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Evaluation of Floodplain Modifications to Reduce the Effect of Floods Using a Two-Dimensional Hydrodynamic Model of the Flint River at Albany, Georgia

Scientific Investigations Report 2008–5223

U.S. Department of the Interior
U.S. Geological Survey

Cover. Oakridge Drive Bridge at Flint River, Albany, Georgia: (left) March 2005, (right) February 2003. Background, see figure 3.

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Conversion Factors

Multiply	By	To obtain
	Length	
inch	2.54	centimeter (cm)
inch	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	259.0	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
cubic foot (ft^3)	28.32	cubic decimeter (dm^3)
cubic foot (ft^3)	0.02832	cubic meter (m^3)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88)

Horizontal coordinate information is referenced to North American Datum of 1983 (NAD 83)

Altitude, as used in this report, refers to distance above the vertical datum.

Evaluation of Floodplain Modifications to Reduce the Effect of Floods Using a Two-Dimensional Hydrodynamic Model of the Flint River at Albany, Georgia

By Jonathan W. Musser

Abstract

Potential flow characteristics of future flooding along a 4.8-mile reach of the Flint River in Albany, Georgia, were simulated using recent digital-elevation-model data and the U.S. Geological Survey finite-element surface-water modeling system for two-dimensional flow in the horizontal plane (FESWMS-2DH). The model was run at four water-surface altitudes at the Flint River at Albany streamgage (02352500): 181.5-foot (ft) altitude with a flow of 61,100 cubic feet per second (ft^3/s), 184.5-ft altitude with a flow of 75,400 ft^3/s, 187.5-ft altitude with a flow of 91,700 ft^3/s, and 192.5-ft altitude with a flow of 123,000 ft^3/s. The model was run to measure changes in inundated areas and water-surface altitudes for eight scenarios of possible modifications to the 4.8-mile reach on the Flint River. The eight scenarios include removing a human-made peninsula located downstream from Oglethorpe Boulevard, increasing the opening under the Oakridge Drive bridge, adding culverts to the east Oakridge Drive bridge approach, adding culverts to the east and west Oakridge Drive bridge approaches, adding an overflow across the oxbow north of Oakridge Drive, making the overflow into a channel, removing the Oakridge Drive bridge, and adding a combination of an oxbow overflow and culverts on both Oakridge Drive bridge approaches. The modeled inundation and water-surface altitude changes were mapped for use in evaluating the river modifications. The most effective scenario at reducing inundated area was the combination scenario. At the 187.5-ft altitude, the inundated area decreased from 4.24 square miles to 4.00 square miles. The remove-peninsula scenario was the least effective with a reduction in inundated area of less than 0.01 square miles. In all scenarios, the inundated area reduction increased with water-surface altitude, peaking at the 187.5-ft altitude. The inundated area reduction then decreased at the gage altitude of 192.5 ft.

Introduction

The U.S. Geological Survey (USGS)—in cooperation with the City of Albany, and Dougherty County, Georgia—is conducting floodplain studies along the Flint River at Albany, Georgia (fig. 1). During 1994 and 1998, the City of Albany experienced two major floods. During July 1994, Tropical Storm Alberto caused record-breaking flooding in most of the Flint River Basin. The maximum flood flow in Albany was about 123,000 cubic feet per second (ft^3/s) at a water-surface altitude of about 192.5 feet (ft) at the Flint River at Albany streamgage (02352500) at the Norfolk Southern railroad bridge (fig. 2). The probable recurrence interval (RI) of the flood was estimated to be about 200–300 years (Stamey, 1996). The flood inundated a large part of Albany, caused widespread community infrastructure and property damage, affected public safety and health, and required the evacuation of about 75,000 people. Floodwaters at Albany remained above the 100-year flood stage, about a 187.5-ft water-surface altitude, for 7 days. The second major flood, during March 1998, resulted from a regional winter storm, which also caused substantial flooding at Albany and required the evacuation of about 14,000 people. This flood was estimated to have about a 70-year RI, about 86,100 ft^3/s flow, and a water-surface altitude of about 186.5 ft (Stamey and Hess, 1993).

The USGS developed a two-dimensional finite-element flood-inundation model (FESWMS-2DH) (Musser and Dyar, 2007) to determine areas of flooding based on river stage at the Flint River at Albany streamgage (02352500). Since development of the flood-inundation model, a number of possible modifications to the Flint River channel, floodplain, and bridges over the river have been considered by the City of Albany and Dougherty County. The USGS has modified the existing flood-inundation model to simulate these possible modifications and to determine the effect of these changes on depth of water and amount of inundated areas during flood events.

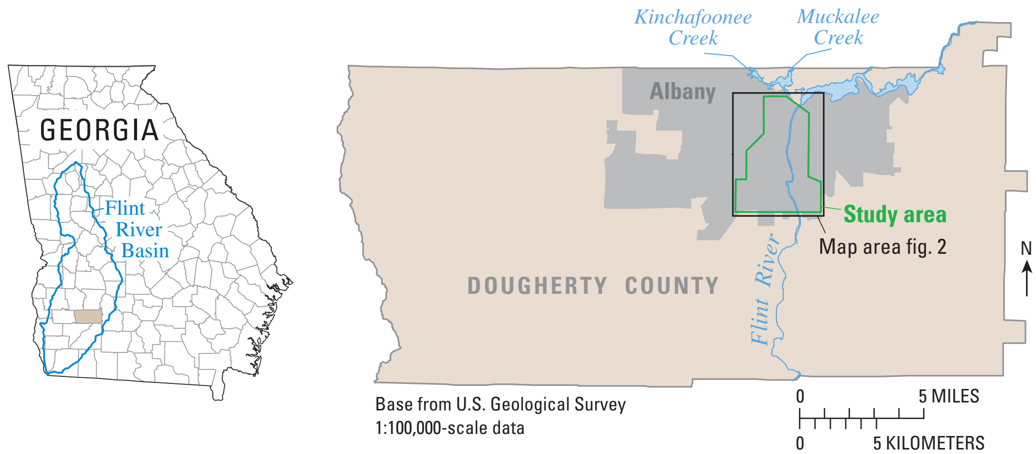


Figure 1. Location of two-dimensional model study area along the Flint River at Albany, Georgia.

Purpose and Scope

The purpose of this report is to describe the procedure and results of a study conducted to model possible floodplain modifications of the Flint River in Albany, Georgia. The scope of the work included field examination of the study area, and evaluation of multiple changes to the channel and floodplain geometry using FESWMS-2DH (U.S. Geological Survey, 2008) covering a 4.8-mile reach of the Flint River near Albany. The model was run for eight different scenarios.

- Remove peninsula—Removal of a human-made peninsula downstream from Oglethorpe Boulevard.
- Increase bridge opening—Lowering the Flint River channel bottom below the Oakridge Drive bridge.
- East culvert—Placing a set of box culverts through the east approach to the Oakridge Drive bridge.
- West and east culvert—Placing sets of box culverts through the west and east approaches to the Oakridge Drive bridge.
- Oxbow overflow—Creating a channel at bank level through the oxbow north of the Oakridge Drive bridge.
- Oxbow channel—Lowering the oxbow-overflow scenario channel bottom to the same altitude as the bottom of the Flint River channel.
- No bridge—Removing the Oakridge Drive bridge and its approaches.
- Combination west and east culvert and oxbow overflow—Combining west-and-east-culvert and oxbow-overflow scenarios.

Each model scenario was run at different flows corresponding to four water-surface altitudes at the Flint River at Albany streamgage (02352500).

- 181.5-ft altitude with a flow of 61,100 ft^3/s,
- 184.5-ft altitude with a flow of 75,400 ft^3/s
- 187.5-ft altitude with a flow of 91,700 ft^3/s
- 192.5-ft altitude with a flow of 123,000 ft^3/s.

Description of Study Area

In the Albany area, the natural state of the Flint River has been changed by construction of dams, a human-made peninsula, and numerous bridges (fig. 2). The northern part of the study area includes the Muckafoonee Diversion Dam and the Lake Chehaw Dam (a Georgia Power Company facility), which regulate the combined flows of the Flint River (drainage area of 4,190 square miles [mi^2]), Kinchafoonee Creek (drainage area of 658 mi^2), and Muckalee Creek (drainage area of 443 mi^2). The recreation area around Lake Chehaw is partially connected to downtown Albany by Riverwalk Park. In the 4.8-mile study reach, the Flint River flows under five highway and two railroad bridges. (The Liberty Expressway crossing is composed of two bridges.) In addition to the river community infrastructure, which includes dams, roadway embankments, and bridges, two natural features substantially affect flood flows in the study reach—a natural river constriction near the Broad Avenue and Oglethorpe Boulevard bridges and a river oxbow near Oakridge Drive. Both features constrain flood flow through Albany. River flow through the study area also is limited by a human-made peninsula approximately 500 ft downstream from the Oglethorpe Boulevard bridge. This peninsula is an area of the channel filled in from the east bank of the river and is visible at low flows. During high flows, the peninsula creates a large amount of turbulence.

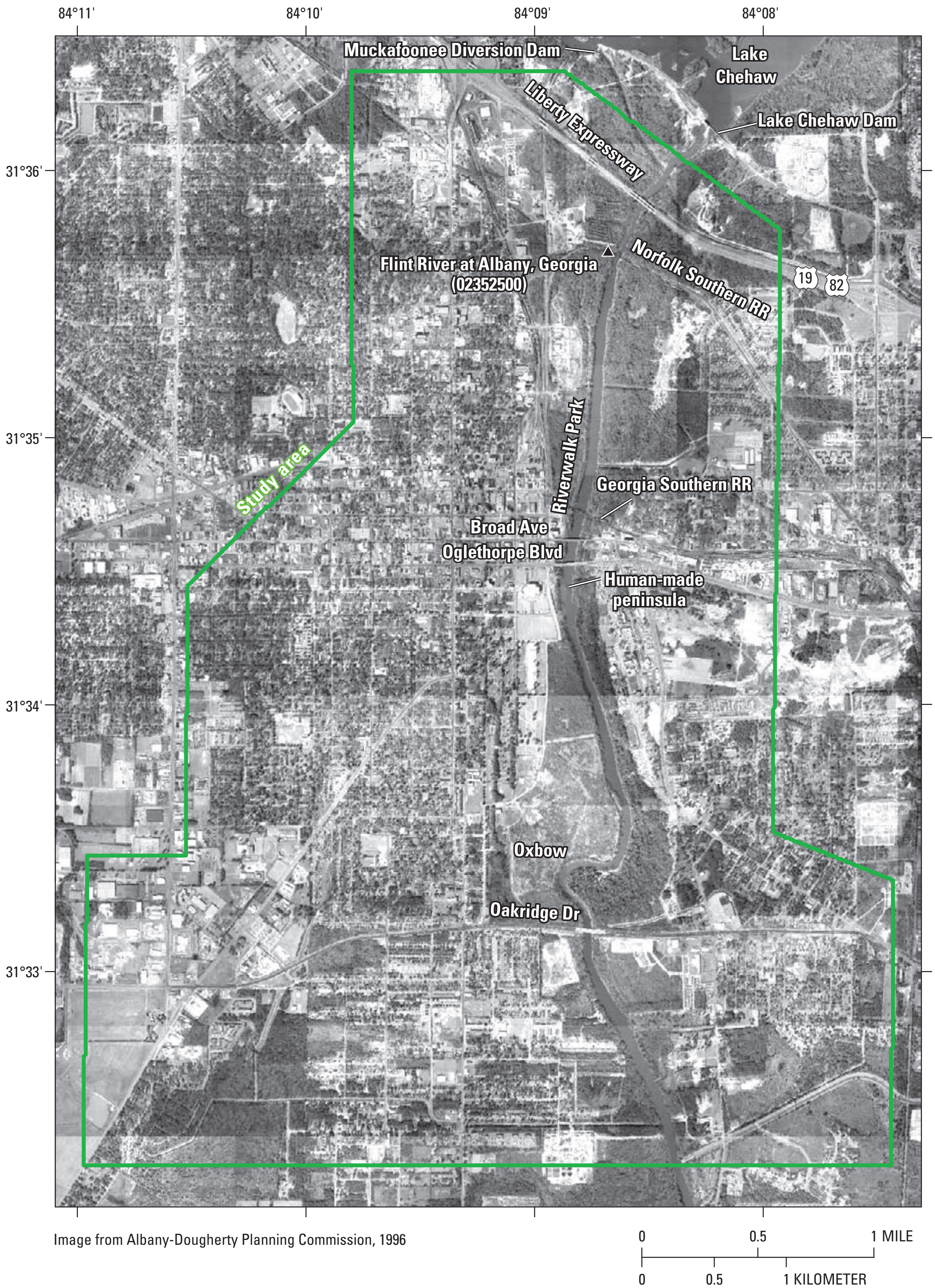


Figure 2. Flood-inundation study area showing all major Flint River crossings, Albany, Georgia. [RR, Railroad; Ave, Avenue; Blvd, Boulevard; Dr, Drive]

Previous Studies

A two-dimensional flood-inundation model of the Flint River at Albany, Georgia (Musser and Dyar, 2007) was calibrated and verified, and was used as the basis for the modeling scenarios in this study. Additional studies include a flood-insurance study for Dougherty County and incorporated areas (Federal Emergency Management Agency, 2001) and a U.S. Army Corps of Engineers (USACE) Section 205 detailed project report for the Flint River at Albany (U.S. Army Corps of Engineers, Mobile District, 2002), which included simulation of the Flint River at Albany. The USACE study involved usage of the one-dimensional step-backwater model, HEC-2, developed by the Hydrologic Engineering Center in Davis, California (U.S. Army Corps of Engineers, Hydraulic Engineering Center, 1990). The HEC-2 model was calibrated to high watermarks from the flooding caused by Tropical Storm Alberto during July 1994.

Method of Study

The study included review of previous studies, completion of model scenarios, and analysis of results. The study was performed in several stages:

1. Different scenarios were selected based on modifications proposed by the City of Albany and Dougherty County.
2. The finite-element surface-water inundation model was modified to reflect the different scenario changes using the Surface Water Modeling System (SMS) (Environmental Monitoring Systems, Inc., 2006) and FESWMS-2DH (U.S. Geological Survey, 2008).
3. Model scenarios were run to match the selected gage (02352500) altitudes of 181.5 ft with a flow of 61,100 ft^3/s, 184.5-ft with a flow of 75,400 ft^3/s, 187.5 ft with a flow of 91,700 ft^3/s, and 192.5 ft with a flow of 123,000 ft^3/s.
4. Model results were transferred to a geographic information system layer, and inundation areas and water depths were determined based on a 10-ft by 10-ft horizontal cell ground-surface altitude layer with a vertical resolution of less than 0.1 ft.
5. Changes in the extent of inundated area and altitude for each scenario were compared with results from the original model and mapped onto a base map containing roads and rivers.

Acknowledgments

The technical assistance of Randy Weathersby, Elizabeth Dean, and Tracy Hester, Albany and Dougherty County Planning and Development Services, is greatly appreciated.

Evaluation of Floodplain Modifications

The USGS two-dimensional, steady-state flow model (Musser and Dyar, 2007) was modified (fig. 3) to evaluate changes to flood characteristics of the Flint River in Albany. In each scenario, the model was adjusted and run to match the following water-surface altitudes at the Flint River at Albany streamgage (02352500; fig. 2): 181.5 ft (about the March 2005 flood altitude), 184.5 ft, 187.5 ft (about the 100-year flood altitude), and 192.5 ft (about the altitude of flooding from Tropical Storm Alberto). The details on the creation of the model and its results can be found in Musser and Dyar (2007).

Remove-Peninsula Scenario

The remove-peninsula scenario was simulated by removing the human-made peninsula located in the Flint River just south of the Oglethorpe Boulevard bridge (fig. 2). The altitude of the model's finite-element mesh in the river channel, at the location of the peninsula, was changed to effectively remove the peninsula.

This channel modification resulted in a decrease of less than 0.01 mi^2 in the amount of area inundated for all water-surface altitudes (table 1). The areas of inundation for this scenario are shown in Appendix A, figures A1–A4. A few cells along the edge of the inundated area changed between the original model and the remove-peninsula model. These changes do not constitute a significant change and are probably due to the mathematical precision of the model and data.

Appendix B, figures B1–B4, show the changes in water-surface altitude for the 4.8-mile reach for this scenario. The changes, which are a maximum of 0.1 ft, are not considered significant. Areas in figures B1–B4 showing a change of 0.1 ft in the water-surface altitude also can be explained based on mathematical precision of the model and data, and these changes should not be considered as significant.

Increase-Bridge-Opening Scenario

The increase-bridge-opening scenario simulated effects of increasing the opening under the Oakridge Drive bridge (fig. 2) by lowering the channel bottom 3 ft. This modification was suggested by the USACE in their Section 205 detailed project report for the Flint River at Albany (U.S. Army Corps of Engineers, Mobile District, 2002). The 3-ft altitude reduction of the channel bottom in the model was extended for approximately 300 ft upstream and downstream, as well as under the bridge.

This scenario showed a 0.01-mi^2 decrease in inundated area for the 181.5-ft and the 192.5-ft gage altitudes, a 0.03-mi^2 decrease for the 187.5-ft gage altitude, and a 0.07-mi^2 decrease for the 184.5-ft gage altitude (table 1; Appendix A, figs. A5–A8).

The changes in water-surface altitude for the reach for this scenario are shown in figures Appendix B, B5–B8. At all gage altitudes, areas upstream from the Oakridge Drive bridge showed a slight decrease in water-surface altitude. Most of these areas decreased by only 0.1 ft. Downstream from the Oakridge Drive bridge, areas showed a slight increase in water-surface altitude, primarily within 0.25 mile of the bridge. Most of these increases were only 0.1 ft.

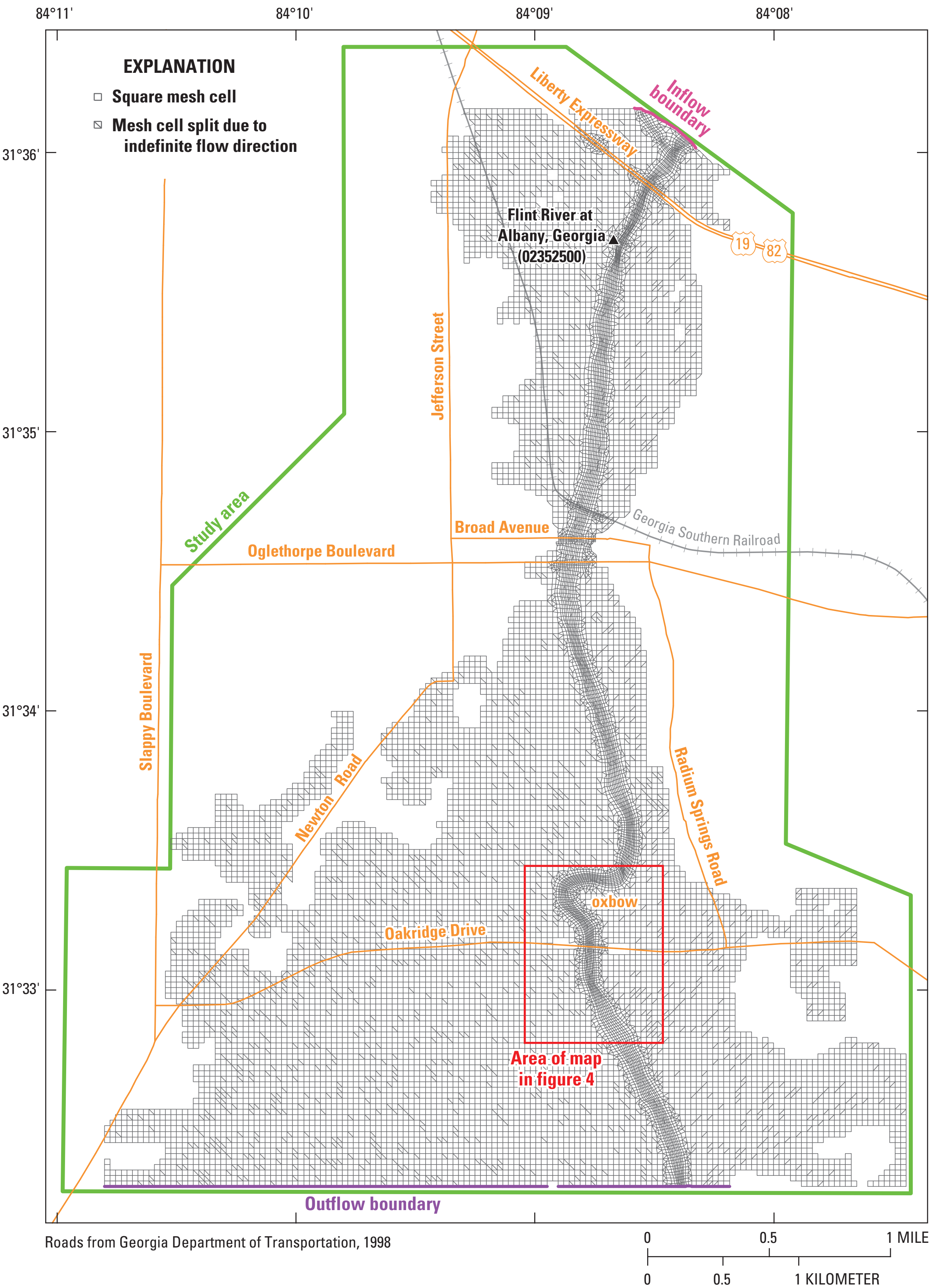


Figure 3. Original finite-element mesh used for two-dimensional model of the Flint River at Albany, Georgia. Inflow and outflow boundary conditions are for a water-surface altitude of 192.5 feet at the Albany streamgage (modified from Musser and Dyar, 2007).

Table 1. Changes in simulated flood inundation area from original model for each scenario, at water-surface altitudes of 181.5, 184.5, 187.5, and 192.5 feet, at the Flint River at Albany streamgage (02352500), for the Flint River in Albany, Georgia.

[Inundated area and reduction in inundation, in square miles; —, no reduction because column is difference between inundated area for model scenario and inundated area for original model; <, less than]

Model scenario	Water-surface altitude, in feet							
	181.5		184.5		187.5		192.5	
	Inundated area	Reduction in inundation	Inundated area	Reduction in inundation	Inundated area	Reduction in inundation	Inundated area	Reduction in inundation
Original	1.71	—	2.62	—	4.24	—	5.87	—
Remove peninsula	1.71	<0.01	2.62	<0.01	4.24	<0.01	5.87	<0.01
Increase bridge opening	1.70	0.01	2.55	0.07	4.21	0.03	5.86	0.01
East culvert	1.68	0.03	2.53	0.09	4.10	0.14	5.86	0.01
West and east culvert	1.67	0.04	2.51	0.12	4.08	0.16	5.85	0.02
Oxbow overflow	1.68	0.03	2.52	0.10	4.08	0.16	5.85	0.02
Oxbow channel	1.67	0.04	2.44	0.18	4.02	0.22	5.84	0.03
No bridge	1.68	0.03	2.49	0.13	4.06	0.18	5.72	0.15
Combination culverts and oxbow overflow	1.66	0.05	2.43	0.19	4.00	0.24	5.71	0.16

East-Culvert Scenario

In the east-culvert scenario, six 20-ft by 20-ft box culverts were simulated through the Oakridge Drive eastern road embankment. One culvert was placed between nodes on the north and south sides of the embankment about 240 ft from the east end of the bridge, four culverts were placed between nodes about 300 ft from the east end of the bridge, and one culvert was placed between nodes about 360 ft from the east end of the bridge. The base altitude of the culverts was 162 ft. Additionally, 120-ft-wide flow paths were created by lowering the land surface upstream and downstream from the culverts to an altitude of 162 ft. The material (roughness) property in the model was changed to “clear” to simulate clearing of trees and underbrush from the flow paths. The flow paths connected the culverts to the Flint River upstream and downstream from Oakridge Drive (fig. 4).

The reduction in inundated area was 0.03 mi^2 at the 181.5-ft gage altitude, 0.09 mi^2 at the 184.5-ft gage altitude, 0.14 mi^2 at the 187.5-ft gage altitude, and only 0.01 mi^2 at the 192.5-ft gage altitude (table 1; Appendix A, figs. A9–A12). The reductions in inundation area were greatest for the 184.5-ft and 187.5-ft gage altitudes, as indicated by the blue shading in figures A10 and A11. The decrease in inundation reduction at the 192.5-ft gage altitude is due to the large flow (123,000 ft^3/s) that inundates a large part of Albany and overtops the Oakridge Drive approach. The added culverts had little effect on this large flow. This same reduction in inundation at the 192.5-ft gage altitude is seen in the other scenarios.

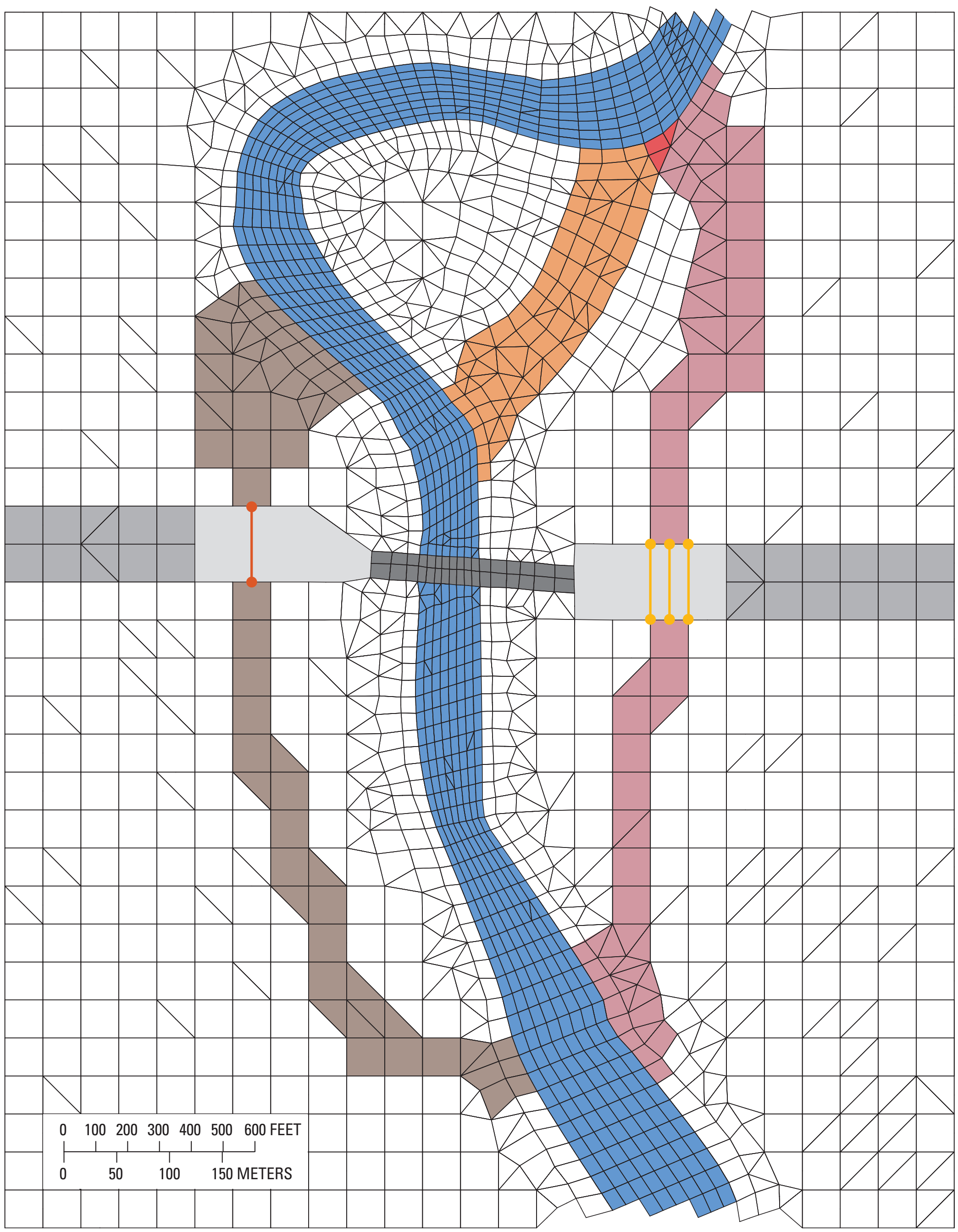
At all gage altitudes, a decrease of the water-surface altitude was indicated upstream from Oakridge Drive, and an increase of water-surface altitude was indicated directly south of the Oakridge Drive bridge (Appendix B, figs B9–B12). Most of the altitude changes were less than 0.4 ft.

West-and-East-Culvert Scenario

The west-and-east culvert scenario uses the same culverts and flow-path modifications as the east-culvert scenario and adds culverts through the embankment on the west side of the Oakridge Drive bridge. Six 20-ft by 20-ft box culverts were simulated at nodes from north of the embankment to south of the embankment about 375 ft from the west end of the bridge. These culverts also had a base altitude of 162 ft, and a 120-ft-wide flow path was created upstream and downstream from the culvert (fig. 4). The material (roughness) property of these flow paths was changed to represent a cleared condition as in the east-culvert scenario.

The reductions in inundation area (table 1; Appendix A, figs. A13–A16) for the west-and-east-culvert scenario were 0.04 mi^2 at 181.5-ft gage altitude, 0.12 mi^2 at 184.5 ft, 0.16 mi^2 at 187.5 ft, and 0.02 mi^2 at 192.5 ft. The larger decreases of the 184.5-ft and 187.5-ft gage altitudes are indicated by the blue shading in figures A14 and A15.

At all gage altitudes, a decrease of the water-surface altitude was indicated upstream from Oakridge Drive, and an increase of water-surface altitude was indicated directly south of the Oakridge Drive bridge (Appendix B, figs. B13–B16). These reductions in water-surface altitude mostly were less than 0.4 ft except in the area immediately around the Oakridge Drive bridge.



EXPLANATION

- Flint River channel
- Oakridge Drive Bridge
- Approach not in model
- Approach in model
- Model mesh

Cell modified from original model (Musser and Dyar, 2007)

- West-and-east-culvert-scenario flowpath
- East-culvert-scenario and west-and-east-culvert -scenario flowpath
- Oxbow-overflow scenario and oxbow-channel scenario
- East-culvert scenario and west-and-east-culvert scenario flowpaths, and oxbow-overflow scenario and oxbow-channel scenario

Culvert

- Used for west-and-east-culvert scenario
- Used for east-culvert scenario and west-and-east-culvert scenario

Figure 4. Cells modified from original finite-element mesh used for two-dimensional model of the Flint River at Albany, Georgia. Modified cells include west-and-east-culvert-scenario flowpath, east-culvert-scenario flowpath, oxbow-overflow scenario, and oxbow-channel scenario.

Oxbow-Overflow Scenario

In the oxbow-overflow scenario, an overflow channel was simulated across the oxbow located north of the Oakridge Drive bridge (fig. 2). The model mesh was modified to create a direct path across the oxbow (fig. 4). The altitude of the overflow channel was set at 156 ft, which is the approximate altitude of the river bank in the area, and the material (roughness) property was changed to "channel" to simulate the creation of a channel for river flow. The width of the overflow channel is approximately 230 ft to 250 ft depending on the size of the mesh cells that compose it. The purpose of this overflow channel was to provide a shorter and more direct flow path for the flood water when the river overflows its banks.

The changes in inundation area are shown in Appendix A, figures A17–A20. The reductions in inundated area for the 184.5-ft and 187.5-ft gage altitudes are 0.10 mi^2 and 0.16 mi^2, respectively (table 1). The reductions in inundated area are much smaller at the 181.5-ft gage altitude (0.03 mi^2) and 192.5-ft gage altitude (0.02 mi^2).

At all gage altitudes, a decrease in water-surface altitude was seen north of the Oakridge Drive bridge (Appendix B, figs. B17–B20). These decreases are mostly between 0.3 ft and 0.5 ft, except for the 192.5-ft gage, altitude which resulted in decreases mostly between 0.1 ft and 0.3 ft. The area downstream from the Oakridge Drive bridge had little water-surface altitude change. Some areas to the southwest of the Oakridge Drive bridge also showed a slight decrease in water-surface altitude.

Oxbow-Channel Scenario

The oxbow-channel scenario used the same channel that was simulated for the oxbow-overflow scenario, with the bottom of the middle part of the channel lowered to 136 ft (fig. 4). This value is approximately the altitude of the bottom of the river channel in the area where the oxbow channel connects to the river channel on the upstream end. The width of the 136-ft cells is between approximately 110 and 140 ft.

The changes in inundation area for this scenario are shown in Appendix A, figures A21–A24. The results from this scenario are similar to the oxbow-overflow scenario with little change in inundation area at the 181.5-ft gage altitude and the 192.5-ft gage altitude (table 1). The decreases in inundation area at the 184.5-ft gage altitude (0.18 mi^2) and 187.5-ft gage altitude (0.22 mi^2) are the second largest decreases at those gage altitudes.

Appendix B, figures B21–B24 show changes in water-surface altitude for the oxbow-channel scenario. At the 181.5-ft and 184.5-ft gage altitudes, water-surface altitude decreases north of the Oakridge Drive bridge except for in the area immediately north of the bridge where the oxbow channel rejoins the Flint River channel. An increase in the water-surface altitude occurs in this area. The 187.5-ft and 192.5-ft gage altitudes show a similar pattern, with areas of decreased water-surface altitude extending southwest from the Oakridge Drive bridge. At the 182.5-ft, 184.5-ft, and 187.5-ft gage altitudes, the area north of the Oakridge Drive bridge had water-surface altitude reductions mostly in the range of 0.3 to 0.8 ft. At the 192.5-ft gage altitude, the reductions were between 0.1 and 0.3 ft.

No-Bridge Scenario

In the no-bridge scenario, the Oakridge Drive bridge, its approaches, and all of the piers and bridge decking were simulated as being removed from the model. In addition, the land-surface altitude of the bridge approaches was lowered to 170 ft, which is approximately the altitude of the floodplain in that area. The simulations were run with this lower altitude value for the bridge approaches, but the inundated area was computed with the bridge-approach altitude unchanged so that comparisons in inundated area between the original model and the other model scenarios could be made.

The reduction in inundated area is 0.03 mi^2 at the 181.5-ft gage altitude, 0.13 mi^2 at the 184.5-ft gage altitude, and 0.18 mi^2 at the 187.5-ft gage altitude (table 1). The reduction in inundated area then decreases to 0.15 mi^2 at the 192.5-ft gage altitude. At 181.5-ft, 184.5-ft, and 187.5-ft gage altitudes, the reductions in inundated area primarily were northwest of the Oakridge Drive bridge where areas were not inundated and small areas south of the Oakridge Drive bridge which were inundated by the model change (Appendix A, figs. A25–A27). At the 192.5-ft gage altitude, the only substantial reduction occurred northeast of the Oakridge Drive bridge where one area was not inundated (fig. A28).

At all gage altitudes for the no-bridge scenario, water-surface altitude decreases north of the Oakridge Drive bridge and increases south of the bridge (Appendix B, figs. B25–B28). The increase disappears approximately halfway between the bridge and the southern boundary of the model. Additionally, at the 187.5-ft and 192.5-ft gage altitudes, the water-surface altitude decreased west of the Oakridge Drive bridge. Immediately north of Oakridge Drive, the water-surface altitude decrease was as much as 1.0 ft except at 192.5-ft gage altitude, which only had a decrease of 0.4 ft. Immediately south of Oakridge Drive, the water-surface altitude increase was as much as 0.8 ft except at the 192.5-ft gage altitude, which had an increase of 0.3 ft.

Combination West-and-East-Culvert and Oxbow-Overflow Scenario

The combination scenario combines the west-and-east-culvert scenario and oxbow-overflow scenario because they are the two scenarios that would seem to be the least costly to implement. By combining the two scenarios, reduction of inundated area was greater than for any other scenario. The reduction was 0.05 mi^2 at the 181.5-ft gage altitude, 0.19 mi^2 at the 184.5-ft gage altitude, 0.24 mi^2 at the 187.5-ft gage altitude, and 0.16 mi^2 at the 192.5-ft gage altitude (table 1). At gage altitudes of 181.5-ft, 184.5-ft, and 187.5-ft, decreases in inundated area generally were north and west of the Oakridge Drive bridge, while increases in inundated area were south of the bridge (Appendix A, figs. A29–A31). At the 192.5-ft gage altitude, the decrease in inundated area was mostly to the east of the Oakridge Drive bridge, and there was little area inundated only by the combination scenario (fig. A32).

At all gage altitudes, water-surface decreases are north of the Oakridge Drive bridge, and water-surface altitude increases are south of the bridge (Appendix B, figs. B29–B32). At the 187.5-ft and 192.5-ft gage altitudes, water-surface altitude decreases west of the Oakridge Drive bridge. At the 192.5-ft gage altitude, the water-surface altitude increases mostly are between 0.0 and 0.1 ft, and the decreases mostly are between 0.1 and 0.6 ft. At all of the other gage altitudes, the water-surface altitude decreases were mostly between 0.2 and 1.1 ft, and the increases are mostly between 0.1 and 0.6 ft. Simulated water-surface profiles for this scenario and the original model were computed to show the decrease in water-surface altitude north of the Oakridge Drive bridge, and the increase south of the bridge (fig 5).

Model Limitations

The results of the model scenarios in this study could differ from actual flood results for several reasons. The model is based on a steady-state constant flow and does not account for rising or falling flow values or for any inflow into the system from sources other than the Flint River. The boundary condition at the outflow is assumed to be a constant value across the entire southern edge of the mesh, and these values are not known precisely. Only the areas directly inundated by surface-water flows from the Flint River were examined in the model, and some areas near the river are known to become inundated because of ground- and surface-water interaction (Musser and Dyar, 2007). Finally, the discretization of the altitude and mesh causes the model to be an approximation of the actual conditions in the area.

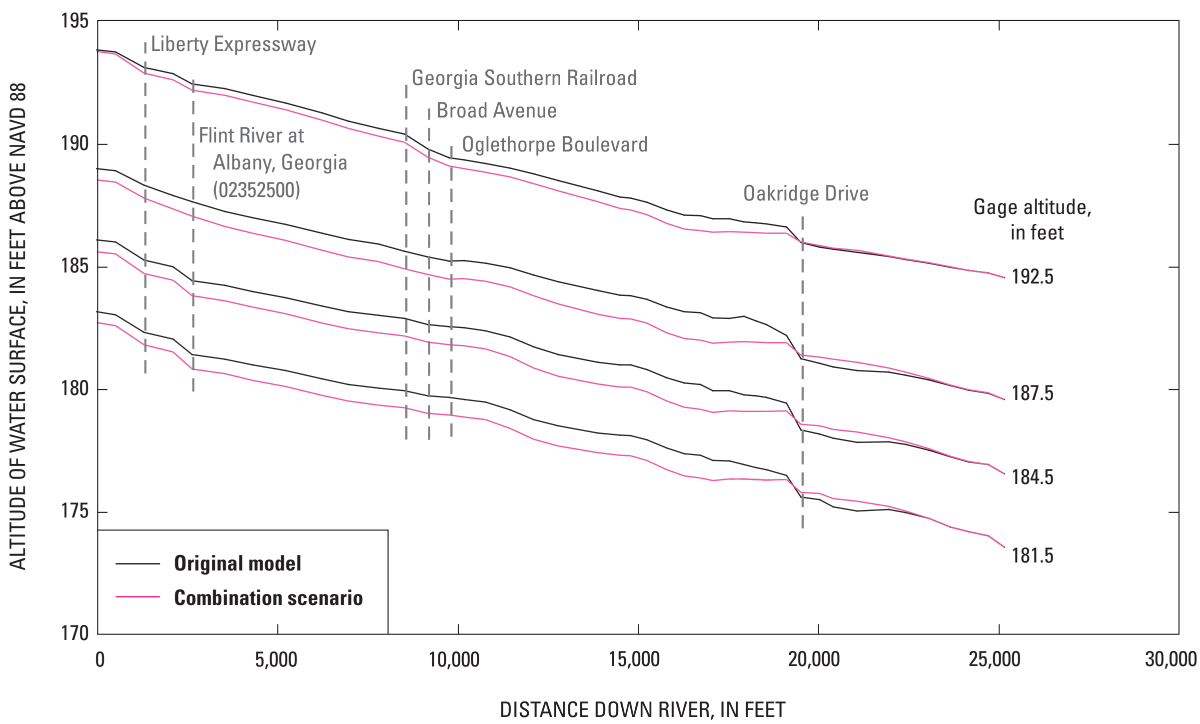


Figure 5. Simulated water surface profiles for the original model and the combination scenario for the Flint River at Albany, Georgia.

Summary and Conclusions

Potential flow characteristics of future flooding along a 4.8-mile reach of the Flint River in Albany, Georgia, were simulated using recent digital-elevation-model data and U.S. Geological Survey (USGS) finite-element surface-water modeling system for two-dimensional flow in the horizontal plane (FESWMS-2DH). This model was previously calibrated and verified (Musser and Dyar, 2007). This study was conducted by the USGS—in cooperation with the City of Albany and Dougherty County, Georgia—to provide data to local agencies seeking ways to reduce effects of future floods.

Modifications to the original model (Musser and Dyar, 2007) included removing a human-made peninsula south of the Oglethorpe Avenue bridge, increasing the opening under the Oakridge Drive bridge, adding culverts to the Oakridge Drive bridge approach on the east side as well as on the east and west sides, creating an overflow channel through the oxbow north of the Oakridge Drive bridge, and creating a stream channel through this oxbow. The model was also modified to simulate having no bridge or approach at Oakridge Drive. Finally, a combination of adding culverts at Oakridge Drive and creating an overflow channel through the oxbow was simulated. These scenarios were modeled at gage altitudes of 181.5 feet (ft), 184.5 ft, 187.5 ft, and 192.5 ft. Results were compiled into a geographic information system and mapped to show changes in inundation and changes in water-surface altitude.

The remove-peninsula scenario had a decrease of less than 0.01 square mile (mi^2) in inundated area at all altitudes. All of the inundation reductions for the other scenarios were small at the 181.5-ft gage altitude, increased at the 184.5-ft gage altitude, and peaked at the 187.5-ft gage altitude. Reductions in inundation decreased at the 192.5-ft gage altitude. The flow at this gage altitude (123,000 cubic feet per second) inundates a large part of Albany and overtops most of the Oakridge Drive approach. The channel and floodplain modifications in the scenarios have little effect on this large of a flow, so changes in the inundated area are not as large as at lower gage altitudes. The most effective scenario was the combination of the west-and-east-culverts scenario and oxbow-overflow scenario, which had a reduction of inundation of 0.24 mi^2 at the 187.5-ft gage altitude.

In all of the scenarios, except for the remove-peninsula scenario, the water-surface altitude decreased upstream from Oakridge Drive and increased downstream from Oakridge Drive. The bridge, its approaches, and the oxbow upstream inhibit water flowing in the Flint River, which results in a rise in the water-surface profile upstream and a resulting decline in the profile downstream. The flow improvements in the scenarios level out the water-surface profile resulting in the decrease in water-surface altitude upstream and the increase in water-surface altitude downstream from Oakridge Drive.

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