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FINAL REPORT



JANUARY 1995



FEMA DR-GA-1033

INTERAGENCY HAZARD MITIGATION TEAM

FLOODING IN GEORGIA FROM TROPICAL STORM ALBERTO

PREPARED BY THE
BUILDING AND DAM
PERFORMANCE ASSESSMENT TEAM



FEMA DR-GA-1033

**INTERAGENCY HAZARD MITIGATION TEAM
FLOODING IN GEORGIA FROM TROPICAL STORM ALBERTO**

Final Report

MITIGATION DIVISION
JAN 23 1995
F E M A
ATLANTA REGIONAL OFFICE

Prepared by the

**Federal Emergency Management Agency
Program Implementation Division
Technical Assistance and Compliance Branch**

January 1995

EXECUTIVE SUMMARY

The remnants of Tropical Storm Alberto dropped heavy rains on central and southwest Georgia in early July 1994. This rainfall caused extensive flooding that damaged buildings, levees, dams, and local infrastructure such as roads, bridges, and utilities.

As elements of the Interagency Hazard Mitigation Team (IHMT) process, a Building Performance Assessment Team (BPAT) and a Dam Performance Assessment Team (DPAT) (which consisted of structural, geotechnical, and civil engineers) were deployed by the Federal Emergency Management Agency to evaluate damages and determine possible mitigation opportunities for buildings and dams damaged by the flooding. Both teams performed field evaluations and identified issues that need further attention, such as dam failures causing sudden increased flows and loss of facility usefulness, levee failures causing additional flooding, building failures and loss of building contents from water velocities and/or inundation, and other related issues identified. This report documents the findings of both teams and is intended to supplement the separate IHMT report.

The general conclusion of the BPAT was that most of the flooded buildings were damaged by soaking. This damage due to high water included loss of furnishings and fixtures. Few buildings experienced hydrodynamic forces sufficient to cause significant structural damage. The DPAT concluded that the dam failures which occurred were due primarily to overtopping resulting from spillways that were not capable of passing the large events (i.e., magnitude greater than 100-year flood) experienced. The lack of regulation of many of the dams allowed them to exist without meeting state-of-the-art design standards.

The teams' findings indicated that mitigation opportunities exist for the reconstruction or repair of the damaged buildings, levees, and dams, including the following:

Buildings

- residential structure flooding
- commercial structure flooding
- public facilities structure flooding

Levees

- levee maintenance
- levee rehabilitation

Dams

- unregulated dams
- flood management impacts of impoundments

- watershed planning for dams
- selection of spillway design flood
- standards for design, construction, and maintenance of dams
- decision analysis for reconstruction of failed dams
- flood control function of dams

The findings presented herein are based on a representative sample of the total number of facilities that suffered flood-related damages. These findings provide a sound basis for developing conclusions and recommendations regarding the affected areas and corresponding key issues. As a result, the teams' findings will assist the IHMT in obtaining a more technical understanding of the magnitude of damages as well as taking advantage of opportunities to implement hazard mitigation measures early in the reconstruction process.

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I. BACKGROUND

In early July 1994, flooding from the remnants of Tropical Storm Alberto in communities in central and southwest Georgia caused extensive damage to dams, levees, buildings (including commercial, residential, and public), and local infrastructure such as roads, bridges, and utilities. On July 7, 1994, the President declared four Georgia counties a major disaster area as a result of flood damages from the remnants of tropical storm Alberto. The following day, 28 counties were quickly added to the declaration. As damage reports became available, additional counties were included. By the end of July the total stood at 52 counties or approximately one-third of the State of Georgia. Two more amendments were issued in August, bringing Telfair and Dodge Counties into the declaration for individual assistance only (see Figure 1).

During the week of July 23-29, 1994, the Federal Emergency Management Agency (FEMA), through the Interagency Hazard Mitigation Team (IHMT) process, deployed a Building Performance Assessment Team (BPAT) and a Dam Performance Assessment Team (DPAT), consisting of structural, geotechnical, and civil engineers currently under contract to FEMA, to conduct a field investigation in support of the Hazard Mitigation Program function. The BPAT and DPAT visited and evaluated representative samples of damaged buildings, levees, and dams in the hardest hit areas. A summary of the scopes, purposes, and accomplishments of the two teams is presented in the following sections. Field observation notes, photographs, other relevant information obtained by the teams during these evaluations, and the BPAT and DPAT recommendations are provided in Appendixes A, B, and C of this report. Selected representative photographs are also provided in the appendices.

II. OBJECTIVE

The primary purpose for the deployment of the BPAT and DPAT under the IHMT process was to conduct technical assessments of the damaged structures, determine the possible causes of structural failures, and identify possible programmatic and technical mitigation opportunities that can be implemented to reduce or prevent future damages. The deployment of the BPAT and DPAT was intended to enhance FEMA's ability to provide technical guidance to local and State officials involved in responding to this disaster, in identifying and evaluating mitigation alternatives, and in addressing issues affecting the National Flood Insurance Program (NFIP) and the National Dam Safety Program.

The objectives established for the BPAT and DPAT included the following:

- Visit designated sites within the federally declared disaster areas.
- Evaluate typical damages to residential, commercial, and public buildings and identify factors/issues that may have contributed to failures.

FIGURE 1. COUNTIES INCLUDED IN DISASTER DECLARATION (SHOWN IN RED)



- Evaluate damages to selected dams and levees and identify factors/issues that may have contributed to their failures.
- Identify general and specific mitigation opportunities for addressing future disasters and provide general technical and programmatic recommendations to the IHMT for addressing the issues identified.

III. SCOPE

At 9:00 a.m. on Sunday, July 24, 1994, the IHMT leader held a kickoff meeting at the Disaster Field Office in Albany, Georgia. The meeting included the BPAT and DPAT team members (see Tables 1 and 2), staff from FEMA's Mitigation Directorate (from the Region IV Office in Atlanta, Georgia, and FEMA Headquarters in Washington, DC), and staff from FEMA's Region IV Infrastructure Division (Public Assistance). The purpose of the meeting was to refine the scope of work and review any preliminary damage information that was available at that time. From preliminary discussions in this meeting and subsequent contacts made with local officials and with the Georgia Department of Natural Resource (DNR), an initial list of representative sites and corresponding schedule of activities was developed by each team. Tables 3 and 4 list the damage areas visited, and Tables 5 and 6 list the individuals contacted during these visits. Also see Figure 2.

Table 1 -- BPAT Members

<u>Name</u>	<u>Organization</u>
Charles E. Bornman, P.E.	Greenhorne & O'Mara, Inc. Greenbelt, Maryland
Robert L. Dooley, P.E.	Greenhorne & O'Mara, Inc. Marietta, Georgia

Table 2 -- DPAT Members

<u>Name</u>	<u>Organization</u>
Albert V. Romano, Team Leader	Greenhorne & O'Mara, Inc. Greenbelt, Maryland
Timothy C. McCormick, P.E.	Greenhorne & O'Mara, Inc. Greenbelt, Maryland
Joseph R. Kula, P.E.	Woodward-Clyde Consultants, Inc. Gaithersburg, Maryland

Table 3 -- Schedule of BPAT Site Visits

<u>Date</u>	<u>Site Visited</u>	<u>City</u>	
<u>County</u> 7/25/94	Montezuma Business District	Montezuma	Macon
	Americus Residential Areas & Public Facilities	Americus	Sumter
	Lake Blackshear Residential Areas	Unincorporated	Crisp/Worth
7/26/94	Newton Town Center & Surrounding Residential Area	Newton	Baker
	Albany State College	Albany	Dougherty
	Southern Residential Areas	"	"
	Northwest Residential and Commercial Areas	"	"
7/27/94	Macon Residential & Commercial Areas	Macon	Bibb

Table 4 -- Schedule of DPAT Site Visits

<u>Date</u>	<u>Site Visited</u>	<u>City</u>	<u>County</u>
7/24/94	Lake Blackshear	Warwick	Sumter/Crisp/Worth
7/25/94	Lake Blackshear Dam	Warwick	Sumter/Crisp/Worth
	Lake Hancock Dam and adjacent dam	Americus	Sumpter
	Unnamed Lake Dam No. 1	"	"
	Unnamed Lake Dam No. 2	"	"
	Browns Mill Pond Dam	"	"
	Whitewater State Park Dam	Montezuma	Macon

Table 4 -- Schedule of DPAT Site Visits (Continued)

<u>Date</u>	<u>Site Visited</u>	<u>City</u>	<u>County</u>
7/26/94	Leisure Lake Dam	Warner Robins	Houston
	Lower lake (Wilkinson Lake)	"	"
	Western lake (West Reach)	"	"
	Houston Lake Dam	"	"
	Lake Tobesofkee Dam	Macon	Macon/Bibb
7/27/94	Barnesville Water Supply Dam	Barnesville	Lamar
	High Falls State Park Dam	Unincorporated	Monroe/Butts
	Senoia Water Supply Dam	Senoia	Coweta
	Iris "B" Lake Dam	McDonough	Henry

Table 5 -- Individuals Contacted by the BPAT

<u>Name</u>	<u>Position</u>	<u>Location</u>
Gerald Abbott	EMA Coordinator	Macon County
Jack Maffetts, Sr.	Property Owner	Montezuma
Sybil Smith	City Administrator	Americus
Patricia Jones	EMA Director	Crisp County
Pat McKnight	Building Inspector	Crisp County
Major Ken Janney	USAF National Guard	Macon County

Table 6 -- Individuals Contacted by the DPAT

<u>Name</u>	<u>Position</u>	<u>Location</u>
Bryan D. Bodine	Sheriff's Department	Sumter County
Thomas G. Abbott	EMA Director	Macon County
Steve Rentfrow	General Manager	Crisp County Power Commission
Clinton H. Walls	Utilities Director	Warner Robins
Walter Gray, III	City Engineer	Warner Robins
Francis E. Fiegle, II, P.E.	EPD Safe Dams Program Manager	Atlanta
Tom Woolsey	EPD Safe Dams Program Engineer	Atlanta
James W. Williams, Jr.	EMA Deputy Director	Houston County
Kenneth D. Roberts	City Manager	Barnesville

FIGURE 2. CITIES VISITED BY THE BPAT AND DPAT (SHOWN IN RED)



Table 6 -- Individuals Contacted by the DPAT (Continued)

<u>Name</u>	<u>Position</u>	<u>Location</u>
Dicky Carreker	Safety Coordinator	Barnesville
Carmen Westerfield	USDA District Conservationist	Barnesville
Billy B. Campbell	EMA Director	Lamar County
Lester H. Mann, Jr.	Mayor	Senoia
Jim Howell	Assistant Director Engineering	Henry County
Jim O'Neal	Assistant Director Roads	Henry County
Jeff Landress	City EMA	Bibb County

Field visits were conducted by the BPAT and DPAT during the period of July 24-27, 1994. The BPAT visited six communities and evaluated over 5,000 residential, commercial, and public buildings and 2 levees. The DPAT visited over 10 communities and evaluated 14 dams during the same period. The teams met with several local residents, local government officials, and State and Federal representatives, including Georgia DNR officials and a Soil Conservation Service (SCS) District representative in Barnesville, Georgia.

The BPAT scope of activities was limited to evaluating the overall structural performance of public, residential, and commercial buildings and levees. The scope of work also included a requirement to identify possible mitigation opportunities, including both structural and non-structural measures for both the buildings and levees.

The DPAT scope of activities included identifying and evaluating the performance of publicly and privately owned dams. Several dams were selected for evaluation so that a representative sample of damages could be obtained. The following types of damaged dams were evaluated: dams classified as Category I non exempt (State regulated) and Category II under the Georgia Safe Dams Act of 1978; large and small dams; federally regulated dams; unregulated private dams; dams that may have cumulative impacts (series or parallel) if failure occurs; and dams that have received public attention as a result of their overtopping or failure. Both the BPAT and DPAT evaluations were limited to field visits and reviews of existing regulatory requirements using telephone contacts and meetings. The results of the teams' preliminary assessments and recommendations were presented to the IHMT on July 29, 1994.

IV. FIELD ASSESSMENTS AND CONCLUSIONS

Summaries of the field assessments are included in Appendixes A and B for the BPAT and DPAT, respectively. The BPAT summary includes an overview of field observations and potential mitigation opportunities within each community visited, along with copies of photographs. The DPAT summary includes information for each of the 14 dams assessed, including site information, structure information, copies of photographs, and a description of the facility's performance during the flooding.

The general conclusion of the BPAT was that most of the flooded buildings were damaged by soaking. This damage due to high water included loss of furnishings and fixtures. Few buildings experienced sufficient hydrodynamic forces to cause significant structural damage. A variety of non-structural mitigation opportunities exist to reduce the mitigate the flood hazard in the affected communities.

The DPAT concluded that the dam failures which occurred were due primarily to overtopping resulting from spillways that were not capable of passing the large events (i.e., magnitude greater than 100-year flood) experienced. The lack of regulation of many of the dams allowed them to exist without meeting state-of-the-art design standards. Numerous mitigation opportunities exist, including increased regulation of existing dams, retrofitting of existing dams, stronger standards for new/rehabilitated dams, and increased awareness of the risk factors associated with dams in the NFIP.

V. RECOMMENDATIONS

Based upon the field assessments and conclusions, the BPAT and DPAT teams identified several issues that may require further evaluation and action to be taken. Possible short-term and long-term mitigation opportunities were identified and are recommended as noted in the worksheets provided in Appendix C.

APPENDIX A
BPAT
FIELD REPORTS, MITIGATION OPPORTUNITIES, AND PHOTOGRAPHS

BPAT FIELD REPORT

Date: July 25, 1994
Prepared By: Robert L. Dooley & Charles E. Bornman
Subject: 1994 Flooding in South Georgia
Location: MONTEZUMA, GA (Macon Co.)

We called the Macon County Emergency Management Agency (EMA) and talked to the Director, Mr. Gerald Abbott. We explained the purpose of our visit and invited him to accompany us to the area. He indicated that he would be unavailable to do so since he was headed to the airport to escort other visitors.

We then visited the downtown area along South Dooly Street (SR 90) from the Flint River bridge to Oglethorpe Road. This area, according to several local merchants, had sustained water damage due to the release of water from breached dams in the Beaver Creek watershed on Wednesday morning, and following that, a flow of water they believed came from an end run around a levee or breach of the levee. These conclusions were based on the observation that lumber and other building materials were seen floating onto South Dooly Street from the Cherry Street area.

Local sources indicate that a flood in 1948 prompted the construction of the levee between 1950-1951 with the aid of Federal monies. This levee was constructed between the two rail lines that pass through the city. Additionally, in 1990, the city received some water damage from flooding and later on had filled in an area with fill material to prevent further flooding.

Photographs (slides and prints) of the flooded buildings were taken. Additionally, the structures were investigated to determine the type and extent of damage. It appeared that the majority of the structures are in good condition given the circumstances. One noticeable feature was structures having wooden floors suffered greater damage. All of the structures having concrete floors were spared additional replacement costs associated with floor and sub-floor replacement. One of the slides shows what appears to be a stormwater pumping station located in a low area adjacent to the railroad tracks. The status of the facility regarding its success or failure during the flooding event was unknown.

A local merchant, Jack Maffets, Sr., owner and operator of several buildings along one side of the street, was having two of his wooden floors replaced with concrete during our visit.

Mitigation Opportunities

Based on the observations made above, during our site visit of July 25, 1994, we identified the following opportunities for substantially reducing damages from possible future events:

- 1) The levees constructed to protect the low-lying areas of the city from flooding should be properly sized, constructed, and maintained (see Recommendation Worksheet on page C-9)

of Appendix C). Adequate hydrologic and hydraulic analyses must be considered critical design elements. Proper construction techniques must be followed to ensure proper performance of the levee system during flooding events. Maintenance and inspection programs must be implemented in order to provide a long service life for the levees.

- 2) In areas where minor flooding was observed, it may be feasible to dry-floodproof commercial buildings by providing portable flood barriers at door and window openings and sealing exterior walls against floodwater infiltration. A combination of levee improvement and reconstruction and floodproofing may be an alternative to complete levee redesign and improvement.
- 3) Individual structures subject to inundation levels that could not be handled by dry floodproofing may be better off if relocated, elevated in place, or bought out and reconstructed in another location.

PHOTOGRAPHS
for
MONTEZUMA, GA



1. Robert's Law Office. Flooding caused extensive damage to timber subflooring and flooring.



2. Looking toward Flint River along S. Dooly Street.
Damaged furnishings.



3. Plumbing business near Flint River. High water mark
indicated by arrow.



4. Cole insurance office next to Flint River. Loss of interior walls and furnishings.



5. 1946 structure with original exterior brick walls. Interior updated with pre-engineered steel columns. High water mark indicated by arrow.



6. View down side street. High water mark indicated by arrow.

BPAT FIELD REPORT

Date: July 25, 1994
Prepared By: Robert L. Dooley & Charles E. Bornman
Subject: 1994 Flooding in South Georgia
Location: AMERICUS, GA (Sumter Co.)

We met with Ms. Sybil Smith, City Administrator, to discuss the areas of the city impacted by the recent flooding. She gave us a map indicating impact areas within the city limits and the locations of dams outside the city limits that had breached and may have caused the local damage. She also referred us to Ms. Barbara McCarty, Sumter County Administrator, for information regarding damage in the unincorporated areas of the county.

City infrastructure elements damaged by floodwater included local roads and utility lines. At the time of the visit, it appeared all of the necessary repairs had been completed and systems were operational. Ms. Smith indicated that FEMA personnel had been to see her and that she wanted them to dredge Town Creek to improve the conveyance of stormwater.

We visited the Town Creek area indicated on the map and found some severe erosion along a tributary of Town Branch that partially parallels Town Creek Circle. The only structural damage that we noted in this area was to a small storage shed that had been swept downstream about 300 feet and demolished.

It should be noted that the stormwater discharge from a 60-inch corrugated metal pipe crossing under Railroad Drive is directed toward the left bank of the stream. It appeared that discharge velocities from the pipe were significant enough to cause partial erosion of the stream embankment. Further downstream at a hard right turn in the course of the stream, there was also evidence of bank erosion and overtopping of the embankment. Several rear yards had been stripped of their recently placed sod.

It was also noted that Railroad Avenue in the area of the public works building had suffered some minor pavement displacement along its eastern side near Town Creek Circle and had not yet been repaired. We also noted that a portion of the railroad embankment opposite the damaged pavement had recently been stabilized with new ballast material. An inspection on the upstream side of the railroad track revealed that runoff debris had accumulated near the top of the rails. Apparently, runoff had overtopped the rails and caused a partial washout of the downstream rail embankment and the pavement.

Mitigation Opportunities

Based on the observations made above, during our site visit of July 25, 1994, identified the following opportunities for substantially reducing damages from possible future events :

- 1) Improvements to Town Creek, including dredging and hydrologic and hydraulic analysis with subsequent channel improvements, may improve the conveyance capacity of the creek and substantially reduce flooding from future events.
- 2) In areas where minor flooding was observed, it may be feasible to dry-floodproof commercial buildings by providing portable flood barriers at door and window openings and sealing exterior walls against floodwater infiltration. A combination of levee improvement and reconstruction and floodproofing may be an alternative to complete levee redesign and improvement.
- 3) Individual structures subject to inundation levels that could not be handled by dry floodproofing may be better off relocated, elevated in place, or bought out and completely reconstructed in another location.
- 4) Outfalls, such as the one observed along Railroad Avenue should be properly sized and properly constructed in order to minimize erosion at outlets. Rip rap protection could be placed to reduce or eliminate streambank erosion. Stream or creek improvements could be designed after proper hydrologic and hydrologic analyses. Channel lining or realignment of meandering channels could improve flow characteristic and thereby lessen the impact of high volumes of water during flood conditions.

PHOTOGRAPHS
for
AMERICUS, GA



1. Success story. House built adjacent to but far enough away from creek.



2. Looking down tributary of Town Creek from railroad tracks.
House in photo 1 above located just to the left of creek.



3. Eroded banks along tributary. Proximity of house to creek channel shows danger of siting too close to a waterway.



4. Looking downstream from existing storm drain pipe. Discharge from pipe is directed at stream bank; stream meanders to right then turns left and parallels houses. Possible mitigation opportunity exists: channel improvement or proper siting of structures.

BPAT FIELD REPORT

Date: July 25, 1994
Prepared By: Robert L. Dooley & Charles E. Bornman
Subject: 1994 Flooding in South Georgia
Location: CORDELE, GA (Crisp Co.)

We called Ms. Patricia Jones, EMA Director for the county. We stated the purpose of our visit, but she indicated that she was unavailable to accompany us on a site visit. We then called the County Building Inspector, Mr. Pat McKnight, at the county courthouse. His secretary stated that he was not in the office. She indicated that the city had not received any flood damage but that a county structure along the Flint River and above Lake Blackshear dam had been affected. We then went to the powerhouse at Lake Blackshear and talked with one of the plant personnel about the purpose of our visit. He indicated that we needed to inspect the area on the east side of the lake, namely River Road and Lakeshore Drive. These areas are primarily lakefront lots with full-time occupants. Photographs were taken of damaged structures as well as those that did not receive any damage. The damages appear to have been caused by a significant rise in the water-surface elevation behind the dam. The high water mark on the structures and surrounding vegetation indicated that varying depths of flooding had occurred within the structures. The only commercial structure noted during the visit was the Smoak Bridge Marina at Swift Creek. It appeared to have received a significant amount of flooding.

It should be noted that some boat houses supported on wooden piers were listing at various angles. We believe that this damage was caused by an unusually high lake level coupled with a rapid lake drawdown caused by a breach in the earthen section of the dam.

Mitigation Opportunities

Based on the observations made above, during our site visit of July 25, 1994, we identified the following opportunities for substantially reducing damages from possible future events:

- 1) The dam that was constructed to create Lake Blackshear (see DPAT Field Assessment Summary Sheets in Appendix B) should be properly sized, constructed, and maintained. Adequate hydrologic and hydraulic analyses must be considered critical design elements. Proper construction techniques must be followed to ensure proper performance of the dam during flooding events. Maintenance and inspection programs must be implemented in order to provide a long service life for the facility.

PHOTOGRAPHS
for
CORDELE, GA



1. House on Lake Blackshear damaged by high water.
Interior goods and furnishings damaged by floodwaters.



2. House on Lake Blackshear. Fence damaged by floodwaters.



3. House on Lake Blackshear damaged by high water.
High water mark indicted by arrow.



4. View of dam and breach.



5. View of house on pilings. House damaged by floodwaters that rose high enough to float the structure.



6. View of fishing pier overturned at Walker house on Lakeshore Drive. Possibly floated by rising floodwaters and toppled by the flow of water rushing downstream.



7. Walker House. Water rose above the eaves.



8. View of elevated house. Water mark below first floor level indicated by arrow.



9. Blackshear Marina at State Route 300. Interior goods and furnishings damaged by floodwaters.

BPAT FIELD REPORT

Date: July 26, 1994
Prepared By: Robert L. Dooley & Charles E. Bornman
Subject: 1994 Flooding in South Georgia
Location: NEWTON GA (Baker Co.)

We began our inspection in the downtown area of the city along Water Street and found numerous structures that had been damaged by rising waters from the Flint River. These structures were primarily masonry construction and included the courthouse and several commercial establishments, some of which appear to have been uninhabited for a long period prior to the flood. The depth of flooding according to water marks along the buildings had reached at least 12 feet.

Water Street also contains several residential structures that had been damaged by rising water. The depth of flooding ranged from at least 12 feet in structures within the downtown area to as little as 6 feet in structures located further north along Water Street. Residential structures included brick and frame construction; newer construction was primarily of brick. Even though these structures sustained water damage, there were no visible structural failures due to high-velocity floodflows. One significant structure that sustained water damage was a fairly modern Southern Bell switching facility constructed of brick and block. The depth of water within the building had reached about 6 feet.

We then visited Broad Street and found a single-story residential frame structure that had partially collapsed. A portion of this slab-on-grade structure appears to have floated off its foundation and collapsed. The remainder of the structure was still intact. Further along Broad Street, we found a frame structure that had floated off its concrete block pier foundation and been displaced about 20 to 30 feet.

The next area inspected was Clear Lake Road on the western side of the city limits. This area consists of one-story frame residential structures. The true level of flooding could not be accurately determined since these structures were still flooded

The final area to be visited was along State Route 37 at the Flint River. The remains of a commercial establishment known as Rivertrace Restaurant were scattered along the western banks of the river above and below the State Route 37 bridge. An inspection of the debris indicates that the structure was of frame construction on concrete block piers.

Mitigation Opportunities

Based on the observations made above, during our site visit of July 26, 1994, we identified the following opportunities for substantially reducing damages from possible future events :

- 1) In view of the depths of flooding experienced in the city proper, it is our opinion that a complete relocation of the city is an alternative to be considered. However, a complete hydrologic and hydraulic study should be undertaken to determine the storm recurrence interval and to determine the flood levels expected during the design flood.
- 2) If design flood levels are determined to be significantly less than this event, it may be feasible to dry-floodproof commercial buildings by providing portable flood barriers at door and window openings and sealing exterior walls against floodwater infiltration.
- 3) Residential structures could be elevated in place to raise first floor levels to above the 100-year flood elevation.
- 4) A levee system could be designed and constructed to protect the city proper from future flood events.

PHOTOGRAPHS
for
NEWTON, GA



1. Flooded mobile home at intersection of W. Springdale and N. Springdale. High water mark indicated by arrow.



2. House on E. Parks Avenue. High water mark indicated by arrow.



3. Cowart House on E. Parks Avenue under repair. Interior goods and furnishings damaged by floodwaters.



4. House at E. Parks and Water Street. High water mark indicated by arrow.



5. Southern Bell Facility at E. Phipps and Water Street. High water mark indicated by arrow.



6. Courthouse. High water mark indicated by arrow.



7. Commercial buildings across from courthouse. All goods and furnishings damaged by floodwaters.



8. House across from courthouse. High water mark indicated by arrow.



9. Abandoned commercial building at Hall and S. Water Street. High water mark indicated by arrow.



10. Abandoned commercial building on Main Street was completely inundated.



11. House failure on Broad Street (frame construction). Collapse likely due to floodwaters floating the structure off its foundation.



12. Main Street. Frame house floated off foundation and moved 20-30 feet.



13. House on Clear Water Street still flooded.



14. House on Clear Water Street still flooded.



15. Remains of Rivertrace Restaurant along bank of Flint River at State Route 37 Bridge

BPAT FIELD REPORT

Date: July 26, 1994
Prepared By: Robert L. Dooley & Charles E. Bornman
Subject: 1994 Flooding in South Georgia
Location: ALBANY, GA (Dougherty Co.)

We met with Todd Davison (Chief, Technical Assistance and Compliance branch, Washington, DC) at the FEMA Disaster Field Office on Roosevelt Street and discussed the areas that had been significantly impacted by flooding from the Flint River. The first area to be inspected was Albany State College, located off Radium Springs Road and State Route 62. The campus is laid out in a linear fashion and has minimal topographic relief across its length. Numerous buildings were inspected and found to have been subjected to flood depths of approximately 10 to 12 feet. An inspection of the levee that separates the campus from the Flint River revealed that two breaches had occurred, one behind a mens' dormitory adjacent to a set of tennis courts and the other at the southern end of an athletic field. Both breaches range in width from of 20 to 25 feet and both involved a loss of about 6 feet in the height of the levee.

There was one structure failure noted on the campus, that being in the area of the gymnasium. A one-story building consisting of brick-and-block construction had collapsed, apparently due hydrostatic pressure on the outside walls. It appears that the building had been constructed in such a manner as to prohibit the entrance of water. As a result, rising water created unequalized hydrostatic pressure and subsequently caused the wall to implode.

The next area inspected was around Martin Luther King Drive. This area included numerous commercial buildings and single-story, single-family residential structures. These structures were of either brick or frame construction with either slab-on-grade or crawlspace foundations. This area had been subjected to flood depths ranging from 4 to 6 feet. No visible signs of structural damage due to high floodwater velocities were evident.

The next area inspected was a commercial district located on Flint Street near Front Street. This area included single-story, slab-on-grade commercial buildings constructed of concrete block with brick facing. This area had been subjected to flood depths ranging from 1 to 2 feet. No visible signs of structural damage due to high floodwater velocities were evident. These businesses had already completed cleanup and were back in operation.

We then inspected a residential area in the northwest section of the city around 10th Avenue. This area contains primarily brick-faced, single-story residences but also has several two-story masonry apartments located near a local drainage canal. The area of single-story residences had sustained flood depths ranging from 2 to 5 feet due to local topography, while the apartment complexes sustained a 5-foot depth.

The next area visited was around Edgewood and Whispering Pines in the Northwest section of the city. The structures investigated included a masonry church and a masonry/frame two-story residence. Each appeared to have sustained a flood depth of about 3 to 4 feet with no apparent structural damage due to high floodwater velocities.

Mitigation Opportunities

Based on the observations made above, during our site visit of July 26, 1994, we identified the following opportunities for substantially reducing damages from possible future events:

- 1) The levees that were constructed to protect the college from flooding should be properly sized, constructed, and maintained (see Recommendation Worksheet on page C-7 of Appendix C). Adequate hydrologic and hydraulic analyses must be considered critical design elements. Proper construction techniques must be followed to ensure proper performance of the levee system during flooding events. Maintenance and inspection programs must be implemented in order to provide a long service life for the facility. A combination of levee improvement and reconstruction and flood closures may be an alternative to complete levee redesign and improvement.
- 2) In areas where minor flooding was observed, it may be feasible to dry-floodproof commercial buildings by providing portable flood barriers at door and window openings and sealing exterior walls against floodwater infiltrations.
- 3) Individual structures may be better off relocated, elevated in place, or bought out and reconstructed in another location. Because of the sheer numbers of flood-damaged structures in Albany alone, an alternative to elevating and/or relocating thousands of homes may be the construction of a flood control levee along the Flint River adjacent to this low-lying section of town or a combination of buyout and structural alternatives (e.g., buyout of buildings in the floodway and construction of a levee). A properly sized and constructed levee may be a solution to the flooding provided a complete hydrologic and hydraulic study is conducted and economic comparisons are made between levee construction and performing flood control at individual housing units.

PHOTOGRAPHS
for
ALBANY, GA



1. Blaylock Dormitory at Albany State College. High water mark indicated by arrow.



2. Hartnett Criminal Justice Building. High water mark indicated by arrow.



3. Looking toward gymnasium. Levee at left.



4. Dormitory adjacent to Blaylock Dormitory. Interior goods and furnishings damaged by floodwaters.



5. Sanford Hall gymnasium and pool. High water mark indicated by arrow.



6. Hattie Malone Infirmary. High water mark indicated by arrow.



7. Peace Hall. Interior goods and furnishings damaged by floodwaters.



8. Building failure near gymnasium. 4-inch block wall faced with brick collapsed.



9. Classroom building next to dining hall. Interior goods and furnishings damaged by floodwaters.



10. ROTC building. High water mark indicated by arrow.



11. Breach in levee near end of recreation field.



12. Temporary emergency levee at lower end of recreation field.



13. Single-family houses on King Drive near Gains Avenue. Interior goods and furnishings damaged by floodwaters.



14. Single-family houses on Flintside Drive. Flood depths reached 5 to 6 feet. All interior goods and furnishings damaged by floodwaters.



15. Martin Luther King Middle School. Interior goods and furnishings damaged by floodwaters.



16. Single-family house on Wadkins Street. Interior goods and furnishings damaged by floodwaters.



17. Two-story housing on Habersham Street. Interior goods and furnishings on lower level damaged by floodwaters.



18. Commercial buildings at Flint Street and Front Street. Floodwaters reached depths of approximately 2 feet, damaging interior goods and furnishings.



19. Single-family house on 10th Street. Interior goods and furnishings damaged by floodwaters.



20. Single-family houses on 10th Street. Interior goods and furnishings damaged by floodwaters.



21. Jamestown Apartments. Lower level flooded. Interior goods and furnishings damaged.



22. Willows Apartments. High water mark indicated by arrows.



23. Church near Whispering Pines at Edgewood Drive. Interior goods and furnishings damaged by floodwaters.



24. Single-family residence on Valley Street. Lower level flooded

BPAT FIELD REPORT

Date: July 27, 1994
Prepared By: Robert L. Dooley & Charles E. Bornman
Subject: 1994 Flooding in South Georgia
Location: MACON, GA (Bibb Co.)

We met with Major Ken Janney, Georgia Air Force Reserves, on Sunday July 24, 1994, to discuss the possibility of having someone on his staff or someone knowledgeable of the area delineate the areas of the city that had received damage by floodwaters from the Ocmulgee River and its tributaries. He indicated that he would have the map marked on Monday and that we could pick it up later in the week.

We returned to his office on July 27, 1994, to pick up the map. City personnel had also prepared a map and a printout indicating all damaged homes, commercial establishments, and drainage structures within the city limits.

The area first visited was a single-family residence located at 2595 N. Nancelon Circle off of Pierce Avenue (State Route 247). The house was a single-story brick structure with a partially exposed full basement located next to a drainage ditch. The high water mark indicated that the floodwaters reached a depth of about 12 to 15 feet at the house. Downstream of this house, and on the same drainage course, is the Bowman Creek Apartment complex. This is a two-story brick/frame structure with a crawlspace. It appears that the depth of flooding at the structure was about 7 to 8 feet. Neither structure appeared to have sustained structural damage as a result of high floodwater velocities.

The next area investigated was east of I-75 around Huntington Drive and Delano Street near the city's water treatment facility and the Ocmulgee River. There were numerous single-story, single-family residential structures within this area that had been damaged by rising waters. However, none of the structures inspected appeared to have been damaged by high floodwater velocities.

Savage Creek, located on the north side of the city, was inspected for water-damaged structures. Charter Lake Hospital, located along an impounded area of Savage Creek, did receive about a 4-foot flood depth according to the water mark along the lake side of the building. The hospital is a multi-level structure constructed of brick-and-block construction. There appeared to be no damage or failures associated with high-velocity floodwaters.

The next area investigated was located along Spencer Circle, Tyler Street, and St. Charles Avenue. This residential area is located behind the Pio Nono Plaza Shopping Center off Rocky Creek Road. The area consists of single-story, single-family structures with a mixture of masonry and non-masonry construction. The foundations were a mixture of crawlspace and slab-on-grade construction. Flooding depths varied from 2 to 4 feet, depending on structure location. None of the structures exhibited flotation or lateral displacement due to flooding.

The Pio Nono Plaza shopping center located off Pio Nono Drive was inspected for flood damage. The center has a drainage course that runs parallel with and then crosses under Pio Nono Drive. Based on site observations, it appears that the depth of flooding did not exceed 2 feet. All of the businesses were open at the time of this visit.

Mitigation Opportunities

Based on the observations made above, during our site visit of July 27, 1994, we identified the following opportunities for substantially reducing damages from possible future events:

- 1) In view of the depths of flooding experienced widely throughout the city, it is our opinion that a complete hydrologic and hydraulic study should be undertaken to determine the storm recurrence frequency and to determine the flood levels that would be expected at design flood.
- 2) In areas where minor flooding was observed, it may be feasible to dry-floodproof commercial buildings by providing portable flood barriers at door and window openings and sealing exterior walls against floodwater infiltration.
- 3) Individual structures subject to inundation levels which could not be handled by flood closure devices, may be better off relocated, elevated in place, or bought out and reconstructed in another location. In addition, channel improvements to improve flow characteristics, or other such flood control measures, if economically feasible, may be appropriate.

PHOTOGRAPHS
for
MACON, GA



1. Single-family residence at 2595 N. Nancelot Circle. High water mark indicated by arrow.



2. Bowman Creek Apartments on Pierce Avenue. Lower level flooded. Interior goods and furnishings damaged.



3. Homes along Huntington Drive at Delano Street near water treatment plant.
High water mark indicated by arrow.



4. Single-family house on Spencer Circle. Minor water damage.



5. Single-family house on St. Charles Place. Minor water damage to interior goods and furnishings.



6. Pio Nono Plaza. Minor flood damage to interior goods and furnishings.



7. 4509 Pinedale. Minor water damage.

APPENDIX B

DPAT FIELD ASSESSMENT
SUMMARY SHEETS AND PHOTOGRAPHS

LAKE BLACKSHEAR DAM

IHMT DPAT FIELD ASSESSMENT SUMMARY SHEET

Site Information

- Structure Name: Lake Blackshear Dam
- Structure Location (City/County): Crisp County
- Date and Time of Visit: July 25, 1994, a.m.
- Individual(s) Contacted: Steve Rentfrow, General Manager, Crisp County Power Commission
- Average Amount of Rainfall Received in a 24-hour period (source): Approximately 11 to 20 inches (Steve Rentfrow)

Structure Information

- Type of Dam or Levee: Earthfill with multi-gated spillway
- Owner: Crisp County Power
- Owner Type (Federal, State, local, private): local
- State Hazard Category (I, II, exempt): Exempt (FERC regulated)
- Responsible Regulatory Agency: FERC
- Approximate Maximum Height: 31 feet
- Stream/Flooding Source: Flint River
- Approximate Spillway Design Floodflow: 90,000 cfs
- Approximate Year Constructed: 1927
- Primary Purpose/Use (flood control, recreation, power generation, farming): Power generation
- Observed Dam Material: Primarily fine sands with some areas of silty to clayey fine sands

- **Previous Repairs/Retrofits Accomplished:** Geotechnical report by Law (Feb. 11, 1977). Downstream drain system installed about 30 years ago and instrumentation installed between Stations 7 and 16. Steve Rentfrow indicated past problems with "piping" near Station 17.

Failure/Successful Performance Modes

- **Possible Mode of Failure (overtopping, breach):** Eyewitness accounts indicate dam was overtopped, eroded, and breached between Stations 7 and 13. High-velocity flows concentrated in this area, which was armored with riprap, apparently contributed to the failure. It was reported that the dam was overtopped by 0.1 foot for 30 minutes when the failure occurred. The gates were reported to be completely open from mid-day, July 6, 1994, through the failure on July 9, 1994. The tailwater was reported to be about 3 feet below the pool level at the time of failure. Based on these accounts, the piping discussed earlier did not contribute to the failure.
- **Observations of other possible failure mechanisms:** Piping (see above) and slope sloughing were observed along the downstream slope.
- **Approximate Date and Time of Failure:** July 9, 1994
- **Observed Impacts of Failure in Pool Reach (life, property, infrastructure):** Downstream flooding along Flint River, flooding of residences along the reservoir rim, loss of power generation, and loss of recreation in reservoir
- **Observed Impact of Failure in Downstream Reach (life, property, infrastructure):** No observed impacts



1. Downstream side of dam showing riprap embankment failure area.



2. Looking upstream at dam across embankment failure area.



3. View along embankment showing failure area (foreground) and remaining embankment (background).



4. Lake area after loss of water; dock indicates original water level.

**LAKE HANCOCK DAM
AND ADJACENT DAM**

IHMT DPAT FIELD ASSESSMENT SUMMARY SHEET

Site Information

- Structure Name: Lake Hancock Dam
- Structure Location (City/County): Americus, Sumter County
- Date and Time of Visit: July 25, 1994, p.m.
- Individual(s) Contacted: Bryan Bodine, Sheriff's Department
- Maximum Amount of Rainfall Received in a 24-hour period (source): 21.1 inches (NOAA)

Structure Information

- Type of Dam or Levee: Earthfill
- Type of Spillway: Rectangular drop inlet with RCP outlet and two concrete slab emergency spillways
- Owner: Unknown
- Owner Type (Federal, State, local, private): Private
- State Hazard Category (I, II, exempt): II
- Responsible Regulatory Agency: None
- Approximate Maximum Height: 10 feet
- Stream/Flooding Source: Town Creek
- Approximate Spillway Design Floodflow: Unknown
- Approximate Year Constructed: Unknown, but estimated to be more than 30 years old

- **Primary Purpose/Use (flood control, recreation, power generation, farming):**
Recreation
- **Previous Repairs/Retrofits Accomplished:** Unknown

Failure/Successful Performance Modes

- **Damage Assessment:** Lake Hancock Dam did not breach but sustained severe downstream erosion beneath the emergency spillways and slope due to overtopping. Observed three or four possible piping holes along eroded downstream slope. Observed organics in the embankment fill. Earth dam downstream of Lake Hancock was breached with no sign of spillway structure. Observed damage to downstream floodplain.
- **Approximate Date and Time of Failure:** July 6, 1994, early a.m.
- **Observed Impacts of Failure in Pool Reach:** Loss of recreation opportunity
- **Impact of Failure in Downstream Reach:** Reported downstream flooding in Americus, but the extent to which dam failure contributed to this flooding is unknown.



1. Eroded embankment on downstream dam face.



2. Eroded embankment, damaged road, and small failed pond on right.

UNNAMED LAKE DAM NO. 1

IHMT DPAT FIELD ASSESSMENT SUMMARY SHEET

Site Information

- Structure Name: Unnamed Lake Dam No. 1
- Structure Location (City/County): Americus, Sumter County
- Date and Time of Visit: July 26, 1994, PM
- Individual(s) Contacted: Brian Bodine, Sheriff's Department
- Maximum Amount of Rainfall Received in a 24-hour period (source): 21.1 inches (NOAA)

Structure Information

- Type of Dam: Earth
- Type of Spillway: observed CMP riser. Could not observe outlet. Farm workers indicated pipe(s) existed on the right abutment serving as emergency spillway.
- Owner: Unknown. Dam located on private farm
- Owner Type (Federal, State, local, private): Private
- State Hazard Category (I, II, exempt): Exempt
- Responsible Regulatory Agency: None
- Approximate Maximum Height: 20 feet
- Stream/Flooding Source: Town Creek upstream of Lake Hancock
- Approximate Spillway Design Floodflow: Unknown
- Approximate Date Constructed: Unknown
- Primary Purpose/Use (flood control, recreation, power generation, farming):
Recreation

- **Observed Dam Material:** Clayey sand
- **Previous Repairs/Retrofits Accomplished:** Unknown

Failure/Successful Performance Modes

- **Damage Assessment:** Dam breached to left of riser. Breach width on order of 100 feet wide. From farm workers' account, dam would have been overtopped by at least 3 to 4 feet.
- **Approximate Date and Time of Failure:** July 5, 1994, p.m.
- **Observed Impacts of Failure in Pool Reach (life, property, infrastructure):** Loss of reservoir and recreation potential
- **Observed Impact of Failure in Downstream Reach (life, property, infrastructure):** Reported downstream flooding in Americus, but the extent to which dam failure contributed to this flooding is unknown.



1. Lake area after loss of water



2. Lake area after loss of water

UNNAMED LAKE DAM NO. 2

IHMT DPAT FIELD ASSESSMENT SUMMARY SHEET

Site Information

- Structure Name: Unnamed Lake Dam No. 2
- Structure Location (City/County): Americus, Sumter County
- Date and Time of Visit: July 26, 1994, p.m.
- Individuals Contacted: Bryan Bodine, Sheriff's Department
- Maximum Amount of Rainfall Received in a 24-hour period (source): 21.1 inches (NOAA)

Structure Information

- Type of Dam: Earthfill
- Type of Spillway: Observed remnants of CMP downstream of breach
- Owner: Unknown
- Owner Type (Federal, State, local, private): Unconfirmed, but likely private
- State Hazard Category (I, II, exempt): Exempt
- Responsible Regulatory Agency: None
- Approximate Maximum Height: 25 feet
- Stream/Flooding Source: Town Creek upstream of Unnamed Dam No. 1
- Approximate Spillway Design Floodflow: Unknown
- Approximate Year Constructed: Unknown, but estimated to be more than 30 years old
- Primary Purpose/Use (flood control, recreation, power generation, farming): Unconfirmed, but likely recreation
- Observed Dam Material: Silty to clayey fine sand

- Previous Repairs/Retrofits Accomplished: Unknown

Failure/Successful Performance Modes

- **Damage Assessment:** Dam is breached at probable location of spillway structure. Breach width of more than 100 feet. Gated lake drain (two to three 4-inch metal pipes) observed to left of breach. Observed trees on embankment and wood organics mixed with embankment soil. Appears that a second breach may exist in the embankment to the right of the first breach, but team could not reach that location.
- **Approximate Date and Time of Failure:** Unknown
- **Observed Impacts of Failure in Pool Reach (life, property, infrastructure):** Loss of reservoir and recreation potential
- **Impact of Failure in Downstream Reach (life, property, infrastructure):** Reported downstream flooding may have contributed to failure of downstream dams and flooding in Americus to some unknown extent. Overtopping and failure of county road downstream of dam appear to have partially resulted from the dam failure.



1. Site of breached dam



2. Lake area after loss of water

BROWN'S MILL POND DAM

IHMT DPAT FIELD ASSESSMENT SUMMARY SHEET

Site Information

- Structure Name: Brown's Mill Pond Dam
- Structure Location (City/County): Americus, Sumter County
- Date and Time of Visit: July 26, 1994, p.m.
- Individual(s) Contacted: Bryan Bodine, Sheriff's Department
- Maximum Amount of Rainfall Received in a 24-hour period (source): 21.1 inches (NOAA)

Structure Information

- Type of Dam: Earthfill with partial upstream concrete wall to left of breach (looking downstream)
- Type of Spillway: Could not be determined from visual observations.
- Owner: Unknown
- Owner Type (Federal, State, local, private): Private
- State Hazard Category (I, II, exempt): Exempt
- Responsible Regulatory Agency: None
- Approximate Maximum Height: 15 feet
- Stream/Flooding Source: Lime Creek Watershed
- Approximate Spillway Design Floodflow: Unknown
- Approximate Year Constructed: Unknown, but estimated to be more than 50 years old
- Primary Purpose/Use (flood control, recreation, power generation, farming): Original purpose was power for a mill. Current use is limited to recreation.
- Observed Dam Material: Silty to clayey fine sand

- Previous Repairs/Retrofits Accomplished: Unknown

Failure/Successful Performance Modes

- **Damage Assessment:** Dam is breached at probable location of spillway structure. Breach width of more than 100 feet. Observed decaying wood within the breached section that appears to be part of the structure of a cofferdam left in place. Observed deep erosion holes on upstream right abutment.
- **Approximate Date and Time of Failure:** July 6, 1994, p.m.
- **Observed Impacts of Failure in Pool Reach (life, property, infrastructure):** Loss of reservoir and recreation potential; loss of roadway access and water line across embankment
- **Impact of Failure in Downstream Reach (life, property, infrastructure):** Drawdown of the lake during rapid failure of the dam may have contributed to failure of a road/bridge crossing through the lake, leading to the loss of three lives.



1. Breached dam; purpose of timber pilings near bottom of photo unknown (possibly cofferdam)



2. Lake area after loss of water

WHITEWATER PARK LAKE DAM

IHMT DPAT FIELD ASSESSMENT SUMMARY SHEET

Site Information

- Structure Name: Whitewater Park Lake Dam
- Structure Location (City/County): Near Montezuma, Macon Co.
- Date and Time of Visit: July 25, 1994, p.m.
- Individual(s) Contacted: Gerald Abbott, Macon County Emergency Coordinator
- Maximum Amount of Rainfall Received in a 24-hour period (source): 10.7 inches (NOAA)

Structure Information

- Type of Dam: Earthfill
- Type of Spillway: Multi-gated, concrete spillway
- Owner: Macon County
- Owner Type (Federal, State, local, private): Local
- State Hazard Category (I, II, exempt): II
- Responsible Regulatory Agency: None
- Approximate Maximum Height: 15
- Stream/Flooding Source: Unnamed Tributary to Flint River
- Approximate Spillway Design Floodflow: Unknown
- Approximate Date Constructed: Early 1900s
- Primary Purpose/Use (flood control, recreation, power generation, farming): Recreation (former power generation dam)
- Observed Dam Material: Clayey sand embankment

- Previous Repairs/Retrofits Accomplished: Unknown

Failure/Successful Performance Modes

- **Damage Assessment:** Indications are that the dam was overtopped, eroded, and breached. The old gates in the principal spillway could not be opened to allow additional flow out of the lake. Because of limited access, damage to the spillway could not be assessed.
- **Approximate Date and Time of Failure:** July 5, 1994, 8:00 p.m.
- **Observed Impacts of Failure in Pool Reach (life, property, infrastructure):** Loss of recreational opportunity
- **Observed Impact of Failure in Downstream Reach (life, property, infrastructure):** No observed impacts



1. Looking upstream at dam breach area

LOWER LEISURE (WILKINSON) LAKE DAM

IHMT DPAT FIELD ASSESSMENT SUMMARY SHEET

Site Information

- Structure Name: Lower Leisure (Wilkinson) Lake Dam
- Structure Location (City/County): Warner Robins, Houston Co.
- Date and Time of Visit: July 26, 1994, a.m.
- Individual(s) Contacted: James Williams, Houston County Emergency Coordinator
- Maximum Amount of Rainfall Received in a 24-hour period (source): 8.7 inches (NOAA)

Structure Information

- Type of Dam: Earthfill
- Type of Spillway: Gated brick overflow spillway with concrete bridge emergency spillway
- Owner: Unknown
- Owner Type (Federal, State, local, private): Private
- State Hazard Category (I, II, exempt): II
- Responsible Regulatory Agency: None
- Approximate Maximum Height: 15 feet
- Stream/Flooding Source: Sandy Spring
- Approximate Spillway Design Floodflow: Unknown
- Approximate Date Constructed: 1930s
- Primary Purpose/Use (flood control, recreation, power generation, farming): Recreation
- Observed Dam Material: Red, clayey sand predominant with some gray-tan fine sand

- Previous Repairs/Retrofits Accomplished: Unknown

Failure/Successful Performance Modes

- **Damage Assessment:** Indications are that the dam was overtopped, eroded, and breached. The old gates in the principal spillway could not be opened to allow additional flow out of the lake. Other possible contributing factors included vegetation on the embankment and utilities in the embankment.
- **Approximate Date and Time of Failure:** July 5, 1994, 11:00 p.m.
- **Observed Impacts of Failure in Pool Reach (life, property, infrastructure):** Loss of recreational opportunities
- **Observed Impact of Failure in Downstream Reach (life, property, infrastructure):** No observed impacts



1. Top view of gates that failed to open



2. Front view of gates



3. Dam breach area showing replaced utility lines



4. Closeup of embankment at breach

UPPER LEISURE (WEST REACH) LAKE DAM

IHMT DPAT FIELD ASSESSMENT SUMMARY SHEET

Site Information

- Structure Name: Upper Leisure (West Reach) Lake Dam
- Structure Location (City/County): Warner Robins, Houston Co.
- Date and Time of Visit: July 26, 1994, a.m.
- Individual(s) Contacted: James Williams, Houston County Emergency Coordinator
- Maximum Amount of Rainfall Received in a 24-hour period (source): 8.7 inches (NOAA)

Structure Information

- Type of Dam: Broad earthfill (including homes on embankment)
- Type of Spillway: Concrete capped overflow spillway with concrete bridge emergency spillway
- Owner: Unknown
- Owner Type (Federal, State, local, private): Private
- State Hazard Category (I, II, exempt): I
- Responsible Regulatory Agency: Georgia DNR
- Approximate Maximum Height: 15 feet
- Stream/Flooding Source: Sandy Spring
- Approximate Spillway Design Floodflow: Unknown
- Approximate Date Constructed: 1978
- Primary Purpose/Use (flood control, recreation, power generation, farming): Recreation
- Observed Dam Material: Unknown (spillway embankment completely washed away)

- Previous Repairs/Retrofits Accomplished: Unknown

Failure/Successful Performance Modes

- **Damage Assessment:** Indications are that the capacity of the spillway was exceeded and the embankments were eroded, which undermined the spillway. The capacity of the emergency spillway was limited by a bridge built after completion of the spillway. Utilities in the spillway could have contributed to the failure.
- **Approximate Date and Time of Failure:** July 6, 1994, early a.m.
- **Observed Impacts of Failure in Pool Reach (life, property, infrastructure):** Loss of recreational opportunities; slumping of concrete hard edge around lake due to rapid drawdown of lake during failure
- **Observed Impact of Failure in Downstream Reach (life, property, infrastructure):** None (Lower Leisure Lake just downstream)



1. Control structure on one arm of lake



2. Closeup of control structure showing clogged openings



3. Failure area



4. Failure area, opposite view

LAKE HOUSTON DAM

IHMT DPAT FIELD ASSESSMENT SUMMARY SHEET

Site Information

- Structure Name: Lake Houston Dam
- Structure Location (City/County): near Warner Robins, Houston Co.
- Date and Time of Visit: July 26, 1994, p.m.
- Individual(s) Contacted: James Williams, Houston County Emergency Coordinator
- Maximum Amount of Rainfall Received in a 24-hour period (source): 8.7 inches (NOAA)

II. Structure Information

- Type of Dam: Earthfill
- Type of Spillway: Multi-gated spillway on rubble fill
- Owner: Unknown
- Owner Type (Federal, State, local, private): Private
- State Hazard Category (I, II, exempt): II
- Responsible Regulatory Agency: None
- Approximate Maximum Height: 20 feet
- Stream/Flooding Source: Tributary to Indian Creek
- Approximate Spillway Design Floodflow: Unknown
- Approximate Date Constructed: Unknown, but estimated to be over 100 years old
- Primary Purpose/Use (flood control, recreation, power generation, farming): Recreation (formerly power generation)
- Observed Dam Material: Clayey sand embankment
- Previous Repairs/Retrofits Accomplished: Unknown

Failure/Successful Performance Modes

- **Damage Assessment:** The capacity of the spillway was exceeded, and the pool overtopped the dam causing erosion and eventually breaching of the dam. The timber foundations of unknown structures were found in the dam which may have contributed to the failure. Utilities in the embankment may also have contributed to the failure. The gates in the spillway could not be opened to increase the capacity.
- **Approximate Date and Time of Failure:** July 6, 1994
- **Observed Impacts of Failure in Pool Reach (life, property, infrastructure):** Loss of recreational opportunities
- **Observed Impact of Failure in Downstream Reach (life, property, infrastructure):** Downstream road washout



1. Failed dam structure



2. Looking upstream across failure area; purpose of wood piles unknown



3. View of failure area on opposite bank



4. Closeup of opposite bank failure; purpose of wood pilings unknown

LAKE TOBESOFKEE DAM

IHMT DPAT FIELD ASSESSMENT SUMMARY SHEET

Site Information

- Structure Name: Lake Tobesofkee Dam
- Structure Location (City/County): Macon, Bibb County
- Date and Time of Visit: July 26, 1994, p.m.
- Individual(s) Contacted: Jeff Landress, Kyle Steele, Frank Patterson
- Maximum Amount of Rainfall Received in a 24-hour period (source): 9.73 inches (NOAA)

Structure Information

- Type of Dam: Earthfill with concrete section for gated spillway
- Type of Spillway: Two automatic gates.
- Owner: Bibb County
- Owner Type (Federal, State, local, private): Local
- State Hazard Category (I, II, exempt): Exempt: Federally maintained.
- Responsible Regulatory Agency: Maintained and inspected annually by SCS.
- Approximate Maximum Height: 40+ feet
- Stream/Flooding Source: Tobesofkee Creek
- Approximate Spillway Design Floodflow: Unknown. Operator reports one gate will pass 100-year flood.
- Approximate Year Constructed: 1964-1966
- Primary Purpose/Use: Recreation, flood control (original function)
- Observed Dam Material: Unknown

- **Previous Repairs/Retrofits Accomplished:** Rehabilitation of gates was occurring during the site visit of July 26, 1994.

Failure/Successful Performance Modes

- **Damage Assessment:** None observed. Dam was not overtopped.
- **Approximate Date and Time of Failure:** No failure
- **Observed Impacts in Pool Reach:** Upstream flooding around reservoir rim and loss of boats and boatramps
- **Impact to Downstream Reach:** Reported downstream flooding of several residences and washout of a roadway bridge from spillway releases; observed damage to vegetation and erosion along streambanks
- **Remarks:** Operator reported problems with the automatic gates occurred during the flooding that necessitated a switch to manual operation. No formal early warning system exists, and no hydrologic/hydraulic information exists that would assist the operator in making decisions on gate operation and spillway releases. A telephone call from an upstream resident alerted the operator of an impending flood wave crest in the pool area. As a result, the Operator opened spillway gates in order to prevent the dam from overtopping. Operator reported pool level rose to within about 6 inches of the crest.



1. Electronic gate system did not work; mechanism had to be operated manually



2. Gate counterweight



3. Downstream erosion

HIGH FALLS DAM

IHMT DPAT FIELD ASSESSMENT SUMMARY SHEET

Site Information

- Structure Name: High Falls Dam
- Structure Location (City/County): High Falls State Park, Monroe/Butts County
- Date and Time of Visit: July 27, 1994, p.m.
- Individual(s) Contacted: Receptionist
- Maximum Amount of Rainfall Received in a 24-hour period (source): Unknown

Structure Information

- Type of Dam: Masonry
- Type of Spillway: Two overflow sections
- Owner: State of Georgia
- Owner Type (Federal, State, local, private): State
- State Hazard Category (I, II, exempt): Category I
- Responsible Regulatory Agency: Georgia DNR
- Approximate Maximum Height: 35 feet (estimated visually)
- Stream/Flooding Source: Towaliga River
- Approximate Spillway Design Floodflow: Unknown
- Approximate Year Constructed: Late 1800s
- Primary Purpose/Use: Recreation (original purpose was power)
- Observed Dam Material: Dam is founded on rock.
- Previous Repairs/Retrofits Accomplished: State DNR reports that dam was tied down to foundation with rock anchors in recent years.

Failure/Successful Performance Modes

- **Damage Assessment:** Both dam abutments exhibited erosion along the dam-abutment contact.
- **Approximate Date and Time of Failure:** No failure
- **Observed Impacts of Failure in Pool Reach:** Minor flooding of ranger station above dam right abutment
- **Observed Impacts in Downstream Reach:** Washout of pedestrian bridge downstream



1. Dam remained intact; erosion at dam abutment



2. Erosion at dam abutment

BARNESVILLE WATER SUPPLY DAM

IHMT DPAT FIELD ASSESSMENT SUMMARY SHEET

Site Information

- Structure Name: Barnesville Water Supply Dam
- Structure Location (City/County): Barnesville, Lamar County
- Date and Time of Visit: July 26, 1994, p.m.
- Individual(s) Contacted: Kenneth Roberts, Billy Campbell, R.L. Carreker
- Maximum Amount of Rainfall Received in a 24-hour period (source): 15 inches estimated by City staff.

Structure Information

- Type of Dam: Earthfill
- Type of Spillway: Concrete lined overflow spillway along right abutment
- Owner: City of Barnesville
- Owner Type (Federal, State, local, private): Local
- State Hazard Category (I, II, exempt): Exempt: Category II
- Responsible Regulatory Agency: None
- Approximate Maximum Height: 21 feet
- Stream/Flooding Source: Lake Edie
- Approximate Spillway Design Floodflow: Unknown
- Approximate Year Constructed: 1952-1953
- Primary Purpose/Use: Water supply
- Observed Dam Material: Clayey sand

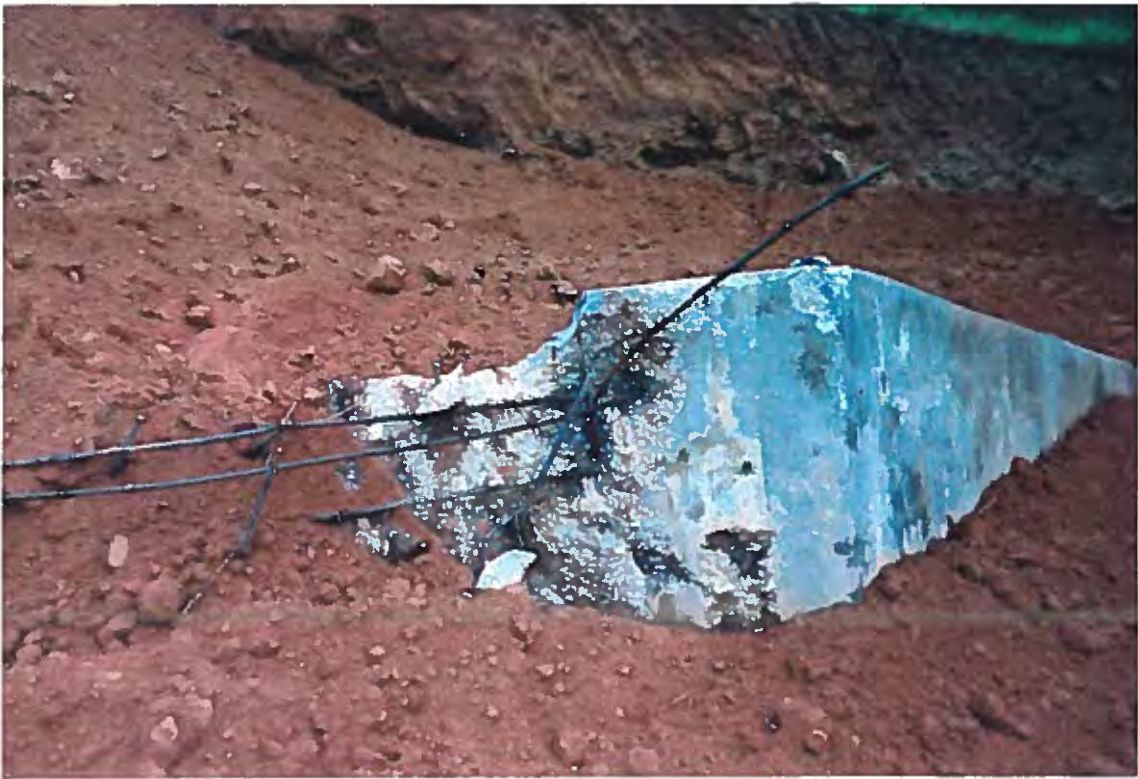
- **Previous Repairs/Retrofits Accomplished:** Following the dam breach, the city instituted temporary emergency repairs to maintain the water supply. These consisted of an earth cofferdam across the breach and an armored emergency spillway excavated along the left abutment.

Failure/Successful Performance Modes

- **Damage Assessment:** Dam was reportedly overtopped by 4 to 5 feet of water and breached following severe erosion at left wingwall of emergency spillway. Erosion was reported as about 30 feet deep extending into the dam foundation. Left side of emergency spillway failed.
- **Approximate Date and Time of Failure:** July 6, 1994, a.m.
- **Observed Impacts in Pool Reach:** Temporary loss of water supply
- **Impact to Downstream Reach:** Reported downstream flooding of Monroe County. Bridge downstream remained intact.
- **Remarks:** City has retained an engineering firm to expand reservoir capacity. Conceptual drawings were provided by the firm.



1. Dam breach area



2. Dislodged and damaged wingwall



3. View along top of embankment showing vegetation

SENOIA WATER SUPPLY DAM

IHMT DPAT FIELD ASSESSMENT SUMMARY SHEET

Site Information

- Structure Name: Senoia Water Supply Dam
- Structure Location (City/County): Senoia, Coweta Co.
- Date and Time of Visit: July 27, 1994, p.m.
- Individual(s) Contacted: Lester H. Mann, Jr., Mayor
- Maximum Amount of Rainfall Received in a 24-hour period (source): 7.0 inches (NOAA)

Structure Information

- Type of Dam: Earthfill
- Type of Spillway: Concrete pipe riser with bridged emergency spillway
- Owner: City of Senoia
- Owner Type (Federal, State, local, private): Local
- State Hazard Category (I, II, exempt): II
- Responsible Regulatory Agency: None
- Approximate Maximum Height: 20 feet
- Stream/Flooding Source: Line Creek
- Approximate Spillway Design Floodflow: Unknown
- Approximate Date Constructed: 1940s
- Primary Purpose/Use (flood control, recreation, power generation, farming):
Water supply and recreation
- Observed Dam Material: Silty clay
- Previous Repairs/Retrofits Accomplished: Unknown

Failure/Successful Performance Modes

- **Damage Assessment:** Spillway pool rose above top of dam, causing erosion and eventually breaching. Utilities in the embankment may have contributed to the failure.
- **Approximate Date and Time of Failure:** July 5, 1994
- **Observed Impacts of Failure in Pool Reach (life, property, infrastructure):** Loss of recreational opportunities and water supply
- **Observed Impact of Failure in Downstream Reach (life, property, infrastructure):** Dam also included road that failed, limiting access to some properties.



1. Breached section of dam and damaged road



2. Closeup of breach area

IRIS "B" LAKE DAM

IHMT DPAT FIELD ASSESSMENT SUMMARY SHEET

Site Information

- Structure Name: Iris "B" Lake Dam
- Structure Location (City/County): Henry Co.
- Date and Time of Visit: July 27, 1994, p.m.
- Individual(s) Contacted: Jim O'Neal, Assistant Director of Roads
- Maximum Amount of Rainfall Received in a 24-hour period (source): 7.0 inches (NOAA)

Structure Information

- Type of Dam: Earthfill
- Type of Spillway: Hooded, CMP-riser
- Owner: Unknown
- Owner Type (Federal, State, local, private): Unknown (possibly public)
- State Hazard Category (I, II, exempt): I
- Responsible Regulatory Agency: None
- Approximate Maximum Height: 25 feet
- Stream/Flooding Source: Unnamed tributary
- Approximate Spillway Design Floodflow: Unknown
- Approximate Date Constructed: Unknown
- Primary Purpose/Use (flood control, recreation, power generation, farming):
Recreation
- Observed Dam Material: Red silty clay embankment

- **Previous Repairs/Retrofits Accomplished:** Plans developed to repair dam after damage in 1990 storm. Plans under revision to reduce \$500,000 construction fee.

Failure/Successful Performance Modes

- **Damage Assessment:** Small outlet was not adequate to convey storm runoff. Overtopping caused erosion and eventual failure of the embankment. The steep downstream slope (i.e., 1:1) may have contributed to the failure. Evidence of piping was observed on the downstream face of the embankment.
- **Approximate Date and Time of Failure:** July 5, 1994
- **Observed Impacts of Failure in Pool Reach (life, property, infrastructure):** Loss of recreational opportunity
- **Observed Impact of Failure in Downstream Reach (life, property, infrastructure):** No observed impacts



1. Failed section of dam and road



2. Closeup of dam breach area



3. Undersized outlet

APPENDIX C

BPAT AND DPAT RECOMMENDATION WORKSHEETS

BPAT RECOMMENDATION WORKSHEET

1) **Issue:** Residential Structure Flooding

2) **Background:** Within the areas visited, numerous single-family structures sustained varying levels of water damage as a direct result of rising floodwaters. These structures were constructed of traditional building materials, either brick-and-block or frame construction with varying interior finishes. A majority of these structures were partially elevated over crawlspace foundations. However, some slab-on-grade construction was noted.

In many cases during the site visit, it was noted that the interiors of the structures were being or had been stripped of materials that had been damaged by floodwaters. The materials included drywall, wood paneling, insulation, carpet and padding, and furnishings, including appliances and personal belongings. Many residents were rebuilding damaged portions of their structures.

A review of the Flood Insurance Rate Maps (FIRMs) for the visited areas indicated that many of the structures receiving water damage were within the Special Flood Hazard Area (SFHA), i.e., the 100-year floodplain. Some homes inundated by the floodwaters appeared to be outside the SFHA. It should be noted that the recurrence interval for this flood event has yet to be determined.

3) **Work Element:** Several types of mitigation measures are available to reduce and/or eliminate flood damage as follows:

A. Residential buildings could be elevated above the flood level. Elevating a building originally constructed on a crawlspace foundation could be accomplished by increasing the height of the existing foundation walls. A slab-on-grade building could be elevated on fill (provided the building is not in the floodway) or raised and placed on a newly constructed crawlspace foundation. Either measure (dry floodproofing or structural elevation) could be employed for both isolated and grouped buildings.

B. Regarding structures that received a greater degree of flood damage, isolated and small clusters of residential structures could be elevated above the design flood level. In areas that include large groups of structures, an on-site levee or similar flood control measure could be used.

C. For structures located downstream of or on an impoundment, corrective mitigation measures entail 1) promulgation of ordinances that would prohibit the construction of structures within the hazard reach for impoundment breach and 2) the construction of homes with lowest floor elevations several feet above the top of impoundment design elevation.

4) **Lead Agency:** (To be determined by IHMT)

- 5) **Support Agency(ies):** (To be determined by IHMT)
- 6) **Funding:** (To be determined by IHMT)
- 7) **Schedule:** (To be determined by IHMT)

BPAT RECOMMENDATION WORKSHEET

1) **Issue:** Commercial Structure Flooding

2) **Background:** Several commercial establishments within the areas visited sustained varying levels of water damage as a direct result of rising floodwaters. These structures were generally constructed of masonry building materials, either brick or concrete block, with varying interior finishes. The majority of these structures had lowest floors that were concrete slabs constructed on grade. However, a few of the older structures had wooden floors with a small crawlspace beneath. One commercial establishment completely destroyed by floodwaters was a wood-frame structure constructed on a concrete block foundation on the banks of the river.

During the site visit, it was noted that many of the commercial structures had been placed back into service or that owners were making needed repairs. The interiors of the structures were being or had been stripped of materials that had been damaged by floodwaters.

A review of the FIRMs for the visited areas indicated that many of the commercial structures were within the SFHA. Some structures that had been impacted by the floodwaters appeared to be outside the SFHA. In most of these instances, it appeared that localized flooding and overtopping of drainageways had occurred.

3) **Work Element:** Several types of mitigation measures are available to reduce and/or eliminate flood damage as follows:

A. In areas where minor flooding (i.e., flood depths of less than 3 feet) was observed, it may be feasible to dry-floodproof commercial buildings by providing portable flood barriers at door and window openings and sealing exterior walls against floodwater infiltration. If dry floodproofing is to be employed, an analysis must be performed to determine whether the walls are capable of withstanding the hydrostatic, hydrodynamic, and impact loads caused by floodwaters. An alternative, but more permanent, measure is to elevate the building above the flood level. Elevating a building originally constructed on a crawlspace foundation could be accomplished by increasing the height of the existing foundation walls. A slab-on-grade building could be elevated on fill (provided the building is not in the floodway) or raised and placed on a newly constructed crawlspace foundation. Either measure (dry floodproofing or structural elevation) could be employed for both isolated and grouped buildings.

B. For commercial structures that received a greater degree of flood damage, an on-site levee or similar flood control measure could be used.

4) **Lead Agency:** (To be determined by IHMT)

5) **Support Agency(ies):** (To be determined by IHMT)

6) **Funding:** (To be determined by IHMT)

7) **Schedule:** (To be determined by IHMT)

BPAT RECOMMENDATION WORKSHEET

1) **Issue:** Public Facilities Structure Flooding

2) **Background:** Several public facilities sustained varying levels of water damage as a direct result of rising floodwaters. These facilities included a hospital, a college campus, and numerous schools. All of these structures were generally constructed of masonry building materials, either brick or concrete block, with varying interior finishes and floors that were concrete slabs constructed on grade. Only one building had collapsed as a result of floodwaters. A college campus building, apparently an athletic dressing room, had collapsed, apparently because of excessive unequalized hydrostatic pressure on the structure walls. It appeared that because of a lack of apertures for water to enter the structure, an equalized pressure across the wall could not be maintained. These structures were being cleaned and being stripped of materials that had been damaged by water. None of the structures had been placed back in operation.

A review of the FIRMs for the visited areas indicated that many of these public facilities structures were within the SFHA. Some structures that had been impacted by the floodwaters appeared to be outside the SFHA. In most of these instances, it appeared that localized flooding and overtopping of drainage ways had occurred. One hospital that had been damaged was located on a small impoundment and had been flooded to a depth of about 2 feet as a result of rising water elevations behind the dam. It should be noted that the recurrence interval for this particular flood event has yet to be determined.

3) **Work Element:** Several types of mitigation measures are available to reduce and/or eliminate flood damage as follows:

A. In areas where minor flooding (i.e., flood depths of less than 3 feet) was observed, it may be feasible to dry-floodproof buildings by providing portable flood barriers at door and window openings and sealing exterior walls against floodwater infiltration. If dry floodproofing is to be employed, an analysis must be performed to determine whether the walls are capable of withstanding the hydrostatic, hydrodynamic, and impact loads caused by floodwaters. An alternative, but more permanent, measure is to elevate the building above the flood level. Elevating a building originally constructed on a crawlspace foundation could be accomplished by increasing the height of the existing foundation walls. A slab-on-grade building could be elevated on fill (provided the building is not in the floodway) or raised and placed on a newly constructed crawlspace foundation. Either measure (dry floodproofing or structural elevation) could be employed for both isolated and grouped buildings.

B. For public facilities structures that received a greater degree of flood damage, an on-site levee, improvements to existing levees, or similar flood control measure could be implemented.

C. For structures located downstream of or on an impoundment, corrective mitigation measures entail 1) promulgation of ordinances that would prohibit the construction of structures within the hazard reach for impoundment breach and 2) the construction of buildings with lowest floor elevations several feet above the top of impoundment elevation.

- 4) **Lead Agency:** (To be determined by IHMT)
- 5) **Support Agency(ies):** (To be determined by IHMT)
- 6) **Funding:** (To be determined by IHMT)
- 7) **Schedule:** (To be determined by IHMT)

BPAT RECOMMENDATION WORKSHEET

- 1) **Issue:** Levee Maintenance
- 2) **Background:** During this disaster, several levees failed to contain the floodwater. Extensive damage, including severe breaches, occurred to these structures. A common thread running through these structural failures is that of improper and untimely maintenance and irregular inspections. Lack of maintenance of the surface structures as well as ancillary structures such as flap gates, closures, and pump stations contributed to the failures. Objects foreign to structure design, such as tree roots and underground utilities were present, escalating erosion.
- 3) **Work Element:** Institute a levee inspection, evaluation, and maintenance program.
- 4) **Lead Agency:** Local government
- 5) **Support Agencies:** USACE, SCS, ASCS
- 6) **Funding:** Regular programs
- 7) **Schedule:** Ongoing -- initiate immediately

BPAT RECOMMENDATION WORKSHEET

1) **Issue:** Levee Rehabilitation -- Albany State College

2) **Background:** The campus of Albany State College is on the east bank of the Flint River in downtown Albany and contains 31 buildings with a gross floor area of approximately 700,000 square feet. The estimated value of the facilities is 80 million dollars. For flood protection, the college depends entirely on a levee built along the western boundary of the school grounds. The levee was built in the 1930s and does not conform to current engineering standards.

During the disaster, the levee was breached in three places on July 7, 1994, 4 days before the floodwater peaked on the Flint River. Prior to the initial breach, floodwater was observed backflushing through the stormdrain system and beginning to flood the campus. A few minutes after the initial breach, two more breaches appeared. After 45 minutes, the entire campus was inundated by several feet of water. Ultimately, the river crested near the elevation of the 500-year flood, above the elevation of the entire levee. Water depths in buildings ranged from 1.5 to 12 feet throughout the campus. The best estimate of the total flood damages is 36 million dollars, according to USACE preliminary figures.

At the request of FEMA, the USACE completed a levee study in which three rehabilitation alternatives were presented for the failed levee. The first alternative is essentially to repair the levee to its pre-storm level. The second alternative is to upgrade the levee to current design standards and raise the height of the levee to provide 3 feet of freeboard above the 100-year flood elevation. The third alternative is to upgrade the levee to current design standards and raise the height of the levee to provide 3 feet of freeboard above the 500-year flood elevation.

The USACE's recommendation is to repair the levee as soon as possible using alternative one. Although they recommended a study be done to determine a permanent solution, "there is every indication that the best plan could well be a combination levee/flood wall plan providing a level of protection somewhere between alternatives 2 and 3."

3) **Work Element:**

- | | | |
|-------------------|----|---|
| Short term | -- | Repair the damaged levee to its pre-storm elevation to provide protection during subsequent rehabilitation. |
| Intermediate term | -- | Rebuild the existing levee to the 100-year elevation plus 3 feet using current engineering standards. A new levee can be constructed without demolition of the old levee to allow flood protection during construction. |

4) **Lead Agency:** Georgia Board of Regents

5) **Support Agencies:** GEMA, FEMA, Albany State College, USACE

6) **Funding:** FEMA Infrastructure (construction)
Albany State College (maintenance)

7) **Schedule:** Complete within 1 year

BPAT RECOMMENDATION WORKSHEET

1) **Issue:** Levee Rehabilitation -- Montezuma Levee

2) **Background:** The USACE, Mobile District, constructed a levee in Montezuma in 1957 to protect the town from flooding from Beaver Creek and the Flint River. The levee was constructed at an elevation of 287 feet (NGVD), 2.7 feet higher than the flood of record. Around 1980 the Georgia Department of Transportation relocated the railroad from the center of town and reconstructed it on top of the levee. A portion of the levee was then reconstructed toward Beaver Creek, encroaching on the floodway and causing further constriction of flood flows.

On July 6, 1994, Beaver reek overtopped the levee on the northeast end and flooded the town. The floodwaters then overtopped the levee on the southern end and flowed outward toward Beaver Creek. During this event an outward section of the levee about 375 feet long and about 18 feet deep was scoured. Preliminary surveys indicate that the failure began with scour at the toe of the levee caused by high flow velocities and was intensified by overtopping of the levee above.

On July 8, 1994, the crest from the Flint River overtopped the levee again, causing a second flooding of the town, resulting in damages of \$13 million to 45 homes, 67 businesses, and major portions of the city's infrastructure. The USACE measured the floodwater elevations at 290.8 feet.

To allow the floodwaters to exit the town after the river subsided, a cut 6 feet deep and 25 feet wide was made in the levee. The cut was necessary due to the failure of the interior pumping system. The USACE is conducting a study to rehabilitate the levee under P.L. 84-99, which allows the reconstruction of the project to pre-disaster conditions.

FEMA has tasked the U.S. Geological Survey (USGS) to determine the 100-year flood elevation for the City of Montezuma for flooding from the Flint River.

3) **Work Element:** Request a floodplain reconnaissance study from the USACE to determine mitigation opportunities for protecting the city from future flooding.

4) **Lead Agency:** City of Montezuma

5) **Support Agency:** USACE, USGS, FEMA

6) **Funding:** USACE

7) **Schedule:** Initiate request immediately

DPAT RECOMMENDATION WORKSHEET

1) **Issue:** Unregulated Dams

2) **Background:** The Safe Dams Program of the Georgia DNR covers only a fraction of the dams in the state. Only non-Federal dams whose failure would result in loss of life are included in the State's program. Approximately 280 of the 4,500+ dams in DNR's dam inventory are currently subject to the State's dam safety regulations. Some dams (primarily large facilities) not regulated by the State are regulated, operated, or inspected by Federal agencies, including the U.S. Army Corps of Engineers (USACE), the Federal Energy Regulatory Commission (FERC), and the SCS. Most of the remaining dams are not regulated by any governmental agency.

This lack of regulation for many dams leads to a number of concerns:

- High variability between design standards and construction techniques used on different dams
- Low design and construction standards used on many dams
- Many older dams that do not meet current dam safety standards
- Unknown or unclear ownership/maintenance responsibilities for dams and impoundments
- Limited information (e.g., designs, plans, specifications) available on dam characteristics (e.g., design storm, hydrologic and hydraulic characteristics).

3) **Work Element:** Expand the regulatory program to cover additional dams whose failure would cause significant impacts. At the State level, develop a new intermediate dam hazard classification covering dams whose failure could cause significant economic or environmental impacts or threaten public facilities (including roads). The Georgia DNR would review proposed and existing dams to ensure that dams in this intermediate classification meet appropriate design standards, that Emergency Action Plans and Operation & Maintenance Plans are in place, and that these plans are followed.

For other dams not regulated by the State, establish standards and develop a program for review of studies and construction plans. The program could be implemented through a combination of local (county and municipal) agencies and local SCS offices.

Develop an expanded education program for owners/operators of existing and proposed dams. The program should include dam safety issues, requirements, regulations, roles, and responsibilities. Appropriate educational materials and training seminars should be prepared and provided to owners/operators through an aggressive outreach program.

- 4) **Lead Agency:** Georgia DNR
- 5) **Support Agency(ies):** USACE, SCS, FEMA, FERC
- 6) **Funding:** (To be determined by IHMT)
- 7) **Schedule:** (To be determined by IHMT)

DPAT RECOMMENDATION WORKSHEET

- 1) **Issue:** Flood Management Impacts of Impoundments
- 2) **Background:** The NFIP and the State's floodplain management program do not address the full range of issues related to dams and reservoirs. Some of the hydrologic and hydraulic effects of impoundments are included in the standard floodplain delineation techniques followed for the NFIP. However, inclusion of these impacts is typically limited to large facilities. Other impacts are often not included. These additional impacts include the following:
 - Flooding due to elevated reservoir pool water-surface elevations during extreme events
 - Downstream flooding within the limits of the danger reach during extreme events
 - Downstream flooding due to spillway releases during extreme events
 - Impacts of potential dam failures during 100-year flood events
 - Cumulative impact of dam failures in series and in parallel
- 3) **Work Element:** Evaluate alternative floodplain management techniques to manage the risks associated with all impacts of impoundments on development in and near the floodplain. Evaluate the development of a "dam hazard" zone to indicate risks due to flooding within the reservoir pool and in the downstream danger reach. Develop protocols to assess the potential impacts of dam failures (both singular and cumulative) on the SFHA during the development of FIRMs.
- 4) **Lead Agency:** FEMA
- 5) **Support Agency(ies):** USACE, Georgia DNR, SCS
- 6) **Funding:** (To be determined by IHMT)
- 7) **Schedule:** (To be determined by IHMT)

DPAT RECOMMENDATION WORKSHEET

1) **Issue:** Watershed Planning for Dams

2) **Background:** Many of the dams that failed may have been impacted by the failure of upstream dams. Multiple dam failures also likely caused increased flooding in many of the hardest hit communities (e.g., Americus, Montezuma). Watershed planning offers the opportunity to evaluate existing and proposed dams based on their relation to one another and on their relation to the watershed.

Under a watershed planning approach, hydrologic analyses, selection of spillway design floods, and preparation of danger reach evaluations would be performed within a watershed framework. The full range of factors affecting the design and evaluation of existing and proposed structures would be considered.

3) **Work Element:** Where appropriate, utilize a watershed planning approach to the design and analysis of existing and proposed dams that considers the impact of upstream dams on the subject dam and the impacts of the subject dam on downstream dams. Model applications of this technique would be developed and documented for other uses.

4) **Lead Agency:** Georgia DNR

5) **Support Agency(ies):** USACE, SCS, FEMA, FERC

6) **Funding:** (To be determined by IHMT)

7) **Schedule:** (To be determined by IHMT)

DPAT RECOMMENDATION WORKSHEET

1) **Issue:** Selection of Spillway Design Flood

2) **Background:** Although complete hydrologic/hydraulic data are not available for the failed dams, based on observations of the dams and eyewitness accounts, it appears that the dam spillway structures could not safely pass the flows generated by the rainfall. Some of the dams appeared to have both principal and emergency spillways, while others had only one spillway structure. Current State regulations contain requirements for the design of spillways for Category 1 dams, but do not require Category 2 dam spillways, either new or existing, to be designed to any particular standard. The requirements for Category 1 dams are based on size and are as follows:

- Small Dams: 25 percent of Probable Maximum Precipitation (PMP)
- Medium Dams: 33 percent of PMP
- Large Dams: 50 percent of PMP
- Very Large Dams: 100 percent of PMP

These requirements for high-hazard dams are less stringent than those of Federal agencies and many states that require design using the full PMP for large- and medium-size high-hazard dams.

Spillways should be designed to pass floodflows from a predetermined storm event without overtopping the dam embankment. This spillway design flood should be selected based on the consequences of dam failure. Typical spillway design floods range from the 100-year flood to the full PMF.

3) **Work Element:** Evaluate the recurrence interval of the recent floods as well as the extent of inundation. The impacts of the dam failures that occurred should also be assessed in terms of loss of life, impacts to infrastructure and public facilities, and property damage. Hydrologic/hydraulic analyses should be conducted by routing floodflows of various recurrence intervals downstream of the dam with and without a dam breach. Inundation areas and impacts from each scenario should be evaluated. For each flood event analyzed, the incremental damage between a dam passing that floodflow and the flows generated from a dam breach should be assessed. The appropriate spillway design flood should be selected based on the above analyses and evaluations.

4) **Lead Agency:** Georgia DNR

5) **Support Agency(ies):** FEMA, USACE, SCS, FERC

6) **Funding:** (To be determined by IHMT)

7) **Schedule:** (To be determined by IHMT)

DPAT RECOMMENDATION WORKSHEET

- 1) **Issue:** Standards for Design, Construction, and Maintenance of Dams
- 2) **Background:** The Georgia DNR has standards for non-Federal, Category I dams (i.e., dams not owned or regulated by a Federal agency that would likely result in loss of life in the event of a failure). However, no standards currently exist for any other non-Federal dams. This includes older existing dams as well as new and proposed dams that can be built without a formal engineered design. Many of the failed dams were older structures that do not meet current dam safety practices and are not adequately maintained. These deficiencies may have contributed to some or all of the failures.
- 3) **Work Element:** Standards should be established for the design, construction, and maintenance of all existing and proposed dams within the state. The standards should be commensurate with the function of the structure and the anticipated impacts from a dam failure. Elements which should be addressed include the following:
 - Selection of spillway design flood
 - Design of principal and emergency spillways
 - Design of embankment, including material selection, compaction criteria, slope stability, seepage control, and erosion protection
 - Construction quality control
 - Operations and maintenance
 - Emergency action plans (depending on failure impacts)
- 4) **Lead Agency:** Georgia DNR
- 5) **Support Agency(ies):** FEMA, USACE, SCS, FERC
- 6) **Funding:** (To be determined by IHMT)
- 7) **Schedule:** (To be determined by IHMT)

DPAT RECOMMENDATION WORKSHEET

- 1) **Issue:** Decision Analysis for Reconstruction of Failed Dams
- 2) **Background:** More than 100 dams reportedly failed in Georgia during the recent flooding. Many of these were older dams which have not been used for their original purpose for some time. In addition, many of these dams were constructed without modern design practices and had deteriorated over the years.
- 3) **Work Element:** A decision analysis model should be developed to determine which of the failed dams should be reconstructed and which ones would provide little value if replaced. Issues to be considered in this model include the following:
 - Function of the reservoir
 - Environmental impacts
 - Potential flood impacts or flood control benefits
 - Overall impact on the watershed
 - Recreational benefits

The dams selected for reconstruction should be designed and constructed according to defined standards for dams. FEMA should include only public facilities that meet these standards in the Public Assistance Program. The standards should be commensurate with the function of the structure and the anticipated impacts of a dam failure. Elements which should be addressed include the following:

- Hydrologic/hydraulic analyses for the selection of the spillway design flood and design of the principal and emergency spillways
 - Geotechnical investigation
 - Design of embankment, including material selection, treatment of foundation, compaction criteria, slope stability, seepage control, and erosion protection
 - Construction quality control
- 4) **Lead Agency:** FEMA
 - 5) **Support Agency(ies):** Georgia DNR, USACE, SCS, FERC

6) **Funding:** (To be determined by IHMT)

7) **Schedule:** Immediately

DPAT RECOMMENDATION WORKSHEET

- 1) **Issue:** Flood Control Function of Dams
- 2) **Background:** Few of the failed dams were designed to provide flood protection for downstream areas. The reconstruction of these failed structures provides the opportunity for evaluating the feasibility of designing selected replacement dams to provide downstream flood control.
- 3) **Work Element:** Hydrologic/hydraulic analyses should be conducted on a watershed basis to evaluate the extent of inundation under various storm frequencies without replacing the dams. Frequent storms, such as the 2-year and 10-year events, should be considered as well as larger storms, such as the 100-year and 500-year events. Additional analyses should then be conducted for those storm frequencies assuming the dam is in place. Various spillway design floods should be evaluated to determine whether flood protection is feasible and to select the appropriate design storm(s) for sizing the spillway.
- 4) **Lead Agency:** FEMA
- 5) **Support Agency(ies):** USACE, SCS, Georgia DNR
- 6) **Funding:** (To be determined by IHMT)
- 7) **Schedule:** (To be determined by IHMT)