk for an individual structure can be reduced through mitigation such as elevation or dry flood proofing. As discussed in section 3.3.5, dry flood proofing is the prevention of flood waters from entering a commercial structure through implementation of engineered systems.

If dry flood proofing is a consideration for reducing flood risk, it is recommended that the structure owner employ closure barriers which have been certified through the National Flood Barrier Testing and Certification program. The purpose of the testing program is to provide a process for evaluating flood fight products in terms of their resistance to floodwaters, their material properties, and consistency of product manufacturing. Products are tested against water forces in the USACE Engineer Research and Development Center laboratory, tested against material forces in an FM Approval laboratory setting, and undergo periodic inspection of the manufacturing process for consistency of product.

Additional information regarding the certification program can be found at the following Association of State Floodplain Managers website: http://nationalfloodbarrier.org/

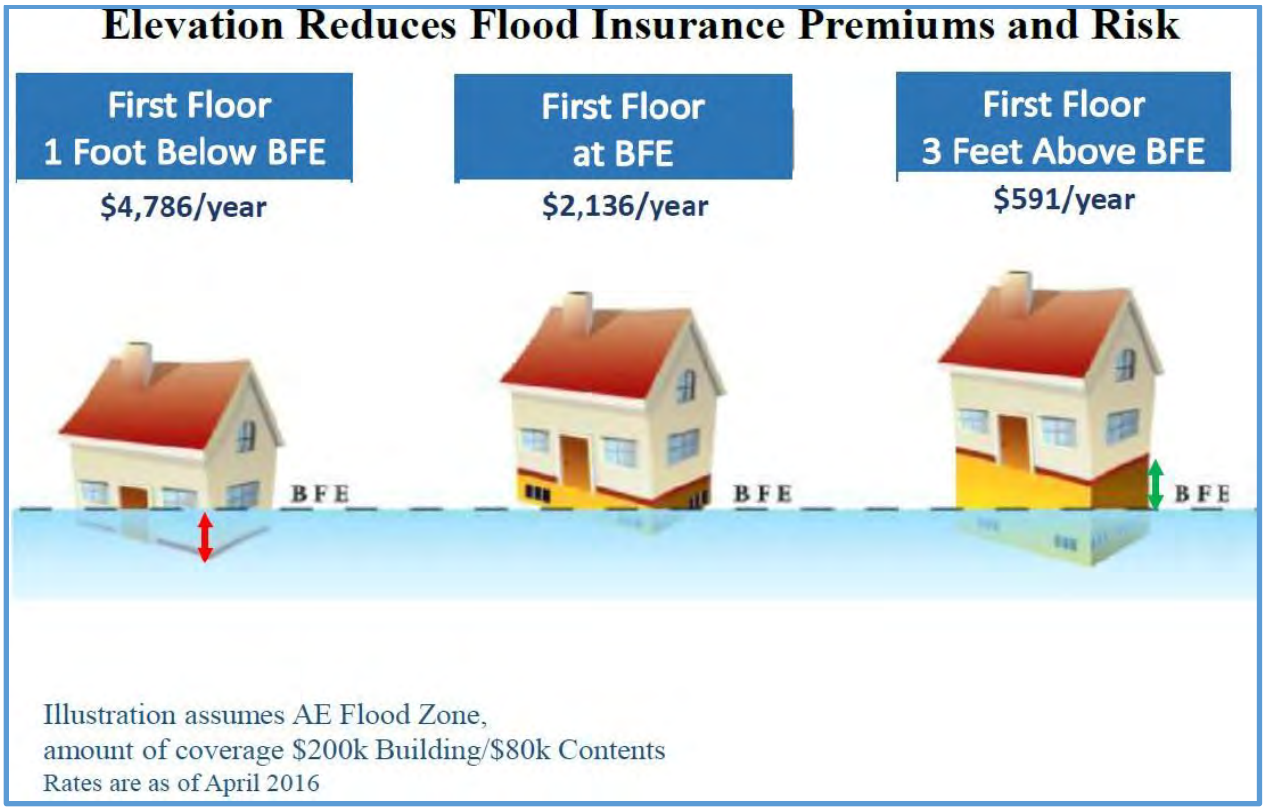

Figure 10. Example Flood Insurance Premium Reduction through Elevation.

8.0 Assessment Conclusions

Sprague, Washington, is at substantial risk of flooding from Negro Creek, which flows through the middle of the community in a channel and underground in a pipe. There are numerous residential and nonresidential structures located within the 1% ACE floodplain. The USACE – Walla Walla District collaborated with the Washington Silver Jackets team and the City of Sprague on a nonstructural assessment sponsored through the USACE National Flood Risk Program, Floodplain Management Services, accessed through the national Silver Jackets Program to identify potential NS measures on a reconnaissance level for all 94 of the structures identified within the floodplain, as well as several properties adjacent to Sprague Lake. This assessment recommends potential NS measures for each structure, suggests potential temporary measures that could be implemented throughout the community, and recommended some larger flood fight strategies for the community to consider.

In this reconnaissance-level assessment, the depth of flooding and areal extent were combined with structure attributes of the 94 structures to determine the most appropriate potential course of action for each structure. As an example, if the 1% ACE flood depth were no greater than a foot or two above the first floor elevation of a structure, there would be no need to consider acquisition or relocation of the structure, when dry flood proofing the structure may significantly decrease the flood risk.

Since flooding within the city could occur at any given time prior to the community as a whole, or owners/tenants individually, implementing permanent NS measures, this assessment also provides practical information for the implementation of temporary measures. Materials and equipment needs are described in order to provide the owner/tenant with enough background information to develop a

successful emergency flood response plan. Some recommendations for flood fight tactics were also presented.

Elevation appeared to be the most appropriate permanent NS measure for the majority of the residential structures assessed in this study. Dry flood proofing was the primary permanent NS measure identified for nonresidential structures.