

Memorandum

To: Programs, Projects and Operations Subcommittee
From: Lori Laster, Stormwater Management Engineer
Date: January 5, 2022
Re: Little Papio Inundation Mapping

The District has been in the process of updating FEMA Digital Flood Insurance Rate Maps (DFIRMs) for the Papillion Creek Watershed. Although DFIRMs allow users to see which areas could be affected by 100-year and 500-year floods they do not show the extent and depth of flood inundation that could occur based on forecasted water-level stage during a flooding event. To address this information gap, the United States Geological Survey (USGS) has developed the Flood Inundation Mapping Program (U.S. Geological Survey, 2012), (<https://fim.wim.usgs.gov/fim/>). The USGS FIM provides valuable flood-inundation maps and data to emergency responders, floodplain managers, the media, and the public—available via the Internet—on a continuous and real-time basis.

This work was completed for Big Papillion Creek in 2016 and is currently available for use. In 2019, the District worked through the US Army Corps of Engineers' Silver Jackets program to have the initial modeling completed to complete the same type of predictive inundation mapping on Little Papillion Creek. That modeling was completed at no cost to the District in 2021. In order to complete the mapping and make the tool available to the public, USGS has prepared the attached agreement. The estimated cost to complete the map development and publication is \$100,400. USGS will provide \$30,900 in matching funds and the District will be responsible for the remaining \$69,500.

Management recommends that the Subcommittee recommend to the Board that the General Manager be authorized to execute a contract with USGS to complete the Little Papio Flood Inundation Mapping with a total District cost of \$69,500 subject to changes deemed necessary by the General Manager and approval as to form by District Legal Counsel.

FLOOD INUNDATION MAPPING FOR LITTLE PAPILLION CREEK IN OMAHA, NEBRASKA

PAPIO-MISSOURI NATURAL RESOURCES DISTRICT

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BACKGROUND AND PROBLEM

The Papillion Creek watershed is one of the most flood-prone areas in the State of Nebraska. It is also one of the most heavily populated. Development and urbanization of the western part of the watershed contributes to increases in the volume of stormwater runoff and alters the timing of runoff events. This, in turn, amplifies the severity and occurrence of flooding. (Papio-Missouri River Natural Resources District, undated)

The Papio-Missouri River Natural Resources District (NRD) is in the process of completing the hydrologic and hydraulic analyses for the Papillion Creek watershed, and Digital Flood Insurance Rate Maps (DFIRMs) will be drafted thereafter. Although DFIRMs allow users to see which areas could be affected by floods with a 1% and 0.2% chance of being equaled or exceeded in any given year, they do not show the extent and depth of flood inundation that could occur based on forecasted water-level stage during a flooding event. To address this information gap, the United States Geological Survey (USGS) has developed the Flood Inundation Mapping Program (U.S. Geological Survey, 2012), so that the extent and depth of flooding based on forecasted or actual water-level stage can be displayed in real time at the USGS Flood Inundation Mapper (FIM) Web site (<https://fim.wim.usgs.gov/fim/>). The USGS FIM provides valuable flood-inundation maps and data to emergency responders, floodplain managers, the media, and the public—available via the Internet—on a continuous and real-time basis.

OBJECTIVES AND SCOPE

The objective of this proposal is to create a flood-inundation-map library for the Little Papillion Creek (fig. 1) that will be linked to real-time water-level stage information at existing USGS streamgage locations and display estimated flood-inundation areas and flood depths associated with selected water-level stages. These maps will be served to the public on the USGS FIM Web site: <https://fim.wim.usgs.gov/fim/>. The maps will be created for 2 reaches of the Little Papillion Creek: Reach 1 one will start at the Little Papillion Creek near Irvington, Nebraska streamgage (station number 06610750) and end upstream of the confluence of the Little Papillion Creek and Cole Creek (fig. 1); Reach 2 will start just downstream of the Little Papillion Creek and Cole Creek confluence and end near the Cornhusker Road bridge that crosses the Big Papillion Creek (fig. 1). Reach 2 will include the confluence of Little Papillion Creek and Big Papillion Creek. There are multiple flow scenarios that could occur in Reach 2 that could result in numerous flood inundation conditions. To accurately map the possible flow/stage scenarios Reach 2 will use stage information from both the Little Papillion Creek at Ak-Sar-Ben (station number 06610765) and the Big Papillion Creek at Q Street (station number 06610770) streamgages in a dual slider configuration similar to what is show in figure 2. At both reaches, flood-inundations maps will be created at one-foot intervals for stages from approximately bankfull to the “major flood” stage category as defined by the National Weather Service at the streamgages.

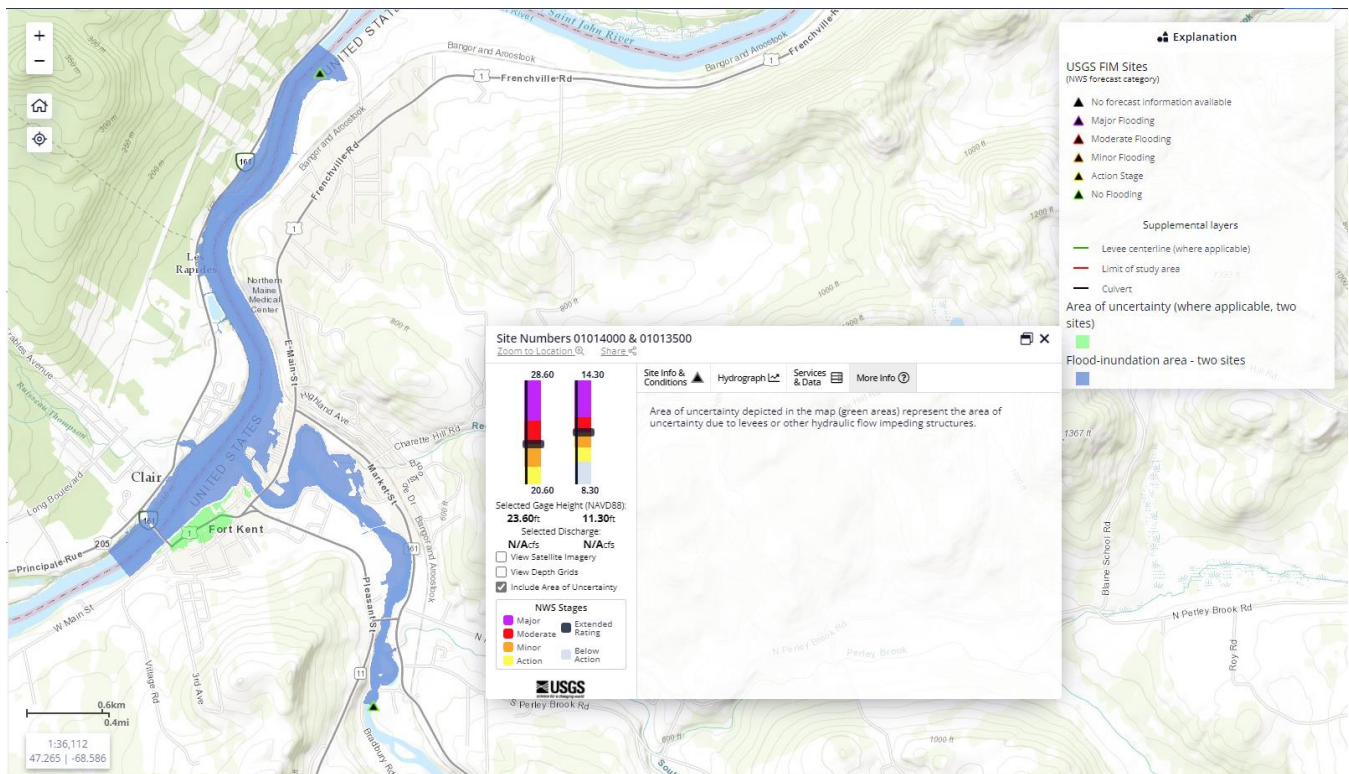


Figure 2. Example of a dual gage slider on the USGS Flood inundation mapping website

RELEVANCE AND BENEFITS

The proposed work is consistent with the USGS 21st-Century Science Strategy 2020-2030 (Circular 1476) in addressing vulnerability to natural hazards and delivering actionable intelligence. Flood-inundation-map libraries provide the NRD, city, floodplain managers, emergency responders, and the public with a valuable tool to protect life and property. Flood-inundation mapping converts a point measurement of stage-discharge at a streamgage and expands it to an aerial map that communicates the flood risk to a wide area. The maps will provide city and emergency responders with information to better coordinate in times of flooding (anticipation of road closures, evacuation of areas, etc.) to better protect life and property. The maps also provide the community a flood-risk awareness and education tool to better inform the public of flood risks that exist outside of the traditional DFIRMs. Finally, the maps will provide the NRD and city a tool to help in future flood planning and risk mitigation.

APPROACH

The USGS is proposing to develop flood-inundation-map libraries for flood stages ranging from approximately bankfull to the “major flood” stage category as defined by the National Weather Service at the streamgage in one-foot increments. The flood-map library will be posted to the USGS [FIM Web site](#) (fig. 2), which displays extent and depth of flooding based on actual water-level stage in real time. The USGS will perform the work in 5 steps: 1) compile necessary data, 2) hydraulic modeling, 3) flood-layer development, 4) posting to the FIM Web site, and 5) documentation. The steps are described in more detail below.

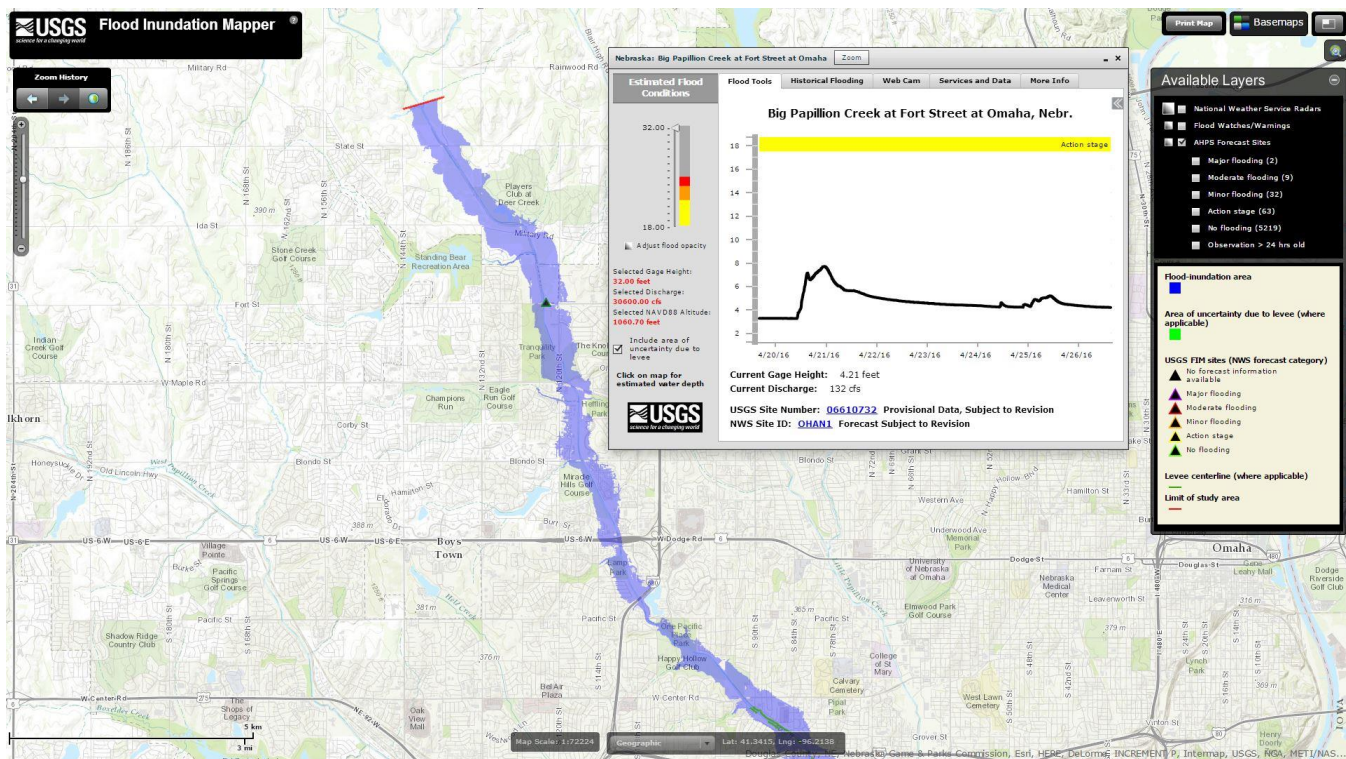


Figure 3. Example displaying flood inundation maps on the FIM Web site.

1. **Data Compilation.** Hydrographic and topographic datasets needed for the project will have vertical datum of North American Vertical Datum of 1988 (NAVD 88) and a horizontal datum of North American Datum of 1983 (NAD 83). VERTCON software will be used to convert datasets of other datums to NAVD 88. Light detection and ranging (LiDAR) collected in 2016 for the NE Nebraska Urban Area Lidar project will be used for the elevation base source for model development and flood-map creation. Hydrographic datasets will consist of streamgage datum elevation, historic flood-peak information, streamgage rating curve, high-water mark data, historic flood profiles, FEMA flood insurance study (FIS) materials, and existing hydraulic and hydrologic models.
2. **Hydraulic Modeling.** Water-surface profiles for the flood-inundation-map library will be created using a hydraulic stream model. For Reach 1 (fig. 1), it will be appropriate to use the steady-state modeling routing in HEC-RAS, however for Reach 2 the unsteady and or 2D routines of HEC-RAS version 5.0 will be used because of the complicated hydraulics at the confluence and the levees in the downstream portion of the reach. The models that were developed for the recent Silver Jackets hydraulic study will be modified to estimate the water-surface profiles for the flood-inundation-map library. Streamflow input will correspond to flows published for the most current rating curve from the collocated streamgage. The downstream water-surface elevation will be determined by high-water-mark data, historic profile data, and/or specifying an energy slope that will be used to determine normal depth. The USGS will calibrate the models to water-level stage data at the USGS Little Papillion Creek near Irvington, Nebraska (station number 06610750), Little Papillion Creek at Ak-Sar-Ben (station number 06610765), and the Big Papillion Creek at Q Street (station number 06610770), as well as other available flood peak information for the reach. Manning's N roughness coefficient and other hydrologic parameters will be adjusted as needed.
3. **Flood-Layer Development.** The water-surface profiles developed by the hydraulic modeling for each stage will be used to create a series of water-surface GRIDS (ESRI raster format). Using GIS, the

ground-surface DEM will be subtracted from the water-surface GRID; the resulting layer will be a depth GRID with the positive values indicating flooded areas. The resulting inundation depth GRID (positive values only) will then be exported as a polygon layer, and polygons not connected to the main reach will be deleted. This process will be repeated for each modeled stage.

4. Posting to the USGS Flood Inundation Mapper. Each provisional map library, hydraulic models, and supporting documentation will be reviewed by a team consisting of the following: two USGS technical reviewers and NRD personnel. Once approved the maps will be made available to the public on the USGS FIM Web site: <http://wimcloud.usgs.gov/apps/FIM/FloodInundationMapper.html>.
5. Documentation. The USGS will document steps necessary to produce the maps in an online Scientific Investigations Report (SIR). GIS layers will be published as a data release on USGS ScienceBase with appropriate metadata. The report and metadata will be written, reviewed, and published according to USGS publications approval standards. The models and associated data will also be archived according to the USGS policies.

QUALITY ASSURANCE PLAN

The stream stage and discharge data used in this study will follow the procedures in the “Surface-Water Quality-Assurance Plan for the U.S. Geological Survey, Nebraska Water Science Center” (U.S. Geological Survey, 2013). The production of the flood inundation map library will follow the procedures detailed in the USGS Office of Surface Water Technical Memorandum 2015.03 USGS Flood-Inundation Map Development and Documentation Standards (U.S. Geological Survey, 2015).

PRODUCTS

The product of the study is an online USGS Scientific Investigations Report, GIS inundation area polygon layers and depth rasters as a data release on USGS ScienceBase, as well as posting of the map libraries to the FIM Web site.

PROJECT COST

Activity	Cost	Estimated Hours
1. Project Coordination/Administration	12500.00	100.00
2. Hydraulic Modeling (1D and 2D)	0.00	0.00
3. Flood Layer Development	53400.00	340.00
4. Publication	34500.00	200.00
Total	100400.00	640.00
PMRNRD	69500.00	--
USGS Cooperative Matching Funds	30900.00	--

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