

Prepared in cooperation with *Cooperating Agency(ies)*

Flood-Inundation Maps for the *XXX* *River* from *XXX* to *XXX*, *STATE, YEAR*

By ***AUTHOR(S)***

***Purpose of this Scientific Investigations Map template***

*This template provides guidance for [SIM report series] documentation of USGS flood-warning and flood-inundation studies that are intended to be used for the development of a National Weather Service (NWS) Advanced Hydrologic Prediction Service’s forecast site.*

*Technical details not needed for general use of the map libraries should be documented separately in a “Technical Summary Notebook” that can accompany the data delivered to colleague reviewers, the NWS, or other interested parties. This document is not intended to be followed word for word—if models, techniques, and conditions differ significantly, one should revise the documentation as necessary and flag those sections for SPN editors so they can pay close attention to those changes during their reviews. Otherwise, the organization and wording used in this report has been approved by SPN to expedite review and processing. Although ANY part can be revised as needed, the more obvious decision points have been* ***italicized and bolded*** *in* ***blue*** *for consideration by the author.*

*Pamphlet to accompany*

Scientific Investigations Map ***XXXX***

U.S. Department of the Interior

U.S. Geological Survey

U.S. Department of the Interior

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# Acknowledgments

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1. ***XX*** feet

2. ***XX*** feet

3. ***XX*** feet

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5. ***XX*** feet

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Conversion Factors

Inch/Pound to SI

|  |  |  |
| --- | --- | --- |
| Multiply | By | To obtain |
| Length |
| inch (in) | 25.4 | millimeter (mm) |
| foot (ft) | 0.3048 | meter (m) |
| mile (mi) | 1.609 | kilometer (km) |
| Area |
| square foot (ft2) | 0.0929 | square meter (m2) |
| square mile (mi2) | 2.590 | square kilometer (km2) |
| Flow rate |
| cubic foot per second (ft3/s) | 0.02832 | cubic meter per second (m3/s) |
| Hydraulic gradient |
| foot per mile (ft/mi) | 0.1894 | meter per kilometer (m/km) |
| Vertical coordinate information is referenced to either (1) stage, the height above an arbitrary datum established at a streamgage, or (2) elevation, the height above North American Vertical Datum of 1988 (NAVD 88).Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). |

Flood-Inundation Maps for the *XXX* *River* from *XXX* to *XXX*, *STATE, YEAR*

By ***Author(s)***

# Abstract

Digital flood-inundation maps for a ***XX***-mile reach of the ***XXX*** ***River*** from ***POINTA*** to ***POINTB,*** ***STATE***, were created by the U.S. Geological Survey (USGS) in cooperation with the ***COOPERATOR***. The inundation maps, which can be accessed through the USGS Flood Inundation Mapping Science Web site at <http://water.usgs.gov/osw/flood_inundation/>*,* depict estimates of the areal extent and depth of flooding corresponding to selected water levels (stages) at the USGS streamgage at ***STATION*** ***NAME*** (sta. no. ***XX***-***XXXXXX***). Current conditions for estimating near-real-time areas of inundation by use of USGS streamgage information may be obtained on the Internet at <http://waterdata.usgs.gov/>. In addition, the information has been provided to the National Weather Service (NWS) for incorporation into their Advanced Hydrologic Prediction Service (AHPS) flood warning system ([http:/water.weather.gov/ahps/](http://water.weather.gov/ahps/)). The NWS forecasts flood hydrographs at many places that are often colocated with USGS streamgages. NWS-forecasted peak-stage information may be used in conjunction with the maps developed in this study to show predicted areas of flood inundation.

In this study, flood profiles were computed for the stream reach by means of a one-dimensional step-backwater model. The model was calibrated by using the most current stage-discharge relations at the ***STATION NAME*** gage ***and documented high-water marks from recent floods (if available)***. The hydraulic model was then used to determine ***XX*** water-surface profiles for flood stages at ***XX***-foot intervals referenced to the streamgage datum and ranging from bankfull to approximately the highest recorded water level at the streamgage. The simulated water-surface profiles were then combined with a geographic information system (GIS) digital elevation model (DEM, derived from ***Light Detection and Ranging (LiDAR)*** data having a ***X.X***-foot vertical and ***XX***-foot horizontal resolution) in order to delineate the area flooded at each water level.

The availability of these maps along with Internet information regarding current stage from USGS streamgages and forecasted stream stages from the NWS provide emergency management personnel and residents with information that is critical for flood response activities such as evacuations and road closures as well as for postflood recovery efforts.

# Introduction

The City of ***XXX*** is a [***large/medium/small***] urban community with an estimated population of ***XXX*** (U.S. Census Bureau, ***XXXX***). ***CITYNAME*** has experienced severe flooding numerous times, most notably in ***YEAR1***, ***YEAR2***, and ***YEAR3***. Damage costs [***adjusted/not adjusted***] for inflation within ***CITYNAME*** for these floods were reported to be $***XXX,XXX*** (***SOURCE1***), $***XXX,XXX*** (***SOURCE2***), and $***XXX,XXX*** (***SOURCE3***) for each year, respectively. The majority of flood damages have occurred along the ***XXX*** ***River*** and several tributaries (***TRIB1***, ***TRIB2***, ***TRIB3***), all of which flow through the city. Flood plains within ***CITYNAME*** are [***moderately to highly***] developed and contain a mix of residential and commercial structures.

Prior to this study, ***CITYNAME*** officials relied on several information sources, all of which are available on the Internet, to make decisions on how to best alert the public and mitigate flood damages. One source is the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) for ***CITYNAME*** dated ***DATE***, ***YEAR*** (Federal Emergency Management Agency, ***YEAR***). A second source of information is USGS streamgage ***STATION*** ***NAME*** (sta. no. ***XX***-***XXXXXX***), from which current or historical water levels (stage) can be obtained. A third source is the National Weather Service’s forecast of peak stage at the ***USGS/U.S. Army Corps of Engineers (USACE)*** gage through the AHPS site. Although USGS current stage and NWS forecast stage information is particularly useful for residents in the immediate vicinity of a streamgage, it is of limited use to residents farther upstream or downstream because the water-surface elevation is not constant along the entire stream channel. Also, FEMA and State emergency management mitigation teams or property owners typically lack information related to how deep the water is at locations other than near USGS streamgage or NWS flood-forecast points.

## Purpose and Scope

The purpose of this report is to describe the development of a series of estimated flood-inundation maps for the ***XXX River*** near ***CITYNAME***, ***STATE***. The maps and other useful flood information are available on the USGS Flood Inundation Mapping Science Web site and the NWS Advanced Hydrologic Prediction Service Web site. Internet users can select estimated inundation maps that correspond to (1) current stages at the USGS streamgage, (2) the NWS forecasted peak stage, or (3) other desired stream stages.

The scope of the study was limited to the ***XXX*** ***River*** between ***POINTA*** and ***POINTB*** (fig. 1). Tasks specific to development of the maps were (1) [***installation***/***upgrade***/***reestablishment***] of ***XX*** streamgages on the ***XXX*** ***River*** (table 1), (2) collection of topographic data and geometric data (for structures/bridges) throughout the study reach, (3) determination of energy-loss factors (roughness coefficients) in the stream channel and flood plain and compilation of steady-flow data (***or use/verification of similar flow-distribution data from previous studies***), (4) computation of water-surface profiles by use of the U.S. Army Corps of Engineers HEC–RAS computer program (U.S. Army Corps of Engineers, 2010), (5) production of estimated flood-inundation maps at various stream stages by use of the U.S. Army Corps of Engineer’s HEC–GeoRas computer program (U.S. Army Corps of Engineers, 2009) and a GIS, and (6) development of a Web interface that links to USGS real-time streamgage information and (or) NWS forecasted peak stage to facilitate the display of user-selected flood-inundation maps on the Internet.

1. Location of study reach for the ***XXX* *River*** and location of USGS streamgage and National Weather Service forecast sites.
2. USGS streamgage and miscellaneous site information for study basin, ***XXX*** ***River***, ***STATE***.

[mi2, square miles; ft, feet]

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Station name | Station number | Drainage area (mi2) | Latitude | Longitude | Period of record | Maximum recorded stage at gage (ft) and date |
| ***Blanchard River near Findlay*** | ***04189000*** | ***346*** | ***35°10′10″*** | ***80°10′10″*** | ***Nov. 1981 to current year*** | ***35.50,******Jan. 25, 1990*** |

Methods used are generally cited from previously published reports. If techniques varied significantly from previously documented methods because of local hydrologic conditions or availability of data, they are described in detail in this report. Maps were produced for water levels referenced to the stage at ***STATION NAME*** and ranging from approximately bankfull to the maximum observed water level at the streamgage.

## Study-Area Description

The ***XXX*** River is in [***southwest, northeast, etc.***] [***STATE***] in the [***XX*** ***physiographic*** ***province(s)*** or ***ecoregion(s)***]. The drainage area ranges from ***XXX*** mi2 at the ***STATION*** ***NAME*** gage to ***XXX*** mi2 at the [***upstream/downstream***] extent of the study reach. The headwaters originate in ***XXX*** County, and the stream flows generally [***DIRECTION***]ward before entering the city limits. ***XX*** major tributaries to the ***XXX*** ***River*** join the main stem as it flows through ***CITYNAME***. The basin terrain is generally (***flat***, ***steep***, or ***moderately*** ***hilly***). The study reach is approximately ***XX*** mi long and has an average top-of-bank channel width of about ***XX*** ft and an average channel slope of ***XX*** ft/mi. About ***XX*** percent of the land contiguous to the study reach is classified as urban or developed, ***XX*** percent as forest, and ***XX*** percent as cropland. The basin is still under development [***with*** ***new*** ***houses***, ***commercial*** ***businesses***, etc.], as evidenced by a population increase of ***XX*** percent from ***XX*** to ***XX*** between ***YEAR*** and ***YEAR [CITE SOURCE]***. The main channel within the study reach has ***XX*** major road crossings or other structures that lie within the channel or the adjacent flood plain.

## Previous Studies (*if applicable...if not, state none*)

The current FIS for ***CITY*** (Federal Emergency Management Agency, ***YEAR***) was completed by [***BUSINESS***/***AGENCY***] in ***YEAR***. That study provided information on the 1.0- and 0.2-percent annual exceedance probability water-surface profiles and associated flood-plain maps for the ***XXX*** ***River***, ***TRIB1***, ***TRIB2***, and ***TRIB3***. Estimates of the peak discharges for the 1.0-percent annual exceedance probability flood along the ***XXX*** ***River,*** as listed in table 2 below for the study reach, are described by FEMA (***YEAR***).

1. 1.0-percent annual exceedance probability peak-discharge estimates, drainage areas, and percentage of total discharge for selected locations on the ***XXX*** ***River*** (from Federal Emergency Management Agency, ***YEAR***).

[mi2, square miles; ft3/s, cubic feet per second]

|  |  |  |  |
| --- | --- | --- | --- |
| Location on *XXX* River | Drainage area(mi2) | Discharge estimate (ft3/s) | Percentage of total discharge |
| Upstream from ***County Road XX*** | ***300*** | ***10,000*** | ***100*** |
| Upstream from ***TRIB1*** | ***275*** | ***8,000*** | ***80*** |
| Upstream from ***TRIB2*** | ***250*** | ***7,000*** | ***70*** |

# Constructing Water-Surface Profiles

The water-surface profiles used to produce the ***XX*** flood-inundation maps in this study were computed by using HEC–RAS, version 4.1.0 (U.S. Army Corps of Engineers, 2010). HEC–RAS is a one-dimensional step-backwater model for simulation of water-surface profiles with gradually varied, steady-state (or unsteady-state) flow computation options. The HEC–RAS analysis for this study was done by using the steady-state flow computation option.

## Hydrologic and Steady-Flow Data

The study-area hydrologic network consists of ***XX*** streamgages (fig. 1; table 1). ***XX*** of the gages already were in operation, ***XX*** gages were upgraded with continuous recorders, and ***XX*** gages were reactivated for this project. Water level (stage) is measured continuously at all of the sites, and continuous records of streamflow are computed at ***XX*** of the ***XX*** sites. All water-surface elevations are referenced to the North American Vertical Datum of 1988 (NAVD 88). The gages are equipped with satellite radio transmitters that allow data to be transmitted routinely on the Internet within an hour of collection. ***XX*** of the sites also are equipped with recording tipping-bucket rain gages. ***In addition, some discrete discharge measurements were made at sites for which long-term streamflow records were unavailable (table 1). These measurements were made during periods of moderate to high flow and were used for model calibration.*** Longitudinal water-surface profiles from high-water marks along the main channel were documented following floods in ***YEAR1***, ***YEAR2***, and ***YEAR3*** and also were used for model calibration (***SOURCE***).

Steady-flow data consisted of flow regime, boundary conditions (either known stage associated with a discharge measurement, critical depth, normal depth, or streamgage rating-curve value), and peak-discharge information. The steady-flow data for the study reach were obtained from previous studies and field measurements of streamflow at the ***XXX*** River streamgage made at ***STATION*** ***NAME*** or at miscellaneous sites. At gaged sites, all computations based on discharge values with known stages from actual streamflow measurements or stage-discharge relations were used. ***[If applicable you might mention if the stage and discharges from a previous FIS were used, citing the source]***. For ungaged sites, normal-depth boundary conditions were assumed by using a friction slope estimated from the average streambed slope through the reach unless miscellaneous discharge measurements referenced to a known datum were available.

## Topographic/Bathymetric Data

 ***[Note: If data from an existing FIS study were used for modeling, you will need to cite the study here. Additionally, you may need to state that the cross sections were spot-checked during this investigation with surveyed field data. All roadway crossings were verified by field survey, and structures that were added or modified since the latest FIS were surveyed or resurveyed, respectively, as needed for inclusion in the model].*** Channel cross sections were developed from USGS field surveys that were conducted in ***MONTH YEAR***; these cross sections provide detailed channel-elevation data below the water surface and were collected by using hydroacoustic instrumentation to measure depth and Differential Global Positioning System (DGPS) instrumentation to determine horizontal position. LiDAR data with horizontal resolution of ***XX*** ft were used to provide digital elevation data for the portions of the cross sections that were above the water surface at the time of the surveys. The LiDAR data were collected in ***YEAR*** by the ***AGENCY***; postprocessing of these data was completed by ***WHOM*** in ***MONTH*** ***YEAR***.

Various manmade drainage structures (bridges, culverts, roadway embankments, levees, and dams) in and along the stream affect or have the potential to affect water-surface elevations during floods along the stream. To properly account for these features in the model, structural dimensions for ***XX*** bridges [***XX culverts, XX dams, and so forth***] were measured and surveyed in the field concurrently with the stream-channel surveys. A detailed description of the methods used to acquire and process the topographic and bathymetric data can be found in Bales and others (2007).

## Energy-Loss Factors

Field observations and high-resolution aerial photographs were used to select initial (precalibration) Manning’s roughness coefficients (“*n*” values) for energy-loss (friction-loss) calculations. The final Manning’s *n* values used ranged from 0.***XXX*** to 0.***XXX*** for the main channel and 0.***XXX*** to 0.***XXX*** for the overbank areas modeled in this analysis.

## Model Calibration and Performance

The hydraulic model was calibrated to the most current stage-discharge relation at the ***XXX*** ***River*** streamgage and to high-water marks from the floods in ***YEAR1***, ***YEAR2***, and ***YEAR3***. The estimated peak discharge for the ***YEAR1*** flood was ***XX*** ft3/s at an estimated stage of about ***XX*** ft at the gage. The measured peak discharges (and stages) for the ***YEAR2*** and ***YEAR3*** floods were ***XX*** ft3/s (***XX*** ft) and ***XX*** ft3/s (***XX*** ft), respectively. Model calibration was accomplished by adjusting Manning’s *n* values and, in some cases, changing the channel cross section or slope until the results of the hydraulic computations closely agreed with the known flood-discharge and stage values. Differences between measured and simulated water levels for measured or rated flows at USGS streamgage ***XX-XXXXXX*** were equal to or less than ***XX*** ft. Differences between measured and simulated water levels for models calibrated to high-water marks in the study reach were less than ***XX*** ft (table 3). The results demonstrate that the model is capable of simulating accurate water levels over a wide range of flows in the basin. Details on techniques used in model development and calibration can be found in Bales and others (2007).

1. Comparison of hydraulic-model output and surveyed high-water mark elevations from the flood of ***DATE***, ***YEAR***, ***XXX*** ***River***, ***STATE***.

[ft, feet]

|  |  |  |  |
| --- | --- | --- | --- |
| River station(mi) | High-water mark elevation(ft) | Model water-surface elevation (ft) | Elevation difference(ft) |
| ***50.1*** | USGS Streamgage ***XX-XXXXXX*** |
| ***51.0*** | ***1,000.00*** | ***1,000.10*** | ***+0.10*** |
| ***52.0*** | ***1,1001.00*** | ***1,000.80*** | ***-0.20*** |
| ***53.0*** | ***County Road XX*** |
| ***55.0*** | ***1,010.00*** | ***1,010.00*** | ***0.00*** |

## Development of Water-Surface Profiles

Profiles were developed for a total of ***XX*** stages at ***XX***-ft intervals between ***XX*** ft and ***XX*** ft as referenced to the ***STATION*** ***NAME*** (sta. no. ***XX***-***XXXXXX***). Discharges corresponding to the various stages were obtained from the most current stage-discharge relation (rating no. ***XX***) at the ***XXX*** ***River*** gage.

Discharges for all profiles (table 4) at locations [***upstream/downstream***] of station no. ***XX***-***XXXXXX*** on the ***XXX*** ***River*** were selected with the assumption that the percentage contribution to the total flow was the same as that assumed for the ***YEAR*** FIS (table 2). ***[Note: Other scenarios representing alternative flow or backwater conditions may be necessary. If no FIS was available, you may need to describe the hydrology assumed in your model; that is, the relative contributions of intervening tributaries within your study reach.]***

1. Stages and water-surface elevations for the streamgage on the XXXX River (XXXXXXXX), with corresponding discharge estimates at selected locations along the ***XXX*** ***River***, ***STATE,*** for selected simulated water-surface profiles.

[NAVD 88, North American Vertical Datum of 1988. Sheet numbers correspond to the separate flood-inundation maps available online at [**http://URL**](http://URL) ***for the SIM*** ]

|  |  |
| --- | --- |
| Location | Stage, in feet above gage datum(elevation, in feet above NAVD 88)associated with the indicated discharge value, in cubic feet per second |
| *10.00**(750.00)* | *11.00**(751.00)* | *12.00**(752.00)* | *13.00**(753.00)* | *14.00**(754.00)* | *15.00**(755.00)* | *16.00**(756.00)* | *17.00**(757.00)* | *18.00**(758.00)* | *19.00**(759.00)* |
| ***Upstream from County Road XX*** | ***5,000*** | ***6,000*** | ***7,000*** | ***8,000*** | ***9,000*** | ***10,000*** | ***11,000*** | ***12,000*** | ***13,000*** | ***14,000*** |
| ***Upstream from TRIB1*** | ***4,000*** | ***4,800*** | ***5,600*** | ***6,400*** | ***7,200*** | ***8,000*** | ***8,800*** | ***9,600*** | ***10,400*** | ***11,200*** |
| ***Upstream from TRIB2*** | ***3,500*** | ***4,200*** | ***4,900*** | ***5,600*** | ***6,300*** | ***7,000*** | ***7,700*** | ***8,400*** | ***9,100*** | ***10,800*** |
| ***Sheet no.*** | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***8*** | ***9*** | ***10*** |

# Inundation Mapping

Flood-inundation maps were created for ***XX*** of the USGS sites, ***XX*** of which have been designated as NWS flood-forecast points (as of ***YEAR***) [***Inundation maps were not developed for STATION NAME, where flooding can result from hurricane storm surge***]. The maps were created in a GIS by combining the water-surface profiles and DEM data. The DEM data were derived from ***XX***-ft horizontal resolution LiDAR data with a vertical accuracy of ***X***.***X*** ft obtained from ***AGENCY*** (***CITE SOURCE***). Estimated flood-inundation boundaries for each simulated profile were developed with HEC–GeoRAS software (U.S. Army Corps of Engineers, 2009). HEC–GeoRAS is a set of procedures, tools, and utilities for processing geospatial data in ArcGIS by using a graphical user interface (Whitehead and Ostheimer, 2009). The interface allows the preparation of geometric data for import into HEC–RAS and processes simulation results exported from HEC–RAS (U.S. Army Corps of Engineers, 2010). USGS personnel then modified the HEC–GeoRAS results to ensure a hydraulically reasonable transition of the boundary between modeled cross sections relative to the contour data for the land surface (Whitehead and Ostheimer, 2009). The resulting inundation maps have a vertical accuracy of about ***X.X*** ft. The maps show estimated flood-inundated areas overlaid on high-resolution, georeferenced aerial photographs of the study area for each of the water-surface profiles that were generated by the hydraulic model.

## *XXX River, STATE* Flood-Inundation Maps on the Internet

The flood-inundation maps and current study documentation are available online at the USGS Publications Warehouse ([http://pubs.usgs.gov/sim**/YEAR/XXXX**](http://pubs.usgs.gov/sim/YEAR/XXXX)). Also, a Flood Inundation Mapping Science Web site has been established at <http://water.usgs.gov/osw/flood_inundation/>to provide a portal for USGS flood-inundation study information to the public [.](http://water.usgs.gov/osw/flood_inundation/.) That Web portal has a link (<http://wim.usgs.gov/FIMI/FloodInundationMapper.html>) to interactive online map libraries that can be downloaded in several commonly used electronic file formats. At the map library site, each stream reach displayed contains further links to NWISWeb graphs of the current stage and streamflow at USGS streamgage ***XXXX*** to which the inundation maps are referenced. A link also is provided to the NWS AHPS site ([http:/water.weather.gov/ahps/](http://water.weather.gov/ahps/)) so that the user can obtain applicable information on forecasted peak stage. The estimated flood-inundation maps are displayed in sufficient detail to note the extent of flooding with respect to individual structures so that preparations for flooding and decisions for emergency response can be performed efficiently. Roadways and bridges were closely reviewed and are shown as shaded (inundated and likely impassable) or not shaded (dry and passable) to facilitate emergency planning and use. However, buildings that are shaded do not reflect inundation but denote that bare-earth surfaces in the vicinity of the buildings are inundated. When the water depth (as indicated in the Web Mapping Application by holding the cursor over an inundated area) adjacent to the building of interest exceeds that building’s height, the structure can be considered fully submerged.

## Disclaimer for Flood-Inundation Maps

Inundated areas shown should not be used for navigation, regulatory, permitting, or other legal purposes. The USGS provides these maps “as-is” for a quick reference, emergency planning tool but assumes no legal liability or responsibility resulting from the use of this information.

## Uncertainties and Limitations Regarding Use of Flood-Inundation Maps

Although the flood-inundation maps represent the boundaries of inundated areas with a distinct line, some uncertainty is associated with these maps. The flood boundaries shown were estimated based on water stages and streamflows at selected USGS streamgages. Water-surface elevations along the stream reaches were estimated by steady-state hydraulic modeling, assuming unobstructed flow, and using streamflows and hydrologic conditions anticipated at the USGS streamgage(s). The hydraulic model reflects the land-cover characteristics and any bridge, dam, levee, or other hydraulic structures existing as of ***MONTH YEAR***. Unique meteorological factors (timing and distribution of precipitation) may cause actual streamflows along the modeled reach to vary from those assumed during a flood, which may lead to deviations in the water-surface elevations and inundation boundaries shown. Additional areas may be flooded due to unanticipated conditions such as: changes in the streambed elevation or roughness, backwater into major tributaries along a main stem river, or backwater from localized debris or ice jams. The accuracy of the floodwater extent portrayed on these maps will vary with the accuracy of the DEM used to simulate the land surface. Additional uncertainties and limitations pertinent to this study may be described elsewhere in this report.

If this series of flood-inundation maps will be used in conjunction with NWS river forecasts, the user should be aware of additional uncertainties that may be inherent or factored into NWS forecast procedures. The NWS uses forecast models to estimate the quantity and timing of water flowing through selected stream reaches in the United States. These forecast models (1) estimate the amount of runoff generated by precipitation and snowmelt, (2) simulate the movement of floodwater as it proceeds downstream, and (3) predict the flow and stage (and water-surface elevation) for the stream at a given location (AHPS forecast point) throughout the forecast period (every 6 hours and 3 to 5 days out in many locations). For more information on AHPS forecasts, please see: [http://water.weather.gov/ahps/pcpn\_and\_river\_forecasting.pdf.](http://water.weather.gov/ahps/pcpn_and_river_forecasting.pdf.%20)

# Summary

Estimated flood-inundation maps were developed in cooperation with the ***XXX*** for the ***XXX*** ***River*** between ***POINTA*** and ***POINTB***. These maps, in conjunction with the real-time stage data from the USGS streamgage at ***STATION*** ***NAME*** (sta. no. ***XX***-***XXXXXX***) and National Weather Service flood-stage forecasts, will help to guide the general public in taking individual safety precautions and will provide city officials with a tool to efficiently manage emergency flood operations and flood mitigation efforts.

The maps were developed by using the U.S. Army Corps of Engineers’ HEC–RAS and HEC–GeoRAS programs to compute water-surface profiles and to delineate estimated flood-inundation areas for selected stream stages. The maps show estimated (shaded) flood-inundation areas overlaid on high-resolution, georeferenced aerial photographs of the study area for stream stages between ***XX*** ft and ***XX*** ft at the ***XXX*** ***River*** streamgage. The maps are available at a USGS Web portal at **http://URL for *the SIM***. Interactive use of the maps by using the mouse cursor to click within the shaded areas can give users a general indication of depth of water at any point.

# References Cited

Bales, J.D., Wagner, C.R., Tighe, K.C., and Terziotti, Silvia, 2007, LiDAR-derived flood-inundation maps for real-time flood-mapping applications, Tar River Basin, North Carolina: U.S. Geological Survey Scientific Investigations Report 2007–5032, 42 p.

U.S. Army Corps of Engineers, Hydrologic Engineering Center, 2009, HEC–GeoRAS, GIS tools for support of HEC–RAS using ArcGIS—User’s manual, version 4.2 [variously paged].

U.S. Army Corps of Engineers, Hydrologic Engineering Center, 2010, HEC–RAS River Analysis System—Hydraulic reference manual, version 4.1 [variously paged].

U.S. Census Bureau, 20XX, State population datasets—Population, population change and estimated components of population change: April 1, 2000 to July 1, 2006 [***replace with actual info used***]

Whitehead, M.T., and Ostheimer, C.J., 2009, Development of a flood-warning system and flood-inundation mapping for the Blanchard River in Findlay, Ohio: U.S. Geological Survey Scientific Investigations Report 2008–5234, 9 p.

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